Challenges to technological and economic foresight in the information society

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Abstract: What happens to our foresight prowess when foundational social changes take place? The paper outlines some basic parameters of the new realities brought about by the information society. Thinking of social forecasting as entailing a combination of economic method with technological foresight, one is able to articulate a more nuanced approach and go beyond the clichés of the day. The paper explores a series of challenges to the practice of technological and economic foresight arguing that, in conjunction, these challenges invite a significant change of attitude in how we approach the practice of social prediction.

Keywords: knowledge-based society; information revolution; economic foresight; technological foresight; natural resources; technological platform; human capital; entrepreneurship; globalisation; social networks.

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1 Introduction

The current technological, economic and social challenges invite a considerable change of attitude in how we approach the practice of social forecasting. This change of attitude has implications for the foresight activities of both the public authorities, i.e., governmental bodies (at national or regional levels), and the private organisations. In this evolving context, it is important to revisit the distinction between two facets of the forecasting practice: technological foresight and economic foresight.

In regard to economic foresight, it is essential to focus on issues such as: internet technology creates unprecedented opportunities for entrepreneurial action and predictably will speed up economic development by reducing various search costs, yet, it speeds it up in largely unforeseeable directions. The increased localised diversity and the increased global homogeneity allows us to use standard economic foresight on a larger scale, and, yet, unpredictable events of creative destruction also have larger scale (even global) effects. The increased non-fungibility of human labour creates larger uncertainty in the social realm.

In regard to technological foresight, it is of interest to emphasise an often neglected distinction between products and services, on one hand, and on the other hand, what we call 'technological platforms' on which these products and services are built. Technological platforms are pieces of technology that have a large disruptive potential due to the fact that they create a new economic niche and they affect the complementary or substituting couplings between pre-existing products and services. They are in fact the engine of 'creative destruction'. As we'll further detail, the foresight practice is forced to approach the issue of technological platforms with exceptional attention.

These are some of the parameters that should be considered when we discuss about the problems of foresight in the knowledge economy and information society. The paper looks at these challenges, and argues that the foresight practice should move away from the attempts at pure prediction towards a foresight practice inspired from the entrepreneurial perspective over uncertainty – i.e., to focus more on developing reactive strategies for various possible challenges and opportunities, rather than attempting to predict which of these changes and opportunities will come about (or with which probability). The argument entails the notion that a successful entrepreneurial-style foresight practice is one that tries to conceptualise uncertainty not as objective *randomness* but as subjective *lack of control* and that consequently tries to connect the epistemic with the pragmatic dimensions.

2 Knowledge-based economy, information society, communication technology

Herman Kahn, a founding father of the field of futures studies, distinguished between various classes of variables that are used in the foresight practice. Some of them are intrinsically volatile and in rapid flux, while others are more stable and changing slowly (Kahn, 2009). Our forecasting exercises, he explained, should take as reference point the latter. Even when we are talking about a 'new era', we are talking about gradual changes at the level of a fundamental class of variables, changes which significantly redefine their environment once they reach a critical threshold. To understand why forecasting may be more or less difficult in a social and historical context as compared to the preceding context, one has to start by identifying such key variables that define the new, emerging configuration of the social system in a paradigmatic way.

When talking about the 'new era', contemporary social theorists and futurologists usually think first and foremost of "knowledge and information production and dissemination" as such a key variable. In some sense, the expression "knowledge-based economy" is a pleonasm. From the oldest times, literally since the Stone Age, superior, more efficient, production methods were always a matter of better knowledge. Romer emphasised this point with the cooking recipe analogy:

> "If economic growth could be achieved only by doing more and more of the same kind of cooking, we would eventually run out of raw materials and suffer from unacceptable levels of pollution and nuisance. Human history teaches us, however, that *economic growth springs from better recipes*, not just from more cooking. New recipes generally produce fewer unpleasant side effects and generate more economic value per unit of raw material." (Romer, 2008)

From this point of view, which focuses on knowledge, the development of better information processing and communication methods is the hallmark of a new stage of economic and social history. Faster and more widely available communication tools allow the dissemination of knowledge (of better 'recipes') faster and in larger circles, and thus lead to faster technological developments as well as to more intense social change. This is indeed only a quantitative change compared to previous times. Yet it has a threshold-crossing nature that makes it analytically and historically significant. And thus there is, no doubt, enough justification to speak about a *novel* knowledge-based economy and, with it, about a new stage or 'era' in the economic history of humankind. The threshold we are mentioning has to do with the increased importance of human capital alongside physical capital (Becker, 2008). One could illustrate this by taking a comparative look at the classic and the contemporary perspectives on economic development.

The classic perspective on economic development considers labour fungible and focuses mainly on capital accumulation. One of the most important points of classical political economy was that workers' productivity increases mostly due to technological factors (i.e., workers use better machines), rather than due to personal skill. Consequently, the division of labour pivots around the technological organisation of the production process and, in turn, this technological organisation is what determines the required skills and the kinds of available jobs in the capitalist workforce. In short, technology and labour are economic complements, and the required skills on the labour market are largely determined by the specificities of the particular technologies used in various production processes. The general increase in welfare is a consequence of the fact that firms reinvest most of their profits into improving the production technology (i.e., 'capital accumulation') which leads to increased labour productivity and to larger wages as firms compete for attracting workers (i.e., overall increases in welfare) (Mises, 1979, Chapter 1).

