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Whither the evolution of the contemporary social fabric? New technologies and old socio-economic trends

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01/2019 March

This project has received funding from the European Union Horizon 2020 Research and Innovation action under grant agreement No 822781

Whither the evolution of the contemporary social fabric? New technologies and old socio-economic trends

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Abstract

The reflections which follow build on two interrelated questions, namely, first, whether we are witnessing another "industrial revolution", and second, what is the impact of technological transformations upon the current dynamics of the socio-economic fabric, especially with respect to employment, income distribution, working conditions and labour relations. We argue that the processes of innovation and diffusion of what we could call "intelligent automation" are likely to change, or more likely reinforce, the patterns of distribution of income and power, which have been there well before the arrival of the technologies we are concerned about: some are indeed intrinsic features of capitalism since its inception, while others are features of the last thirty-forty years. First, we shall offer a fresco of such tendencies which certainly preceded any potential "Fourth Industrial Revolution" but are going to be amplified by the latter. Second, we discuss the features of such possible new techno-economic paradigms. Third, we examine the relationships between technology, productivity and growth, and the ensuing impact on jobs, division of labour, distribution of knowledge, power, and control. Finally, we address some policy implications.

Keywords

Social fabric, technology, macroeconomic development, division of labour, knowledge, inequality

JEL codes

O10, E6, D63, F6

Acknowledgements

The authors wish to thank Martin Kenney, Mario Pianta, Andrea Mina, Massimo Moggi, Alessandro Nuvolari for fruitful discussions on the topics. We gratefully acknowledge the support by the European Union Horizon 2020 Research and Innovation programme under grant agreement No. 822781 - GROWINPRO.

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The first man who, having enclosed a piece of ground, bethought himself of saying "This is mine", and found people simple enough to believe him, was the real founder of civil society.

[*Discourse on the Origin and Basis of Inequality Among Men*, 1754, J. J. Rosseau]

1 Introduction

The reflections which follow build on two interrelated questions which have been of great concern to us as well as to many other observers of contemporary socio-economic transformations,[1] namely, first, whether we are witnessing another "industrial revolution", and second, what is the impact of technological transformations upon the current dynamics of the socio-economic fabric, especially with respect to employment, income distribution, working conditions and labour relations.

Of course, an easy reductionist approach would be to resort to the usual economists' repertoire: a production function, some proxies for changing skills, supplies and demand for labour, and the answer is readily served: in the long-run the system will self-adjust to the equilibrium path, with all unemployment being frictional or voluntary, rising wages for those who accomplish complementary tasks to technologies, and reducing wages for those one who accomplish substitutable tasks. The latter ones are somewhat responsible for not being adequate to what the market is asking them, so they should be able to retrain themselves in some way.

The route we chose to explore here has been quite different back to the basics and addressing the coupled dynamics between technological change and socio-economic evolution. In this respect, in this work we intertwine different levels of analysis. First, before assessing the impact of *new* technologies one should evaluate the pre-existing trends in income distributions, labour relations, and industrial structures. Second, the nature and the impact of technologies, old and new, ought to be assessed in their own right, well before plugging them into some, more or less far-fetched, history-invariant economic model. Third, the new and old technologies are nested in complex political economy, at all levels of analysis, ranging from the organization of labour and power at firm level all the way to the policies concerning law-making, taxation, and demand-management. Forth, whatever impact of technological and institutional changes ought to be assessed well beyond per-capita GDP growth rates. For example, welfare and working conditions, equality in opportunities, social mobility and quality of life are at least, if not more, equally important. Arguably, never since the First Industrial Revolution the competition between man and machine and the ensuing working conditions have been starker especially coupled with the explosion of rent-seeking behaviour and the risk of social exclusion as in today's globalised and financialised economy.

What can we learn from the past? Historians are quick to point out that such concerns are not unique to this age, but have characterised all industrial revolutions, during which the relationship between machines and human labour saw dramatic developments. On

[1] For a complementary discussion see, among the others, Franzini and Pianta (2015); Milanovic (2016).

the one hand, new technologies threaten established ways of doing things; on the other hand, they provide new opportunities for economic growth and social change. So much so that in the long run, technology has proved a formidable engine of growth and has enabled very significant improvements in living conditions. Emergent technologies can provide new business opportunities and enable effective solutions in areas of application which existing technologies are not able to cope with. Therefore, activities such as medical services and health care, where costs are increasing rapidly and disproportionately, can derive enormous advantages from the adoption of new technologies, provided those in need have adequate access to them.

Similarly, at macroeconomic and societal levels, paraphrasing Chris Freeman, new technologies may herald an "economics of hope", with work for all and equitable social inclusion, or conversely, mass unemployment, mass inequality and social exclusion, leading to a "re-feudalization" of Western societies (Freeman, 1992; Freeman and Soete, 1994). In all that, technologies are not good or bad as such. However, in the emergence and the early selection of the new dominant paradigms, social and economic factors are crucial.

Nowadays, we are still in a position to collectively "choose" where one is heading in terms of constellation of paradigms,[2] and it is one of the rare historical window of opportunity. In this respect, we can think of two extreme archetypes. The first one, call it the "Blade Runner" scenario:[3] a sort of techno-feudalism, extremely sophisticated in its small ruling class, with a vast majority of "lumpenproletariat", and a very intelligent, almost obedient humanoid population in between, enforcing power and income distribution in favour of the rich and powerful. One drawback of the film is that it forgets an even more horrific scenario: a class of ignorant and greedy rentiers sharing power and wealth with the techno-feudal class. At the opposite extreme there is a range of alternatives going from progressive and liberal proposals a' la Keynes (1930), still within the scope of the capitalist society, to the Communist Manifesto opting for the entire reorganization of societies, based on the Marxian utopia "From each according to his ability, to each according to his needs". Under this archetype, new technologies will free mankind from boring, degrading, alienating works and we shall all be able to spare most of our time for leisure, playing, satisfying curiosity, learning, enjoying life. Nowadays indeed we are in the position to consider it as a *workable utopia*, at least in developed economies.[4]

Come as it may, the processes of innovation and diffusion of what we could call "intelligent automation" are likely to change, or more likely reinforce, the patterns of distribution of income and power which have been there well before the arrival of the technologies we are concerned about: some are indeed intrinsic features of capitalism since its inception, while others are features of the last thirty-forty years.

In Section 2 we shall offer a fresco of such tendencies which certainly preceded any potential "Fourth Industrial Revolution" but are going to be amplified by the latter. Section 3 briefly discusses the features of such possible new techno-economic paradigms. In

[2] *Techno-economic paradigms* in the sense of Freeman and Perez (1988).

[3] From the science-fiction film *Blade Runner*, 1982, by Ridley Scott.

[4] For developing economies this is still far-away: a lot of technological and organizational learning, together with demographic control, lies ahead: however, qualitatively, the alternative between the two archetypes applies at all levels of development.

Section 4 we examine the relationships between technology, productivity and growth, and the ensuing impact on jobs in Section 5. The current division of labour, distribution of knowledge, power, and control inside the organizations are analysed in Section 6. Finally, in Section 7 we address some policy implications.

2 Some broad trends

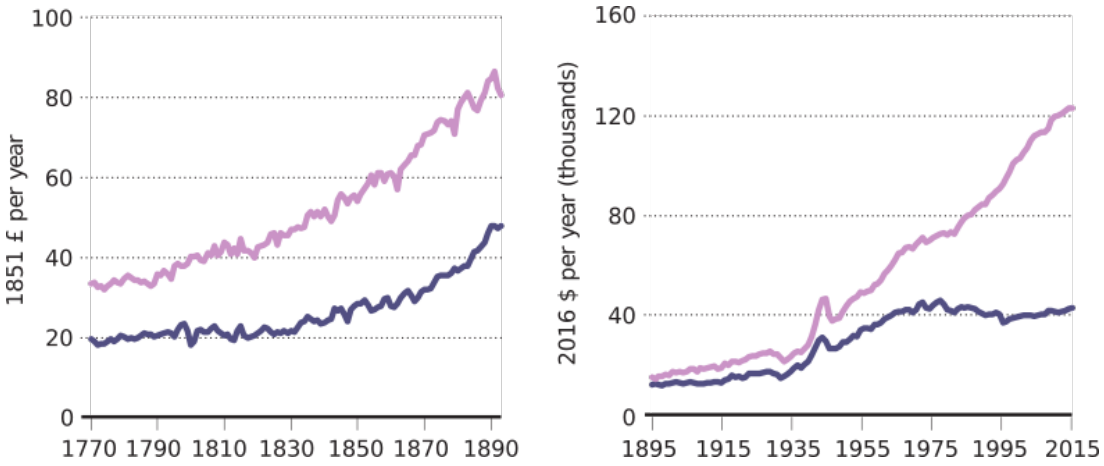
It is broadly understood that economic growth takes place slowly and unevenly, most often in relative terms but sometimes even in absolute ones. This applies across countries and also across social groups and classes within countries. The Industrial Revolution has been possibly the biggest episode in human history entailing such an explosion of divergences, even much more than the bifurcation of agricultural societies from hunter-gatherers one, a few thousand years ago (Dosi et al., 1994). Our primary concern here is however what happens with industrial societies characterised since their take off by persistent technological change leading to exponential growth in labour productivity. In this respect a crucial issue regards the relationship between productivity and wage dynamics.

