Sergio Beraldo
University of Naples 'Federico II' and ICER, Torino – Italy

Enrico Colombatto*
University of Turin and ICER, Torino – Italy

Valerio Filoso
University of Naples 'Federico II', Napoli – Italy

Marco Stimolo
University of Salerno, Salerno – Italy

Growth in One (Short) Lesson

Abstract – This paper argues that the economic theorizing about growth leads to one simple conclusion: the key notion is innovation and the history of growth can be aptly synthesized as the history of successful innovation. Innovation includes technological progress and entrepreneurship, which in turn depend on tolerance, interaction, and – more generally – a favourable institutional environment. Besides the importance a community assigns to credibility and reputation and from a public policy perspective we emphasize the role of both contract enforcement and protection of property rights as necessary, even though not sufficient, conditions for growth.

Keywords – Economic growth, innovation, technological change, institutional change, market-based incentives

JEL Classification Codes – O30, O31, O33, O43

1. – *Introduction*

Economics studies how individuals strive to improve their wellbeing by weakening the constraints imposed by scarcity and economic growth is a (rough) way of summarizing to which extent these efforts meet success. When growth is positive, it shows that an individual or a community manages to make better use of the resources at his/its disposal.

Despite its obvious importance, however, from the marginalist revolution and until the second half of the 20th century the analysis of growth played a secondary role within the economics profession.

The traditional growth theories based on trade and capital accumulation

* Corresponding Author
E-mail: enrico.colombatto@unito.it; *tel*: +39 0116706068

predicted that growth would soon peter out; either because the size of the markets is limited by geography and demography, or because the diminishing marginal productivity of fixed capital would gradually reduce profitability and bring net investment close to zero. At first sight, the empirical evidence seemed consistent with these views and predictions.

For millennia, living conditions throughout the world were barely enough to allow individuals to survive for a relatively low number of years [MADDISON, 2005]. In particular, until about the 16th century AD, growth in the production of goods and services was indeed positive, but roughly equal to the growth rate of population, so that income per capita stayed more or less constant. The picture started changing in the 16th century, when growth picked up in selected areas, and further evolved in the 19th century, when growth took off in the Western world and later spread to other parts of the planet. With few exceptions and despite widespread skepticism – which included even J.M. KEYNES [1920, chapters 2 and 6], according to whom the 19th century growth was a historical accident — one can safely claim that for the past two hundred years the world economy has never stopped growing.

Among the many elements emphasized by the literature [LEVINE — RENELT, 1992], is it possible to identify a crucial element to be considered as the engine of this success story of economic growth? In this short article, we claim that such an element might be given by innovation, *i.e.* the ability to find new ways of meeting individuals' needs, either/both by offering new goods and services or/and by introducing and adopting improved production techniques [*e.g.* OECD, 1997]. On this account, the history of growth can be aptly synthesized as the history of successful innovations [MOKYR, 1990]. It is clear, however, that this appears true when looking at the picture in a very long-run perspective, for, in this case, it is possible to abstract away from factors which are indeed relevant in the shorter run, such as the availability of savings and an adequately skilled labour force.

Innovation includes two fundamental and interrelated components: technological progress and entrepreneurship. Technological progress is the result of advances in science and engineering [LIPSEY *et al.*, 2005]. In our context, science means knowledge, notably in the so-called natural sciences (astronomy, biology, chemistry and physics). It originates from systematic research efforts, but also from luck, casual observation, and trial and error. For example, luck and casual observation were fundamental in the discovery of penicillin, while trial and error in the 18th and the 19th centuries led to many key breakthroughs in metallurgy. In the 19th and 20th centuries, the development of fertilizers owed a great deal to intense efforts in research promoted primarily by laboratories financed by chemical companies.

Yet, knowledge by itself is not enough to generate technological progress, let alone growth. Once science and engineering have produced technological opportunities, one needs entrepreneurship in order to transform opportunities into business ventures by means of risk taking and investments [HOLCOMBE, 2007].

In this article, we try to investigate the nature of the elements that lead to successful innovation according to the outline depicted above. In particular, section 2 reviews the conditions that promote scientific advance; section 3 and 4 focus on the features of technological progress; section 5 examines entrepreneurial action; section 6 is devoted to the role of institutions, which affect productive entrepreneurship; and section 7 concludes.

2. – *Scientific advance*

Sustained growth needs scientific advance. One can hope to perfect the techniques derived from a body of existing knowledge, but there are obvious limitations to how far a given technology can be developed. This explains the importance of understanding under which circumstances scientific progress flourishes or stagnates.

History provides ample evidence that casual scientific insights can occur any time. Yet, science is more than happenstance. Nowadays, most breakthroughs are the outcome of carefully designed controlled experiments, which require appropriate educational backgrounds and complex research agendas that are subject to ongoing change as new insights are obtained and new avenues of investigation open up. Certainly, one can stumble upon unexpected results. However, there is no doubt that experienced and professional scientists are better placed than the ordinary individual to spot the meaning and potential of accidental events. To repeat, the quality of the educational curricula and the ease with which research agendas can be framed and pursued are critical.