Thus, this classic perspective focuses less on the knowledge behind the technology and more on physical capital itself. There is a deep reason for this: although an entrepreneur may have the *knowledge* about the best production technologies, she or he may not have the resources to *purchase or build* those technologies. This is the situation in which the phenomenon of *investment* becomes a particularly important fast track to economic prosperity if the entrepreneur happens to be in a developing country: by means of foreign investment the capital accumulated in one place is utilised in another place, perhaps half a way around the world, where the labour is initially cheaper (Mises, 1979, Chapter 5; Romer, 2008).

By contrast, the contemporary world, due to the fact that it is largely a tertiary sector economy and to the fact that many technological processes have been automated, relies to a much larger extent on *human capital* (Becker, 1993, 2008). As technology has become much more complex, a threshold has been crossed. An increasingly important factor determining economic progress is the accumulation of human capital alongside physical capital. As Becker put it,

> "The continuing growth in per capita incomes of many countries … is partly due to the expansion of scientific and technical knowledge that raises the productivity of labour and other inputs in production. And the increasing reliance of industry on sophisticated knowledge greatly enhances the value of education, technical schooling, on-the-job training, and other human capital. *New technological advances clearly are of little value to countries that have very few skilled workers who know how to use them.* Economic growth closely depends on the synergies between new knowledge and human capital, which is why large increases in education and training have accompanied major advances in technological knowledge in all countries that have achieved significant economic growth." (Becker, 2008)

The key change that characterises the new economy is that workers are becoming less and less interchangeable. As such, the human resource and its quality (seen as a mass phenomenon) becomes an increasingly important part of the economy. This is a significant and genuinely novel economic development and, as we'll see, has important consequences for social foresight practices. Moreover, in 2006, for the first time in human history, more people, globally, became hired in the services sector than in agriculture, and they got directly from agriculture to services, without passing through the industrial sector first (KILM, 2007). Needless to emphasise, communication technologies, as vehicles for knowledge accumulation and diffusion and as instruments for making economically efficient vast areas of the service sector, have a pivotal role to play in this story. Considering the world from this perspective, we understand that *communication technology is important not just as a factor in the dissemination of knowledge about new technologies but also as a factor shaping the labour market*.

It should also be pointed out that, increasingly, the knowledge that matters most in the new economy is the *knowledge of other people and the observation of social opportunities*, rather than the knowledge of things. The social networking aspect may concern the fact that firms can now outsource many jobs in the services sector to workers throughout the world (Friedman, 2005), that new business models like the open source software movement become possible (Raymond, 1999; Benkler, 2006), and that information systems for finding jobs allow one to explore a much larger number of available options. Thus, while the more traditional knowledge dissemination factor is still of course important, in dealing with economic and technological forecasting one must now focus on the labour market and on the social networking aspects to a much larger extent than before.

To sum up, changes are sufficiently profound to force us to seriously consider the ways we are navigating cognitively and strategically in the new territories emerging as the result of what has been dubbed "the knowledge and information revolution". In these circumstances, sooner or later, we have to ask ourselves what are the *new* problems and difficulties for the foresight practice. To address this challenge, we need to go beyond slogans and superficial images and develop an approach based on two things: First of all, on a more nuanced understanding of the foresight practice, an understanding that is aware of the distinction between the economic and the technological dimensions of foresight. Secondly, to use as a vehicle an example that in itself is very relevant for the new realities of the 'new era' – the very issues of resources. Foresight regarding resources was notoriously tricky and difficult in the industrial society. Thinking about it in the new information society will provide us with a comparative yardstick of the problems and challenges of the 'new era'.

3 The interplay between economics and technology in the practice of foresight

Social forecasting is faced with two major sources of uncertainty, one regarding technological innovation development and another regarding supply, demand costs and incentives. As such, it has two intertwined aspects. The first one regards *technological forecast* per se, based on understanding the particular logic or structure of the technological processes involved in the issue one is forecasting about. The second one regards *economic forecast*: a forecast that takes into account economic incentives, resources, supply and demand, the way people react to changes in prices etc. In other words, a comprehensive social forecast implies two types of approaches: one concerning the logic of technology, the other the logic of economy. Elaborating this point in the context of discussing the case of resources is a step further in understanding the general problem and difficulties of forecasting in the new social and economic context of the 21st century.

Pure economic forecast, be it at the micro level or at the macro level – such as the Solow-Swan neo-classical growth model (Solow, 1956, 1957; Swan, 1956) or the more modern growth models (Lucas, 1988; Romer, 1990) – tends to ignore technological details and focus mostly on aggregate macro flows or on micro incentive structures. For example, if the price of oil increases significantly, while restrictions on using coal are kept in place, economists will simply assume that alternative technologies will be developed (due to the emerging incentives to develop them). Such analyses might seem unrealistic and over-optimistic due to the perceived lack of deterministic 'guarantees'. What if the technological developments *do not happen*, although the incentives for their development are there? Nonetheless, despite the intuitive appeal of such pessimism, history has so far supported the more optimistic perspective: It is important to bear in mind that past technological forecasts which have failed to take such an economic conjectures into account, such as the Club of Rome predictions, have been notorious failures (Simon, 1981, pp.31–38; Simon, 1996, pp.41–52). The major difficulty in making such pure economic predictions is due to the difficulty of forecasting things like consumer demand – guessing what people will be willing to buy. There are however *some* areas in regard to which we *can* predict consumer demand reasonably well. For example we can be fairly sure that most people will always want more leisure time, larger living spaces (toward a certain maximum limit?), higher social status, better healthcare and longer lifespan, etc. Psychological and behavioural economics research provides valuable insight into such universal or quasi-universal kinds of consumer demand and, consequently, they provide valuable input to economic foresight.