In aggregate terms, such relationship between productivity gains arising from new technology and wage growth has been punctuated by alternate phases. During the First Industrial Revolution (1770-1830) wages almost stagnated and started to rise from 1830, approximately sixty years after the initial growth of output, what Allen (2009) calls the *Engel pause* (left panel of Figure 1). At the same time, a whole sub-continent, India, was reduced to an "early deindustrialization" and massive starvation. A much tighter link between productivity and wage growth characterised the "Western ascent to affluence" (1830-1970), according to the periodisation proposed by (Allen, 2017). However, a new phase of decoupling started in the seventies and has continued ever since – Allen calls it the "problem-ridden present" (right panel in Figure 1).

In fact, it might be an euphemism to mean *capitalism back to normal*, after the Glorious decades post-WWII, whereby, together, near full-employment, trade union organizations, social conflict and the scare of the Soviet Union led to relatively fair deals in the labour markets and in labour relations, as well as to highly redistributive fiscal regimes. Let us never forget that President Eisenhower's taxation scheme in the 50's included the average tax on profits well above 60% and the marginal rate on personal income at around 92%. An that was the period of highest US growth and highest investment rates over the whole US history.

All this regarding the long-term patterns. Conversely, on a shorter time scale other phenomena – to repeat, relatively independent from major technological changes – have deeply affected income distribution, labour relations and working conditions. Let us briefly consider a few of them.

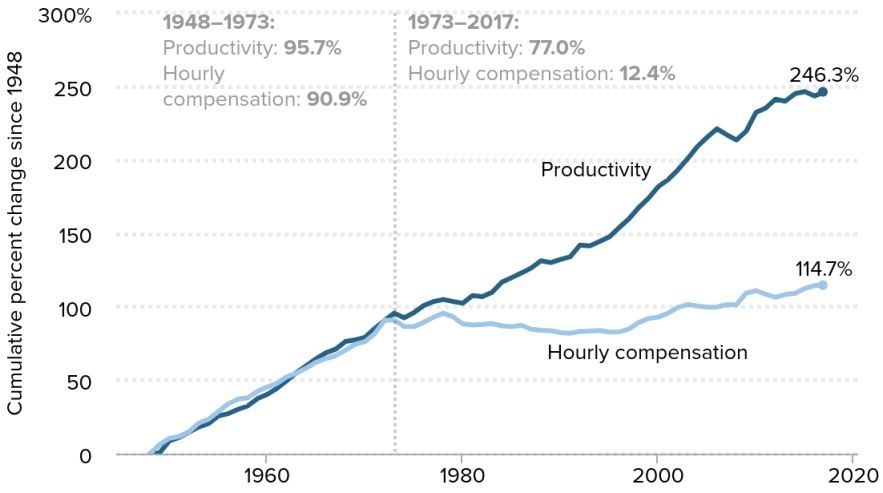
Figure 1: Wages in Britain 1770-1893 (left panel): the Engel pause. Wages in the United States 1895-2015 (right-panel): the long term wage-GDP gap. Pink line: GDP per worker, purple line: wages. Source: Allen (2017), p. 2.



TREND 1: GLOBALIZATION AND THE EMERGENCE OF CHINA AS THE WORLD FACTORY ECONOMY. After forty years of harsh promotion of free trade, the liberalization of capital movements clearly turned out to be one of the main drivers of instability and precursor of financial and economic crises (Stiglitz, 2002). On the real side, the global distribution of value chain has resulted into an international division of labour favouring some high skilled workers and capital owners in both developed countries (with a loosing middle class) and developing ones (still incapable to develop a middle class and with manufacturing workers massively exploited), exacerbating inequalities and social divide. The large fraction of value creation of international products and services is still done in the headquarters located in developed countries, while what has been delocated are the low value added phases of the production process (Timmer et al., 2014; Trade Development Report, 2018). However, the most striking phenomenon has been the emergence of China as the world factory economy, that in few decades, with a spectacular growth became the largest manufacturing producer and the largest economy of the world. But with that came also a massive change in the international distribution of working conditions (see also below).

TREND 2: STAGNANT WAGES AND DIVERGENCE BETWEEN PRODUCTIVITY GROWTH AND WAGE GROWTH. If the Golden Age of capitalism was characterized by a balanced wage/productivity growth, and a constant wage share, since the eighties the wage-productivity nexus has weakened, with a declining pass-through from the latter to the former (Figure 2). The decoupling of the two elements is highlighted by two concurrent factors: a declining labour share (Figure 3) and an increasing divergence between median and mean wage income (Schwellnus et al., 2017; Hutchinson and Persyn, 2012; Karabarbounis and Neiman, 2013).

Figure 2: The wage-productivity gap in the US, 1948-2017. Source: update from Figure A in Bivens and Mishel (2015).



TREND 3: A SURGE IN CORPORATE PROFITS AND TOP LEVEL INCOMES. Most likely this is the result of weaker labour bargaining power and the deterioration of labour market institutions: profits and top incomes have been the only components of GDP which underwent huge increases in the last decades. Corporate profits have been extremely resilient to the Great Recession, with just a temporary decline, immediately largely rebalanced by massive growth (Dabla-Norris et al., 2015) (Figure 4). Even the IMF (Jaumotte and Buitron, 2015) points at the transformation of labour market institutions as the source of both functional and personal income inequalities. In all that, extremely relevant are the declining unionization rates, as unions have always played an import role in promoting a relative egalitarian income distribution both at the aggregate level (Figure 5), and at the level of the firms (Figure 6).

TREND 4: A TENDENCY TOWARD A WINNER TAKES ALL DYNAMICS ESPECIALLY IN THE KNOWLEDGE ECONOMY. Concentration and "monopoly capitalism" are quite well-known traits of capitalist development (Hilferding, 1910; Lenin, 1920), but new traits are emerging in relation to the role of big-tech companies in what we could call *rentification of capitalism*.

First of all, these companies are experiencing an unprecedented market capitalization completely *unrelated* with the *value* and the price of the products they sell. Far from any relation to the market fundamentals, the extremely high capitalization of these companies relies on the massive ownership of individual data which allows both consumers but even citizens profiling (think of the case of Cambridge Analytica). These tech companies are actually valued not for the products they do but rather for the knowledge they posses and the ensuing power they master. This is highlighted by Figure 7 showing the shares of the big-tech companies among the top one hundred transnational corporations, in terms of market capitalization, profits, physical assets, revenues. Strikingly, while the market

Figure 3: Declining labour share: Source Global Wage Report (2015), p. 11, 12. Source: European Commission AMECO database.