Moreover, technical education and its interplay with the size of the family (fertility) play a pivotal role in the explanation of the very long-run trajectory of economic growth. Since technical progress requires highly educated workers, parents face a high quality-quantity trade-off when production becomes more technologically sophisticated. Accordingly, they can increase the wellness of their offspring decreasing the number of children and investing in more education per child. This mechanism is supposed to drive the endogenous transition from the Malthusian regime of high fertility and low growth to the modern regime of low fertility and sustained increase in the standards of living [GALOR, 2011; GALOR *et al.*, 2000].

Scientific education, freedom to investigate and the ease with which research agendas expand have been varying across centuries, depending on the extent to which communities have allowed and possibly encouraged individuals to develop their projects, and also on the extent to which individuals have been able to communicate, discuss their ideas, compare results, correct mistakes, and possibly reap material and immaterial rewards for their accomplishments. We call these requirements 'tolerance' and 'interaction'.

Tolerance has varied across time and countries, but it is widely accepted that it was relatively low until relatively recent times. Only in the 17th and 18th centuries, and in a limited number of countries, was scientific investigation considered no longer a threat to the existing political order. Interaction has never been absent. Yet, it was highly correlated with tolerance until the 19th century, when the cost of communication decreased substantially and interaction could intensify even if tolerance was no longer a major issue.

3. – *Science and engineering*

As mentioned in the introductory section, technological progress also depends on engineering. Engineering is the ability to transform scientific achievements into general-purpose technologies, *i.e.*, into techniques and products that can be exploited to compete in the market.

The history of engineering has been marked by two critical points, following which large-scale manufacturing became possible. One point regarded metallurgy and consisted in the ability to produce low-cost equipment with given characteristics of weight, reliability and performance. The other point regarded precision measurement, without which large-scale production of standardized items is impossible. By and large, both tipping points were reached in the 18th century, when major breakthroughs occurred in smelting and made the industrial revolution possible.

Towards the end of the 19th century, the worlds of science and engineering came together. An increasingly large share of the scientific community started paying attention to the requests of entrepreneurs and consumers at large; while engineers became eager to acquire, develop and apply the insights coming from the world of science [ROSENBERG, 1982]. According to Mokyr [2002], this was the essence of the Western economic success, a story that started at the beginning of the Scientific Revolution (late 16th century), when intellectual investigation successfully broke free from the corset of intolerance, and is still underway today.

In particular, Mokyr [2000] summarizes the evolution of the relationship between scientific research and entrepreneurial ventures in three steps. Until the beginning of the 19th century, scientific breakthroughs were the results of the efforts of lone scientists or inventors. A typical example was Lister's microscope [MOKYR, 2000, p. 22]. Later, the industrial revolution featured intense interaction between entrepreneurs, engineers and scientist. The steam engine aptly illustrates this context: scientific insights into the physics of atmospheric pressure and water evaporation/condensation led to a machine – the steam engine – that generated the necessary energy to siphon off water from coal mines. Finally, as of the late 19th century, the world of business became the handmaiden of scientific research and of engineering developments. For example, Edison, Siemens and Swan were fully aware of the market demand for electricity and of the profit opportunities that the industry could offer.

4. – *Is technological growth an ever accelerating phenomenon?*

As pointed out earlier, the industrial revolution witnessed a shift in emphasis, from a science-pull theory of growth, according to which scientific discoveries create innovation; to a demand-pull approach, following which innovation is primarily promoted by entrepreneurial spirits and the size of the market (demographic growth and free trade). In particular, although scientists have continued to play a crucial role, their activities have been increasingly driven by the consumers' desires and by the entrepreneurs' and engineers' efforts to meet those desires.

During the past decades, economists have taken this line of reasoning one step further. In particular, they have wondered whether the interaction among scientists, engineers and entrepreneurs could be framed as some kind of production function, rather than just as the result of chance (brilliant ideas and intuitions). Most of the economics profession has answered in the positive and has focused on two possibilities. On the one hand, some authors have argued that when an idea is developed, improvements originate new ideas, which in turn promote further knowledge [JONES *et al.*, 2000]. In other words, it has been suggested that a stock of original knowledge operates in a way similar to a fixed cost, so that the production of additional insights is subject to increasing returns to scale. This is also known as the 'standing-on-shoulders' effect: new advances become easier the larger the present stock of knowledge, the larger the population of potential innovators, and the higher the level of education. On the other hand, other authors have argued in favour of the so called 'fishing out' effect, according to which the main improvements are obtained in the first stages of development, whereas further progress requires larger efforts and longer learning periods [GRILICHES, 1998]. If so, knowledge would be subject to decreasing returns to scale.

