



Technological Growth and Unemployment: A Global Scenario Analysis

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Abstract

The aim of this article is to explore the possible futures generated by the development of artificial intelligence. Our focus will be on the social consequences of automation and robotisation, with special attention being paid to the problem of unemployment. In spite of the fact that this investigation is mainly speculative in character, we will try to develop our analysis in a methodologically sound way. To start, we will make clear that the relation between technology and structural unemployment is still controversial. Therefore, the hypothetical character of this relation must be fully recognized. Secondly, as proper scenario analysis requires, we will not limit ourselves to predict a unique future, but we will extrapolate from present data at least four different possible developments: 1) unplanned end of work scenario; 2) planned end of robots scenario; 3) unplanned end of robots scenario, and 4) planned end of work scenario. Finally, we will relate the possible developments not just to observed trends but also to social and industrial policies presently at work in our society which may change the course of these trends.

1. Technology and Unemployment: The Vexata Quaestio

While discussing the role of slavery and the difference between instruments of production and instruments of action, Aristotle (350 B.C.E.) states that “the servant is himself an instrument which takes precedence of all other instruments. For if every instrument could accomplish its own work, obeying or anticipating the will of others, like the statues of Daedalus, or the tripods of Hephaestus, which, says the poet, ‘of their own accord entered the assembly of the Gods’; if, in like manner, the shuttle would weave and the plectrum touch the lyre without a hand to guide them, chief workmen would not want servants, nor masters slaves”. In other

words, if automata were sophisticated enough to replace humans in every activity, slavery and work would be unnecessary.

Analysing the motives behind the revolt of the Luddites, in 18th and 19th century Europe, Karl Marx (1867) made a sarcastic comment on Aristotle's philosophy of technology: "Oh! those heathens! They understood (...) nothing of Political Economy and Christianity. They did not, for example, comprehend that machinery is the surest means of lengthening the working-day. They perhaps excused the slavery of one on the ground that it was a means to the full development of another. But to preach slavery of the masses, in order that a few crude and half-educated parvenus, might become 'eminent spinners,' 'extensive sausage-makers,' and 'influential shoe-black dealers,' to do this, they lacked the bump of Christianity."

Both the Luddites and Marx have noticed that machinery did not free humans from labour, but rather caused unemployment and the inhumane exploitation of those still employed. However, they proposed different remedies. As is well known, the Luddites saw the solution in the destruction of the machines,¹ while Marx and the socialists preached that the proletarians would benefit more from a revolution aimed at taking full possession of the machines (the means of production). It is worth noting that not only the anti-capitalist front, but also a supporter of free market economy like John Stuart Mill (1848) was honest enough to admit that "it is questionable if all the mechanical inventions yet made have lightened the day's toil of any human being."

Since then, it has been restlessly debated as to whether technological development really frees humans from work, or on the contrary produces more exploitation and unemployment. There is a copious literature supporting the first or the second thesis, spanning over the last two centuries. And the debate is still going on.

The theory that technological change may produce structural unemployment has been repeatedly rejected by neoclassical economists as nonsense and labelled 'the Luddite fallacy.' These scholars contend that workers may be expelled from a company or a sector, but sooner or later they will be hired by other companies or reabsorbed by a different economic sector.

It is however well known that economics is a multi-paradigmatic discipline. Therefore, supporters of the idea of technological unemployment keep appearing on the stage. In the 1990s, right after the beginning of the Internet era, a few influential books focusing on the problems of automation and artificial intelligence appeared. Among these, we may cite books like *Progress without People* by David F. Noble (1995), *The End of Work* by Jeremy Rifkin (1995), or *Turning Point* by Robert U. Ayres (1998).

Noble stands in "defence of Luddism" and moves accusations of irrationalism to "the religion of technology" on which modern society is supposedly based. According to him, "in the wake of five decades of information revolution, people are now working longer hours, under worsening conditions, with greater anxiety and stress, less skills, less security, less power, less benefits, and less pay. Information technology has clearly been developed and used during these years to deskill, discipline, and displace human labour in a global speed-up of unprecedented proportions (Noble 1995: XI)."

Rifkin points out that people that lose a low-skilled job often lose the only job they are able to do. Many of people involved for instance in assembly or packaging can barely read and write. They are on the lowest rung of ability and learning. However, the new job that arises from the machine that 'steals' their job is one involving taking care of that machine, which often requires high school computer programming, if not a college degree in computer science. These are in turn qualifications requiring abilities at the higher end of the ladder. In brief, "it is naive to believe that large numbers of unskilled and skilled blue and white collar workers will be retrained to be physicists, computer scientists, high-level technicians, molecular biologists, business consultants, lawyers, accountants, and the like (Rifkin 1995: 36)."

Finally, Ayres emphasizes the fact that, even if we admit that workers can be relocated, new jobs may be less satisfactory than old jobs, in terms of wages, fulfilment, and security. And this is not an irrelevant aspect. This is evidence that globalization and automation are good for some social classes and bad for others. Indeed, “many mainstream economists believe that in a competitive free market equilibrium there would be no unemployment, since labor markets – like other markets – would automatically clear. This means that everyone wanting a job would find one – at some wage.” The problem is that “there is nothing in the theory to guarantee that the market-clearing wage is one that would support a family, or even an individual, above the poverty level (Ayres 1998: 96).”