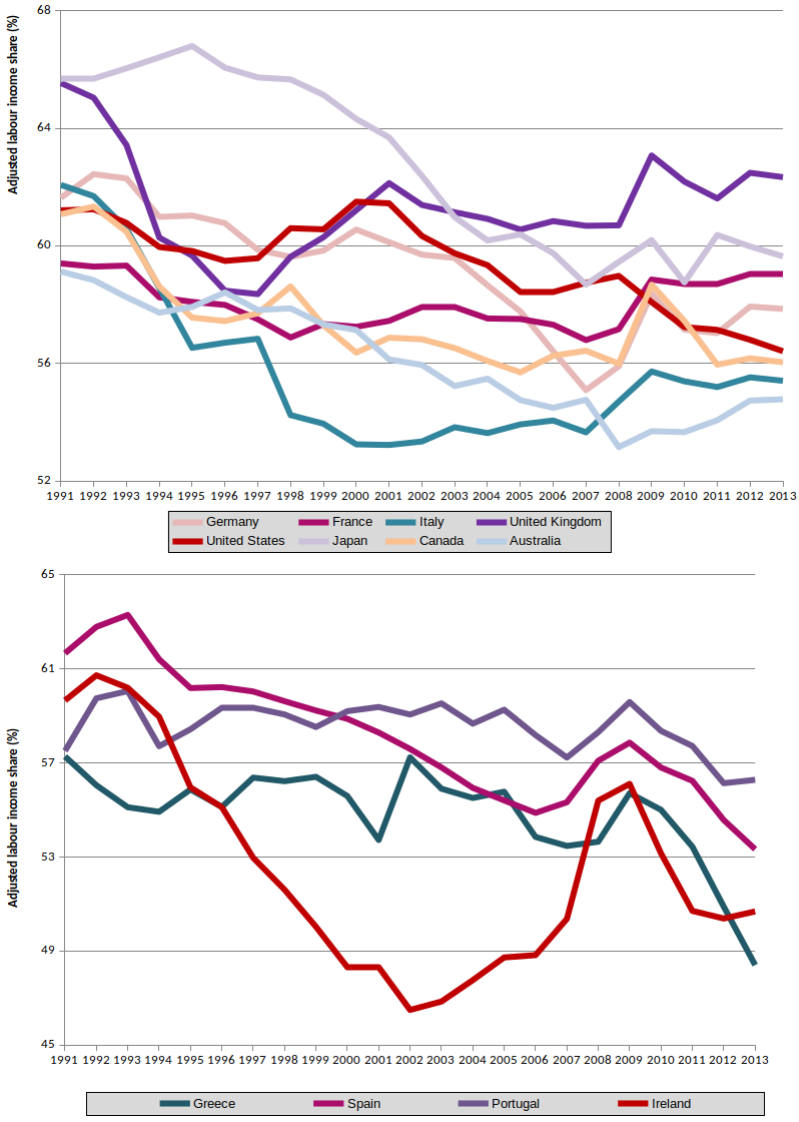
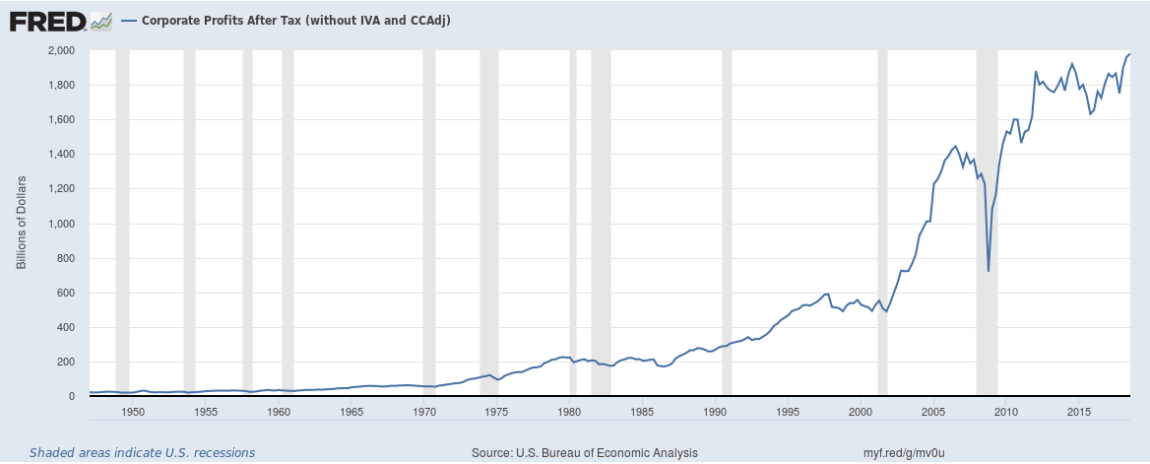


Figure 4: Surge of corporate profits. Source: Fred data set, US economy.



concentration remains unaltered in the period $2000 - 2015$, with almost a constant share of sales, the share of market capitalization and profits significantly increase. Going back before the Dot-Com crisis, Figure 8 shows that the share in market capitalization almost doubles between 1996 and 2015, but with a constant share of employment in the same period (around 25% of total employment of the top non financial firms).

In fact, to understand the uncoupling between real market dynamics and financial one, just compare the $Fortune500$ list (2018),[5] ranking firms in terms of their revenues, with the $Fortune$ list ranking them in terms of profitability.[6] Walmart is first in the former list, and only $20th$ in the latter one. Conversely, Facebook is $76th$ in the first list and $12th$ in the second one.

Another side of the *rentification* of the economy is the financialization of non-financial firms, entailing the use of the profits they generate from their businesses to found financial investments for the companies themselves or to increase the wealth of their shareholder (Lazonick and Mazzucato, 2013; Lazonick, 2014). Therefore, companies such as Amazon, Google, Apple, Facebook control more financial assets than many of the top investment banks. Together, many firms increasingly use their profits to buyback their own shares instead of undertaking physical and research investments, with the exclusive intent of asset appreciation for their stockholders.

TREND 5: POLARISATION AND CASUALIZATION OF WORK. The service economy, where the largest fraction of the working population is nowadays located, is undergoing rapid transformations increasingly characterized by non-standard and flexible forms of labour relations and contractual regulations. This is linked to deteriorating patterns of working conditions, neo-Taylorism, both physical and digital, and to an equally profound deterioration in the legal protection of gig-workers' rights.

[5] http://fortune.com/fortune500/

[6] http://fortune.com/fortune500/list/filtered?sortBy=profits&first500

Figure 5: Declining unionization rate and increasing income inequality. Source: Gordon and Eisenbrey (2012).

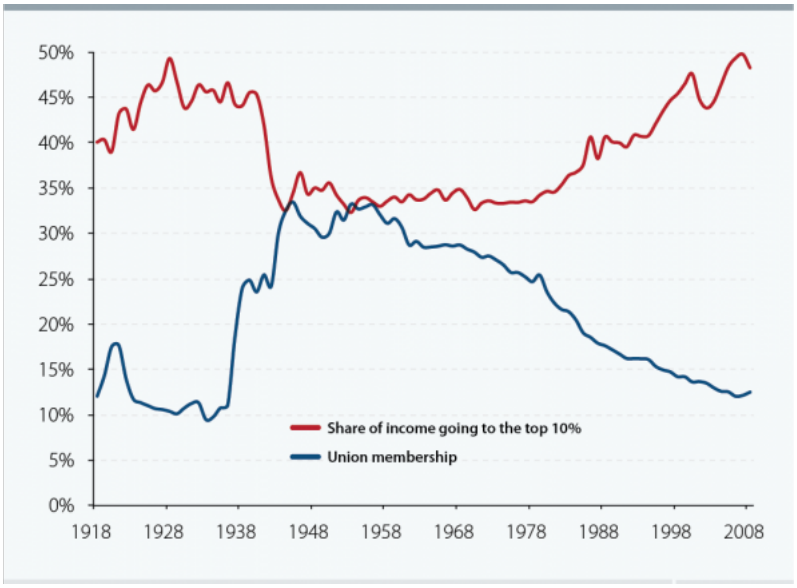


Figure 6: The more egalitarian wage distribution under unionization (firm level): Source Freeman (1984).

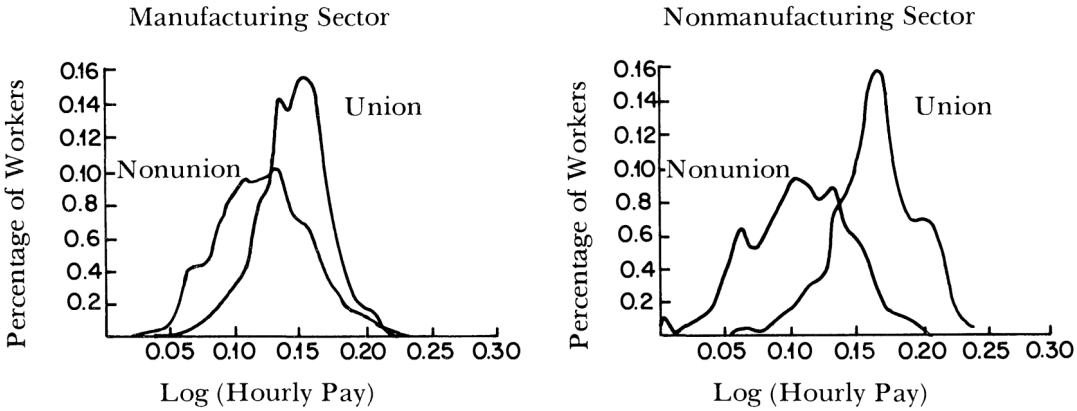


Figure 7: Shares of big-tech companies in top 100 non-financial corporations, 1996-2015. Source: UNCTAD Database, elaboration of Thompson Reuters, Trade Development Report (2018), p. 80.