Clearly, if the standing-on-shoulders thesis is confirmed, we can expect constant or possibly increasing rates of technological progress. By contrast, the fishing out thesis would predict a constant increase in the stock of knowledge, with some irregularities, depending on the technological trajectories developed by the major breakthroughs.

The empirical evidence is mixed. On the one hand, during the past two centuries, the economic history of the world has shown plenty of ups and downs, both in aggregate and in specific countries. In particular, the US economy in the 20th century showed a constant rate of output growth, despite increasing investments in human capital and research. This would play against the standing-on-shoulders view. Yet, one must also take into account that the analysis should actually focus on the growth of technology, rather than on the growth of material output, as documented by GDP or other similar metrics. It is plausible that the two variables – technology and output – are correlated, but it is not obvious that the correlation is linear. For example, one could observe increasingly fast technological progress but slow economic growth because people work less, and/or because people end up wasting resources (inefficiencies brought about by rent-seeking practices). To summarize: no firm conclusion has been reached, and there is no doubt that a lot of empirical work is still required before judgment on these theses can be passed or recommendations for policymaking can be put forward.

5. – *Entrepreneurship*

The transformation of scientific insights and technical advances into business ventures is the job of productive entrepreneurs, *i.e.*, individuals who spot challenging prospects, accept the possibility of failure (they take risks), and set out to create wealth by meeting consumers' preferences. When productive entrepreneurship is weak, technological insights are overlooked and possibly discarded or forgotten; and growth stagnates. Indeed, differences in the presence of productive entrepreneurs, and in the environments within which their talents are developed and put to work, are the main explanation of the variance of living standards across countries.

The analysis of entrepreneurship in terms of judgment under uncertainty has a long tradition, from Turgot [1999/1766] and Cantillon [1959/1755] until Mises [1963/1949]. In brief, the entrepreneur analyzes actual and potential consumers' demand, and takes action if he believes that he can beat his competitors and reap a profit. Surely, the core issue consists in the identification of profit opportunities, which depend on the available technology and on the perception of uncertainty. The technological challenge encourages entrepreneurs to keep abreast of the latest developments in the

worlds of science and engineering, and also to engage in the promotion/financing of specific research projects designed to solve well-identified questions. By contrast, the problem of uncertainty has no immediate solution: it relates to the individual propensity to take chances and accept responsibility. Certainly, the constraints created by uncertainty can be eased through personal interactions facilitating the access to the relevant information: once again, tolerance and interaction play a crucial role.

As Casson puts it, a society emphasizing the value of voluntary actions and guaranteeing free access to relevant knowledge is more likely to promote good entrepreneurial abilities as well as profitable networks of trade [Casson, 2010, p. 140].

6. – *Institutions and economic performance*

Entrepreneurial activities are constrained by the institutional environment in which individuals operate, institutions being «the humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints (sanctions, taboos, customs, traditions, codes of conduct), and formal rules (constitutions, laws, property rights)» [North, 1991, p. 97].

During the last decades, the literature has followed up on North's insights and pursued two avenues of investigation. One group of authors has focused on the economic performances of societies with different political regimes, diverse legal systems or different informal institutions [*e.g.*, López de Silanes *et al.*, 1998; Knack – Keefer, 1997]. By contrast, another set of contributions has analyzed the origin of the institutions that characterize a given society or country: religion has been frequently mentioned as a critical component, though the available evidence is still debated [Barro *et al.*, 2003].

The literature on these issues is growing rapidly and its survey is beyond the scope of these notes. However, it is worth observing that most of these studies would agree on two basic conclusions. First, effective contract enforcement and protection of property rights are necessary, even though not sufficient, conditions for growth [Acemoglu *et al.*, 2005; Alchian *et al.*, 1973]. Second, a favourable institutional environment is one that enhances cooperation at relatively low costs [North, 1994]. Hence, the role usually attributed to an effective judiciary that guarantees contract enforcement, and the importance a community assigns to credibility and reputation.

The empirical evidence on the role of institutions in promoting growth is a hotly debated topic, mostly because institutions do shape economic exchange but in turn they tend themselves to adapt to changing economic conditions: the direction of causality can seldom be trusted when observational data are the only game in town. An interesting often quoted case is that of Korea, resembling most closely a natural experiment of history. In 1948, Korea split in two, with the northern part becoming totalitarian communist whereas the southern part remaining a democratic liberal regime. While the economic, social, ethnic, and cultural conditions before the split were virtually identical between the two halves, as of 2011, the GDP per capita in South Korea is roughly 17 times the corresponding numbers for North Korea. The satellite view of Korea by night, with the South full of lights and the North almost completely dark is probably the best representation of how institutions do influence prosperity and material well-being [ACEMOGLU, 2009].