The reaction to these works is in the same vein as criticism of previous Luddite predictions. The main argument against the thesis that automation produces structural unemployment is that the many times predicted catastrophes never happened. The rate of unemployment may go up and down, but it never happened that technological change has produced an irreversible crisis. Ten years ago, Alex Tabarrok (2003) confessed to be “increasingly annoyed with people who argue that the dark side of productivity growth is unemployment.” He added that “the ‘dark side’ of productivity is merely another form of the Luddite fallacy – the idea that new technology destroys jobs. If the Luddite fallacy were true we would all be out of work because productivity has been increasing for two centuries.”

Apparently this is an invincible argument, but it did not stop predictions of technological unemployment. The reason is simple: Tabarrok reaches his conclusion by means of inductive reasoning. The premises of an inductive logical argument provide some degree of support for the conclusion, but do not entail it. That is, the fact that the catastrophe did not happen until now does not imply that it cannot happen today or tomorrow. After all, every technological change is qualitatively different from the previous ones. In particular, the novelty of the present situation is that artificial intelligence and its products (computers, robots, industry automation, Internet, etc.) intertwine with globalization – AI unfolds in a situation in which nation-states have a limited possibility to implement corrective policies. There is also a suspicion that not only the speculations of the bankers but also accelerating computer technology have contributed to the genesis of the financial crisis which exploded in September 2008 with the bankruptcy of Lehman Brothers. This is, for instance, the point made by Martin Ford in his *The Lights in the Tunnel* (2009).

On 13th June 2013, Nobel Prize winner Paul Krugman added his voice to this debate with an article significantly entitled “Sympathy for the Luddites.” This economist recognizes that, in the past, the painful problems generated by mechanization were solved thanks to the more intensive education. However, the problems generated by artificial intelligence are not solvable the same way, because they effect educated workers as well. Thus, today, “a much darker picture of the effects of technology on labor is emerging.” Krugman reminds us that

The McKinsey Global Institute recently released a report on a dozen major new technologies that it considers likely to be ‘disruptive,’ upsetting existing market and social arrangements. Even a quick scan of the report’s list suggests that some of the victims of disruption will be workers who are currently considered highly skilled, and who invested a lot of time and money in acquiring those skills. For example, the report suggests that we’re going to be seeing a lot of ‘automation of knowledge work,’ with software doing things that used to require college graduates. Advanced robotics could further diminish employment in manufacturing, but it could also replace some medical professionals.

In the present investigation, we will tentatively assume that the picture drawn by Krugman and others is correct, and we will try to extrapolate possible futures from it. The debate seems

to be mainly crystallized on the dichotomy “technology is bad” (Luddites, technophobes) versus “technology is good” (anti-Luddites, technophiles), but it is worth noting that there are many more armies on the battlefield. As we have seen above, Marx built his own value judgment by taking into account one more variable: the system. In short, his position was “technology is good, the system is bad.” This third position disappeared somehow in the shadow in the second half of the 20th century, for many reasons that I cannot discuss here, but it seems to be an indispensable one. One does not need to be a revolutionary socialist in order to ask for a more complex analytical model. Krugman (2013) also points his finger at the degeneration of the system, more than at technology itself. The Nobel Prize winner stresses that

the nature of rising inequality in America changed around 2000. Until then, it was all about worker versus worker; the distribution of income between labor and capital – between wages and profits, if you like – had been stable for decades. Since then, however, labor’s share of the pie has fallen sharply. As it turns out, this is not a uniquely American phenomenon. A new report from the International Labor Organization points out that the same thing has been happening in many other countries, which is what you’d expect to see if global technological trends were turning against workers.

As a response, he does not propose to get rid of the machines, but to activate a policy of redistribution of wealth, “one that guarantees not just health care but a minimum income, too.” Note that he is not asking for a radical change of the system, as Marx does, but just to fix it. Therefore, it is important to elaborate a model capable of taking into account positions with a focus on the system, and of different types, like those of Krugman or Marx.

2. Some methodological tools for scenario analysis

Many futurological speculations follow a simple pattern: they always and invariably see technology as a cause and social structure as a consequence, never the other way round. Therefore, the attitude toward technology becomes the one that really matters. In other words, these theories do not give much weight to the role that social and industrial policies can play in shaping the future. This typically happens when futurologists are also engineers. They know better than anybody else how technologies are produced and work, but they also tend to underestimate the complexity of the social, political, and economic world. On the contrary, social scientists teach us to view social problems in a more complex way, to be aware that it is often hard to distinguish cause and effect, and that the forecasts themselves sometimes bring about the very process being predicted – the so-called ‘self-fulfilling prophecy’ (Merton 1968: 477). In the social reality, one more often observes a chaotic interaction between different variables, rather than a simple cause and effect chain.

The society of the future will partly depend on structures inherited from the past that cannot be easily changed. Some of our behaviors depend on what sociologists call ‘social constraint,’ on what philosophers call ‘human condition,’ and on what biologists call ‘human bio-physical constitution’ – all variables that change very slowly. However, the future will be partly shaped also by crucial decisions of powerful people and by the predictions of influential futurologists. Even if the different attitudes and beliefs of individuals (Terence McKenna would call it ‘the cultural operating system’) can be rather stable and randomly distributed in society, the equilibrium of power may change in a sudden and unpredictable way. The rulers

may become the ruled. Marginal worldviews may become mainstream ideas. So, what really matters is the attitudes and beliefs of the ruling class (politicians, bankers, entrepreneurs, top managers, scientists, opinion leaders, etc.) *in the moment* in which crucial decisions have to be taken. That is why, to draw pictures of possible futures we need models (attitudinal typologies) a little more complex than a simple dichotomy ‘technophobes vs. technophiles.’ To start we propose an attitudinal typology that combines ‘technological growth’² and ‘the system.’ We will call ‘growthism’ a positive attitude to technological growth and ‘degrowthism’ its antonym. We will call ‘conservatives’ those that support the invariance of the system and ‘revolutionaries’ those that want to change it.