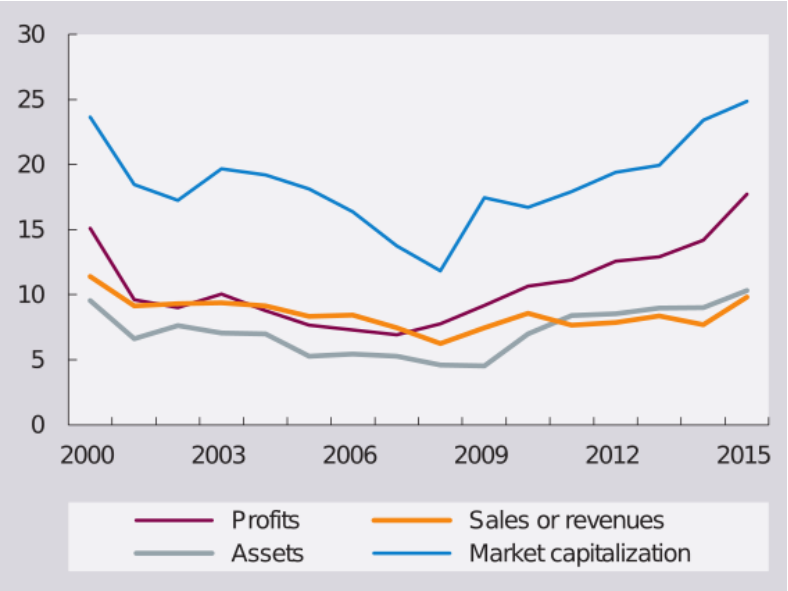
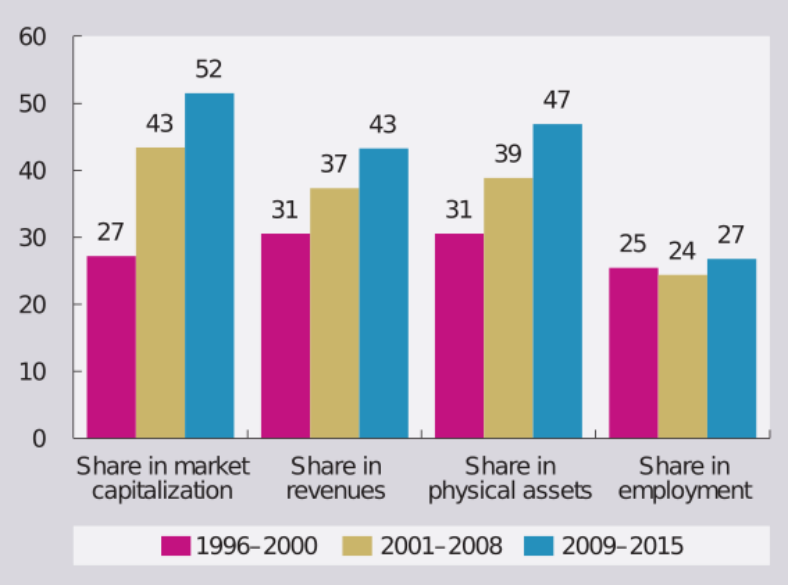


Figure 8: Shares of top 1 per cent companies (identified by intangible assets in the sector) from technology, software and IT-services sector. Source: UNCTAD Database, elaboration of Thompson Reuters, Trade Development Report (2018), p. 80.



All the foregoing factors may well threaten societal, political and economic sustainability also because they affect the universality of the welfare system in domains such education, health and pensions, thus deepening inequality in opportunities and actual living standards. And, indeed, the may interact with and amplify the effects of technological changes. But, what type of technological changes are we talking about?

3 The emergence of a new techno-economic paradigm?

The massive introduction of robotized work certainly characterizes the industrial sector, with robotic devices able to substitute for repetitive and routinized activities. However, artificial intelligence and software developments are becoming increasingly relevant also in the service sectors, which, to repeat, nowadays employ the largest labour share. As a direct consequence, robotization and AI do not represent a threat only for blue-collars workers, but for the white-collars as well. If the ability of the IBM's Deep Blue computer to defeat the world chess champion Gary Kasporov did not come as a great surprise, because in a chess game human heuristics can be substituted by a complete search of highly dimensional, but still finite, combinatorics of moves, the new grand challenge undertaken by IBM software developers in 2004 was to program a computer, Watson, able to beat the human champion in Jeopardy. Unlike chess, Jeopardy is an open ended game that requires pronounced learning, linguistic, semantic, and association abilities. The latter cognitive capacities are not at all usual characteristics of computers. In 2011 Watson was able to beat two world champions in Jeopardy demonstrating the ability of the machines, not only able to compute, but to understand, learn and react according to changing information and environments. Machines might be heading to become "intelligent". Robots are nowadays able to compose music, write newspaper articles, grade high schools exams, paint artworks, play the piano. If it so, not only low cognitive abilities, but also higher ones may be potentially threatened by technology.[7]

Are these only good news? In fact, many emerging companies in the Silicon Valley or in the Boston Area are explicitly meant at creating and developing technologies able to entirely substitute for human labour. Momentum Machine is a start-up company founded with the aim of completely automatize the production of gourmet hamburgers. The founders explicitly state how their device is not meant at increasing labour efficiency but at getting rid of human labour force (Ford, 2015).

Conversely, sectors like medicine and health care are still missing robots and machine learning algorithms whose massive usage could be complementary to human activity rather than replacing it. Potentially, there is ample room to go well beyond the use of robots and artificial intelligence in already standardized and high productive sectors, like fast-food production and delivery, to less standardized sectors like medicine and health care, whose costs curve are disproportionately increasing, threatening the right to health care of a soaring fraction of the population both in countries which have universal cover-

[7]Indeed, together with one episode of success there are plenty of episodes of failures, like the use of the MOOC platform to spur on-line learning which resulted into a debacle in his ability to promote education for low-income students (Ford, 2015).

age (like Italy) and those which do not (like US).

Is all this a "Fourth Industrial Revolution" or rather part of some incremental deepening and convergence among pre-existing technological paradigms? The question is very important as it is at the core of the analysis of continuities and discontinuities of knowledge basis, of the institutions and firms generating and supporting them, and of the national location of leading actors. However, this is beyond the scope of this work. The task of conjecturing on the relationship between the foregoing technological patterns – no matter their degree of discontinuity – and socio-economic dynamics is already a daunting one.

4 Technology, productivity and growth

Consider the relation among technology, productivity and growth. In a first approximation, technological progress is the core driver of economic growth: since the Industrial Revolution, when mechanization and specialization in the industrial production has been introduced, machines helped human activity in improving the quantity (and also the quality) of production (Dosi, 1984). In turn, technological innovation translated into productivity, and the latter into economic growth. But this is just a first, and indeed quite rough approximation. To see this, consider the identity:

$$g_y = g_\pi + g_n \tag{1}$$

From an accounting point of view this is just an identity which tells us that the growth rate of aggregate income y is given by the sum of the growth rate of productivity π and the growth rate of the working population n. In terms of theory of growth, however, it is much more complicated. In order to say that it is the growth of productivity and demography which straightforwardly drive growth of GDP, necessary conditions are the assumptions that: (i) the initial conditions are equilibrium one; (ii) the rate of growth of employees corresponds to the rate of growth of labour supply – i.e., the system is in equilibrium at least in the long-run, whereby there is no involuntary unemployment and no endogenous changes in the participation rates; (iii) productivity growth is exogenous, or even if endogenous, there is no feedback between income growth rates and productivity growth (hence, no "Smith-Young-Kaldor" dynamic increasing returns). Here, however, we shall advocate a quite different story.