Pure technological forecast tries to use estimations of technological extraction capabilities to predict the quantity of available resources, e.g., the amount of usable energy or computing power. In regard to natural resources, the technological method builds on the assumption that a certain amount of a given mineral 'exists' out there in nature. It estimates that amount and, based on that estimation, it then calculates the availability of the resource into the future, considering various costs of extraction (which are calculated as a function of the predicted extraction methods). Considering the speculative nature of economic forecasts, as they have to depend on guesswork about economic conditions, market prices, demand, and so on, one may believe that technological forecasts, although economically blind, are more trustworthy. Apparently, they rely on *fact*: the known amount of reserves. However, the 'known reserves'

technological approach has to rely on even more speculative assumptions than the economic one. In Simon's words, technological forecasting "depends heavily upon how well the forecaster can imagine the methods of extraction that will be developed in the future". In this case, using an 'unimaginative' assumption that

> "future technology will be the same as present technology, would be like making a forecast of 20th-century copper production on the basis of 18th century pick-and-shovel technology." (Simon, 1981, pp.36, 37)

But if one makes assumptions that differ markedly from the present, then a wide speculative element gets introduced. Moreover, by ignoring the economic perspective, this speculative element lacks the proper constraints and ignores the ends-means structure of human action. In other words, economically blind technological foresight lacks the tools for a reasonably *realistic* perspective on the speed of technological development: the prediction is either overly optimistic (as in the case of various predictions about flying cars, robots and space exploration) or overly pessimistic (as in the case of the 'imminent' exhaustion of 'vital' resources such as oil and gas). The overly-optimistic technological predictions are the outcome of ignoring consumer demand, while the over-pessimistic technological predictions are the outcome of ignoring supply-side incentives for developing new extraction technologies. By contrast, the economic approach needs to make only one assumption: that in the long-run the cost trend will continue. *This assumption, together with a price-dependent supply schedule and predictions conditional on various prices, are sufficient to develop a relatively solid estimation.* Thus, even in its most speculative mode, economic forecasting seems to be less speculative than the purely technological one. Even a superficial overview, as the one above, shows why, irrespective of historical moment (industrial, post-industrial, information society etc.), the tension between technological and economic forecast is so important.

Let's further elaborate the point, highlighting another important, but often neglected, aspect, continuing to use the resources example. The first question we must ask is: What counts as a resource? What should be measured? The economic view builds on the assumption that what is a 'resource' depends on many contextual parameters – including, to be sure, economic ones. It is vital not to miss the fact that what counts as an available natural resource is conditioned not only by technology but also by economic factors. A small change in *prices* creates incentives for an increase or decrease in potential supplies. Price determines what is economically available – or profitable – to extract. For this reason, forecasts limited to supplies of the resource available at current prices, with current technology, are misleading and completely unreliable. For instance, what at today's cost, with today's methods of extraction, might be a resource, might not be considered one at different technological and cost parameters (Reisman, 1996, chapter 3, part A). By implication, the very notion of 'known reserves' is a deceptive notion. The resources that will be available in the future will be operational under different parameters and therefore will be determined differently. For instance, a change in the difficulty of extracting the resource or the emergence of substitutes and alternatives to it, are enough to determine what the 'reserves' will be at that time.

Humans constantly create new supplies of resources, not only by discovering them in new places but by redefining their nature as resources through new modes of using them in the production process: natural phenomena such as copper and oil and land were not resources until humans discovered their uses and found out how to extract and process them, and thereby made their services available to us. Hence resources are, in the most

meaningful sense, *created*, and when this happens their availability increases and *continues to increase as long as our knowledge of how to obtain them increases faster than our use of them*, which, perhaps surprisingly, is indeed the history of all natural resources (Simon, 1981, p.76). This alternative mode of defining and understanding natural resources, with its focus on human action and creativity, opens up a series of issues that go at the very core of two radical different ways of understanding the world and the future.

That being said, *pure* economic foresight does have its shortcomings, due to the nature of technology. We have reached here a crucial point in our argument, namely that not all technology is the same – different technologies influence the structure of economic incentives in different ways. We can thus *classify technology based on its economic effects, especially relative to its 'creative destruction' potential*. In analysing and forecasting technological development we need to consider these different types of technology, each having a widely different potential impact on society and involving different structures of incentives. An important set of distinctions could thus be introduced. This is obviously a very complex issue, requiring a detailed analysis, especially when one is actually doing a foresight analysis. However, for the sake of our argument, which overviews foresight practices from a meta-level, we do not need to enter in all these important details. It is sufficient for us here to just roughly distinguish among three main types of technology domains: resource extraction, consumer products, and what we'll call 'technological platforms'.

Resource extraction methods (or resource creators) are technologies that allow us to obtain more resources from the same physical substrate, e.g., new oil extraction technologies or better processors providing more computing power. From an economic point of view, the development of resource creators can be forecasted with the same ease as the development of consumer products. The notion of 'technological platform' could be explained using an example: the combustion engine is a technological platform, while individual brands of automobiles, motorcycles, buses, etc. are consumer products built on that platform. There are technological platforms for resource creators as well. For example the genetic engineering technology is a novel platform for increasing agricultural output applicable to a whole range of crops and which, at least to some extent, competes with the traditional usage of pesticides and fertilisers.

