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Objections and suggestions most welcome

Institutions for the Selection of Entrepreneurs: Implications for Economic Growth and Financial Crises

by

Pavel Pelikan

Address: IUI, Box 5501, S-114 85 Stockholm, Sweden; tel: (46-8) 783-8440; fax: (46-8) 661-7969; e-mail: pavelp@iui.se

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Abstract: The search for growth-promoting policies is found to demand knowledge of how growth depends upon actions of entrepreneurs and how these actions depend upon the prevailing institutions. While institutions have extensively been examined for their influences upon the freedoms and the incentives of entrepreneurs, and thereby upon the *level* of employment of resources, this paper examines their influences upon the selection of entrepreneurs, and thereby upon the *efficiency* of that employment. This selection is crucial in the realistic but in theory seldom considered cases in which *all* agents, including entrepreneurs, may differ in economic abilities. A simple model shows that in the long run, selection by market competition, especially when extended to financial markets, vastly outperforms selection controlled or protected politically. Such selection may outperform market selection only during a limited period, extendable only at the price of growing bad debts and financial crises.

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1 Introduction

If an economy suffers from a low or negative growth, which policies could help it to grow faster? This is the central question of the present inquiry, which I undertake with two purposes in mind. One is to contribute to the development of economic growth theories from interesting descriptions to useful guidelines for practical policies. The second purpose is to productively employ, and thus to justify, some of my earlier research about scarcity of economic abilities, entrepreneurs, and institutions.

The first purpose leads the inquiry beyond the usual macroeconomic theories, in which growth is reduced to a function of aggregate variables. Macro-analysis cannot indeed give much advice to policy on how to promote growth, for either the aggregate variables are not under direct government control, or setting them to some indicated values may still not help, if their efficient disaggregation into specific micro-uses is not guaranteed. In fact, as extensive government control of aggregate variables is often the very cause of important micro-inefficiencies, such policy would often be harmful.

Striking examples can be found in the now defunct socialist economies of Central and Eastern Europe, where not even high investments in education and research — the favorite aggregate variables of some recent growth models — could prevent economic collapse. Extensive government control was indeed both what allowed these investments to be so high in the aggregate and what caused them and their results to be so inefficiently allocated and used in detail. Somewhat less striking, but nevertheless substantial inefficiencies of similar nature can also be observed in the disaggregation of government investments in education and research in Western Europe, at both the national and the EU levels.¹

To advance the search for growth-promoting policies, it is therefore necessary to turn to the micro-sources of economic growth in actions of individual agents, and to look for ways of enhancing such sources by more subtle policies with less negative side-effects. It is these steps that put entrepreneurs and institutions in the center: entrepreneurs are the key agents whose actions (or inaction) are of particular importance for how the growth potential of any economy will actually be exploited, and institutions are the main factors that both strongly influence the

¹That the latter inefficiencies are indeed substantial has been revealed in the current debate about the economic activities of the EU Commission during 1998.

actions of entrepreneurs and can themselves be strongly influenced by policy.²

As the terms 'entrepreneurs' and 'institutions' are frequently used, but not always clearly defined, their present meaning needs to be spelled out. Entrepreneurs are defined as those agents who know, or believe to know, investment projects with designs for specific uses of specific resources, and who can, in response to suitable incentives, initiate the implementation of such projects by taking appropriate actions — such as founding or expanding firms, creating jobs, and putting to work new technologies. To mark the difference between the functions of entrepreneurs and those of managers — which are sometimes performed by the same persons and may thus appear confused — the job-creating role of entrepreneurs is defined to include the creation of the jobs for managers, which entrepreneurs may or may not assign to themselves. These are moreover the only jobs that they need directly create: the creation of all other jobs, if any, may then be delegated to the managers, who may delegate parts of it further to other agents within the enterprise.

Note that this definition is not limited to private entrepreneurs, but also includes the politicians and government officials who initiate the implementation of public investment projects and create jobs within the government sector, including government-owned firms. How entrepreneurs of different kinds can effectively contribute to economic growth is one of the main questions to be examined.

Institutions are defined in the modern narrow sense of formal and informal constraints upon decision sets, or 'rules of the game,' which are used within each economy to shape the interactions of its agents, and of which the main instances are law and custom (cf. North, 1990:3). This definition implies that the possibly strong influence of policies is also strongly limited: while formal institutions may be substantially and rapidly modified by legislation and law enforcement, the culturally evolved informal institutions are typically resistant to deliberate change and may severely constrain both the scope and the speed of effective institutional change that any policy can achieve.

As the present inquiry will only be concerned with growth-promoting institutions, without examining the extent to which they could effectively be implemented by policies, it may be useful to note what use the knowledge of such institutions may have. In part, legislators may find it

²Arguments showing the importance of entrepreneurs and institutions for economic growth can be found in the evolutionary literature following Schumpeter (1912/1934) and the institutional one following North and Thomas (1973) and North (1990).

useful to know which institutions would best promote economic growth, even if for various cultural and political obstacles such institutions cannot be precisely and immediately implemented. In part, such knowledge may help to identify within different cultures those of their norms and habits by which economic development is most seriously hindered, and which the members of these cultures who wish their economies to grow may thus be induced to modify, while members of other cultures may be warned not to imitate.

There are several parallel ways in which the prevailing institutions influence what entrepreneurs do for economic growth. The most frequently discussed ones involve the freedoms of enterprise and the incentives of entrepreneurs, often with particular attention to transaction costs. In contrast — and this is the consequence of its second purpose — the present inquiry will focus on the less explored ways in which growth is influenced by the economic abilities of entrepreneurs, and thus by the institutions for the selection of entrepreneurs on which these abilities strongly depend.

The incentives of entrepreneurs, however, will not be forgotten. The focus on economic abilities is only to capture part of the attention that the incentives usually attract: without denying that entrepreneurs may fail to do the right things because of the wrong incentives, it only adds that they may also do the wrong things because of insufficient abilities.³ The two will even be found interestingly connected, as social efficiency will turn out to require the incentives to be substantially stronger when economic abilities are scarce than if they were abundant.

This calls for another definition: the term 'economic abilities' denotes the abilities of economic agents to use available information for conducting economic calculus and thereby for taking decisions about the uses of scarce resources.⁴ These abilities are distinguished from technological ones, understood as abilities to exploit available technologies for the production of high quality outputs. Both types of abilities are included among scarce resources, in the usual category of 'human' or 'personal' capital, but with two important differences: (i) the economic abilities of entrepreneurs are usually much more difficult to assess than their technological abilities; and (ii) economic abilities are needed for assessing the value, and taking decisions about the uses, of both.

³Interesting empirical evidence that the performance of entrepreneurs also depends on their intrinsic abilities, and not only on their incentives, can be found in Barbers et al. (1996).

⁴Following comments on my earlier attempts to deal with this notion, the term 'economic abilities' appears more suitable than the previously used 'economic competence.'

Difference (i) is empirical, and appears in virtually all observations of real-world firms and industries: it is much easier to observe the physical properties of actually produced outputs, which more directly depend upon the technological abilities, than the profits or losses of producing the outputs, which are more hidden and easier to keep so, and whose dependence upon the economic abilities is moreover more disturbed by noise (influences of 'luck'). In consequence, two entrepreneurs who differ in their economic abilities, and thus in the profits or losses they are likely to realize, may for a long time be difficult to distinguish, if they are of similar technological abilities, and thus similarly able to create jobs, use capital, and apply advanced technologies for producing high quality outputs. As the making of such distinctions ('screening') is one of the most important tasks of investors, this difficulty implies that also investors need high economic abilities. That investors of low economic abilities, if kept supplied with new capital, may keep investing it with entrepreneurs of high technological but low economic abilities, and thus cumulate bad debts without noticing it, appears indeed as an interesting hypothesis about the causes of financial crises, on which more will be said in Section 6.

Difference (ii) is logical, with a theoretically disturbing consequence: it implies that economic abilities coincide with economic rationality, and thus constitute a singularity among scarce resources. To recognize their scarcity means to abandon the assumption of perfect (unbounded) rationality, on which most of modern economics still reposes, and to depart from it even farther away than to the now familiar assumption of bounded rationality.⁵

The additional distance includes the recognition that bounded rationality is itself a scarce resource which may be unevenly distributed — in other words, that rationality may be more bounded for some agents than for others. This in turn raises the difficult problem of its efficient allocation in society, in particular in the production sector of the economy. Sound economic growth and social efficiency in general clearly require that the most important decisions, concerning the uses of the largest chunks of available capital, be allocated to agents of the least bounded rationality, alias the highest economic abilities. The singularity — which can be seen to disturb in a quasi-Gödelian fashion the entire axiomatic building of formal resource-allocation theories — is caused by the double function of scarce economic abilities: they are both among the resources that are being allocated and qualities of the economic calculus by which the allocation

⁵The analytical inconvenience of this depart seems to explain why the scarcity of economic abilities has not yet been fully admitted in economic theory, although the scarcity of many other human abilities has been increasingly studied.

is guided. This means, among other things, that high economic abilities are needed to recognize and efficiently allocate high economic abilities, which raises the difficult problem of how efficient resource-allocation can start, when no one can know very well who the economically most able agents are, with the possible exception of these very agents.

