EXPLORING THE ROLE OF TALENT AND LUCK IN GETTING SUCCESS*

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We review recent numerical results on the role of talent and luck in getting success by means of a schematic agent-based model. In general, the role of luck is found to be very relevant in order to get success, while talent is necessary but not sufficient. Funding strategies to improve the success of the most talented people are also discussed.

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Power-law distributions are ubiquitous in many physical, biological and socio-economical complex systems and are a sort of mathematical signature of strong correlations and scale invariant hierarchical structure [1–3]. It was the economist, Pareto, the first one to show the presence of power-law distributions in the wealth of countries and of single individuals [4]. This fact indicates a strong inequality in our society: a very small amount of people have the same richness of the rest of the world. In some sense, one could consider the personal wealth as a proxy of success and think that a very successful person should also be, proportionally, a very talented individual. However, this point of view, characteristic of the standard meritocratic paradigm, is in strict contrast with the accepted evidence that human features and qualities (height, IQ, weight, *etc.*) and also efforts (evaluated, for example, in working hours) follow a symmetric Gaussian distribution around a given mean: actually, there is not an individual who is thousands

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of times more talented or more skilled or more intelligent than the rest of the population, just as there is not an individual who works thousands of times more than another one.

A key to understand this apparent contradiction can be found in the structure and in the complexity of our globally networked socio-economic system, full of feedback mechanisms and winners-take-all domains. In this highly non-linear context, the adoption of a simple linear paradigm to connect intellectual capacity or productivity efforts with the scale invariant wealth distribution does result at least rather naive. Indeed, it frequently happens that small advantage/disadvantage in IQ or small differences in efforts could lead to large increase/decrease in the resulting income, since the latter may be strongly influenced by cumulative effects induced by the multiplicative dynamics of the system. In such a context, so sensitive to external circumstances, it can also happen that some small random and unpredictable event, completely independent of talent and efforts, may provide the seed for generating a cascade process of lucky opportunities which end in generating a final power-law distribution of success or wealth.

The fundamental role of luck/chance in our life, as well as that of unpredictable events not under our control, has been, traditionally, strongly underestimated. This fact has been recently realized and discussed by authors such as Taleb [5, 6], Mauboussin [7], Frank [8] and Watts [9]. On the other hand, there is a lot of literature presenting data in favor of the importance of chance in getting success. A few examples among many others are the following: (a) scientists have the same probability along their career of publishing their most important paper [10]; (b) individuals with earlier surname initials are significantly more likely to receive tenure positions [11]; (c) one's position in an alphabetically sorted list may be important in determining access to over-subscribed public services [12]; (d) people with easy-to-pronounce names are judged more positively [14]; and even the probability of developing a cancer is often due to random errors in DNA replication [15].

In a recent paper [16], by means of an agent-based model, we tried to quantify in a simple but realistic way the respective role of luck and talent in order to have a successful career. We summarize the main results in the following.

The model simulate the evolution of careers of a group of N agents ($N = 1000$) over a working period of 40 years. Agents are endowed with a talent $T_i \in [0, 1]$, extracted from a Gaussian distribution [17] centered at 0.6 and with a standard deviation 0.1, and have the same initial capital/success $C_i = 10$. They are placed at random in fixed positions within a virtual squared world and are surrounded by a certain number $N_{\rm E}$ events, someone lucky, someone else unlucky, moving at random during each simulation run.

The initial capital of the agents can change every six months according to these simple rules:

(1) If a lucky event intercepts the position of agent A_k, this means that a lucky event has occurred during the last six month; as a consequence, agent A_k doubles her capital/success with a probability proportional to her talent T_k. In other words, $C_k(t) = 2C_k(t-1)$ only if $\text{rand}[0,1] < T_k$, *i.e.* if the agent is smart enough to profit from his/her luck.

(2) If an unlucky event intercepts the position of agent A_k, this means that an unlucky event has occurred during the last six month; as a consequence, agent A_k halves her capital/success, *i.e.* $C_k(t) = C_k(t-1)/2$.

We discuss in the following the main results of the model, presenting numerical simulations averaged over 100 runs (events) with different initial conditions.