A. Attitudinal Typology toward ‘Technological Growth’ and ‘The system’

		The system	
		accept	reject
Technological growth	accept	Conservative Growthism	Revolutionary Growthism
	reject	Conservative Degrowthism	Revolutionary Degrowthism

In order to talk about a truly revolutionary ‘system change’ we will stipulate here that at least points 5 and 7 of Marx and Engels’s *Manifesto* (1888) must be fulfilled, namely: a) “Centralisation of credit in the hands of the state, by means of a national bank with State capital and an exclusive monopoly”; b) “Extension of factories and instruments of production owned by the State.” As a consequence, we would say that a system change (or revolution) had occurred in EU and USA, if and only if the two central banks (BCE and FED) were nationalized and the robotized industries of the two countries were owned by all citizens.

When it comes to promoting or opposing technological growth, we may find different perspectives: some believe that technology develops in a spontaneous way, while others believe that governments (even in capitalist countries³) play a crucial role in shaping science and technology by mean of industrial policies. Obviously, as often happens, the truth is somewhere in the middle. We may find historical examples supporting the first or the second idea. It is however important what the ruling class believes, and here again we may have various combinations between attitudes.

B. Attitudinal Typology toward ‘Technological growth’ and ‘Industrial policies’

		Industrial policies	
		accept	reject
Technological Growth	accept	Programmed Growthism	Spontaneous Growthism
	reject	Programmed Degrowthism	Spontaneous Degrowthism

Finally, when we shift attention from technology to people, we may find other combinations of attitudes. Among growthers, some are happy with the market distribution of wealth, while others call for the social redistribution of wealth. The same divide may appear also among degrowthers. It is important to emphasize, once again, that social policies do not necessarily imply a system change.

C. Attitudinal Typology toward ‘Technological growth’ and ‘Social policies’

		Social policies	
		accept	reject
Technological Growth	accept	Redistributive Growthism	Distributive Growthism
	reject	Redistributive Degrowthism	Distributive Degrowthism

By using these models, we will try to speculate what could happen in the near future to an industrialized nation-state. We will not explore all the possible combinations of the above presented attitudes, but only four possible scenarios. We will examine the possibilities of a *future* to some extent shaped by the desiderata of the ruling class (planned), although with different orientations, involving the *extinction* either of workers or robots. Then we will consider the same two outcomes, but as unwanted (unplanned) consequences of other attitudes and policies.

D. Typology of possible future scenarios

		Future	
		unplanned	planned
Extinction	workers	Unplanned end of work scenario	Planned end of work scenario
	robots	Unplanned end of robots scenario	Planned end of robots scenario

3. The unplanned end of work scenario

The unplanned end of work scenario is generated by 1) technological growth; as an outcome of 2) the political and economic system not changing; 3) spontaneous growth; and 4) market distribution of wealth. Let us see how.

One author who has tried to foresee the possible developments of automation society on the basis of these premises is Hans Moravec. As a robotic engineer he has a solid grounding in technology, from which he extrapolates present data and projects them into the future. Moravec offers a very interesting point of view that it is worth thinking carefully about. He shows us what might happen in the case of *laissez-faire*, that is, if governments do not try to guide the course of future history.

In part one of the essay “The Age of Robots”, Moravec (1993) describes four generations of universal robots which happen to coincide with the first four decades of the 21st century. We will not enter into the technical details, but limit ourselves to observe that the first generation of robots is that of robots that we sometimes see on television or in exhibitions, while the second generation is already able to replace humans in a variety of tasks outside manufacturing; the third generation displays even more ‘human’ traits and therefore competes with human labor in all sectors, while the fourth displays traits that are downright ‘superhuman.’⁴

In the second part of the article, Moravec dwells on the social consequences of the emergence of universal robots, distinguishing short, mean and long term consequences. In the long term, according to Moravec, the superhuman robot will gradually be able to design even more potent and intelligent ‘children,’ and thus robots will acquire traits that are ‘semi-divine.’ Machines will merge with those humans who stay on – via the technology of mind-uploading – and will colonise space, converting other inorganic matter into thinking matter. These are bold speculations, but not at all impossible. We leave them however to the reader’s curiosity.

Here it is enough to analyse the short term, which coincides with the first half of the 21st century. Moravec – who is anything but a Luddite or a left-wing extremist⁵ – recalls first of all the painful transition from the agricultural society to the industrial society. The human cost of millions of workers forced to cram in the suburban areas of industrial districts and to compete for badly paid jobs that were never enough to satisfy demand. This period brought

child labor, precarious employment, and inhumane working hours without any social security, health care, trade unions, or pension schemes. We exited this 19th century 'savage capitalism' because of trade unionization, revolutions and reforms, to finally arrive at the welfare state. In particular, the system has been saved thanks to the recurring reduction of working hours, aimed at counteracting technological unemployment and reducing exploitation. But in the era of robots will it be possible to continue with these reforms?

Not according to Moravec because even if working hours continue to fall (which it should be said is no longer even the case), their decline "cannot be the final answer to rising productivity. In the next century inexpensive but capable robots will displace human labour so broadly that the average workday would have to plummet to practically zero to keep everyone usefully employed." While governments may oblige private companies to reduce the working time of employees, they certainly can't oblige companies to hire and pay people to do nothing. But this is not the only problem. Even today, many workers are re-employed to perform 'frivolous' services and this will be even truer in the future, because as we have seen, services requiring efficiency rather than creativity will also be performed by robots. In practice, the function of humans is and will increasingly be to 'entertain' other humans with games, sports, artistic works or speculative writings (like this one). Some people are even paid to do trivial and utterly uninteresting jobs: think of some state-employed bureaucrats, often hired for no other purpose than an attempt to reduce unemployment, assigned to useless if not downright harmful tasks of control and regulation, who therefore end up as a burden to other citizens.