While more general discussions of this problem can be found elsewhere,⁶ here it will be considered only in the context of economic growth and growth-promoting policies. The inquiry is organized as follows. Section 2 clarifies how entrepreneurs of uneven economic abilities may contribute to economic growth, states the problem of their selection, and shows the central role played in this problem by institutions. Section 3 models the basic logical structure of this problem in a grossly simplified economy. Section 4 uses this model for comparing the growth effects of three stylized institutional alternatives and illustrates the results by an artificial numerical example. Section 5 considers policy implications for the simplified economy of the model. Section 6 concludes by discussing possible implications for real-world economies.

2 Economic Growth with Unevenly Able Agents

Entrepreneurs can be seen to contribute to economic growth by driving the transformation of savings into investments. As opposed to macroeconomics, in which this transformation is usually assumed automatic and certain, microeconomics shows it to depend on actions of individual agents. It is among them that entrepreneurs in the above-defined sense are central. Their knowledge of investment projects is needed to specify the uses of available resources, and their initiative is needed to put such projects to work. It is only those resources for which there is a corresponding supply of entrepreneurship — meaning entrepreneurs who know how to employ them and are both allowed and motivated to do so — that can actually be transformed and thus become factors of growth.

An immediate implication worth noting is that a corresponding supply of entrepreneurship is also needed for any supply of labor, if this is to be employed. Relative shortage of suitable and willing entrepreneurs is indeed the most fundamental cause of all unemployment. Although this cause is less frequently studied than low intensity of search for jobs due to advantageous unemployment insurance, it is clearly far more fundamental: without entrepreneurs allowed,

⁶I started to note this problem in Pelikan (1988, 1989, 1993) and discussed it more extensively in Pelikan (1997).

willing, and able to create jobs, the unemployed would have nothing to search for.

Under the standard assumption of perfect rationality (abundance of economic abilities), attention to entrepreneurs may be limited to attention to their incentives. The economy's growth potential is then fully exploited if the incentives are only so strong — the rewards only so high and the transaction costs only so low — as to induce an equilibrium supply of entrepreneurship, equilibrium in the sense that the projects of all the activated entrepreneurs together create efficient employment opportunities just for the resources available, neither for more nor for less.

Some selection can nevertheless be said to take place also under this assumption: the perfectly rational potential entrepreneurs who decide, in response to given incentives, whether or not to become actual entrepreneurs, can be said to self-select. But no other selection can make sense: given efficient prices, no perfectly rational agents would self-select unless their projects belong to an efficient allocation of resources in society.

It is first when the perfect rationality assumption is abandoned and economic abilities admitted unevenly distributed that the selection problem appears in its entirety. Then not all of the self-selected entrepreneurs, if any, can be expected able to efficiently employ resources. Many of them may definitely be unsuitable, in spite of their believing the opposite. The subtle reason is that economic abilities are needed for the assessment and allocation of economic abilities without exception, and therefore also within each single agent: the ability of an agent to assess own economic abilities depends on these very abilities. An agent whose economic abilities are low may thus mistakenly believe them high, and then misjudge both her projects and her abilities to implement projects.⁷ Efficiency can no longer be obtained by self-selection alone: some additional selection is required.

The first important implication is that many more entrepreneurs are needed to self-select than under the assumption of perfect rationality: if only a minority of them are suitable, efficiency requires this minority to be so large as to supply all the entrepreneurship needed to fully employ the resources available. They must thus also include a corresponding majority of unsuitable entrepreneurs, in order to provide the selection with a sufficiently broad basis in which the needed minority could possibly be found. The above-mentioned connection between incentives and

⁷Theoretical economics rarely admits such mistaken beliefs. In the theories which do admit that agents may be of different abilities, the usual assumption has been that only the abilities of others may be difficult to know, but everyone knows perfectly well one's own. Yet in philosophy, knowledge of oneself is often considered most difficult to acquire. And in practice, it is not unusual to meet persons of low abilities which prevent them from recognizing how low their abilities are.

scarce economic abilities can now be made more precise: compared to the theoretical equilibrium under perfect rationality, the incentives of entrepreneurs need to be substantially stronger — promising higher rewards and/or lower transaction costs — to induce the needed surplus of entrepreneurs to self-select.

Up to a point, this situation resembles the situations studied by the well-known theories of efficient wages and efficient interest rates. To recall, those theories also recognize that agents may be of unequal abilities and then show that efficient wages are higher and efficient interest rates lower than their equilibrium values: namely, employers need to attract more applicants for jobs than they can employ, and investment banks need to attract more applicants for credits than they can satisfy, in order to obtain a sufficiently broad basis of selection, from which they could choose the right numbers of suitable applicants. Because of this resemblance, let me also denote the strengthened incentives of entrepreneurs as 'efficient.'

The point at which the resemblance stops and a fundamental difference appears is that in those theories, the employers and the banks are not included among the agents of unequal abilities, but are instead assumed perfectly able to optimally select ('screen') among the more or less able applicants. In contrast, the present view that the scarcity of economic abilities is general frees no one from the suspicion of lacking them. It even implies that the suspicion should be increased when turning from agents performing simple tasks to agents performing more complex tasks, which makes the employers and the banks more suspect than the applicants.⁸ The problem thus is, how best to select entrepreneurs in a world where no perfect superior agents can help.⁹

There are many ways — some known from economic history and other conceivable in theory — in which the selection of entrepreneurs may be organized. For example, the selection criteria may be based on the results actually achieved, as in the classical case of selection by

⁸Concerning investment banks, the last decade produced enough empirical evidence to make such an increase of suspicion highly justified.

⁹Many theoretical economists appear unwilling to deal with such worlds, in spite of the strong evidence that ours is among them. One reason may be that in addition to being analytically difficult, such worlds are also emotionally disappointing: beliefs in some superior agents, who could from above optimally solve the world's most difficult problems, have been popular during the entire history of humanity. It would otherwise be difficult to explain why so many respected economists kept building theories assuming such agents: in the 50's and 60's socialist planners, in the 70's and 80's industrial policy-makers, and in the beginning of the 90's government protected investment bankers. Some former specialists in socialist planning who later specialized in post-socialist transition appeared indeed to have simply transferred beliefs in superior agents from planners to investment bankers when they kept warning against competitive market privatization and recommending the Japanese bank system — until also this system started to collapse.

competition on product markets,¹⁰ and/or may involve judgments of other agents, such as private investors, bank employees, or government officials. But whenever any other agents are involved — and this is the central point of the present argument — the selection problem must be extended also to them: their judgments cannot but depend on *their* economic abilities, and these must also be expected more or less imperfect.

All feasible ways of selecting entrepreneurs must thus start with some sets of self-selected agents. They are the ones who are both allowed and willing to participate — be it as entrepreneurs, as selectors of entrepreneurs, or as selectors of the selectors — but may be more or less far from able to do so efficiently. Institutions are then needed to specify how the various deeds and judgments of such unevenly able participants will be allowed to contribute to determining the outcomes of the selection. The prevailing institutions thus emerge as the main factor on which the speed and the direction of the selection most heavily depend.

Recalling that institutions also strongly influence the freedoms of enterprise and the incentives of entrepreneurs, which in turn influence the size of the self-selected sets, the two main tasks of growth-promoting institutions can now be stated: (I) to make the freedoms sufficiently broad and the incentives sufficiently strong, in order to induce the relevant sets to be sufficiently large, with sufficient surpluses of inadequately able agents; and (II) to make the selection sharp and aimed at the relevant abilities, in order to find the most able entrepreneurs and make harmless the inadequately able ones.

The two main policy questions consequently are: (1) Which institutions could best perform these tasks? (2) By which mix of legislation, law enforcement, and perhaps also educational campaigns, could such institutions be implemented or best approximated?

While keeping in mind the importance of both these tasks and both these questions, the present attention will be limited to question (1) and focused, as announced, on task (II). To advance into this territory little explored by formal economic analysis in the best tradition of this analysis, the following three sections will deal with a model of a grossly simplified economy whose similarity with real-world economies is limited to the feature that formal models have avoided the most: the complete absence of superior agents of perfect economic abilities.¹¹

¹⁰This selection has been extensively studied in the evolutionary literature following Alchian (1950) and Winter (1971).

¹¹Perhaps the most important exception remains to be Sah and Stiglitz (1991). While a world without superior agents may also be found in evolutionary game-theoretical models, these rarely deal with entire economies: while

Although hints at other possible similarities with the real world will occasionally be made, the only explicit objective of this exercise is to throw light on the logical structure of the problem of selecting entrepreneurs in this absence. To what extent the results of the model may be relevant to real-world economies will in part be discussed in the last section and in part left to the judgement of the readers.