In panel (a) of Fig. 1, the tail of the global distribution of the final capital/success for all the agents collected over the 100 events is shown in log–log scale. The numerical data are well-fitted by a power-law with a slope equal to -1.33: a scale invariant behavior of capital and the consequent strong inequality among individuals, consistent with the Pareto's "80–20" rule is, therefore, observed. In panel (b), we show the final capital of the most successful individuals only, for each one of the 100 events, reported as function of their talent. The highest capital $C_{\text{best}} = 40\,960$ was obtained by an agent with a talent $T^* = 0.6048$, practically equal to the mean of the talent distribution ($m_T = 0.6$). On the other hand, the most talented among the most successful individuals (with a talent $T_{\max} = 0.91$) accumulated at the end of her career a capital $C = 2560$, equal to only 6% of the highest one.

From these simulations and others shown in the original paper [16], our model seems to be able to account for many of the features characterizing the largely unequal distribution of richness and success observed in our society. The results of the model also show, in quantitative way, that having a great talent is not a sufficient condition to guarantee a successful career. On the other hand, people with a talent slightly above the average, provided they have been very lucky, are often able to reach the top of success, a fact which is frequently observed in real life [5, 6, 8]. Thus, it seems that luck/chance does play an important role in reaching a very successful position and this evidence poses a fundamental question about meritocracy in our society.

The meritocratic criteria used to assign honors, funds or rewards are often based on personal wealth or success of individuals, being their talent, in many general contexts, not easy to be evaluated. Our findings strongly

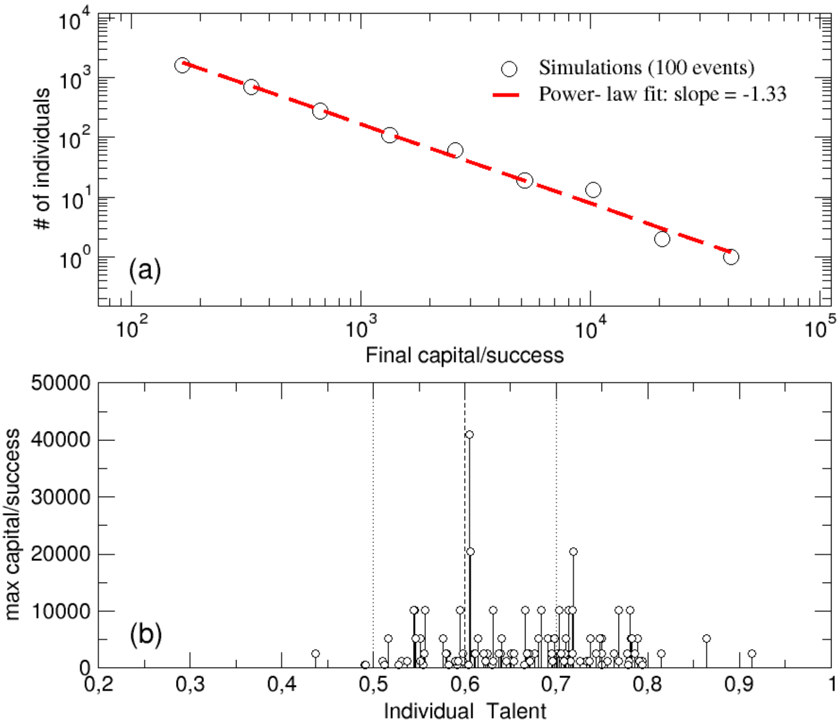

Fig. 1. Panel (a): Tail of the distribution of the final capital/success of the agents calculated over 100 events and considering different random initial conditions. We show also a Pareto-like power-law fit with a slope equal to -1.33. Panel (b): Here, we show the final capital of the most successful individuals in each of the 100 events as a function of their talent. People with a medium-high talent result to be, on average, more successful than people with low or medium-low talent, but very often the most successful individual is a moderately gifted agent and only rarely the most talented one. The mean value of the talent distribution m_T, together with the values $m_T \pm \sigma_T$, are also reported as vertical dashed and dot lines respectively.

suggest that those particular individuals could have been, at the end of the story, just the most lucky. What is worse, such strategies can eventually exert a further reinforcing action on the luckiest individuals through a kind of positive feedback mechanism, the famous "rich get richer" process (also known as "Matthew effect" [18, 19]), with a more unfair result.