Even though being a democracy does not seem to represent a necessary condition for growth, as the case of China shows [*e.g.*, GLAESER *et al.*, 2004], adverse conditions for economic growth such as predation, widespread corruption and systematic use of physical violence are much more likely to occur under autocratic regimes. Indeed a big advantage of any liberal Democracy is the necessary development of metarules (Constitutions) setting limitations to discretionary power, in such a way as to preserve individuals' right and liberties, hence one's legitimate expectations for her own effort.

Put differently, and in contrast with the traditional view prevailing until the early 1980s, it is now widely accepted that poverty is not mainly rooted in the shortage of physical capital or natural resources. Rather, it is a matter of poor incentives, lack of trust and doubtful legitimacy, as a result of which productive entrepreneurship is stifled and wastages are allowed, and/or transformed into a way of gathering political consensus, regardless of its consequences on growth.

7. – *Concluding remarks*

Since the late 1940s, growth has been one of the main fields of interest of the economics profession. This is understandable, since the very nature of economic investigation regards how individuals operate and cooperate to increase their wellbeing. As observed in section 1, technological advances and growth have characterized the entire history of mankind. Yet, only recently have these advances been significant enough to make it possible for the population to increase in numbers and for each individual to live longer and better. Following up on this factual observation, therefore, three key questions emerge: What has made fast technological progress possible? Is

the fast-growth phenomenon that has characterized the world economy during the past two centuries an episode, or is it going to last forever? And what about the dynamics of institutions, which enhance productive entrepreneurship and transform knowledge into growth?

With regard to the first question, economic history has shown that growth needs scientific advance, technological progress and entrepreneurial energies, and that these three ingredients require suitable institutional environments. Religious tolerance and the rising status acquired by 'natural philosophers' as of the second half of the 17th century, ensured that research agendas and targeted experimentation flourished, initially in the Netherlands and Great Britain, later in Germany and the US. These efforts generated a wide range of results in the fields of calculus, astronomy, medicine, chemistry and physics. Metallurgy also made huge progress and a set of critical metallurgical breakthroughs ended up giving birth to modern engineering [MOKYR, 1990]. Furthermore, in selected countries favourable political conditions reined in government intervention, encouraged private initiative and individual responsibility, and thus enhanced the rise of a new class of ambitious entrepreneurs eager to exploit the opportunities offered by the expansion of trade and the appearance of new technologies.

Of course, this view does not deny the importance of natural accidents, such as geography and the endowments of natural resources. For example, there is no doubt that for centuries the regions bordering the Mediterranean Sea enjoyed better economic conditions than other parts of the world such as northern Europe, where the climate was harsher and trade more difficult. Moreover, it is probably true that the presence of low-cost coal greatly enhanced industrialization in England and in other parts of Europe (*e.g.*, Belgium) during the 19th century [CLARK, 2007]. Yet, although easy geography and natural resources are the source of a favourable springboard for growth to take off, one needs tolerance, interaction and entrepreneurship to ensure that a benign natural environment leads to a successful and lasting growth story.

In this light, it is manifest that in the future, growth in each country is going to be heavily dependent on the features of government and of the legal systems broadly understood (institutions). The geographical sites where scientific research concentrates might change over time but, unless the world is going to be dominated by religious extremists or totalitarian regimes advocating central planning, science will continue to bloom and surprise us. Rather, the variables that will determine the speed of future growth are going to be the extent to which the interaction between scientists, engineers and entrepreneurs develops; the freedom to engage in entrepreneurial activities, take chances and reap the benefits of success.

Certainly, the freedom to interact and communicate, and the freedom to engage in entrepreneurial ventures are institutional issues. Nonetheless, economists have still been unable to articulate a convincing theory of institutional change. The mainstream view underscores the existence of path-dependent processes, according to which the features characterizing an institutional environment at time t_0 (call it state A) necessarily leads such environment to evolve towards state B at time t_1 and towards C at time t_2. However, it is also admitted that these path-dependent processes can go awry as a result of a shock: a war, a political crisis, a drastic change in the international terms of trade. The upshot is that path-dependent theorizing often nears ad hoc, ex post explanations of evolutionary processes that remain by and large undetermined and heavily influenced by accidents, erratic phenomena and shared ideological views. After all, a theory that explains all its failed predictions by referring to a shock is not a theory, but rather a description.

More importantly, we believe that renewed attention should be devoted to culture and ideology, two topics that the economics profession has tended to discard as too 'soft'. How will cultural evolution affect economic behaviour and growth? As far as this question is concerned, economists are however ill-equipped to answer in isolation, if answers exist at all. Certainly, much remains to be done in order to frame the question appropriately. This explains why an interdisciplinary view is badly needed and long overdue. This is indeed the basic challenge for those interested in understanding whether future societies will be able to exploit the opportunities offered by new knowledge.

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