3 The Model¹²

Consider an economy with capital K and output Y and observe its growth in discrete time t . The incentives of entrepreneurs are sufficiently high to always obtain full employment of K in production. At each moment, one unit of capital produces one unit of output: $Y(t) = K(t)$ for all t . The choice of the units sets the initial state at $Y(0) = K(0) = 1$. The economy's growth rate at time t is defined as $R(t) = K(t+1)/K(t) = Y(t+1)/Y(t)$.¹³

In the beginning, agents self-select into four sets: *entrepreneurs*, *investors*, *politicians*, and *voters*. One agent can self-select to several or all of them, so that the sets may overlap.

Economic abilities are graded discretely by integer $q \in [1, Q]$, with $q = 1$ denoting the lowest and $q = Q$ denoting the highest. Their distribution function $F(q)$, probability function $P(q)$, and expectation (average) $\bar{q}$ are assumed the same for all the four sets.

For a greater vividness, let me refer to agents of $q = 1$ as 'economic fools,' to those of $q = Q$ as 'economic grand-masters,' and to some of the others as 'economic mediocrities' and 'above-the-average economic experts.' To make it clear that the model is no invitation for us theoretical economists to take a pretentious upper view of the other mortals, let me point out that

modeling the fate of competing populations of agents using differently advantageous strategies, they rarely consider the global impact on any economy which the competing populations together might be seen to constitute.

¹²This model is a streamlined and to the present purposes adapted version of the one elaborated in Pelikan (1997).

¹³The reader may choose between two alternative interpretations of K and Y : (i) K is a unique capital good and Y is a unique consumption good; or (ii) K and Y are the aggregate values of a great and possibly changing variety of capital goods and consumption goods, assuming that the relative prices of all goods are always kept right by a perfect, but unstudied, price mechanism. Whereas for the formal results of the model both interpretations are equally good, the latter facilitates connections to real-world economies. In view of Schumpeter's (1942/1976) famous argument that for economic growth price competition is much less important than the competition that introduces innovations and concerns the very existence of firms, it is possible to claim that the assumption of a perfect price mechanism in the study of the selection of entrepreneurs neglects less important aspects of real-world economies than the usual symmetrical (and usually implicit) assumption of perfect selection of entrepreneurs in the study of price mechanisms.

the abilities to build economic theories are not necessarily correlated with q , the abilities to solve economic problems in practice. This means that we have no right to automatically claim a high value of q (I certainly do not claim it for my q).

Economic abilities are employed in two ways, defined by Assumptions 1 and 2 below. Entrepreneurs employ them according to Assumption 1 for more or less successful decisions about the uses of capital in production. Members of the other sets employ them according to Assumption 2 for more or less successful assessment of the economic abilities of members of other sets: depending on the prevailing institutions, considered in the next section, the investors or the politicians may be asked to assess the economic abilities of entrepreneurs, and the voters may be asked to assess the economic abilities of politicians. As the sets may overlap, some agents may also have to employ their economic abilities to assess these very abilities, in which, as noted, they can also be only more or less successful.

ASSUMPTION 1. If entrepreneurs of economic abilities q_i control at time t capital $k_i(t)$, they produce immediate output $y_i(t) = k_i(t)$ and the capital they will control at the following time $k_i(t+1) = B(q_i)k_i(t)$. The growth rate they are able to achieve with the capital controlled, $B(q_i)$, is assumed to be an increasing function of q_i , with lower limit $B(1) < 1$ and upper limit $B(Q) > 1$.

In plain words, entrepreneurs of different economic abilities are assumed to produce the same output with the same capital, but to differ in the growth rate of the capital controlled: the fools keep losing it, whereas the grand-masters keep making it grow. The assumption of equal outputs can be understood as assuming equality of technological abilities: all are 'technological masters,' but only few are moreover 'economic masters.' This assumption can be justified if we recall the empirical difference between the two types of abilities: as the physical quantity and quality of products are much easier to see than the economic profitability of the production, entrepreneurs of low technological abilities are much easier to recognize than entrepreneurs of low economic abilities: this makes it not too unreasonable to assume the former a priori eliminated, and to reduce the problem of selection of entrepreneurs to the latter.

Assumption 1 implies that the growth rate of the economy at time t will only depend upon the distribution of the control over $K(t)$ among entrepreneurs of different q , described by probability function $P_K(q, t)$. The growth rate of the economy will thus be:

$$R(t) = \sum_{q=1}^Q P_K(q, t) \cdot \pi(q) . \quad (1)$$

In the best case, if all active entrepreneurs were economic grand-masters, the growth rate of the economy would thus attain $R_{max} = B(Q)$.

ASSUMPTION 2. When agents of economic abilities q_i try to select agents of the highest q , they cast their votes over a randomly (irrelevantly) chosen subset of agents of $q \geq q_i$, while systematically excluding all agents of $q < q_i$. The probability that they vote for an agent of abilities q is thus

$$Pr(q_i \rightarrow q) = \begin{cases} \frac{P(q)}{1 - F(q_i - 1)} & \text{for } q \geq q_i, \\ 0 & \text{for } q < q_i. \end{cases} \quad (2)$$

In other words, all agents are assumed perfectly able to recognize agents of lower economic abilities than theirs, but unable to see the more subtle differences among theirs and all the higher abilities.¹⁴ They are moreover assumed to have irrelevant prejudices for which they also exclude a more or large subset of the equally or more able agents: e.g., they may fail to recognize a grand-master, if he has some personal properties which they happen to dislike, and they may also exclude themselves, and thus claim others more able, if they are too modest ('prejudiced against themselves'). Besides appearing realistic — that geniuses may fail to be recognized by mediocrities is amply documented — this part of the assumption makes it impossible to select the most able agents straightforwardly by successive eliminations.

Assumption 2 has three implications of importance (all proofs are in Appendix).

¹⁴The general principle that for recognizing agents of high economic abilities, agents of high economic abilities are more able than agents of low economic abilities appears indubitable. But it may be doubted whether Assumption 2 approximates this principle in an acceptable way. One may put in doubt both the certainty with which all agents can always recognize less able agents, and their complete lack of abilities to see differences among theirs and higher economic abilities. While I admit that some less sharp probabilistic expressions would be more realistic, I have two good reasons for avoiding them: (i) they would not change the main thrust of the argument; (ii) they would cause mathematical difficulties, which could only be overcome by limiting the grades of economic abilities to two (e.g., 'low' and 'high'). While such a limitation was used in a somewhat similar situation by Sah and Stiglitz (1991), and is now standard in the literature dealing with differences in abilities, it would cause the present argument to lose some important points and much of intuitive appeal. As will become clear below, the differences between market and non-market selections of entrepreneurs are easier and more natural to describe if it is possible to distinguish, in addition to 'fools' and 'grand-masters,' also some intermediate 'mediocrities' and 'above-the-average experts.'

LEMMA 1: The expected (average) economic abilities of the candidates voted for by agents of abilities q_i will be

$$\bar{q}(q_i) = \frac{1}{1 - F(q_i - 1)} \sum_{q=q_i}^Q P(q) \cdot q. \quad (3)$$

In plain words, nearly all agents vote for agents whose q is in average higher than their own, with the exception of the grand-masters, 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 fools, 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 abilities q_i obtain will be

$$P_S(q_i) = P(q_i) \sum_{q=1}^{q_i} \frac{P(q)}{1 - F(q - 1)}, \quad (4)$$

where $P_V(q)$ is the probability function with which q is distributed over the elected candidates, assuming that each grade of q is represented in proportion to the votes obtained. The corresponding distribution function $F_V(q)$ and the expected (average) $\bar{q}_V$ can be calculated in the usual way.

To illustrate, consider an artificial numerical example in which $P(q)$ is assumed binomial with $Q = 7$.¹⁵ Table 1 displays its parameters and Table 2 the corresponding results of Lemmas 1 and 2; Figure 1 is a graphic illustration of both.¹⁶ To avoid misunderstandings, it is important to keep in mind that the distributions depicted are accessible only to us as theorists, but not to the economy's agents: they can perceive only parts which are truncated by their q and further limited by their prejudices. As even grand-masters may have prejudices, even their perceptions may only

¹⁵A binomial distribution is chosen as the closest discreet approximation to the notorious 'bell curve,' according to which virtually all measurable human abilities appear to be distributed in any society. While the subtle problem with q is that it cannot be measured objectively, as its measurement depends on the q of the measuring agent, there is no reason to expect its distribution to be different.

¹⁶The 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 of lower q than one's own, the lemmas imply that only clubs formed of persons of the same q may exist. Then, if we kept increasing the precision of grading q by letting its presently assumed discrete distribution converge towards a continuous one, the size of such clubs would converge to zero.

be partial.

(Tables 1 and 2, and Figure 1 about here.)