Just to give an example, in the field of research funding, recent studies [20–22] found that the most funded research groups do not stand out in terms of output and scientific impact, suggesting that it is more productive to follow funding strategies that foster "diversity" rather than "excellence". On the other hand, if chance matters as we claim, it should not be strange that meritocratic strategies are less effective than expected, in particular when one evaluates merit *ex-post*. After all, the word "serendipity" is commonly used for those unexpected discoveries made by chance [31, 32]. Going from penicillin to graphene [16], there is a long anecdotical list of discoveries just due to lucky opportunities. That is why it is quite important to support curiosity-driven research, being very difficult to predict the final outcomes of a research project. We already addressed the problem of "naive meritocracy" in several papers, showing the effectiveness of strategies based on random choices in management, politics and finance [23–30]. In the following, we discuss how it is possible, in the context of the model presented here, to increase the minimum level of success of the most talented people in a world where luck/chance plays an important role.

Let us imagine the periodical distribution of a funding capital F_T among the agents following different criteria. In Ref. [16] we compared several distribution strategies in order to provide additional resources that could allow the most talented agents to increase their initial capital. We assumed to distribute a fixed capital $F_T = 80\,000$ every 5 years, during a period of 40 years spanned by each simulation run, so that $F_T/8$ units of capital will be allocated from time to time. We used as an indicator to check the effectiveness of the adopted funding strategy, the number N_T (averaged over the 100 simulation events) of individuals with talent T greater than 1 standard deviation and with a final success/capital greater than the initial one (we checked that it is a robust measure).

Considering the percentage of these agents with respect to the case with no funding, we can compare the results of each adopted strategy in order to see which one is the most effective. Some results are reported in Table I. For more details, please refer to the original paper [16]. Looking at the table, if the goal is to have the most talented persons with a final capital greater than the initial one, it is much more convenient to distribute periodically equal amounts of capital to all individuals rather than giving a greater capital only to a small percentage of them, selected through their actual level of success — already reached at the moment of the distribution. On the one hand, the table shows that the most "egalitarian" strategies, which assign an equal amount of capital every 5 years to all the individuals, is the most efficient way to distribute funds. On the other hand, the most "elitarian" strategies which assign every 5 years funds only to the best 50%, 25% or even 10% of the already successful individuals, are all at the bottom of the ranking in all of these cases. If one also considers psychological factors (not taken into account in the simulations but relevant in the real world), a mixed strategy could be a good compromise with respect to the egalitarian one. Finally, looking again at the funding strategy table, it is also worthwhile to stress the counterintuitive high efficiency of the random strategies, which occupy two out of the three best scores in the general ranking.

TABLE I

Comparison among different funding strategies averaged over 100 events. A total funding capital of 80 000 units was distributed among the agents every 5 years in a period of 40 years. We report for each strategy the final percentage of the most talented agents (those with T greater than one standard deviation with respect to the mean) who were able to increase their initial capital, compared with the no funding case. See the text for further details.

Funding strategy	Percentage of the most talented people who increased their initial capital with respect to the no funding case
In equal parts to all agents	67.68%
To 50% in a random way	66.66%
Half to 25% best — half to others	65.67%
To 25% in a random way	57.21%
To 10% in a random way	36.27%
To the best 50%	30.73%
To the best 15%	14.85%
To the best 10%	4.37%

In Ref. [16], we studied also the importance of the environment or of the education in order to improve the success of the most talented agents. We saw that a stimulating environment, richer of opportunities, associated with an appropriate strategy for the distribution of funds and resources, are important factors in exploiting the potential of the most talented people, giving them more chances of success with respect to the moderately gifted, but luckier, ones. At the macro-level, any policy able to influence those factors and to sustain talented individuals, will have the result of ensuring collective progress and innovation.

In summary, we have shown, by means of an agent-based model, how it is possible to quantify the role of talent and luck in order to reach success, starting from very simple assumptions. Our simulations show that, although talent is normally distributed among agents, the final distribution of success/capital follows a power-law behavior similar to the Pareto law observed in the real world. We have also found that the most successful agents are almost never the most talented ones, but just very lucky individuals with a medium level of talent, another feature often perceived in real life. The model thus shows the importance, very frequently underestimated, of lucky events in determining the final degree of individual success. We have also compared different funding strategies to increase the level of success of the most talented agents, finding that the most egalitarian ones are those which are the most effective in this respect.

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