It is an evident stylised fact of modern economic systems that there are forces at work which keep them together and make them grow despite rapid and profound modifications of their industrial structures, social relations, techniques of production, patterns of consumption. We must better understand these forces in order to explain possible structural causes of instability and/or cyclicity in the performance variables. It might be useful to start from a more explicit definition of "dynamic stability" and homoeostasis. We probably live in the first social structure where *technological*, *social* and *economic* changes are fundamental features of its functioning. For the first time, what we could call the "bicycle postulate" applies: in order to stand up you must keep cycling (Dosi and Virgillito, 2017).

However, changes and transformations are by nature "disequilibrating" forces. Thus there must be other factors which maintain relatively ordered configurations of the system and allow a broad consistency between the conditions of material reproduction (including income distributions, accumulation, available techniques, patterns of consumption) and the thread of social relations. In a loose thermodynamic analogy, it is what some French works call "regulation". The problem of long term-cycles or innovation waves, which induce changes in the rates of macroeconomic activities, pertains precisely to this level of analysis: are there structural features which produce crises in the "Regulation" set-ups?

Let's distinguish three main domains of the overall socio-economic fabric: (i) the system of technologies, (ii) the economic machine, (iii) the system of social relations and institutions. These three domains clearly interact with each other. Our analysis will build on the following hypotheses:

- Despite powerful interactions, each of these three domains has rules of its own which shape and constrain every inducement and adjustment mechanism between them.
- There is a limited number of configurations of these three domains which allows a relatively well-regulated and smooth consistency between them.
- Unbalanced or crises configurations do not necessarily also embody the necessity of the transition to other ones.

Technical change is fundamentally about two things: either producing existing commodities or services with fewer inputs (i.e. more efficiently), or producing new commodities and services. In practice, product innovation of one sector are often process innovations for other sectors which are using them. The distinction, nonetheless, is theoretically fruitful. We just mentioned that process innovations necessarily imply some input saving. We can be more precise and suggest that in capitalist economies where conflict over labour processes, income distribution and power are structural features, labour saving must be one of the fundamental dimensions of most technological trajectories. Moreover, any labour saving upstream, i.e. in the production of commodities which are also productive inputs, represents an input-saving, in value terms, downstream. Developed industrial systems are functionally characterised, in normal conditions, by reproducibility and not scarcity, demand-pulled in terms of macroeconomic activity, and balance of payment constrained. Under these conditions, paramount importance must be attributed to the broad duality of technical change which on the one hand continuously saves labour and, on the other hand, creates new markets or expands existing ones by means of changing costs and prices of each commodity and services. The balance between demand creation and labour displacement defines the endogenously generated rates of macroeconomic activities and utilizations of the labour force. The dual economic features of technical progress are affected by the pattern of consistency (or the mismatching) between:

- the nature of the fundamental technological paradigms;
- the nature of production and labour processes associated with them;

- the mechanisms of interactions among the major social groups;
- the baskets of consumption, which are a function of income levels, income distribution, and given the latter, of the ways societies organize the use of non-working time, the provision of services, etc.

Years after the Great Recession, European growth is still anaemic and there are increasing concerns that the crisis has permanently slowed down productivity growth, thus reducing long-run growth perspectives, recalling the notion of hysteresis (more in Dosi et al., 2018b). Concerning the US, looking over the last two decades, Syverson (2017) has recently documented that productivity growth more than halved between 1995 and 2015, moving from 2.8% (1995-2004) to 1.3% (2005-2015). A similar pattern characterizes 29 out of 30 countries analysed in the same study, with an average decline of 1.2 percentage points. Without timely interventions, Europe as well as other developed economies, it is suggested, might face a period of secular stagnation.

But, are we really facing the exhaustion of innovative opportunities? Or are we rather witnessing the exhaustion of a growth regime characterized by a smooth matching between product and process innovation, productivity gains, their distribution as wages increases, sustained formation of aggregate demand and, ultimately, sustained GDP growth?

Certainly, at least since the Industrial Revolution, The Unbound Prometheus (Landes, 1969) of technological innovation has driven mechanization and specialization in the production processes together with the generation of increasing variety of products, leading to a secular increase in productivity and per capita GDP. That happened throughout the different industrialization waves (or Industrial Revolutions) characterized by different techno-economic paradigms (Freeman and Perez, 1988) from the steam engine all the way to a potential current Fourth Industrial Revolution. However, some scholars argue, such a secular drive has been exhausted, both in terms productivity growth and of creation of new investment and consumption opportunities comparable to those associated with the revolution in the means of transport, urbanization, central heating, electrification, etc... (Gordon, 2012). Are such social needs exhausted? Hardly so.

Most likely the sources of the productivity slowdown are diverse, potentially attributable to many, possibly complementary causes. Some pertain to the supply side, including lags in the diffusion of the latest wave of new technological paradigms and lack in organizational capabilities and skills apt to fully exploit them. After all, major new technologies such as the electricity-based ones took roughly one century in order to display their full potential. Conversely, nowadays we are just at the start of the digitalization of the economy and of society – based on the convergence, among ICT, automation and Artificial Intelligence – and we are still beginning the exploration of the potential of Bio- and Nano-technologies, and new materials. Other possible causes of the apparent productivity slowdown pertain to the demand side and to the interaction between the latter and the rate and direction of innovative efforts.

For sure, well before the Great Recession, the strikingly successful socio-economic regime of growth observed during three Glorious Decades after World War II came to an end as the smooth matching among technological innovation, productivity growth, in-

come distribution and aggregate demand increasingly broke down (see Section 2). To recall, on the technological side, the sustained rate of growth was based on the rapid development of few fundamental technologies such as automobiles, electrical consumer durables, capital equipments related to mass production and Tayloristic production processes. On the institutional and labour side, some sort of inclusive social compromise guaranteed relatively equal income distribution, a rough indexation of wage on productivity growth and political commitment to near-full employment. In turn, the foregoing conditions on income distribution fostered sustained growth of consumption, optimistic animal spirits regarding investment and the overall growth of aggregate demand.

5 Technology and jobs

The impact of technology upon productivity, through that on demand, and finally on labour demand, has been one of the thorniest issues at least since David Ricardo's chapter "On Machinery". As know, it is often referred to as the problem of *compensation mechanisms* (Vivarelli, 2014). There are at least three channels linking technological change, demand and employment, namely first, via productivity growth to lower prices to higher demand (under positive price elasticities of demand); second, from productivity growth to growing real wages to higher demand, and third, with an opposite sign, from productivity growth to labour displacement to higher unemployment and lower demand. A first important question concerns empirically what has happened and is happening to the relative importance of product- vs process-related technological advancements. Has it changed? And in which direction?

Of course, there is a sectoral dimension to such dynamics. At a bird-eye view, historically the pattern of economic growth has been associated with a movement of the labour force from agriculture to manufacturing, and finally to the service sector. The prevalence of the effects of labour-creation or destruction accompanying the process of structural change basically boils down to whether output growth (demand) is higher/lower than productivity growth. Demand growth and productivity growth are linked via the price elasticity channel: productivity dynamics, in so far as it reduces prices, it spurs demand in sectors experiencing high productivity growth (see the classic Kuznets, 1955; Clark, 1957; Baumol, 1967; Pasinetti, 1983).

The other driver of dynamics rests in the income elasticities of demand: employment absorbing sectors (toward which the labour force tends to move) have been generally characterised by high income elasticity of demand, especially in the initial phase of development (Freeman et al., 1982). While high income- and price-elasticities of demand might compensate, or more than compensate, the labour saving effect of process innovation, under conditions of increasing returns demand growth influences productivity dynamics (the so called Verdoorn-Kaldor law). Such virtuous circles apply primarily to manufacturing and certainly were at work during the Glorious Decades. Are they still at work now?

First of all, in the past, the transition from agriculture to industry meant a shift from a lower productivity toward a higher productivity sector, characterized at the same time

by high income elasticities of demand; and so was the evolution within industry itself from traditional manufacturing to consumer durables (such as cars, white goods, TV, etc). Conversely, nowadays the activities associated with the new technological paradigms are indeed high productivity sub-sectors (e.g., ICT, robotics, biotechnology) but (still) bear a relatively low share in aggregate demand and in employment.