Will we all be assigned to frivolous or useless services? It could be one solution, but it would seem that even this road is blocked. The 'service economy' functions today because many humans willing to buy services work in the primary industries, and so return money to the service providers, who in turn use it to buy life's essentials. As the pool of humans in the primary industries evaporates, the return channel chokes off; efficient, no-nonsense robots will not engage in frivolous consumption. Money will accumulate in the industries, enriching any people still remaining there, and become scarce among the service providers. Prices for primary products will plummet, reflecting both the reduced costs of production, and the reduced means of the consumers. In the ridiculous extreme, no money would flow back, and the robots would fill warehouses with essential goods which the human consumers could not buy.

If we do not reach this extreme, there will in any case be a minority of capitalists (the stockholders) continuing to make profits thanks to a legion of efficient workers who do not go on strike, do not fall ill, work twenty-four seven, demand a 'salary' equal to the cost of energy and, to cap it all, need no pension because they will retire to a landfill. While for the mass of workers employed at frivolous services or at transmitting information (the so called knowledge industry) and for the chronically unemployed (the proletariat) the prospect is a return to the Middle Ages. Moravec effectively reminds us that "an analogous situation existed in classical and feudal times, where an impoverished, overworked majority of slaves or serfs played the role of robots, and land ownership played the role of capital. In between the serfs and the lords, a working population struggled to make a living from secondary sources, often by performing services for the privileged."

A rather discouraging scenario. And very disturbing, if one keeps in mind that it is an enthusiastic robotic engineer and supporter of capitalism who predicted it. In reality Moravec – perhaps worried by the apocalyptic scenario just outlined – hastily adds that things may not go this way. That is, he envisages an alternative scenario, the possibility of a different future that nevertheless implies a new awareness and an attempt to have history take another path.

We will not necessarily venture back to the Middle Ages because today's workers have reached such a level of political awareness and education that they would hardly allow a minority of capitalists to reduce them to slavery. Were we to arrive at such a level of degradation the people would "vote to change the system." But this choice implies a different scenario, a planned one.

4. The planned end of robots scenario

The planned end of robots scenario is generated by 1) technological degrowth; as an outcome of 2) a radical change in the political and economic system; 3) programmed degrowth; and 4) social redistribution of wealth. Let us see how.

To remedy the evaporation of humans from the working environment, various types of solutions have been proposed. Faced with a 'technological apocalypse' many are tempted by the idea of a return to the past. More and more citizens appear fascinated by the perspective of a degrowth in technology and industry – and not only visceral technophobes like the 'Unabomber' Theodor Kaczynski. Therefore it would seem that we must include also this idea in our discussion, although no political agenda is currently contemplating a ban on artificial intelligence. Supporters of this position have been given various labels: Luddites, primitivists, passéists, retrograders, reactionaries, bioconservatives, radical ecologists, etc. Since the idea finds consensus both on the left and right, even though its most radical version has as yet no representatives in Parliament, we have decided to call its supporters 'degrowthers' – a term that does not yet have strong political connotations and that therefore lends itself to this technical use. By symmetry we call 'growthers' the supporters of limitless growth (scientific, technological, industrial, economical).

First of all it must be stressed that the degrowthist idea is rather simple and forthright. Its simplest formulation does not demand any particular intellectual effort, any particular competence, but rather a gut reaction: "If technology is bad, ban it!" The message is simple, clear and limpid. For this reason, it has had some success in the media.

A slightly more careful analysis shows however that giving up technologies based on artificial intelligence carries no fewer risks than does their diffusion inside a framework of *laissez faire*. Indeed a policy of degrowth, that is, one geared for maintaining or restoring obsolete systems of production, would not allow the country that adopted it to stand up to the competition of other nations in a global economy. At the level of quality and prices, goods produced by artisanship would not withstand the competition of those produced by a mixed human-robotic system or even an altogether robotic one. Therefore, were one to ban AI, unemployment would not even be re-absorbed in the short term. Not only would unemployment not disappear, but the worsening of other economic parameters and the collapse of many companies would likely increase it.

Obviously, all degrowthists are not naïve and therefore we should expect a second policy to take place at the same time as a ban on AI: economic autarchy. It is not by chance that degrowthists are generally also anti-globalisation. Leaving the global market would end the competition between national and foreign goods and services, and employment could thus be rescued.

This argument may seem sensible when formulated this way, but it too would carry a hefty bill. Exiting the global economy, closing the borders, and imposing a duty on imports, would rescue the situation in the short run by creating a kind of poor but self-sufficient economic enclave. In the long-term however this economy would be under the constant threat of a black market of technologically advanced products from abroad. Repression by the police or the

military would be necessary to counteract internal mafias that, via smuggling, would look after their own interests and those of foreign companies. The repression could however convince the same mafias, or foreign governments serving large corporations, to stir up rebellions inside the autarchic system. In other words, a system at once autarchic and degrowthist – given its technological weakness – would make itself vulnerable to being swept away at any time by systems that are technologically more advanced, via conventional and non-conventional wars. This scenario should be kept in mind, unless one has unconditional faith in human beings and thinks of them as capable only of intentions that are benevolent.