Yet, simple as it is, the distinction between *consumer products* and *technological platforms* is important when assessing the challenges faced by the foresight practice because new platforms are potential game changers, the technological equivalent of 'paradigm shifts' in the evolution of science. Economically speaking, they are akin to Schumpeter's process of 'creative destruction'. Therefore, it is understandable why the *economic* forecast analysis for consumer products is easier to conduct than for technological platforms. Although we cannot of course predict the exact products that will be developed, we can make broader predictions such that if an expensive consumer product sells well, other firms will produce substitutes and the price for that kind of consumer product will decrease. Such an analysis is however virtually impossible to conduct in regard to technological platforms as the reason for their development is more complicated than a simple reaction to price incentives. The existence of network effects (more people adopt a platform greater the incentive for others to adopt the platform as well) and path dependency further complicates any long term extrapolation (the adoption of a platform may depend on various hard to predict contingencies). One may say that, unlike the case of successful consumer products, if a technological platform proves

successful, the incentive is much lower to produce competing platforms to act as substitutes. On the contrary, the incentive is usually to quickly develop products on the new platform, even if this involves paying the original developer that holds the patent for the platform. Technological platforms thus open up entirely new opportunities to be speculated by entrepreneurs. We thus see that the structure of incentives created by successful platforms is radically different from the one created by successful consumer products. Different types of technology generate different types of economic effects, and it is for this reason that foresight cannot afford to be technologically blind either. We need to consider both matters of technology and matters of economics.

To conclude, by introducing the distinction between technological and economic foresight, and the notion of 'technological platform', we are now in the position to understand a primary and basic aspect that will make forecasting practices more difficult in the 'new era'. The new environment based on the dynamics of human capital and new knowledge creation increases the probability of the emergence of more and more varied new technological platforms. These are game changers and they are difficult to predict in concrete terms, and their consequences are even more difficult to predict. Both the standard technological and the economic approaches are rather ineffective in this regard. Even in the conditions of a classical industrial society such creative consequential technological transformations were difficult to foresee. But the continuous flux that characterises the information society, with its communication flows and transfers of knowledge as well as its changing incentives structures, make things even more difficult to predict. Also, in the light of this more nuanced view of forecasting (a view developed using the distinction between economic and technological forecasts) we can see that the crucial issue of what is considered a 'resource' becomes more problematic. And human resources are even more complex, volatile and hard to anticipate than capital and physical resources. To sum up, the keys of this analytical narrative of the challenges embedded in the new economy and new society are what we called the new 'technological platforms' and the new dimensions and meanings acquired by the 'resources' variable. That should not come as a surprise: these are in fact typical examples of what Kahn has meant when he developed his approach based on variables and classes of variables.

4 Foresight challenges in the new economy

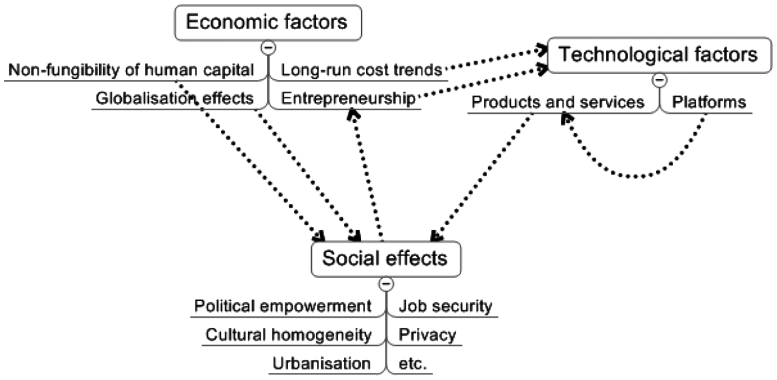
Any discussion of the problems and difficulties generated by the new configuration created by the new knowledge economy should never forget to mention that the past challenges to foresight *remain fully alive today*. The new challenges are *on top* of the old ones. So far, we suggested that social foresight exercises in the new era could only benefit if they acknowledge:

- the importance of taking into account the distinction between consumer products or resource extraction methods on one hand and 'technological platforms' on the other hand
- the fact that technological developments do not just happen by themselves but are constrained by economic factors such as consumer demand and are stimulated by economic factors such as price incentives

- the fact that human capital has become a very important variable by the sheer massive role that it now occupies in the economic performance of the new economy.

The first two ideas help us preempt major sources of errors in the practice of foresight, while the third describes one key variable defining the specific nature of the new economy. These ideas are the background on which we could now make some steps further in addressing some aspects of the new or increased forecasting problems and difficulties in the new economy. The complexity of the situation is hinted by Figure 1.

Figure 1 The complex interaction between economic, technological and social factors



4.1 Economic foresight challenges

The fact that the information society increases the size of the market, increases the global economic interconnectedness, and generates new levels of complexity in uncontroversial. No doubt, that makes forecasting more difficult. As Simon (1995) and Lucas (2002) point out, in the presence of the institutions underlining capitalism, the increase in population contributes to economic progress rather than hampering it. Seen from this point of view, focusing on the 'ultimate resource', namely people and the human capital they represent, the interconnectedness created by the information society, the increasingly wide-spread adoption of market reforms, and the freer trade relations brought by globalisation amount to an increase in the population of the global system. Consequently, following the logic of Simon's argument, the amount of innovation in the world, and thus the speed with which the system changes, has become and is expected to continue faster rates than before. Indeed, one could consider the impact of the increased market size upon more specific issues, such as the nature of diversity, the human resources and the labour market, and entrepreneurship. Each of these specific issues brings its own brand of foresight challenges. The overall result is obvious: whatever progress of forecasting techniques and technologies we make, it is very likely that it will be offset by the complexification of the society.