LEMMA 3: $P_v(q)$ is superior to $P(q)$ in that $P_v(1) < P(1)$, $P_v(Q) > P(Q)$, and $\bar{q}_v > \bar{q}$.

In plain words, if an electorate (or a large jury) and the set of eligible candidates have the same $P(q)$, if the ballots are equally distributed, and if the representation of each value of q is proportional to the votes received, then the candidates elected will include substantially fewer fools, somewhat more grand-masters, and be of a somewhat higher average $\bar{q}$ than the electorate (the jury).

Lemma 3 thus asserts what may be called 'weak advantages of democracy,' and may be used to refute accusations that democracy only promotes the mediocre or the worst.¹⁷ But there are two qualifications: (i) $P(q)$ over the candidates must not be significantly inferior to $P(q)$ over the electorate, which may sometimes be put in doubt; (ii) even if this is so, the candidates elected will in average be only some above-the-average experts, among whom grand-masters will continue to be a very small and mostly unrecognized minority. This qualification explains why the advantages are called 'weak.'

4 The growth effects of three institutional alternatives

Consider three highly stylized institutional alternatives for allocating the control over $K(t)$ to entrepreneurs, termed 'simple market selection' (**1M**), 'double market selection' (**2M**), and 'politico-administrative selection' (**PA**).

Because of the absence of superior agents, all the alternatives must begin with some of the self-selected sets. **1M** begins by distributing $K(0)$ equally to the entrepreneurs. They then start to be selected by competition on product markets, where their shares of $K(t)$ will grow or decrease according to their own performance.

2M begins by distributing $K(0)$ equally to the investors, who allocate it to entrepreneurs. While these are again exposed to competition on product markets, **2M** moreover provides for selection of investors by competition on financial markets. This competition will make investors'

¹⁷An example of such accusation is in Hayek (1944).

shares of $K(t)$ ('portfolios') grow or decrease in function of the performance of the entrepreneurs they have selected.¹⁸

PA begins by equally distributing ballots to the voters, who elect an assembly of politicians, who allocate $K(0)$ to entrepreneurs. This assembly, which may be periodically re-elected, will also keep deciding over the allocation of $K(t)$ to entrepreneurs over the entire future.

Rough connections to the real world can be seen if **1M** is compared to a primitive capitalism, where selection by competition is mostly limited to product markets, while financial markets are insignificant or absent; **2M** to a developed capitalism, where selection by competition is intensive on both the product and the financial markets; and **PA** to a market economy where market competition is allowed to work in the usually studied ways concerning prices, but entrepreneurs are selected, or at least protected from market selection, by political government.¹⁹ **PA** may thus be seen to roughly depict a market economy with wide-spread state ownership of firms — e.g., as used to be popular in South America and Western Europe — or with an elite of private entrepreneurs protected from market selection by various government regulations of banks and financial markets — e.g., as is still the case in Japan and most of South East Asia.

The present task is to compare the influences of these alternatives upon economic growth.²⁰ Recall that all outputs, both of enterprises and of the entire economy, are assumed nominally equal to the capital used for producing them, which makes it possible to reduce

¹⁸To avoid misunderstanding, it should be emphasized that financial markets are modeled here in different conditions and with a different purpose than in standard theory. While standard theory studies financial markets as devices for *allocating investment*, here they are studied as devices for *selecting investors*. As standard theory typically assumes that all investors are perfect optimizers, it models these markets in an ideally developed form, assuming that market selection has well done its job and made all investors of lesser abilities insignificant. Here, in contrast, financial markets are considered from the very beginning, when investors of widely different abilities still try their chance. The present model thus converges to compatibility with standard models in the limit, *if* the selection can work so well that only investors of $q = Q$ remain significant, *and if* Q is so high that it can be considered reasonably close to perfect rationality. Another special feature of the model is that its purpose is purely comparative, meant only to note the most fundamental differences between economies where financial markets are allowed to work and develop, and economies where they are not.

¹⁹The government may, but need not, be democratic. As the subset of the population which selects a non-democratic government — such as the military or a unique ruling party — does not result from a market selection, the distribution of *economic* abilities in it appears reasonable to assume not to be different from the distribution of q in a democratic electorate. This assumption will make it possible to generalize the results of **PA** to all political governments.

²⁰What may be seen as variants of **1M** have been extensively studied in the evolutionary literature following Alchian (1950) and Winter (1971). On the other hand, hardly any attention has been paid to selection by financial markets and within the government sector. **2M** and **PA** must thus be regarded as mostly uncharted territories.

attention to the capital. Recall also that the growth rate $R(t)$ is determined by the distribution of the control over $K(t)$ among entrepreneurs of different q . Letting all three institutional alternatives begin with $K(0) = 1$, the respective growth rates to which they would lead the economy can be found out as follows.

Under **1M**, the control is initially distributed according to $P(q)$. The initial growth rate, equal to the economy's capital at $t = 1$, will thus be

$$R_{1M}(0) = K_{1M}(1) = \sum_{q=1}^Q P(q) \cdot \pi(q) . \quad (5)$$

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

$$k(q, t) = P(q) \cdot [\pi(q)]^t . \quad (6)$$

The economy's capital will thus be

$$K_{1M}(t) = \sum_{q=1}^Q P(q) \cdot [\pi(q)]^t , \quad (7)$$

and its growth rate

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

Under **2M**, $P(q)$ describes the initial distribution of $K(0)$ to the investors, who make their initial investment choices, and thus determine the allocation of $K(0)$ to entrepreneurs. In addition to the performance of entrepreneurs, the growth of the economy will thus also depend on the performance of investors in the selection of entrepreneurs.

In principle, investors of different q will be selecting entrepreneurs for their investments according to Assumption 2, and entrepreneurs of different q will be receiving investments according to Lemma 2. More precisely, the portfolio of investors of economic abilities q_j will start to grow (decrease) at rate $\nu(q_j)$, equal to the expected ν of the entrepreneurs that they have

selected. Following Lemma 1, this initial growth rate will thus be

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

The subsequent growth rate will depend on two circumstances: (i) what new information will become available about the economic abilities of entrepreneurs; and (ii) whether investors will be diligent and often take new investment decisions, or lazy and thus tend to keep their portfolios unchanged. To facilitate analysis, an apparently unrealistic assumption is made about (i):

ASSUMPTION 3: No new information about the economic abilities of entrepreneurs will become available; each investor will continue to judge these abilities according to Assumption 2.

This assumption has two defences. First, it is less unrealistic than it may appear: it may be considered reasonably approximated in the frequently encountered situations in which the investors can only observe (and possibly admire) the physical quantity and technical quality of outputs, while the entrepreneurs succeed in hiding the evidence of their possibly poor economic performance. Second, and more importantly, it will turn out to work *against* the model's results: as the following Section will make it clear, the comparative advantages of the institutional alternative that will be found best increase if it is violated; the more information becomes available, the greater these advantages.

Concerning (ii), it suffices to examine the two extreme cases: extreme short-term investing, in which all the investors completely re-invest after each period; and extreme long-term investing, in which all of them leave their portfolios unchanged after their initial decisions. All intermediate cases can be expected to yield intermediate outcomes.

For investors of abilities q_j , let the cumulative growth of their portfolios after t periods be denoted $\kappa(q_j, t)$ in the case of short-term investing, and $\delta(q_j, t)$ in the case of long-term investing. In the former case, they take a series of t investment decisions, each of which makes their portfolios grow by the same ratio $\rho(q_j)$:

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

In the case of 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 $B(q)$:

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

The interesting result is

LEMMA 4:

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

In plain words, nearly all agents, with the exception of economic grand-masters, 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.²¹ The exception can be seen by setting $q_j = Q$ in (9), (10), and (11), which yields

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

After the initial investment decisions, the growth of the economy will thus depend on how diligent the investors of low abilities happen to be. While this growth may consequently follow many different trajectories, depending on which proportion of such investors take new investment decisions and how often they do so, all these trajectories must be contained between two limits: δ -limit, in which all investors of abilities $q < Q$ take new investment decisions after each period; and θ -limit, in which all such investors leave their initial investment unchanged. To determine these limits, consider that $K(t)$ is both the sum of the capital used by all entrepreneurs and the sum of the portfolios of all investors.