The third move a degrowthist party could make in order to avoid having this sword of Damocles above its head is that of attempting to impose a global ban on artificial intelligence. This is a clearly utopian vision, because an agreement between most sovereign states would not be enough. Just a few dissident growth-oriented nations would be suffice to nullify the contract. The realisation of this utopia would require a global degrowthist empire which is a practical impossibility. Such a project can only be imposed by a global hegemon, and any country that rejects on principle the most revolutionary and powerful technologies cannot remain a global hegemon. It is often said that science-fiction ideas are the prerogative of technophilic futurologists, but in reality the idea of a global ban on advanced technologies is the most ‘science-fictive’ idea of all. We do however want to continue to examine this hypothesis for the sake of discussion.

Let us suppose then that, by some sort of miracle, something like a degrowthist empire came to be (maybe as a result of the global hegemony of a degrowthist religion). So now the question is: how long can it last? This global political regime must not just do away with computers and robots but also with the whole of science that allows the realisation of these machines, that is, with the *know-how*. The degrowthists must destroy universities and libraries, burn books and journals, destroy data banks, arrest or physically eliminate millions of scientists and engineers who might revitalise AI, as well as all growthist citizens who might side along them. Should anything escape the degrowthist thought police, or once the ‘purification’ terminated, should bright and curious children be born who were able to revitalise science, this would be a U turn. A clandestine growthist movement and a black market would be born. The police state would find itself having to fight with obsolete means hypertechnological dissident guerrilla groups. It is hard to imagine that the new system would not sooner or later be defeated by these groups.

It is more than rhetoric when we say that “the world *must* move forward” or “you cannot stop the clock.” It is also an acknowledgement of two social dynamics that do not allow growth and progress to stop for good. These two elements are *the will to power* – a force that moves human history or, in the sense asserted by Friedrich Nietzsche, the life of the universe itself – together with Bacon’s simple observation that *technology is power* (*scientia potentia est*). In other words, the drive for technological mastery cannot be suppressed, and degrowthist victories are always temporary. This happened for example when Judeo-Christianity overcame – with the complicity of other catastrophic events like Barbarian invasions, natural catastrophes and epidemics – the thousand-year old Graeco-Roman civilisation. All that was needed was to leave lying around bits and pieces of that great philosophical, scientific, artistic, technological, commercial and military civilisation for its spores to wake up and regenerate under other forms, despite the severity and conscientiousness of the Inquisition (Russo 2004, Pellicani 2007, Campa 2010).

Therefore, it does seem that the degrowthist solution, in addition to being inefficient and risky, is above all impracticable in its extreme forms. It is not by chance that the governments of the developed world have until now tried to remedy the problem of technological unemployment with all the means save one: banning the new technologies. This however does not mean that technological degrowth is impossible. Actually, industries and technologies can disappear in some regions of the world even if they are welcome. This is another scenario that deserves to be explored.

5. The unplanned end of robots scenario

The unplanned end of robots is generated by 1) technological degrowth; as an outcome of 2) the political and economic system not changing; 3) spontaneous degrowth; and 4) either the market distribution *or* the social redistribution of wealth. Let us see how.

If we look at the programs by parties represented in most Western Parliaments, be it the governing coalition or the opposition, we discover that they are all more or less favourable to growth. It is rare to find a member of Parliament who waves the flag of technological or economic degrowth. At most we find politicians who, courting degrowthist votes, speak of ‘sustainable growth.’ Similarly, we do not find anyone who welcomes upheavals, social conflicts, high unemployment rates and widespread crime. The ideal societies of the various political forces differ in some essential aspects (some dream of a Christian society, others of a secular one, some want it to be egalitarian, others meritocratic, and so on). But as far as growth and employment are concerned, they all agree – at least in principle – that these are positive. Even those who want to abolish the democratic-capitalist system (the political forces at the two extremes: fascists and communists) and who therefore do not rule out a phase of social conflict, do not dream of a permanent chaos, a society of temps, jobless, sick, poor and criminals. They view their ideal society as one fulfilling material needs, offering spiritual harmony and possibly without crime. They want to go beyond capitalism precisely because, in their opinion, it fails to guarantee all this.

However, we can still find political forces that cause degrowth or social pathologies, out of incapacity, corruption or short sightedness. The worry that traditional political parties lack a vision of the future and that this may generate social instability has been expressed by several social scientists.

For instance, now, Europe is facing a very delicate political and economic crisis, characterized by economic depression and a high rate of unemployment. As a response, the EU has been imposing an austerity policy on member states to reduce budget deficits. The European ruling class seems to be firmly convinced that the best recipe for stimulating economic growth is the deregulation of the labour market and the reduction of government spending. This perspective has been criticized by many economists. For instance, Boyer (2012) predicts that this economic policy will fail, because it is founded on four fallacies. First, the diagnosis is false: the present crisis is not the outcome of lax public spending policy, but “it is actually the outcome of a private credit-led speculative boom.” Second, it is fallacious to assume “the possibility or even the generality of the so-called ‘expansionary fiscal contractions.’”⁶ Third, it is wrong to assume that a single policy may work for all states: “Greece and Portugal cannot replicate the hard-won German success. Their productive, institutional and political configurations differ drastically and, thus, they require different policies.” Fourth, “the spill-over from one country to another may resuscitate the inefficient and politically risky ‘beggar my neighbour’ policies from the interwar period.”

The analysis produced by Boyer is quite convincing. However, if it is true that unemployment is partly due to growing and evolving automation, the dichotomy austerity versus government spending, or neoclassical economics versus Keynesian theory, is simply inadequate to draw a complete picture of the situation. It is missing one of the main points.