Together, second, the bulk of the transition nowadays appears to be from manufacturing to services – prima facie characterized by an apparent lower productivity. Certainly there is here a major issue of measurement, as it is hardly possible to compare with the same yardstick the value added of health care with that of car manufacturing. However, it holds that in relatively wealthy, ageing, societies, the share of health services, elderly care, other welfare services are growing and bound to further grow in the future. Conversely, healthcare sector can be a source of a new wave of innovations and technological developments. However, it is hard to imagine increasing return processes similar to manufacturing, almost mechanically linking demand growth and productivity growth, however measured. In turn, this entails a formidable policy challenge (see below). Of course, the process of automation and robotization of industry and increasingly service have, and more so, will have profound effects upon labour productivity.[8] Indeed this should be one of the major objects of analysis, together with the lag structure by which the related innovations are likely to diffuse throughout the economy.

Technological innovation exerts a major impact on jobs, both on their quality and quantity. Many scholars, in the last twenty years, have been studying how the introduction of new technologies have affected the set of worker-skills that firms *demand* (see Autor, 2015 for a review). According to Autor, along the entire skills range, automation and computerization turn out to be *substitutes* for the more routinised activities and *complement* for high-skilled non-routinised jobs, with more limited effects on low-skilled, non-routinised jobs. The outcome of these dynamics suggests a pattern according to which medium-skilled jobs will gradually disappear, together with a relatively stable or increasing demand for both low-skilled and high-skilled jobs. The consequence of the simultaneous relative growth of demand for highly skilled/high-wage workers and low-skilled/low-wage workers suggested leads to a process of both wages and skills polarization.[9]

In turn, the change of the skill composition might also have effects on the ability of the Western economies to regain pre-crisis occupational level (see Jaimovich and Siu, 2012): the extent to which routinised (both manual and cognitive) skills have been automatised can contribute to the explanation of the jobless recoveries. Indeed, the decreasing trend in routinised skills has been particularly severe since the 1991 recession. Prior to that period, routine occupations – despite being hit – were able to effectively recover. This was combined with a generally increasing trend (even in the recession period) of non-routine occupations. However, since 1991, skills associated with routine occupations were not only severely displaced in the recessionary phase, but also never managed to recover. In

[8]This is not the place to discuss why we focus on labour productivity and not so called Total Factor Productivity (TFP) as many economists do. Suffice to say that in a world where capital inputs and labour are complements, and where the former are produced under conditions of non-decreasing returns, TFP measures are likely to be meaningless or even misleading.

[9]For a cross-country comparison on the dynamics of routinesed jobs see Marcolin et al. (2018).

particular, after the 1991 and 2001 recessions, recovery of the pre-crisis employment rate appeared in fact mostly driven by increasing trend in non-routine occupations. After the Great Recession, more worryingly, routine occupations have been hit particularly hard and, for the first time since 1970s, non-routine occupations also declined.

The notion of routinization above discussed often comes with a simplistic view of the relationship between automation and tasks. In fact, the fundamental mediation between technologies and operational tasks goes through organizational routines (see more in Section 6). Moreover many studies conclude that the sources of inequalities have little to do with any pourported skill/routine biased technical change, but they rest in the dismantling of labour market institutions (more in Freeman, 2015; Dosi et al., 2018c).

Moving from the specific organization of the firms to sectoral patterns, the foregoing view also discards the role of structural change across sectors. Jaimovich and Siu (2012) report that job losses in manufacturing accounted for 38% of job polarization since the nineties. In this respect, Groshen and Potter (2003) investigated whether the process of structural change could be associated with jobless recovery, focusing on the 2001 crisis in the United States. Groshen and Potter (2003) suggest that the process of structural change has been a determinant of jobless recovery, highlighting the predominance of permanent job losses over temporary and the shift of jobs across industries. In fact, they argue that the evidence of very low rehire rates militates in favour of the hypothesis that fired workers generally found jobs in other firms and sectors. Distinguishing between cyclical and countercyclical flows, and between structural gains and losses, they suggest that, while the downturns during the seventies and the eighties were characterised by a mix of cyclical and structural adjustments (50% respectively), the share of structural adjustments increased to 57% and 79% respectively in 1990-91 and 2001.

Further evidence on the connection between job polarization and structural change is discussed by Bárány and Siegel (2018). The authors propose a model in which they link the tripartion of skills (manual, routine and abstract) proposed by Autor et al. (2003) with low-skilled services, manufacturing and high-skilled services respectively. Their findings argue in favour of a strong overlap between the routine-skills categories and industry-occupation categories. In particular, the dynamics of manufacturing and routine skills reveal to be clearly similar. Furthermore, examining in depth the industry occupation-categories, Bárány and Siegel (2018) suggest that the decline of routine activities is deep and persistent only in the manufacturing sector. Conversely, routine activities in low-skilled and high skilled-services show an increasing trend or stability, respectively. Hence, the contractions of routine activities are strongly linked with declining shares of the manufacturing sector.

Granted that, of course, the overall quantity of jobs should be a major analytical and policy concern. The threat of *technological unemployment*, given the massive use of automated processes that can substitute for human labour is an issue that concerns the micro, sectoral and macro dynamics. We discusses the relation between innovation and employment at micro and sectoral level in Calvino and Virgillito (2018) and focusing on China in Dosi and Yu (2018). The evidence broadly suggests a positive relationship – especially respect to product innovations. However, it could well be that more innovative firms grow

more also in terms of employment but that it could well happen at the expense of other firms, so that the overall effect might be largely negative. In order to properly address such issue one is bound to consider the sectoral and inter-sectoral dynamics of innovation and employment.

An alternative angle of analysis entails the exploitation of geographic differences in some proxies for innovation propensities and in the composition of employment, building what Moretti (2012) calls the job multiplier. The suggestion is that high-innovative sectors have a higher multiplier: to one hight-tech job in the tradable sector appear to be attached many more jobs in non traded sectors. The idea is that most innovative sectors are those one where productivity increases are, and entail transfer of productivity gains into wages, those higher wages are spent into non tradable goods. Take the case of a Microsoft engineer which earns 180k dollars annualy: after spending money for rents, and savings, and related tradable services (travelling), he has at least 80k dollars to spend in local services, meaning paying salaries for two 40k dollars earners of the same community. This of course matches the Silicon Valley dream, with baby sitters, hair dressers, food delivers, which are all paid more and are also increasingly demanded. Moreover, according to Moretti (2012) this multiplier is higher than the "manufacturing multiplier" which is, according to his estimate, now one to one in US.

Many criticisms apply to this storytelling. In fact, the causal story could run precisely the other way round. First, information-inclusive technologies are likely to generate far less jobs than traditional manufacturing ones. So, a leading new-tech firm like Google is employing a number of people an order of magnitude lower than a traditional/declining firm like General Motors. If that comes together with a much unequal income distribution, as it does, it becomes straightforward that the ratio of productive vs non-tradable workers is likely to be lower in the Silicon Valley than in Detroit. But it is a purely statistical picture of more unequal techno-economic dynamics. Second, one should go beyond pure compositional exercises and we should pay much more attention not only on the number of jobs created, but also on the quality, and salaries, of created jobs. Otherwise one might easily end up in a slavery-like society, where rich people have dozens of individuals who satisfy their own personal needs with associate collective negative externalities. So, for example, high-income jobs determine a surge in living costs, and, particularly exploding home prices.

With wage stagnating and increasing lay-offs, these patterns add to both rentification of the economy discussed earlier, and the worsening quality of life of the majority of the population. Consider homelessness in the mythical Silicon Valley. Although still accurate analyses are dramatically lacking, a big chunk of the increase has been due to the arrival of high-tech firms which have induced a tremendous increase in housing costs, with a one bedroom apartment costing $3,000\$$ per month, that an engineer gaining around $80,000\$$ gross annually is not able to afford. All this should alert about the new patterns of job creation resulting from this capitalism 4.0.

> As of 2014, the city [of San Francisco] is believed to have approximately 7,000 homeless residents. As of 2015, approximately 71% of the city's homeless

had housing in the city before becoming homeless, while the remaining 29% came from outside of San Francisco. This figure is up from 61% in 2013. Of that 71%, 51% had lived in San Francisco for less than 10 years before becoming homeless; 11% had only lived in San Francisco for a year before becoming homeless. By 2016, according to a report by urban planning and research organization SPUR, San Francisco had the third highest per capita homelessness rate (0.8% or 8 in 1000 persons) of all large US cities, as well as the third highest percentage of unsheltered homeless (55%).[10]

Related, one should start to question the extent to which big-tech firms are creators of new knowledge and what can justify the enormous inequality they are producing exercising predatory behaviours. In many cases, the knowledge they produce is recombinatorics of existing pieces of knowledge, with the aim of creating purportedly new needs to be satisfied, or better, to satisfy very old needs with purported new technology. Take the case of social networks: they mainly serve for chatting, gossiping and meeting people but transfer these very basic and old human needs into a virtual, unknown reality. Additionally, these systems extract more value than what they create by monitoring people, tracking and selling consumer profiles.