For the δ -limit, the outcomes can best be deduced from the portfolios of investors. As investors of abilities q are initially endowed with $P(q)$ of capital, which they make grow (decrease) by $\nu(q)$ per period, the sum of all the portfolios will be

$$K_{2Mk}(t) = \sum_{q=1}^Q P(q) \cdot [\rho(q)]^t \quad (14)$$

²¹Lemma 4 thus recognizes in theory what has for a long time been known in practice: *without sufficient abilities, less effort may often be both individually and socially superior to more effort.*

and the growth rate

$$R_{2M\kappa}(t) = \frac{\sum_{q=1}^Q P(q) \cdot [\rho(q)]^{t+1}}{\sum_{q=1}^Q P(q) \cdot [\rho(q)]^t} . \quad (15)$$

For the g -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 grand-masters, who however keep their investment limited to grand-masters. As the investors make their choices according to Assumption 2, the initial capital is distributed among the entrepreneurs according to Lemma 2: the share of entrepreneurs of competence q is thus $P_V(q)$. This share then keeps growing (decreasing) by $B(q)$ per period. In consequence, their sum will be

$$K_{2M\lambda}(t) = \sum_{q=1}^Q P_V(q) \cdot [\pi(q)]^t \quad (16)$$

and the growth rate

$$R_{2M\lambda}(t) = \frac{\sum_{q=1}^Q P_V(q) \cdot [\pi(q)]^{t+1}}{\sum_{q=1}^Q P_V(q) \cdot [\pi(q)]^t} . \quad (17)$$

PA prescribes two levels of elections: the voters elect politicians, who elect entrepreneurs. As at each level, the distribution of q over the elected candidates is superior to the one over the electors according to Lemma 3, the distribution of q over the entrepreneurs will be doubly superior to the one over the voters. The initial growth rate of the economy will thus be

$$R_{PD}(0) = K_{PD}(1) = \sum_{q=1}^Q P_V(q) \cdot \pi(q) , \quad (18)$$

where $P_{VV}(q)$ is the probability function with which q is distributed over the initially elected entrepreneurs. As this function results from two applications of Lemma 2, its value for entrepreneurs of abilities q_i is

$$P_{VV}(q_i) = P_V(q_i) \sum_{q=1}^{q_i} \frac{P_V(q)}{1 - F_V(q-1)} . \quad (19)$$

The corresponding distribution function $F_{VV}(q)$ and expected (average) $\bar{q}_{VV}$ can be calculated in the usual way.

Since in political elections, voters neither lose nor gain ballots in the future depending on how well or poorly they voted in the past, the elected politicians and by them selected entrepreneurs may personally change after each elections, but the distribution of q over both of them must be expected to remain the same. In consequence, the distribution of q over the entrepreneurs is stationary and the rate of growth remains constant:

$$R_{PD}(t) = R_{PD}(0) \quad \text{for } \forall t, \quad (20)$$

which makes it unnecessary to mention time. The capital of the economy at time t will thus grow (decrease) to

$$K_{PD}(t) = R_{PD}^t. \quad (21)$$

The institutional alternatives can now be ranked. As their effects are functions of time, also their rankings may be functions of time. While the entire functions are illustrated by the artificial numerical example below, the algebraic comparison is limited to two points: the initial growth $R(0)$, and thus also the capital $K(1)$, which indicate the short run tendencies, and the limits for $t \rightarrow \infty$, to which $R(t)$ and $K(t)$ converge in the long run. Writing ' $\approx$ ' 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:

$$\mathbf{PA} > 2\mathbf{M}_\lambda \approx 2\mathbf{M}_\kappa > \mathbf{1M} \text{ according to } R(0) \text{ and } K(1).$$

PROPOSITION 2:

$$2\mathbf{M}_\lambda \approx 2\mathbf{M}_\kappa \approx \mathbf{1M} > \mathbf{PA} \text{ according to } R(4),$$

$2\mathbf{M}_\lambda \succ 2\mathbf{M}_\kappa \approx 1\mathbf{M} \succ \mathbf{PA}$ according to $K(4)$.

To illustrate the results of the comparison, let me complement the artificial example from Section 3 by assuming $B(q)$ linear

$$\pi(q) = \pi(\bar{q}) + (q - \bar{q}) \quad (22)$$

with $B(\bar{q}) = B(4) = 0.98$, and $\alpha = 0.05$.²² Tables 3 and 4 present the main results numerically, and Figure 2 graphically. To avoid misunderstandings, only the relative positions of the alternatives, and not their absolute performance, should be accorded significance.

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

In plain words, **PA** starts best, but finishes far worst. **1M** starts worst, but eventually outclasses **PA**. **2M** starts from a middle position and finishes best, especially in its λ -variant. To understand the rise and fall of **PA**, recall that in the beginning, it rapidly selects entrepreneurs of higher economic abilities than **2M**, and even higher than **1M**. But while the market selection under both **1M** and **2M** is slowly but surely improving these abilities and eventually makes them converge to the best available, the political selection under **PA** keeps them 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 **PA**.

The initial advantage of **PA** over **2M** calls for clarification. Since it only depends upon the assumed number of selection levels based on other agents' judgments — two for **PA** and only one for **2M** — it may appear artificial. As considered in more detail below, **PA** may be extended to more than two voting levels, and **2M** may be extended to more than one additional level of market selection. For instance, one or more additional levels of mutual investment funds and/or competitive investment banks may be inserted in between entrepreneurs and the initial holders of capital, and thus form a kind of **XM** with $X > 2$. At first sight, the number of levels considered may thus appear arbitrary. Upon a closer view, however, when political administration and emerging markets are compared for the possibilities of building additional selection levels and for

²²Among the values of $B(\bar{q})$ and α with which I experimented, 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.

the speed of making them effectively work, the administration turns out to clearly win on both accounts. Thus, rather than arbitrary, the assumption of two levels for **PA** and only one for **2M** can be seen as a stylized expression of this fact. Circumstantial supporting evidence appears possible to find in economic history, with Japan and South-East Asia as the latest examples: politico-administrative methods appear indeed to have caused several real-world economies first to grow miraculously fast and later to stagnate or fall into a crisis.

5 Policy Implications within the Model

The way the economy of the model was simplified reduces policy problems to the choice of institutions for the selection of entrepreneurs. The model's policy advice to the economy's agents can be summarized as follows: Unless you had a very high discount rate, opt for the immediately difficult to see but in the long run decisive advantages of **2M**. Beware of **PA**, which would lead you, after a limited period of success, to increasing losses in competition with economies using **2M** or even just **1M**.

Advocates of **PA** might however argue that its long-term performance could be improved by decentralizing the control over $K(t)$ to the initially elected entrepreneurs: those of high q would keep growing their enterprises, while those of low q would be demoted by capital losses and bankruptcies. But this would only mean to effectively privatize all the state-owned enterprises, and thus transform **PA** into **1M**.²³ To maintain **PA**, the task of selecting and/or protecting entrepreneurs cannot be taken away from government and left to market competition.

The advocates might also object, as mentioned above, that **PA** need not be limited to two voting levels. Another level — such as Investors' Committee, elected by the politicians, and replacing them in the task of allocating $K(t)$ to entrepreneurs — would further improve the average q of the entrepreneurs, pushing it even higher above the population's $\bar{q}$ than $\bar{q}_{VT}$. But this would not change the main point: **PA** can rapidly find experts of a significantly higher average q than the population's $\bar{q}$, but for any reasonable number of politico-administrative selection levels, that q remains far from Q and will remain stationary.²⁴

²³An example can be seen in the so called 'wild privatization' which scourged many of the transition economies: during it the former socialist managers of state-owned firms simply made themselves the owners of these firms.

²⁴This fundamental weakness of **PA** can be seen to refute the newest variant of market socialism imagined by Bardham and Roemer (1992). As opposed to the original Lange and Taylor's variants, in which markets were only simulated by central planners, this variant employs real markets and limits socialism to ownership of productive

The advantages of **2M** over **1M** deserve to be pointed out. The short-run advantage is that entrepreneurs selected by self-selected investors provide for a better start than self-selected entrepreneurs: among other things, there will be substantially fewer fools among them. In the long run, however, **1M** eventually catches up with **2M** in growth, and may even catch up with it in accumulated capital, and thus current output, if **2M** is scourged by diligent investors of low q . In the extreme case of **2M κ** , they indeed waste slowly as much of the economy's capital as entrepreneurs of low q waste rapidly under **1M**. To be precise, however, this is not waste, but the price of finding such diligent but economically not very able agents and demoting them from tasks that surpass their abilities. **PA** avoids paying this price, but subsequently pays a much higher price in terms of foregone growth and output over the entire future. The price, however, is somewhat negotiable. **1M** never catches **2M κ** 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 κ** , 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.

Another important advantage of **2M** concerns the wealth distribution over agents of different q . Namely, agents of low q are better off under **2M** than under **1M**, because, as implied by Lemma 4, their capital is growing faster (or shrinking slower) if the existence of working financial markets allows them to use it as investors than if their only choice is to use it as entrepreneurs.²⁵

It can now clearly be seen why Assumption 3 does not weaken the model's results. Namely, it is under it that the claimed advantages of **2M** are the smallest. The more it is violated — in other words, the more information about entrepreneurs' q becomes available, and the more understandable this is even to investors of low q — the greater these advantages will be: thanks to the existence of working financial markets, such information would increase both the speed with which the control over $K(t)$ could move to entrepreneurs of high q , and the gains that investors of low q could realize.

capital, which it puts under the control of politico-administratively selected investors and bank officials. The present results imply that not even this variant could make socialism successful, even if all these agents were the most honest and devoted public servants, innocent of all the usually quoted agency problems and personal rent-seeking: with their best intentions, they would simply be unable to find and select the economically most able entrepreneurs.