4.2 Localised diversity and global homogeneity

The economics of culture is a useful reference in the discussions about the challenges posed by the new economy driven by the information and knowledge revolution. Cowen (2002) explores a wide variety of examples in significant detail and draws the

conclusion that globalisation generally leads to increased diversity within countries (an average individual has access to an ever expanded 'menu of choice'), while decreasing diversity among countries (different countries increasingly have the same 'menu of choice'). In other words, diversity becomes less geographical in nature and more of a feature of every single place. This insight applies not just to culture but to technology in general. The increased localised diversity makes every place more and more unpredictable, while the overall global homogeneity makes innovations, as well as problems, spread very fast. The process by which this happens is demand-driven: As the market becomes more globalised, thanks to communication technology and transportation, it becomes easier to find customers for niche products. This is what increases the production diversity *within* each place. Increasingly, niche producers can make profits, and these niche products can be bought from everywhere.

This trend can be redefined in terms of technology. For instance, what we've called 'technological platforms' tend to become more universal, while diversity tends to concern the consumer products made on these platforms. For example, Cowen points out that handweaving in various parts of the world received a boost not just thanks to higher demand from distant places, but also thanks to a Western technological platform – machine-made yarn, replacing hand-made yarn. Machine-made yarn is now utilised by traditional handweavers throughout the world, each handweaving tradition having their own particular style. Moreover, this technological platform allowed them to focus on design creation rather than on the more tedious process of making the yarn. The upside for the practice of forecasting is that prediction about consumer products may be, in some cases, easier, and thus this increased localised diversity may not lie entirely outside the grasps of economic analysis. The downside is that when new and successful platforms get developed, they impact wide areas, perhaps even the entire world. Thus, precisely the largest developments with the widest impact are the least amenable to prediction.[1]

4.3 The relative scarcity of human capital

Simon (1995, p.13) has made an apparently paradoxical remark which is very significant for our discussion:

> "Only one important resource has shown a trend of increasing scarcity rather than increasing abundance. It is the most important and valuable resource of all – human beings. Certainly there are more people on earth now than ever before. But if we measure the scarcity of people the same way we measure the scarcity of other economic goods – by how much we must pay to obtain their services – we see that wages and salaries have been going up all over the world, in poor countries as well as in rich countries. The amount that one must pay to obtain the services of a barber or a professor has risen in India, just as the price of services of a barber or a professor has risen in USA over decades. This increase in the price of people's services is a clear indication that people are becoming more scarce even though there are more of us."

There are two main explanations for this development, both of which have to do, at least to some extent, with information technology. Focusing on them will allow us to further explore the problems of foresight in the 'new era'.

Communication technology enhances the competition for workers among firms, as information systems for finding jobs allow one to explore a much larger number of available options. This leads to a faster increase in wages and salaries. To put it

differently, prospective workers are better informed and are better equipped to find the best opportunity. It is also the case that information technology allows firms to outsource many jobs in the services sector to workers throughout the world (Friedman, 2005). This contributes significantly to the increases in income in poorer countries, e.g., India. This development is obviously closely related to the increased size of the market brought about by the information revolution.

This rather straightforward economic effect is compounded by the following associated development: labour also becomes scarcer because *the diversity of the types of available job positions increases*. In other words, the supply of workers *per job position* does not increase fast enough to lead to a decrease in wages. We can see the increased labour scarcity as a symptom of the diversification of the labour market. This particular development brings the biggest challenge to the foresight practice because the evolution of the economic 'ecology' of job positions is highly dependent on what we've called 'technological platforms'. It has long been recognised (Schumpeter, 1942) that the biggest social problems associated with the process of creative destruction concern the fact that the technological skills of a large number of people are made obsolete by the development of new technologies. And foresight challenges are generally enhanced by all phenomena that may generate massive social change and radical restructuring. Any type of foresight is difficult in such circumstances.

We can restate the problem from a slightly different angle: Given the nature of the new economy, in which human capital matters to an unprecedented level, the complexification of the labour market, on a global scale, is a factor that multiplies the foresight problems. The new developments of the labour market are important not just due to potential social problems, but also because the dynamics of the labour market is directly related to the rate of social changes. For example the economic boom of the 1920s and later of the late 1950s seems to have lead to more economic opportunities for women and, as a consequence, has lead to an increase in their marrying age and childbearing age. Thus, changes in the labour market can have widespread social and cultural consequences. Such consequences, no doubt that important as they are for the foresight practice, are at the same time very difficult to predict. To some extent, this source of uncertainty has to do with the limitations of our present theoretical understanding of globalisation. The interplay between economic factors on one hand and cultural and social factors on the other hand is an important but under-explored subject. Yet, one should be realistic and acknowledge that in many cases theoretical understanding does not translate and could not translate into better foresight capabilities.