6 Division of labour, knowledge and power

The very nature of the capitalist organization has always involved the power of organizing labour. Historically, this occurred by means of the rationalization of the production process way back since the First Industrial Revolution which entailed a combination of new technological paradigms and organizational innovations. As Adam Smith masterly noticed, the division of labour within organized units dramatically increased productivity, and it did so by transferring knowledge from disorganised artisans and part-time farmers into hierarchical forms of production. In so doing, the initial phase of capitalist development has entailed a process of labour deskilling. Braverman (1974) analysed such dynamics in contemporary capitalism, detailing the micro-organization of the so called *labour process*: the working class is analysed in its relationship with the machine, the shop floor, its management and the related control. The management structure under capitalism is such that the knowledge embodied into workers should be transferred into machines. In this respect the process of technological change has entailed a secular deskilling tendency whereby the machine is used to make it codifiable what before was tacit (Nuvolari, 2002).

To understand the relationship between man and machine it is crucial to understand technology as an evolutionary process. Think of a technology as a *recipe* with 'ingredients', associated procedures and "admissible acts" required, e.g. to build an artefact. A recipe always embodies a degree of codified knowledge but also non-codified and tacit one (the non-written procedures). In turn, the procedures are typically collective implying a process of coordination among members of the organisation. The execution of the recipe coordinated among the members of the organisation entails an ensemble of *organisational*

[10] https://en.wikipedia.org/wiki/Homelessness_in_the_San_Francisco_Bay_Area

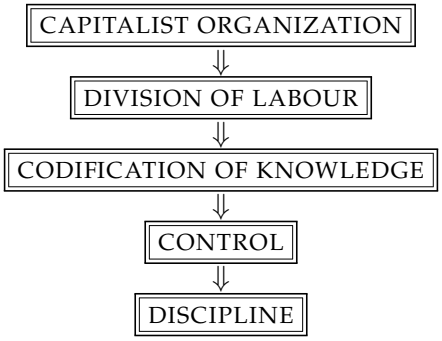


Figure 9: The relation between capitalist organization, knowledge and power

routines. Organisational routines constitute therefore a *trait d'union* between technology and organisation, typically nested into hierarchical structures and power relations (Dosi and Marengo, 2015). Figure 9 illustrates the point. Given the tacit nature of knowledge embodied in the execution of complex tasks, a "natural trajectory" in technical progress has involved the progressive mechanization/automation of production processes and a drive to make simple, repetitive, and codified the routines of the recipe. Control over rhythms of productions, correct execution of tasks, movements along the sequences of production, and discipline of the workforce have been and are the necessary conditions for the codification of knowledge.

If these patterns have always been there since the emergence of capitalist societies, indeed a birthmark of them, it seems that they are now accelerating. More or less intelligent automation is heading toward the very disappearance of a few of such tasks and related jobs, at least as they are performed by humans. Will they be compensated in a comparable number by intelligent jobs? It is hard to predict, but one can hardly see signs for it: even the rather optimist Moretti (2012) sees a large multiplier in terms of gardeners, babysitters, hairdressers, and we would add janitors and, that being America, prison guards and policemen.

There is another major feature of current technological transformations which represents a *discontinuities* vis-a-vis older patterns, and that concerns the "dematerialization" of some sources of aggregate income. All that is intimately connected with a significant part of social activities grounded on technologies that are more akin "information" as ever before, especially on the output side, but also on the input one, the ingredients above. Dosi and Nelson (2010) discuss to a much more detail the differences and similarities between information and technology: while the former is almost universally available, technological knowledge exhibits stickiness and strong path-dependence, ultimately being the source of striking intersectoral and international heterogeneity in all performance variables of firms.

But, there are growing parts of the economy where the technology on the output side, and to some extent also on the input one, is a form of *privately appropriated information*. Take the case of platforms, characterized by the combination of near-zero marginal costs of access and reproduction, with strong economies of scale, and network effects (David, 1985). First, information is non-rivalrous in use. Use by one economic agent in no way

by itself reduces the ability of other economic agents to use that information. Second, sheer information involves high up-front generation costs as compared with lower costs in their repeated utilization. In fact, there is something genuinely special of information in general and also of technical knowledge in that they share a sort of notional scale free property. So, in a first approximation, an idea when fully developed does not imply any intrinsic restriction on the scale of its implementation. In a language which we do not particularly like, were there a production function with information as the only input, it would display an output equal to zero for an information below one unit and a vertical line for information equal one. But, nowadays platforms approach such an archetype. Fourth, as a consequence, there is a fundamental increasing returns property to the use of information. The use of standard economic goods, ranging from shoes to machine tools, implies that use wears them out. This does not apply to information. On the contrary, the persistent use implies at the very least its non-depreciation.

Now, consider together the foregoing dynamics in the division of knowledge, power, and control with *centralization and appropriation of information*. The former is actually leading to more hierarchical power, even if often hidden under the reduction of hierarchical layers. Such reduction ought to be taken on the contrary as a tendency to a more polarized social fabric: "...one king and its subjects...". Put that together with the contemporary use of platforms which entirely exploit the properties of the information economy. Its inherent characteristics entail general non-convexities, Matthew-effects[11] and self-reinforcing processes implying multiple equilibria and trajectories. The two dynamics might be explosive: blending together more micro hierarchies with more information-driven centralization, when unrestrained, may lead to easier exploitative behaviours and massive polarization in the distribution of power, knowledge, and incomes. Think of Uber as an example: the major cost is the set-up of the platform and the marketing for it. Once running, the cost of its maintenance and expansion (marginal costs) are near-zero, while the delivery of the service is done through the exploitation of the service providers themselves, the car-drivers and their own cars.

The gig-economy[12] is an even more general archetype. Algorithms govern labour, not even the human being against whom one can strike. "Little" hierarchy: no one between you and the algorithm. And you are alone, as well many thousands of others, in a pre-industrial condition, similar to the "putting out" system before industrial factories. But, at least then, English peasants doing part-time flexible jobs were able to cheat, steal some of the fabric, control their pace of work. The case of bike-delivery persons, who are nowadays populating the streets of metropolis is another revealing example. These workers use a relatively old, human intensive mean of production (a bike) to provide a service which satisfies an old, basic need, as the one of eating, controlled by an extremely sophisticated software which acts as a boss, which tracks and monitors workers, which sends productivity evaluation messages (time to accept orders, time to deliver, travel time to restaurant, travel time to customers, late orders). However, drivers can't be deemed employees be-

[11] From the "Parable of talents", in Matthew's Gospel: *For to every one who has will more be given, and he will have abundance; but from him who has not, even what he has will be taken away.*

[12] For a further discussion on platform-economy see Kenney and Zysman (2016).

cause they have no obligation at all to log on to the app (Uber). A FT interview[13] to a Ubereats worker documents how the app may immediately change the salary without incurring in any legal implication: the app started paying 20 pounds an hour. Then it moved to 3.30 pounds a delivery plus 1 pounds a mile, minus a 25 per cent "Uber service fee", plus a 5 pounds "trip reward". Then the "trip reward" had been cut to 4 pounds for weekday lunch and weekend dinner times, and to 3 pounds for weekday dinner and weekend lunch times.

General characteristics of *Digital Taylorism* entail: being based on cheap, generally educated workers, without a workplace, fictitiously convinced of being "their own bosses". This type of contract typically transfers the entreprenerial risk from firms to workers. In this respects the power usually represented by a boss is enforced by an algorithm that communicates with workers via smartphones. This division of labour results into the disappearance of both collective and even individual labour contracts (De Stefano, 2015).