²⁵This distribution is examined and numerically illustrated in Pelikan (1997:31-35).

Politically, however, the warning against **PA** may not be believed and **2M** may not be popular. Namely, most of the agents cannot fully appreciate all the relevant finesses of Q , and thus may not see the selection advantages of **2M**. Only a minority can see the crucial difference between $\bar{q}_{VV}$, the stationary average q of entrepreneurs selected under **PA**, and Q , to which the selection of entrepreneurs and investors converges under **2M**. More precisely, only the minority whose $q > q_{VV}$ can see some of this difference, and only the very few whose $q = Q$ can see it in its entirety. The remaining majority may thus find it difficult to understand why after a successful start **PA** should start growing so much worse than **2M** and **1M**. In contrast, the initial superiority of **PA** is easier to see. As the beginnings of post-socialism in Central and Eastern Europe appear to illustrate, the substantially higher frequency of economic fools among entrepreneurs who start trying their chance on emerging markets than among government selected experts can be obvious to all agents of $q \geq 2$.²⁶ And with only $q > \bar{q}_V$, the initial superiority of entrepreneurs selected by **PA**, over both those beginning under **1M** and those beginning under **2M**, can be seen in its entirety. Based on such apparently convincing evidence, the political advocacy of **PA** can flourish.

There are only indirect ways in which this advocacy can be opposed. The model offers an indirect analysis, which allows any agent to deduce the importance of exceptionally high economic abilities logically in theory, without the need to possess them and thus actually recognize them in practice. Indirect evidence can be obtained from other demanding activities where the great importance and the great scarcity of true mastership can more easily be observed — such as sports, arts, and sciences. As the search for the most productive combinations of uses of scarce resources is hardly less demanding, grand-masters in entrepreneurship and investing can hardly be less scarce.²⁷ The importance of continuing market competition for their selection may then be understood in a similar way as, for example, the importance of repeated chess tournaments for the selection of the actual grand-masters in chess, and their safe distinction from eloquent writers about chess.

²⁶In the above example, as can be concluded from Tables 1 and 2, the frequency of economic fools among the entrepreneurs beginning under **1M** can be expected 64 times higher than among the entrepreneurs beginning under **2M**, and 4096 higher than among the entrepreneurs selected by **PA**. While these numbers have no empirical value, they may help intuitive understanding.

²⁷This rather common-sense evidence may be more readily accepted by general public than by theoretical economists, who have built most of their theories on the assumption that the abilities of always taking optimal economic decisions are generally abundant.

6 Possible Implications for Real-World Economies

There appear to be two main obstacles to the export of the model's implications into real-world economies. First, none of the institutional variants examined exists there in a pure form: governments play important roles 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 under the most extensive government control. Second, real-world economies are confronted by many more both micro- and macro-economic problems than those concerning the selection of entrepreneurs. Nevertheless, there are several important points on which the implications of the model appear to hold.

In face of the institutional impurity, the model obviously cannot be taken to the letter. But a suitable extract of its spirit appears able to usefully support some economic reforms which are recommended by an increasing number of practical economists, but which have been only incompletely justified by theory. As discussed in more detail below, this includes improving the incentives of entrepreneurs, reducing the role of governments in production and productive investments, and strengthening the role of market competition, in particular the competition of investors on financial markets and its connections to the competition of entrepreneurs on product markets.

The possibly great variety of real economic problems leaves the main implications of the model unchanged, and may even amplify their practical importance. Namely, whatever the other problems might be, an economy will always fare better with more able entrepreneurs and investors than with less able ones. The importance of their selection will particularly increase if the other problems become so strenuous that only the most able entrepreneurs can succeed at coping with them. While in the generous and quiet world of the above example, the difference between market selection and politico-administrative selection was the one between high growth and modest growth, in the likely much harder real world, it may be the one between modest growth and increasing misery.

Difficulties, however, arise in dividing the responsibility for poor economic growth between insufficient incentives of entrepreneurs and their weak and/or misdirected selection: when people do the wrong things, it may indeed be difficult to distinguish what is due to their improper motivations from what is due to their lack of abilities.²⁸ As the model assumes all problems with

²⁸The difficulty of making this distinction was perhaps most extremely exploited by the brave soldier Svejik in

incentives away, and thus pretends that whatever might go wrong in an economy must be due to someone's low economic abilities, its implications must be expected to lose some weight in the real world, where incentives obviously do matter.

A clear example can be seen in the economic behavior of governments. The model competes there with the well-known theory of public choice, which optimistically assumes all politicians and public administrators to be perfectly able to optimize, and thus puts all the social inefficiencies they might cause on the account of their wrong incentives: the only problem with them is that what they optimize are personal rents, and not social welfare. In contrast, the model assumes with a different optimism that they all have the best intentions to improve the economy's performance, and thus ascribes all the social inefficiencies they might cause to their insufficient economic abilities. In any real-world economy, the truth is obviously somewhere between the two, but it is difficult to tell exactly where. The implications of the model thus remain relevant, but they must be expected weakened by a difficult to estimate factor.

But arguments concerning economic abilities and those concerning incentives do not always weaken each other: at occasions, as noted in Section 3, they may also strengthen each other. To recall, the selection problem raised by the scarcity of economic abilities implies that the incentives of entrepreneurs, to be efficient, must be substantially higher than their equilibrium level under the assumption of perfect rationality, in order to provide the selection with a sufficiently broad basis. In plain words, entrepreneurs may have to be offered the possibility to become very rich, if the entire economy is not to become very poor. Moreover, as the incentives often strongly depend upon various components of transaction costs — such as the costs of enforcing contracts, of dealing with government administration, of hiring and firing labor, and of negotiating with trade unions — also these factors may have to be made much more hospitable to entrepreneurs than an older theoretical analysis could imply.

Although it appears difficult to determine exactly which components of the incentives of entrepreneurs need to be improved and how much, there appear to be two simple but possibly useful rules of thumb: (1) The incentives continue to need improvement as long as some available resources remain idle. This rule appears particularly useful whenever more people find it advantageous, given their culturally conditioned attitudes to risk and preferences for leisure, to search for jobs or stay unemployed than the number of jobs that entrepreneurs find advantageous

to create and are economically able to maintain. (2) If all resources are employed, but with poor effects, the entrepreneurs may lack economic abilities, and the fault may thus be with their selection. Note the 'may': in agreement with standard economics, both idleness of resources and the poor effects of their uses may be caused by distorted relative prices, which fully count as parts of the incentives, but must be considered apart from, and may thus sometimes free from suspicion, the abilities.

All this belong to the context which must be kept in mind when the model is considered as a possible source of implications for the real world. These are of two main types: (i) concerning the economic abilities of governments, and (ii) and concerning the social value of financial markets. Implications (i) stem from the finding that politico-administrative selection can be expected to find decent above-the-average experts, but not exceptional grand-masters.²⁹ Thus, without attacking government in any derogatory way, this finding implies severe ability constraints upon what politicians and public servants can do for economic growth, if they are not to cause, even with the best intentions, more harm than good. References to these constraints can thus be used as theoretical support for various economic reforms which reduce the role of governments in the ownership of firms, in the control of investment banks, in the allocation of productive investments, and in the choice of industrial strategies. If, as considered above, policies are needed to strengthen the incentives of entrepreneurs, these constraints also imply that whatever these policies might be, they should be general, and not selective. Governments are thus recommended to abstain from favoring specific firms, specific industries, firms of certain sizes, and incumbent firms as opposed to new entrants.³⁰

Implications (ii) stem from the finding that financial markets, besides their usually studied role in the allocation of investments, have two additional roles of importance: to function as

²⁹The objection that in the real world, government could acquire the best economic abilities by recruiting its experts among the grand-masters selected by market competition is easily refuted by considering that (a) it is never quite clear who the true grand-masters actually are *and* are about to be, and (b) on markets, much like in sports, no grand-master has a tenure, but is continuously challenged by new emerging talents. Once recruited by government, old grand-masters would not only escape the challenge of new talents, but could even prevent them from emerging.

³⁰To avoid misunderstanding, note that the recommendation of abstinence from selective measures only concerns *industrial* policies, meant to influence production as such, and not policies intervening in final consumption, such as those formulating or modifying the demands for public and merit goods. Such policies cannot of course but favor certain industries, such as education and health insurance, and government may do well by recruiting experts for monitoring the quality of supply. But the recommendation then fully reappears: as entrepreneur or selector of entrepreneurs, government is unlikely to excel even in those industries.

devices for the selection of investors, and thereby, of entrepreneurs; and to allow agents to use their capital as investors, instead of forcing them to use it in possibly inferior ways as own entrepreneurs. While general advantages of market selection are now well known, this finding adds precision by showing that market selection with financial markets is superior to market selection without them, and this both in accelerating growth and in spreading its benefits to agents of low economic abilities. The social value of financial markets is thus revealed greater than usually recognized — in particular compared to the still popular view that they are little more than places of arbitrary wealth redistribution and unproductive rent-seeking.³¹

Emphatically, however, financial markets are not claimed perfect. Their imperfections — such as tendencies to create speculative bubbles and thus contribute to macro-economic instability — are admitted to be possibly both many and serious. The finding only means that regardless of such imperfections, in real-world economies, where no superior *deus ex machina* can help, all other feasible ways of selecting investors and entrepreneurs are even more imperfect.