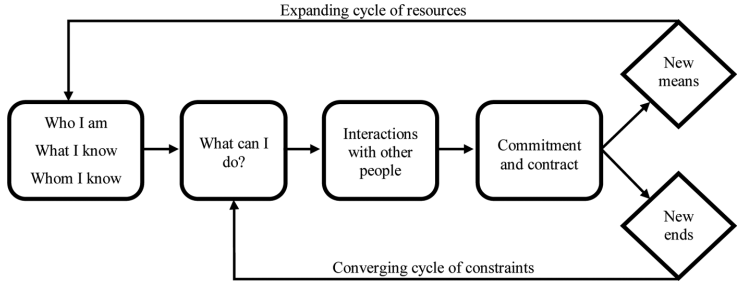
4.4 Entrepreneurship in the era of social networking

Perhaps the most important facet of the new knowledge economy concerns the phenomenon of entrepreneurship itself. The information technology, more specifically the social networking aspect, can be seen as a great enhancer of entrepreneurship. According to Sarasvathy (2001, 2003), Sarasvathy and Dew (2009), entrepreneurship-and-management is a dual process by which an agent, on one hand, selects a goal in service of which to employ his or her available means (entrepreneurship) and, on the other hand, if the goal is known, selects the best means for achieving it (management). One of the most important discoveries about how actual entrepreneurs work is the understanding that, at least in the early stages if not always, entrepreneurs are not trying to maximise of even to obtain profits, but work on the principle of acceptable loss

(Sarasvathy, 2001). They have a certain amount of resources they are willing to spend while doing something they like; sometimes this leads to an expanding business, in which case, management eventually enters the picture.

According to Sarasvathy and Dew (2009), the entrepreneurial activity starts with the actual means available to the entrepreneur, i.e. "Who I am/What I know/Whom I know" and involves the interplay of two complementary processes, dubbed the "expanding cycle of resources" and the "converging cycle of constraints", the first involving the discovery of new means, and the second involving the discovery of new goals (made possible by the expanding resources, human and otherwise), Figure 2. The entrepreneurial activity is highly social involving an epistemic aspect (interacting with various people in order to find out about the various services they can, in principle, provide to you or you to them) and a commitment aspect (forging contracts with various parties and securing their commitment in regard to various forms of collaboration for mutual benefit).

Figure 2 How an entrepreneur works



Source: Slightly modified from Sarasvathy and Dew (2009)

The social networking impact on entrepreneurship has to do with the "expanding cycle of resources". (The "converging cycle of constraints" has to do with issues concerning the labour market, which we have addressed in the previous section.) The greatly enhanced social networks brought about by information technology create unprecedented levels of opportunities for social collaboration, i.e., for finding partners. It is easier to expand the available means and thus new, previously unthinkable, goals also become possible. The downside of internet-based social networking concerns the "commitment and contract" stage: it's unavoidable that the strangers one finds on the internet are less trustworthy than those one gets to know in person for a prolonged period of time (the way business partners traditionally are).

Before addressing the challenges to the foresight practice brought about by the enhancement of entrepreneurship by means of social networking, it is interesting to note that we already have a great example of this phenomenon (although it is not usually described and understood from an entrepreneurial point of view). We are referring to the open-source communities. Although the new theory of entrepreneurship we mentioned above was not created in order to describe the open-source movement, but as a generalisation of observations of how mainstream 'normal' entrepreneurs behave, the theory applies in a telling way to the open-source case. It is an important to note that others (e.g., Benkler, 2006) have portrayed the open-source communities as 'non-market'. The reason for this characterisation is that they identify the market with the profit motive and open-source communities work as gift economies. However, as mentioned above, in some of its facets, entrepreneurship, not just in open-source

communities but in general, is not concerned with the profit motive, but works on the basis of acceptable loss (Sarasvathy, 2003). This is precisely how the open-source communities work (Raymond, 1999). The acceptable loss is the time spent on creating the program.[2] Thus, the open-source communities are actually examples of entrepreneurship in action. It is interesting however that, as Raymond underlines, the open-source community culture and rules of conduct have developed in a very un-self-aware manner. They developed spontaneously in a way that we now recognise as being a *limit case* illustrating a basic theory of entrepreneurship. We now return to the general case.

From the perspective of the foresight practice, this social networking development creates a significant challenge. As entrepreneurs are empowered, the world becomes even more dynamic and unpredictable. Interestingly, as Sarasvathy's research shows, this does not seriously hamper entrepreneurial behaviour itself (although it does make management more difficult) as entrepreneurs tend to see uncertainty as a pool of opportunities rather than as a source of problems. This is a very interesting observation. Our first reaction is to ask: How about our attempts at foresight? Can this kind of mental stance be also available to the futurologist? Or is the futurologist doomed to be overwhelmed by unpredictable details and uncertainty? We return to this issue in a subsequent section below, because in it one may find one of the crucial points of our paper.[3]

4.5 Technological foresight challenges

The favourite topics for technological foresight are probably biotechnology and artificial intelligence. While these are certainly matters that fully deserve the attention received, in the context of our paper we shall continue to focus on the issue of resources. The starting point is the distinction between *physical* resources, *human* resources and *information* as a resource. The foresight challenges related to these three types of resources are distinct. The concept of information as resource has already been addressed both in regard to the issue of knowledge dissemination and in regard to its relation to human capital. We now briefly cover the other two.

4.6 Uncertainty about new energy sources

We have already introduced the argument that resources are not so much 'extracted' but 'created'. While this is somewhat unintuitive in the case of mineral resources, it is quite obvious in the case of other resources such as computing power or hard disk space. However, perhaps the biggest uncertainty about a resource in the long run (i.e., decades to a century) concerns energy itself. The uncertainty has to do with the fact that there are various possible future technological platforms and these technological platforms have radically different potential social and economic consequences. The time frame for these potential developments is also important, in the sense that it may matter a lot which is first. Sequencing matters.