A similar problem can be observed also in the USA. Sociologist James Hughes (2004) noticed as long as ten years ago that in the USA “newspapers are full of bewildered economists scratching their head at the emerging jobless recovery. The right reassures us that job growth is right around the corner, although it wouldn’t hurt to have more tax cuts, deregulation, freer trade and lower minimum wages. Liberals counter that we can cut unemployment with more

job retraining, free higher education, more protectionism, more demand-side tax stimulus and nonmilitary public sector investments.” According to this sociologist, “the problem is that none of these policies can reverse the emerging structural unemployment resulting from automation and globalization.”

We have seen that, in certain conditions, the neoclassical politico-economic approach may lead to the unplanned end of work scenario imagined by Moravec. However, the same approach, in the presence of a new great depression (an hypothesis that Moravec did not consider in 1993), may lead to an end of robots scenario. Austerity policies and a bad application of neoclassical principles are indeed already producing the deindustrialization of some countries (e. g. Italy).

However, the Keynesian approach *per se* may also lead to the unplanned end of robots scenario. To explore this possibility, all we have to do is to analyse the first path indicated by Moravec to escape the gloomy perspective of an unplanned end of work. The obligatory path is to push through with the politics of the gradual reduction of working hours while preserving people’s purchasing power. This could take place in two different ways: 1) by redistributing income via taxation; or 2) by re-distributing shares in corporations and thereby also their profits. In each case people are excluded almost entirely from the production loop, but the first path may have a collateral unwanted effect.

Through the redistribution of income via taxation, the circulation of money can be reactivated by governments as soon as it slows. In this case citizens’ incomes would be equal or similar, but in any case sufficient to keep production going via consumption. However, since the level of taxation would be decided by the people, the system could collapse should this level become unsustainable in a still competitive system. In other words, too heavily taxed robotic industries would fail, leaving the whole population without an income. Without support for an expansion of public ownership governments may be not able to help or buy failing industries. If central banks remain private, governments do not control the money supply and will have to finance themselves on secondary markets as if they were private companies. This situation could render it impossible to implement an effective industrial policy and would precipitate the nation-state in a vicious circle leading to deindustrialization and, therefore, unwanted derobotization.

6. The planned end of work scenario

The planned end of work scenario is generated by: 1) technological growth; as an outcome of 2) a radical change in the political and economic system; 3) programmed growth; and 4) the social redistribution of wealth. Let us see how.

To explore this scenario, we have to follow the second path suggested by Moravec. This path is a kind of socialist-capitalist hybrid founded on allowing the population to own the robotic industries by giving part of the shares to each citizen at birth. In this case, incomes would vary with the performance of the companies. Therefore, for people, it would become more important to elect the best top managers for their factories, instead of the best members of Parliament. Everybody would have enough to live off, but salaries could no longer be decided by political votes. Even if this solution preserved a few features of capitalism (competition and a market economy), the change it entails would be more systemic than what it appears *prima facie*. True, Moravec does not discuss at all the problem of the banking system and the control of money, but to assign at least the property of the productive system directly to the citizens is more ‘socialistic’ than taxing the rich to give some charity to the poor. We quote Moravec’s passage in its entirety:

The trend in the social democracies has been to equalize income by raising the standards of the poorest as high as the economy can bear--in the age of robots, that minimum will be very high. In the early 1980s James Albus, head of the automation division of the then National Bureau of Standards, suggested that the negative effects of total automation could be avoided by giving all citizens stock in trusts that owned automated industries, making everyone a capitalist. Those who chose to squander their birthright could work for others, but most would simply live off their stock income. Even today, the public indirectly owns a majority of the capital in the country, through compounding private pension funds. In the United States, universal coverage could be achieved through the social security system. Social security was originally presented as a pension fund that accumulated wages for retirement, but in practice it transfers income from workers to retirees. The system will probably be subsidized from general taxes in coming decades, when too few workers are available to support the post World War II 'baby boom.' Incremental expansion of such a subsidy would let money from robot industries, collected as corporate taxes, be returned to the general population as pension payments. By gradually lowering the retirement age towards birth, most of the population would eventually be supported. The money could be distributed under other names, but calling it a pension is meaningful symbolism: we are describing the long, comfortable retirement of the entire original-model human race.

Moravec is crediting the idea of the end of work to engineer James Albus, but it is rather a multiple discovery. For instance, James Hughes (2004) also comes to a similar conclusion, even if he would probably implement the distribution of wealth in a different way than Albus. In any case, he warns that "without a clear strategic goal of a humanity freed from work through the gradual expansion of automation and the social wage, all policies short of Luddite bans on new technology will have disappointing and perverse effects. If liberals and the left do not re-embrace the end of work and the need to give everyone income as a right of citizenship, unconnected to employment, they will help usher in a much bleaker future of growing class polarization and widespread immiseration. If libertarians and the right do not adapt to the need to provide universal income in a jobless future they may help bring about a populist backlash against free trade and industrial modernization."

Those thinking that the planned end of work scenario is just a utopia should remember that in pre-industrial societies there were much less working hours than today, if for no other reason than people could work only during the daylight. Besides, they benefited from more religious holidays during the year. If now we work so hard, it is because of the invention of gas and electric lighting which has artificially extended the working day, especially in winter time. The introduction of machinery has done the rest. From the point of view of the capitalist, it makes no sense to buy expensive machines and turn them off at every religious celebration or just because the sun goes down. The prolonging of the working-day at the beginning of the industrial era was analysed in detail by Karl Marx (1867). But this trend began again in the twentieth century. Indeed, sociologist Juliet B. Schor (1993) remarks that "one of capitalism's most durable myths is that it has reduced human toil. This myth is typically defended by a comparison of the modern forty-hour week with its seventy- or eighty-hour counterpart in the nineteenth century." The problem is that "working hours in the mid-nineteenth century constitute the most prodigious work effort in the entire history of humankind." In the preindustrial era the situation was much different. Just to give a few examples, a thirteenth-century estimate "finds that whole peasant families did not put in more than 150 days per year on their land. Manorial records from fourteenth-century England indicate an extremely short

working year -- 175 days -- for servile laborers. Later evidence for farmer-miners, a group with control over their worktime, indicates they worked only 180 days a year.”