Together with this form of *Digital Taylorism*, old forms of Taylorism are still largely in place, particularly in the world factory economy. In this respect, the Foxconn case is almost an archetype (Ngai et al., 2015), among the biggest worldwide employers and top among Chinese exporters. Its hiring strategy is mainly taking advantage of the massive migration from agricultural areas of young workers (born after 1980s), it is organized as a factory-cum-dormitory (Dormitory Labour Regime), with extreme forms of control, with checkpoints and guards standing by 24 hours a day. The factory assumes control as a "total institution" (in the meaning of Foucault) controlling not only the working time, but the entire sphere of human activities. All employees, whether they are going to the toilet or going to eat, must be checked. Physical and verbal violence is systemic in Foxconn system. Workers are harassed and beaten up without serious cause. All this resulted for example into 18 suicides committed in 2010.

> To die is the only way to testify that we ever lived...Perhaps for the Foxconn employees and employees like us – we who are called nongmingong, rural migrant workers, in China – the use of death is simply to testify that we were ever alive at all, and that while we lived, we had only despair.
>
> [A worker blog (after the 12^th suicide at Foxconn), Source: Authors' translation from Ngai et al. (2015).]

All this internal division of labour is accompanied by an international division of production and a value chain which sees Apple squeezing their suppliers, correspondingly in order to secure contracts, Foxconn minimizes costs, and transfers the pressure of low profit margins to front-line workers. Workers are paid at an average wage quite close to the province minimum wage, massively relying upon overtime hours. Nothing of this is particularly new, and applies more widely than the ICT segment. Walmart is another archetypical example.

The cases we discuss vividly illustrate how, from the application of ICT-based technologies to the production, the management of the value chain may lead to forms of

[13] https://www.ft.com/content/88fdc58e-754f-11e6-b60a-de4532d5ea35

"turbo-Taylorism" which look like some "hight tech" versions of the horrors of the factories and Work Houses of the First Industrial Revolution.

7 Some policy scenarios, by way of a conclusion

In the policy debate, there is finally an increasing recognition that something should be done facing the serious increase in inequality, potential massive unemployment, the deterioration of working conditions and slippage of the welfare state. However, discussions are generally partial (a one problem at the time approach) and too often grounded in the interpretative paradigm of the economic orthodoxy of market frictions, rigidities, mismatching, or at most market failures, based on the presumption that markets left to their own means most often can efficiently take care of themselves and by implication take care of all of us. So, for example, there cannot be, by construction, long-term technological unemployment.

We should of course assess the efficacy and the possible trade-offs of alternative policy packages concerning, for example, redistributive policies, taxation in a globalized and digitalized world, education and training policies, employment policies, innovation and industrial policies. But we have to consider them together. And, even more important, the discussion should be placed in the broader context of a transformation of the relations between human beings and work, and between individuals and institutions. Alternative policies will result in different configurations of the State and intermediate institutions – the spectrum ranging e.g. from lean to thick States, from individualistic to collective forms of actions, from public to market-based provision of public services, indeed with quite different implications not only in terms of income growth, but also – and equally important – inclusiveness, the distribution of work and income, and ultimately of power.

Alternative policies concerning labour market institutions include: co-determination with some workers control on corporate strategies, workers ownership, and, at the opposite end of the spectrum, basic and or universal income and minimum wage. Of course, the distributional and social implications are rather different. For example, micro institutional engineering involving workers ownership, and/or profit sharing, or even German-type mitbestimmung are schemes with the burden of redistribution placed upon the single employer/firm, probably quite effective at the local level, but also prone to differentiating elite workers from the rest. Thus, if it has the advantage of increasing the labour share and redistributing productivity gains at firm level, it has the disadvantages of exacerbating across-workers inequalities, while being relatively ineffective in addressing aggregate unemployment and possibly also the cause of conflict between different groups of workers.

Conversely, the bottom of the distribution tends to be addressed by more universalistic schemes such as forms of basic income. However, they are equally controversial. If they provide a safety net for every citizen, their implementation tends to be at best neutral in terms of general income redistribution and generally is advocated together with very strong reductions of the welfare state, implying the transformation of public goods, such as health and education, into (private) income transfers. Recall that Milton Friedman was among the first proponents of the universal negative income tax. Additionally, basic in-

come schemes might be politically biased in so far as the right to access might be linked to the citizenship status, raising fundamental issues of discriminatory treatments vis-a-vis the pool of non-citizens. Increasing the minimum income level might help as well in putting a floor to the labour share which is dramatically falling. However, it might weaken the unions' bargaining power and threaten the collective organization of workers. And in any case, it cannot redress overall income distribution.

In that, taxation will continue to play a major role. New and old forms of progressive taxation ought to be implemented. Particular attention should be devoted in understanding both the dynamics of the tax-base and the ways different types of income, whether profits or wages, and rents (financial and non-financial) have to be taxed. The contemporary pro-market fury has come together with an anti-tax drive which has heavily reduced the redistributive impact of fiscal policies and the universalistic provision of services. For sure, such a drive has to be reverted together with the relative balance of taxation rates: more on rents and wealth than on profits, more on profits than on wages. As well known, there are growing problems in capturing rents and profits, beyond the nil political will to do it – related to their footloose nature – but the technical means are there, in fact profits might be tracked from the countries of origin to the countries of destination, generally fiscal paradises.

But, the objects of taxation are also changing. So, new forms of taxation including the robot tax, the bit tax and the web tax should be analysed. Some scholars suggest that "who owns the robots rules the world" (Freeman, 2015). South Korea has recently introduced a robot tax and the issue is also being debated in the European Parliament. However, while the robot-tax is likely to slow down the adoption of labour displacing technologies, it is still not clear whether such taxation should be on the ownership or the use of robots. Probably, it is much more reasonable to tax the owners: otherwise it would have been like in other epochs, taxing locomotives instead of taxing railroad tycoons. Moreover, robots might have very different usages, many of them not aimed at substituting but at complementing human activities (such as medical and bio-robotic applications), in very diverse activities, ranging from agricultural, to industrial and service sectors.

Another proposal is the *bit-tax*, already in the policy discourse since the beginning of the nineties (Soete and Kamp, 1996). As the transactions and the produced incomes are more and more immaterial, the tax base should shift from physical units toward digital units, that is bits of transmitted information. The web-tax, taxing digital transactions, might be consider a form of bit-tax. The taxation of platforms is another open question of great relevance. Platforms are increasingly using individual assets (such as apartments) to gain corporate profits. Additionally, distributed assets give rise to highly centralised rents.

In addition to income policies, one might consider employment policies. Some are indirect and affect the characteristics of labour supply. Education and training policies come under this heading. And so do so-called active labour market policies, involving training of unemployed people and retraining of workers in order to cope with skills obsolescence. While certainly essential, such policies are arguably hardly sufficient and additional more direct policies might be required (Dosi et al., 2018a). Firms should not expect to hire ad-

hoc trained employees, but rather they have to invest in enhancing employees' learning, mainly via on-the-job training schemes. In order to cope with rapid technological advancement workers should first of all possess a wide range of non-task specific skills. Higher level reasoning and abstract skills have to be taught and developed.

An approach which dates back at least to Roosevelt's New Deal holds the State as *employer of last resort*. Contrary to any notion of a lean State, this view implies the creation of massive job-programs during periods of downturns, with the double advantage of doing useful things and providing income (Minsky, 1986). Another, possibly complementary, employment policy concerns the reduction of working-hours. After all, this has been the secular tendency in industrialised countries since the mid 19^{th} century, matching the long-term patterns of mechanisation and automation of production. It has been recently tried in some advanced countries with the aim of enabling at the same time the creation of new jobs opportunity, and the redistribution of productivity gains. The implications, however, might be blooming, if not matched by strong regulatory limits to involuntary part-time works, non-standard forms of employment and mini-jobs.

The State has always been creator of investment opportunities, backer of long-term and risky research programs and herald of "mission-oriented" innovations (Mazzucato, 2015). It should be even more so now. A fundamental objective ought to be policies fostering the creation of human-enhancing innovations in contrast with human-replacing ones. The tall task is to develop mission-oriented policy episodes able to foster the emergence and diffusion of new technologies, to shape their directions. And the imperative on such directions ought to be environmental and social sustainability, and income redistribution. In fact, the public has to recover his ability not to only regulate, but to clearly mould the strategies of private actors.

We are facing nowadays a historical bifurcation both in technological trajectories and in the forms of socio-economic organisation. We can head towards some form of techno feudalism with a deeply divided society or we can go towards a society that collectively share the benefits of technological advances. The taken route largely depends on the kind of policies we design and implement.

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