The two technologies that seem to support the largest departures from our present situation are solar technology and fusion reactors. The main reason why solar technology is interesting to consider is that it holds the promise of making every household (or small groups of households) *energy independent*. One could conjecture that such a society would be incredibly resilient to a wide range of possible disturbances. In combination with communication technology, allowing a wide range of remotely provided services,

such a society will probably develop a significantly more individualistic outlook. Such developments would undermine to a certain extent the existing incentives structure for people to group into large cities. The result could be the dissolution of existing cities into smaller and more dispersed high-tech communities, but highly interconnected at a global scale. On the other hand, the main attraction of fusion power plants is that they would provide virtually limitless clean energy (New Scientist Editorial, 2006). A fusion power plant may extract from sea water 10–100 thousand times more energy than we obtain now from an equal amount of gasoline. Such huge amounts of energy would open tremendous possibilities. Unlike the case of solar power, such power plants would be, if today's standards are of any guide, quintessential governmental enterprises.

The point of such contrasts is to underline the wide range of possible futures. What happens in the domain of energy may alter the social structure of our societies in a very dramatic way. However, there are so many factors involved, both on the technology side and on the economic and entrepreneurial side, that any claim of being able to make point-predictions should be met with unreserved scepticism.

4.7 The impact of communication technology on society

Arguably among the most interesting new technologies to look for in the near future are the new platforms facilitating work related social interactions. One may conjecture that while classic technological platforms of the industrial era are designed for consumer products or resource extraction methods, the technological platforms of the new economy may be designed for enhancing human capital. Moreover, in the same way as in the industrial economy the customers of new production technologies are firms rather than individuals, it is to be expected that the main customers of the social networking services in the new economy will eventually also be mainly firms. Economic history teaches us that capitalism has developed from craft production to factory production to mass production (Cowen and Parker, 1997, Chapter 2). So why not conjecture that we may now be in regard to the information society at a rather primitive production level, i.e., craftsmanship level, in which the social networking services are still mainly utilised by individuals rather than by firms and corporations? If the last 15 years suggest anything, it is that, in terms of communication, networking and social technologies, the world could change very fast indeed.

Another probable development with a wide range of unforeseeable consequences involves search-and-match technology. Search involves an individual looking for something, while match involves another agent (firm or government) matching the individual's past actions with a prediction (e.g., for advertising and/or recommendation purposes in case of businesses or for criminal profiling in case of governments). The technology involved in search is virtually identical to that involved in matching. At present, search-and-match technology, very much like old economic theory, is based on the hypothesis that individuals are interchangeable. For example when one does a Google search, the web engine displays a list of items ranked according to the valuations of other people with whom the searcher may have nothing in common. The main point is that the search engine delivers the same result to everybody, the results are not calibrated to the individual.[4] A good prediction, i.e., one that takes into consideration the non-interchangeability of people, is not an average made over the *entire* database,

but only on a *small sub-set* of the database. The technical problem of course is to find how to partition the database correctly, without losing relevant data in the process, such that the predictions would become much better than they are now. Such a development is likely to be achieved and thus the search-and-match technology is likely to become much more individualised. For example, Google has already started to individualise search results based on user's geographical location. This is a far cry from what it is possible in principle, but nonetheless it is probably a sign of the incoming trend.[5]

In the context of our own argument, the specific point is that advanced search-and-match technologies may become very important in shaping the way the labour market will function. As the scarcity of human capital and the diversity of possible job positions increase more and more, at the same time as the market for many services becomes globalised, search-and-match technology will become an essential tool shaping the labour market and facilitating its efficiency. And here is the foresight problem: we have no idea what exact form will such technologies take and what their operating details will be; we do not know what their error margins will be, i.e., how efficient the labour market will really be, and what side-effects in terms of social changes and problems they will generate.

Finally, another interesting prospect to consider is the political use of communication technology for democratic purposes. This may be a double edge sword. On one hand, it can make political involvement of regular citizens much cheaper and easier. As such, it can aggregate local knowledge about local issues, the problems may be framed to a larger extent by the citizens themselves rather than by politicians and the traditional media, and it can help citizens to organise into pressure groups and empower them to an unprecedented level. On the other hand, communication technology may lead to wide spread direct democracy. In the absence of strong constitutional rights establishing which are the rights that an individual cannot be deprived of by any means (democratic or otherwise), these direct democracies could vote on a wide range of issues and trample over the individual rights of various people finding themselves in the minority over one issue or another. None of the present constitutional systems seems to be ready for such a technological development, and thus, a technologically facilitated direct democracy may in fact lead to a bizarre and unprecedented form of depersonalised tyranny.

These examples illustrate in a broad and conjectural way the social impact communication technology is likely to have in the relatively near future as well as the great uncertainties introduced. What they have in common is the fact that they are human-centred, they involve the enhancement of human potential and productivity, they appeal to human desires, and the facilitation of collective action. Yet, by reducing uncertainty in some social areas they, at the same time, introduce uncertainty in other areas.

5 Two approaches to foresight

Even this brief overview of the challenges to foresight practice brought about by the new information technologies highlights the fact that we are dealing with a wide range of very different types of problems and/or uncertainties. This focus on newly created uncertainties leads us back to the afore-mentioned distinction between the managerial approach and the entrepreneurial approach to dealing with uncertainty. It is quite obvious

both that the standard approach in futures studies resembles the managerial stance more, and that the managerial approach is less able than the entrepreneurial one to deal with massive amounts of uncertainty. So, one is lead to ask the following question: Can the entrepreneurial mental stance be also available to the futurologist? Can the attitude and approach that we have earlier described as entrepreneurial be replicated in futures studies? Or is the futurologist doomed to be overwhelmed by unpredictable details and uncertainty? We conclude our essay with an attempt to outline the beginning of a possible response.