Implications (ii) appear able to help policy both to avoid costly errors and to do the right things. The errors are of the kind typical for tinkerers who try to mend complex mechanisms without understanding all their essential functions. This includes all the various policies by which the working of financial markets can be hindered or distorted, and which may be implemented or recommended with an impeccable logic and the best intentions, as long as some important functions of these markets are ignored. Examples are taxes upon working capital and/or financial transactions, arbitrary reversals of market verdicts by selective government intervention, and transfers of the allocation of productive investment from financial markets to government-owned or government-protected investment banks.

A particularly strong warning can be deduced against the ambitions of some governments to assume what is generally perceived as high risks in the allocation of investments within young industries. The important point is that the height of such risks is not an objectively given constant, but a function of the economic abilities with which they are assessed: what is a high risk for

³¹This view can even be found in some relatively recent economic theories (cf., e.g., Murphy et al. 1991, or Shleifer and Vishny, 1995). The model can be used to show that up to a limit, financial markets may admit much of rent-seeking and yet remain socially efficient. The limit is that the rents that highly able entrepreneurs extract from less able investors remain lower than what the latter gain, according to Lemma 4, from having their capital fructified with higher economic abilities than their own. From the equity viewpoint, of course, one may dislike the opportunism of the highly able entrepreneurs with which they extract rents from trusting less able fellow agents — although, on the other hand, it might also be argued that such rents are only efficiently priced rewards just for the differences in economic abilities.

politicians and government officials is often a much lower risk for grand-masters with own successful experience in the industry. If such grand-masters are in short supply, to try to replace them by government agencies, instead of improving their incentives and conditions of selection, would thus be a gross policy error, which may profoundly damage the very industries which the government intends to promote.

The search for the right things is directed above all to the activities of legislators and courts. The view of financial markets as selection devices implies that to be efficient, they must also meet an important but not always properly noted demand: to select investors for high economic abilities, and not for low ethical standards. While this demand may to some degree be met by evolution of self-policing based on reputation effects, this can seldom suffice, especially not for emerging markets. Hence the large responsibility of legislators and courts for defining and enforcing suitable institutions.³²

Somewhat more specific guidelines can be obtained from the principle that institutions should protect the selection of high economic abilities from intervention by agents that risk losing in it, or are external to it. For example, in the design of institutions for the market for corporate control, this guideline supports the shareholders' rights to transfer this control against obstacles set up by incumbent managers; and in the design of institutions for bankruptcy procedures, it supports the creditors' rights to select the managers of defaulting enterprises. Namely, inadequate economic abilities of incumbent managers are implied to be the prime suspects among all the possible reasons why take-overs could increase the value of firms in the former case, and why firms have gone bankrupt in the latter case. Although the economic abilities of both stockholders and creditors must also be suspected, the logic of efficient selection implies that the task of selecting managers be nevertheless assigned to them: they are the ones who can effectively be selected for the abilities to select managers, because it is by their capital losses that any lack of

³²The recent history of the Czech post-socialist transformation, which started so well but now continues so poorly, offers an instructive example. As opposed to some analysts who blame the rapidity of mass privatization, the present model implies praise for this rapidity, and blame only for the neglect of institutions for civilized trading of the privatized assets on financial markets. Without sufficient legal framework, and without courts able to effectively enforce the little legal framework there was, the Czech financial markets started indeed to select more for low ethical standards than for high economic abilities. By selecting the wrong investors, they also discouraged many of the right ones to enter. As these most likely included many important and economically highly able foreign investors, this neglect of institutions alone appears indeed able to explain most of the negative growth from which the Czech economy, after a few successful years, started again to suffer. Additional support for this argument can be seen in the fact that for a long time, thanks to excellent macro-economic education of the former prime minister, all the important macro-economic balances were kept in an exemplary order.

these abilities will have to be paid. While the needs to protect minority stockholders and minority creditors may complicate the issue, the guideline remains useful: it helps to distinguish such needs from the vested interests of incumbent managers, who may attempt to protect themselves from the selection by making legislators confuse the two.³³

Some specific guidelines concerning mutual investment funds appear possible to obtain from Lemma 4. By showing the inefficiency of frequent re-investing by investors of low economic abilities, this lemma implies that such funds may be socially more valuable than usually noted: they may indeed be the efficient response to the needs of such investors to restrain their diligence together with the needs of a modern economy to have its allocation of investment frequently revised in face of evolving technologies and changing markets. Such funds can thus be understood as building an additional selection level, and thus transforming **2M** into a kind of **3M**, which may improve the results of **2M** much like **2M** improves the results of **1M**. Although it may again take time before most of the funds managed with low economic abilities lose importance, the selection of the most able entrepreneurs could thus be accelerated, and both the less able investors and the entire economy could consequently grow richer (or less poorer). As such funds are now increasingly replacing direct links between investors and entrepreneurs, and thus raise policy concerns, this understanding may help to guide the design of their institutions towards efficient forms, or at least to protect them against policy errors by which their socially useful functions, if these were poorly understood, might be hindered.

A slight modification of its assumptions allows the model to offer an answer to the puzzling question raised by the recent history of Japan and South-East Asia: How can an apparently successful, rapidly growing economy suddenly lose growth and fall into a deep financial crisis?

The general idea of the answer is roughly indicated by the rise and fall of **PA** in the model. For a more precise answer, the capital available must be assumed to include, in addition to the one produced and saved by entrepreneurs, also some additional sources — such as consumers'

³³Whether or not as a result of such attempts, the US bankruptcy law (Chapter 11) violates the principle in at least two respects. While by itself, the protection of defaulting firms against too rapid liquidation may be socially efficient, its linking to the protection of incumbent managers is definitely not: if, as is often likely, much of the losses incurred have been caused by their insufficient economic abilities, to allow them to keep their positions for another long period will only increase both the losses and the probability of liquidation. Another violation is the extensive authority over the management of defaulting firms accorded to judges: their economic abilities are neither the result nor the object of any relevant market selection, and must therefore be expected far from the top economic mastership, without which most of such firms have no chance to be redressed.

savings, government budget, and foreign investments. Such additional supply of capital increases the potential for growth by the possibilities of debt financing, but it also increases the potential for losses, if the capital borrowed fails to be efficiently employed. Moreover, compared to the above numerical example, the answer also requires a less optimistic (and thus likely more realistic) view of exogenous conditions: they must be expected to be, or gradually to become, so hard that only entrepreneurs of exceptionally high economic abilities can make the capital employed effectively grow.

Consider now institutions which resemble **PA** in that they make the selection of entrepreneurs significantly political — be it directly, through government ownership of firms, or indirectly, through government regulated and/or protected investment banking, which in turn protects incumbent entrepreneurs from market selection. The main difference from the story of **PA** is that thanks to the possibilities of debt financing, the initial growth can be both greater and last longer. Namely, debt financing can both amplify the initial advance which the rapidly selected above-the-average entrepreneurs can realize, and allow the economy to continue to grow even when their mere above-the-average economic abilities no longer suffice to obtain positive returns from the capital employed. The point is that this continuation has a high price: the bad debts then start growing faster than the economy, and can do so until they cause a financial crisis.

To see why bad debts can grow for such a long time, recall the differences between technological abilities and economic abilities. In a civilized society with a high educational level, politico-administrative processes may find it easy to select — e.g., by screening according to university diplomas — entrepreneurs of high technological abilities. These may be perfectly able to found or expand firms, create jobs, and use the most advanced technologies to produce high quality outputs. But, as their economic abilities are likely far from the best, the inputs of all this may often cost more than the outputs. While investors of high economic abilities could rapidly identify and stop the losses, such investors are also unlikely available. The politico-administrative processes which distort the selection of entrepreneurs cannot but also distort the selection of investors. An additional problem may be that the politically favored entrepreneurs may also be politically helped not to reveal, and sometimes even not to see themselves, all the economically bad news. As a result, the easily visible technological excellence combined with the more difficult to see deficiencies in the economic abilities of both entrepreneurs and investors can keep the growing bad debts hidden until they grow all the way to a financial crisis which finally forces them

to light.