There is no reason why a technologically advanced society should *force* its citizens to work harder than their ancestors, when they could work a lot less and without giving up their modern life standards. Among other things, this policy would also give workers more free time to take care of their children, the elderly and the disabled. Or they could just spend time with their families and friends, if the care of people is entrusted to robots. Unfortunately few are aware of the irrationality of our current situation.

According to anthropologist David Graeber (2013), the situation has now become even more paradoxical than before, because most of our jobs are not needed at all. It is worth remembering that “in the year 1930, John Maynard Keynes predicted that, by century’s end, technology would have advanced sufficiently that countries like Great Britain or the United States would have achieved a 15-hour work week. There’s every reason to believe he was right. In technological terms, we are quite capable of this. And yet it didn’t happen. Instead, technology has been marshalled, if anything, to figure out ways to make us all work more. In order to achieve this, jobs have had to be created that are, effectively, pointless.” Graeber surmises that this is not happening by chance. According to him “the ruling class has figured out that a happy and productive population with free time on their hands is a mortal danger (think of what started to happen when this even began to be approximated in the ‘60s).”

That being said, perhaps we should also consider possible negative collateral effects of the planned end of work scenario. Before reaching the final stage when stocks and dividend income are owned by citizens, societies are likely to attempt to redistribute employment by reducing working hours without a reduction in pay. Since firms would rather increase employees’ working hours and reduce their pay, they are likely to react by threatening to relocate to other countries in our increasingly globalized economy. In its drive to pay workers as little as possible the private sector at the micro level is in conflict *with its own interests* on the macro level. It is in the interest of every company to employ a minimum number of workers, pay them a minimum salary and have the highest productivity. But if every company had what it wanted, in a closed system, there would be no consumers and therefore the same companies could not sell what it produced. Capital mobility in the global market has allowed companies to escape this dilemma. But this too, with time, will become a closed system, with the difference that there will be no regulators. In the nation-states, governments have always resolved the contradictions between the micro-rationality of companies and the macro-rationality of the economic systems, mediating between companies and trade unions, and regulating the labour market. But the global economy has no government, so national systems will not have any other option than exiting the global economy.

Indeed it is not hard to foresee that – were we to arrive at the absurd situation of a form of technological progress that generates hunger instead of wealth – nations would one by one withdraw from the global market to try to preserve their levels of employment. It is true that imposing reduced employee working hours on companies, while maintaining salaries at the same level, might convince them to move production elsewhere. However, in a future in which they employ almost exclusively machines and not humans, it would not be possible for companies to blackmail government and citizens by threatening to fire thousands of workers and they would have to transfer to more turbulent countries with chronic unemployment and rampant crime. These companies would therefore stand to lose.

Thus, if a certain degree of autarchy would weaken a degrowthist country, it would not be the same for a technologically advanced country with sufficient sources of energy and endogenous factors of technological development (brains and scientific institutions that are up to standards). A hyper-technological semi-autarchic state could maintain domestic order via the distribution of profits and the concurrent reduction of working hours, positing as an asymptotic ideal a society in which unconscious machines would work for sentient beings,⁷

while sentient beings would devote themselves to recreational or higher activities, such as scientific research and artistic production.

A second unknown is the reaction of people who still work – let us call them the ‘irreplaceable’ – when seeing a mass of people paid to enjoy themselves and to consume. Moravec is clearly enthusiastic about the robots that he is designing and convinced that they will be able to do *any* work. But – if we assume that machines will be very sophisticated but still not conscious – it seems more plausible to think that, even if *any* work could in itself be executed by an intelligent robot (surgical interventions, repairs, artisanal works, transport of goods and people, etc.) there must always be a sentient being in the loop who acts as supervisor. Someone will have to be there, if only to act as maintenance manager of the machine, or of the machine that maintains the machine, or to gather data on the behaviour of the machine (‘spying’ to prevent unpredictable collateral effects). When trains, planes, and taxis are autonomous their users – for psychological reasons – will want to think that a human being is still somewhere in control.⁸ However few these workers may be, why should they work when others do not have to?

The shrinking working class will likely be able to adapt to coexistence with the unemployed and accept that everybody has the right to live off a capital. Irreplaceable workers could receive a salary in addition to the citizens’ wage, which would give them a higher social status in exchange for their job. Or, to preserve a sense of community, societies could institute a compulsory civil or military service that would employ all citizens for a few hours a week to carry out functions of control and supervision.

Besides, it is highly probable that sooner or later all nations will be constrained to remedy technological unemployment in the same way, and, faced with increasingly homogeneous global conditions, borders could once again be opened – to promote at last the free circulation of people and goods. As communications and transports continue to develop, the world becomes ever smaller and borders ever more anachronistic. Therefore autarchy could be just a painful but necessary phase to overcome the resistance of capital to global regulation. And at the end of the process we shall have humans truly liberated from obligatory work.