The importance of distinguishing *prediction* from *explanation* is an important theme of futures studies (Aligica, 2003, 2009). We think that this point of view could be bolstered by the aforementioned theory of entrepreneurship. That move allows one to redefine to some extent the task of the futurologist. The usual weight given to prediction and the desire to identify explanation with prediction (i.e., a phenomenon is considered explained only if it is predicted by a theory) is due to the fact that it then seems that the only way in which one can decide *objectively* which of the available theories is better is to use them to produce predictions and then test those predictions empirically. This is the approach suggested by logical positivist epistemology.[6] However, the main problem with this view inspired by the hard sciences is that it is usually inapplicable (or very difficult to apply) to the social sciences. Social scientists, historians, and for that matter futurologists, often create explanations of various phenomena in the absence of general theories. Such explanations are not predictions of a theory in the standard epistemological sense. They are also difficult to use for making predictions. In this case, how do we cope cognitively with the future, especially when it is an increasingly dynamic and complex future?

We tentatively suggest exploring the beginning of an answer going back to the very notion of entrepreneurship we introduced earlier. For the entrepreneur, *a good conceptual framework is that which allows one to spot the available opportunities as fast as possible*. In other words, it is a pragmatic approach. The point is not to *predict* the future in the positivist sense, but to pragmatically detect/imagine a whole set of possible futures that are all likely to present to us various opportunities as well as challenges. From an epistemological standpoint, this is a pragmatist stance. If the explanation on which we are relying to guide our actions is correct, our actions will more likely be successful. If, by contrast, we are relying on mistaken explanations, we will involuntarily steer ourselves toward a dead end on a road devoid of favourable opportunities.

It is now clear that we can redefine the task of the futurologist away from the traditional predictive task to a pragmatic approach in which the explanatory task is inspired by the entrepreneurial mindset. Identifying and coping with the general challenges brought about by the new economy should thus be seen from this perspective. The ultimate goal is to develop proper conceptual frameworks that could work in practice. Our emphasis on the necessity to combine technological and economical foresight or on the distinction between technological platforms and consumer products should be seen exactly from this perspective. We are not aiming at building precise predictive theories but at setting the stage for flexible conceptual tools able to guide our foresight practice through the maze of dynamic complexity brought about by the new information technologies.

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Notes

[1]Cowen's insights into the workings of globalisation are even more relevant when considered from the perspective of new trade theory (Krugman, 1979, 1980). Krugman's theory explains why countries trade in similar products, a phenomenon that seems to be at odds with the classic comparative advantage explanation of trade. In the context of globalisation, the most important effect of this non-classical trade pattern is that the amount of localised diversity is much larger than one would have expected based on a rough comparative advantage analysis. We may witness brand diversity even in regard to niche products.

[2]An open source programmer usually wants/needs a program that does something and, if an acceptable program does not exist, she or he creates it; once the program (or piece of program) is created in its basic, usually not very user-friendly, form, it is in the interest of the original programmer to make it public (open source) because this way others may come along and improve it further. Besides this interest in having a good program that does something useful (that the original programmer wants/needs), the original programmer may also want to make money from the created program. However, if she or he keeps the code secret, this goal conflicts with the goal of improving the program and hampers the attempt to co-opt others as partners, especially as unpaid partners. In other words, open-sourcing the code is the *solution* found to the "commitment and contract" problem we mentioned above. If the code is kept proprietary virtually no one is willing to contribute to it for free. This type of incentive structure applies even more forcefully in case of technological platforms rather than consumer products. It is thus no wonder that the most successful open-source products, Linux operating system, the Apache Web Server, the MySQL database language, and the PHP programming language, are technological platforms. Interestingly, the technological infrastructure of Internet is predominately the output of the open-source production system.

[3]One important remark about foresight difficulties in the 'new era' and the changes in entrepreneurship made visible by the open-source movement, is that these foresight challenges are not only of academic interest. They concern the public at large as well. The open-source business model differs from the proprietary business model in a very interesting way: Customers buying closed-source products provide the producer a *prize* for novelty, while sponsors of open-source producers give them *grants* for development and receive the novel versions of the product for free. This difference between supporting a producer via prizes or via grants has many implications (Hanson, 1998; Cowen, 2007). We want to emphasise the following one: when people sponsor open-source projects (usually by means of donations) they are actually paying for the perpetuation of familiarity (DiBona *et al*., 1999). In other words, the grant system of paying producers, specific to the open-source community, can be seen as a reaction to the ever faster pace of technological change. One is paying for the future development of the products one is currently using such that one can minimise the amount of necessary learning and re-adaptation to non-familiar products.

[4]Similarly, Amazon or Netflix recommendations are not properly individualised as these recommendations are based on computed averages over the valuations of *all* the other users (although only a small sub-set of those users are good predictors).

[5]The possibilities created by advanced search-and-match technologies rightly generate a wide range of reactions that mirror the uncertainties regarding the possible consequences. On the positive side, advertising may finally become useful and informative, or police would be able to catch more criminals while troubling fewer innocents. On the negative side, privacy may become an extinct concept and dictatorial governments throughout the world may have the perfect tool at their disposal to stifle any possible opposition. At present, one of the main reasons why one finds so much freedom on the Internet is because of anonymity, but this anonymity exists mainly because the search-and-match technologies are very poor.

[6]For example Sarasvathy's theory of entrepreneurship is a good theory by this strong standard because, as we have seen, it describes social phenomena (such as the open-source communities) which it was not specifically designed to describe, i.e., it predicts phenomena outside the original dataset.