This view also explains why financial crises may only poorly respond to macroeconomic remedies. If they are due to extensive bad debts caused by a high proportion of economically far from the best entrepreneurs and investors, a general debt squeeze may also eliminate economically sound enterprises and thus cause a recession, whereas an additional supply of funds will also prolong the tenure of the far from the best agents, and much of it will thus be good money thrown after the bad. The dilemma is similar to the one of a doctor who would try to cure a cancer by food supply: the cancer can be starved, but only together with the patient, or the patient can be strengthened, but only together with the cancer. Clearly, not much progress can be achieved without effective micro-filtering by which the bad debts could sharply be distinguished from good ones. It is easy to see that such filtering cannot succeed without the use of exceptionally high economic abilities, which in turn cannot be obtained without an effective market selection of both investors and entrepreneurs.

At this point, the difficulty of determining to what degree the present abilities-selection answer is relevant, and how much explanatory power it must cede to its incentives-public-choice competitors, reappears in its entirety. Namely, much of the inefficiencies and bad debts revealed by the financial crises can alternatively be explained by the distorted incentives and the consequent opportunities for rent-seeking which the extensive government involvement in industry and investment banking has also caused. The above-mentioned difficulties of distinguishing improper motivations from low abilities make it also difficult to determine the relative weights of the two alternatives with any precision.

But *some* weight for the present answer can certainly be claimed. For this, it suffices to show that the performance of entrepreneurs cannot be entirely explained by their incentives, and that their abilities also matter. This now appears to be a widely accepted truth, for which interesting additional evidence is provided by Barbers et al. (1996): if, as they found, incentives are not all, and some kind of scarce entrepreneurial abilities also matter in primitive Russian shops, such abilities must be expected to matter even more in the complex world of modern industries.

The fundamental obstacle to precise determination of the weights is the elusiveness of economic abilities, which makes them difficult to be measured objectively, without requiring high economic abilities of the measurers. For example, how to objectively measure the differences in economic abilities between the population of Japanese entrepreneurs and the population of the

US entrepreneurs? There seem to be only two relevant facts: (1) Many Japanese entrepreneurs have been selected and/or significantly protected from market selection by the politico-administrative methods provided for by Japanese institutions, while most of the US entrepreneurs have been forced to keep competing for, and winning, the favors of investors, who have themselves been forced to keep competing, and winning, on the relatively open and transparent financial markets provided for by the US institutions. (2) Japanese economy lost its growth and fell into a deep crisis, while the US economy continues to grow and prosper. But the evidence that both these facts can produce is only rough and circumstantial. Although it strongly indicates that the economic abilities of the US entrepreneurs must be expected substantially superior, it does not say how much superior, nor what weight this superiority may have among the causes of the Japanese crisis. As I am unable to answer these questions in any objective way, I must leave the readers free to find their own subjective answers with the help of their own economic abilities.

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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 2, candidates of competence q_i can obtain votes only from agents whose $q \geq q_i$. 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 $q \geq q_i$ while factoring out $P(q_i)$ yields equation (4). Q.E.D.

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

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

where

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

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

$$\bar{q}_V = \sum_{q=1}^Q P(q) \cdot \bar{q}(q).$$

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

$$\bar{q}_V = \sum_{q=1}^Q P(q) \cdot \bar{q}(q) > \sum_{q=1}^Q P(q) \cdot q = \bar{q}.$$

Q.E.D.

Proof of Lemma 4. 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 $\rho(q)$:

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

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 1, $B(q) < B(q+1)$. Hence:

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

If $B(q) < \rho(q)$ for $q < Q$, then also $[B(q)]^t < [\rho(q)]^t$ for $q < Q$ and $t > 0$. As equation (10) shows $[B(q)]^t = \phi(q, t)$, 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 $m \geq 0$, $n \geq 1$, and $(q+m+n) \leq Q$. The former share grows with the rate $B(q+m)$ and the latter with the rate $B(q+m+n)$. Since, according to Assumption 1, $B(q+m+n) > B(q+m)$, the growth of their sum is an increasing function of their ratio $F(q,n,m) = h(q+m+n)/h(q+m)$. In the first period after each investment decision, $F(q,n,m) = P(q+m+n)/P(q+m)$. For the second period, if no new investment decision is taken, this ratio is multiplied by $B(q+m+n)/B(q+m) > 1$. 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 $\delta(q,t)$ is the result of more new investment decisions than the growth according to $s(q,t)$, the Lemma's second inequality follows. Q.E.D.

Proof of Proposition 1. Lemma 3 and equation (19) imply

$$\sum_{q=1}^Q P_{VI}(q) \cdot q > \sum_{q=1}^Q P_V(q) \cdot q > \sum_{q=1}^Q P(q) \cdot q .$$

Following Assumption 1, $B(q)/q > 0$. Hence substituting $B(q)$ for q cannot but strengthen the inequalities:

$$\sum_{q=1}^Q P_{VI}(q) \cdot \pi(q) > \sum_{q=1}^Q P_V(q) \cdot \pi(q) > \sum_{q=1}^Q P(q) \cdot \pi(q) .$$

Following equation (18) the first term equals $K_{PA}(1)$; following equation (16) the second term equals $K_{2M6}(1)$ and, as implied by equations (14), also $K_{2M6}(1)$; following equation (7) the third term is $K_{IM}(1)$. Hence

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

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

Proof of Proposition 2. Following equations (8) and (17), both $R_{IM}(t)$ and $R_{2M6}(t)$ tend to

$$\lim_{t \rightarrow \infty} \frac{\sum_{q=1}^Q P(q) \cdot [\pi(q)]^{t+1}}{\sum_{q=1}^Q P(q) \cdot [\pi(q)]^t} = \lim_{t \rightarrow \infty} \frac{\sum_{q=1}^Q P_{\nu}(q) \cdot [\pi(q)]^{t+1}}{\sum_{q=1}^Q P_{\nu}(q) \cdot [\pi(q)]^t} = \frac{[\pi(Q)]^{t+1}}{[\pi(Q)]^t} = \pi(Q) .$$

Following equation (15), $R_{2M_6}(t)$ tends to

$$\lim_{t \rightarrow \infty} \frac{\sum_{q=1}^Q P(q) \cdot [\rho(q)]^{t+1}}{\sum_{q=1}^Q P(q) \cdot [\rho(q)]^t} = \frac{[\rho(Q)]^{t+1}}{[\rho(Q)]^t} = \rho(Q) .$$

Setting $q_i=Q$ in equation (9) yields $\mathcal{D}(Q) = \mathcal{B}(Q)$. Hence for $t \rightarrow \infty$, $R(t)$ under all the market variants converges to $\mathcal{B}(Q)$. According to equation (20), R_{PA} is time-invariant, and equation (18) implies $R_{PA} < \mathcal{B}(Q)$. This establishes the ranking according to $R(\infty)$.

In the assumed stationary and favorable exogenous conditions, $K(t)$ under all the variants grows beyond all limits, but converges to differently performing growth paths. Equation (7) implies that $K_{1M}(t)$ converges to $P(Q) \cdot [\mathcal{B}(Q)]^t$; equation (14) implies that $K_{2M_6}(t)$ converges to $P(Q) \cdot [\mathcal{D}(Q)]^t$; and equation (16) implies that $K_{2M_8}(t)$ converges to $P_{\nu}(Q) \cdot [\mathcal{D}(Q)]^t$. Following equation (21), $K_{PA}(t)$ grows all the time according to $[R_{PA}]^t$. Since $\mathcal{D}(Q) = \mathcal{B}(Q)$, $P_S(Q) > P(Q)$, and $\mathcal{B}(Q) > R_{PA}$, for a sufficiently large t , the paths ranks as follows:

$$K_{2M_8}(t) > K_{2M_6}(t) = K_{1M}(t) > K_{PA}(t) .$$

This implies the ranking according to $K(\infty)$. The superiority of **2M₈** and **1M** over **PA** is considered 'very large' because the ratio $K_{1M}(t)/K_{PA}(t)$ itself converges to an exponential growth path: $[P(Q) \cdot \pi(Q)/R_{PA}]^t$. In contrast, the ratios $K_{2M_8}(t)/K_{2M_6}(t)$ and $K_{2M_8}(t)/K_{1M}(t)$ converge to the constant $P_{\nu}(Q)/P(Q)$. 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
$q(q)$	4	4.048	4.236	4.714	5.364	6.143	7
$P_V(q)$ percent	0.024	1.04	8.77	26.57	35.91	22.40	5.30

TABLE 3
Comparative performance of institutional alternatives

t	PA		1M		2Mκ		2Mλ	
	$K(t)$	$r(t)$	$K(t)$	$r(t)$	$K(t)$	$r(t)$	$K(t)$	$r(t)$
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 ·10 ⁸	12.996	6.466 ·10 ⁸	12.989	2.187 ·10 ⁹	12.998

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

TABLE 4
Taking-off times for surpassing

type	in K	in r
1M > PA	48.0	21
2Mκ > PA	39.8	20
2Mλ > PA	22.8	10.5
1M > 2Mκ	never	22.9