7. An ethical judgment

We have seen that the social questions arising from the increasing robotisation of industry and from the spread of artificial intelligence in the social fabric are similar in some ways to those that came with the mechanisation of manufacturing during the industrial revolution, and are partly entirely novel ones. In both cases the process arises, mostly, within the context of a capitalist economy, and therefore the effects differ for different social strata.

Put more simply, robotisation is not good or bad in itself but is good for some social classes or categories and bad for others, in accordance with the concrete effects that it has on people’s lives. In a hypothetical perfectly equal society however the effects of robotisation would be generally positive. Computers and robots can replace humans for repetitive or dangerous tasks. In addition they would allow a faster and cheaper production of consumer goods, to the advantage of the consumer. Thus the quality of the product increases, because of the greater precision of machines. Besides, some tasks can *only* be done by robots and computers. For instance, some work requires such precision that no human could do it (fabricating objects at the nanoscale for instance) and others can only be conceived and made with 3D printers and computers.

However, since societies today are highly layered, and some – for instance the Italian one – have a rather rigid class structure offering few possibilities to rise or fall, one cannot disregard

the negative effects that robotisation would have on some social classes without radical political and economic change.

To remedy this situation – as it should already be clear – our preference goes to the planned end of work scenario, for this is the only strategy that takes seriously the need to ensure a widespread distribution of the benefits of automation. The planned end of work scenario would also be the most *fair*. As I wrote in the journal *Mondoperaio* a few years ago:

Machines will be able to do most jobs, including designer jobs, even when they are deprived of consciousness or emotion (a possibility however that cannot at all be excluded). If no company will find it convenient to employ human beings, because they can be replaced by robots that work intelligently with no break, costing only the energy to run them, one will have to think of another social structure that could imply the abolition of work. Citizens could obtain an existence wage (or a citizen's wage) and be paid to consume rather than to produce. This solution would be ethically justified, because science and technology are collective products, that owe their existence to the joint effort of many minds, working in different places and historic times (Campa 2006).

This is the concept of epistemic communalism that I examined in-depth in my book *Etica della scienza pura* (Campa 2007). So I continued: “A quantum computer for example produced by a Japanese company would not have been conceivable without the ideas of Democritus, Galileo, Leibniz and other thinkers. In addition scientific research is often financed with public money. It would be unfair to tax workers in order to finance research the final result of which would be their own social marginalization.”

In brief, the collective character of technoscience amply justifies a politics based on solidarity.

8. Conclusions

To sum up, we have outlined four possible scenarios. Two of them imply the end of robots, two of them the end of work. Among the last two, one scenario is dystopian, the other utopian. In the worst case humanity would be reduced to slavery under a capitalist elite. In the best case humans would live to consume and to enjoy reciprocally, while robots do the hard and dirty work.

The utopian scenario in its turn has two possible faces: one social democratic (redistribution based on social policies supported by taxation) and one socialist-capitalist (redistribution of ownership of robotic industries to citizens). One way or the other the forecast is that the whole of humanity will retire having worked just a little or not at all.

As regards the utopian scenario, one can observe that Moravec seems to have an enormous faith in people's ability to impose its own reasons and its own interests via the tools of democracy. A future that is not necessarily so uniform appears more likely to me, considering that neither the past nor the present have a single face. In other words, an intermediate scenario between dystopia and utopia seems more probable, with variations from country to country, from people to people, depending on political awareness, the level of infrastructure, and the degree of democracy. Contrary to what many futurologists appear to postulate in their analyses, human societies will not have the same future.

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¹ According to David F. Noble (1995: 3-23) the Luddites did not destroy machines because of technophobia, but because of necessity. They had to choose between starvation, violence against the capitalists, or property destruction. The last choice was the most moderate way to protest against unemployment and the lack of compassion of the factory owners.

² See the definition of 'technological growth' by EconModel (www.econmodel.com): "Economic growth models (the Solow growth model, for example) often incorporate effects of technological progress on the production function. In the context of the Cobb-Douglas production function $Y = K^a(L)^{1-a}$, we can identify three basic cases: labor-augmenting (or Harrod-neutral) technological change $Y = K^a(AL)^{1-a}$, capital-augmenting technological change $Y = (AK)^aL^{1-a}$, and Hicks-neutral technological change $Y = AK^aL^{1-a}$."

³ US science and technology would probably be much different if the government did not have so many contracts with the military-industrial complex.

⁴ Moravec writes: "In the decades while the 'bottom-up' evolution of robots is slowly transferring the perceptual and motor faculties of human beings into machinery, the conventional Artificial Intelligence industry will be perfecting the mechanization of reasoning. Since today's programs already match human beings in some areas, those of 40 years from now, running on computers a million times faster as today's, should be quite superhuman."

⁵ John Horgan describes Hans Moravec as a Republican 'at heart,' a social Darwinist and a defender of capitalism, in *The End of Science* (Horgan 1997: 255).

⁶ The Expansionary Fiscal Contraction (EFC) hypothesis was introduced by Francesco Giavazzi and Marco Pagano (1990), by using the fiscal restructurings of Denmark and Ireland as examples. They summed up their argument as follows: "According to conventional wisdom, a fiscal consolidation is likely to contract real aggregate demand. It has often been argued, however, that this conclusion is misleading as it neglects the role of expectations of future policy: if the fiscal consolidation is read by the private sector as a signal that the share of government spending in GDP is being permanently reduced, households will revise upwards their estimate of their permanent income, and will raise current and planned consumption."

⁷ A category that may include humans, transhumans, posthumans, machine-human hybrids or cyborgs, machine-animal hybrids, some animals, etc.

⁸ At least for the first generation of users, since later generations may have more trust in the machines.