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## **CIMR Research Working Paper Series**

*Working Paper No. 23*

# **Technology, development and economic crisis: the Schumpeterian legacy**

by

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June 2015

ISSN 2052-062X

## **Abstract**

This contribution aims at highlighting the complex, non-linear and potentially contradictory nature of the relationships between technological progress, economic growth and social development, in particular within the context of market based economies. The main (provocative) argument put forward in the paper is that the recent neo-Schumpeterian literature, while providing fundamental contributions to our understanding of innovation, has contributed to the rising of a positivistic reading of the relationship between technology, economy and society, with technology being able to guaranty strong economic growth and (implicitly) social welfare. This is confirmed by the fact that, contrary to other influential heterodox economic schools and Schumpeter himself, in the recent neo-Schumpeterian literature technology is only rarely associated to macroeconomic market failures such as systemic crises, structural unemployment, and the growth of social and economic inequalities. It is also argued that the emergence of a “positivistic bias” in the neo-Schumpeterian literature has been associated to the dominance of a supply-side and micro-based view of the technology-economy relationships.

Key words: Technology, Innovation, Schumpeter, Development, Crisis

JEL codes: B52, O00, O30.

## 1. Introduction

There is no doubt that the last economic crisis, with its depth, extension and length, could have, at least in principle, the potentiality of shaking at the fundamentals the dominant neo-liberal economic thinking and policy framework. One could even not rule out the possibility that, as in the 30s the “great depression” paved the way to the “Keynesian revolution”, in the next years or decades a somewhat similar earthquake in economic theory and policy framework might take place (Bellofiore and Halevi, 2011). Whatever will happen in the next future to the economic discipline and policy practice, there is no doubt that the “systemic” nature of the last economic crisis, and its enormous social costs, challenge de facto all theoretical approaches that have magnified the economic and social welfare virtues of un-regulated market economies, downplayed the relevance of structural macro-economic market failures, expelled the “crisis issue” from the economic research agenda (Brancaccio and Fontana, 2011).

In this contribution we argue that the last economic crisis challenges also the widespread (both within and outside orthodox economics) positivistic view on the role technology plays in our economies and societies (Soete, 2013). More specifically, the somewhat provocative argument put forward in this paper is that such a positivistic stand permeates also the neo-Schumpeterian literature, that is that broad stream of research originated in the 70s and 80s having as its main research focus the nature, the determinants and the economic effects of technological change and innovation. Despite being constituted by a rather heterogeneous set of research streams (Fageberg, 2013a; Winter, 2014), all in all this body of literature tends to convey an optimistic scenario of the economic and social effects of technology, with technology being able to guaranty strong economic and employment growth and (implicitly) social welfare. As it will be argued in the following sections this positivistic view on the dynamic and socially progressive virtues that technology plays in capitalist economies is confirmed by the fact that, contrary to classical economists, and Schumpeter himself, in the neo-Schumpeterian literature technology is only rarely associated to macroeconomic market failures such as systemic crises, structural unemployment, and the growth of social and economic inequalities.

The paper is structured as follows. In the next section the flourishing of the new-Schumpeterian literature is put in an historical context. In section 3, along with recognizing the great merits of “neo-Schumpeterism”, we highlight two key methodological and conceptual traits of this stream of literature which, to our view, make the latter unfit to deal with the potentially contradictory relationships between technology, economic development and social welfare in market economies, contradictions emerging especially in periods of prolonged structural crisis as the one we are living in. More in particular, the focus will be on the progressive shift of the bulk of “innovation studies” toward a micro-based and supply side view of the relationship between technology and economy (section 3). In section 4 it will be argued that such a “double shift” has contributed to favor a positivistic and a-critic representation of the economic and social effects of technology, marginalizing “classical” and “heterodox” topics such as the controversial relationships between technology and employment, technology and (economic) development, technology and the dynamic efficiency of markets.

## **2. The emergence of neo-Schumpeterism as a new area of economic heterodoxy**

As well known over the last 150 years “economics” (political economy) as a scientific discipline has been largely dominated by the neoclassical school. This approach is characterized by a relatively high “internal” methodological and formal rigor. Its basic assumptions are however rather restrictive and depict a *modus operandi* of economic agents, markets and economic systems rather far from reality. Basic assumptions and restrictions are functional not only to preserve the internal methodological coherence of the model but also (and perhaps more importantly) to prove the virtues of markets and in particular the capacity of the “invisible hand” to guarantee an objectively “efficient” (Pareto optimal) and “fair” (one among the best possible) allocation of (limited) resources. In this respect it is enough to bear in mind that according to this approach competitive markets determine socially acceptable distribution outcomes, with income shares reflecting the objective and measurable contribution that each production factor provides to economic output. This in turn removes almost any ground for distributional tensions and conflicts; nor this approach is interested in analyzing the economic, institutional,

social historical processes through which asymmetries in individual and social class endowments have been generated. In synthesis, the all theoretical and methodological neoclassical framework is designed in order to prove that market economies consist of harmonic, efficient and non-conflictual socio-economic systems. The functioning of market forces is in fact able to solve in the best way the unique “economic issue” individuals and society as a whole have to tackle: making the most efficient use of a scarce pool of resources (Robbins, 1932).

In the standard neo-classical framework innovation and technological change are considered as exogenous variables, elements not essential for understanding the behaviours of economic agents, the functioning of markets, the aggregate performances of economic systems. Moving away from the “classical tradition”, the bulk of neoclassical theory has in fact focused on the static and equilibrium properties of markets assuming as exogenous (and external to the discipline) all the factors explaining “from within” the dynamism and qualitative changes of market economies, as well as its social structure (Schumpeter, 1912, 1942). As well known, over the last two decades, starting with the contribution of Lucas and Romer, there have been various attempts of endogenising innovation and technological change within formal neoclassical models of economic growth (Lucas, 1988; Romer, 1990, 1994; Aghion and Howitt, 1992, 1998). However, the fundamental conceptual and methodological structure of these models has not significantly changed, remaining strongly anchored to methodological individualism, trusting the functioning of the Say law and the equilibrium properties of markets, assuming that the aggregate performances of markets and economic systems reflect (and are the result of) the individual behaviors and choices of fully rational maximizing agents (Verspagen, 2005).

In order to find an “endogenous”, socially and institutionally embedded treatment of technological change one has to look outside the orthodox field of economics, going back to the insightful (political economic) views of classical authors such as Smith and Ricardo (although in an embryonic form), looking at the titanic works of Marx and Schumpeter, at some important contributions in the post-Keynesian school (Kaldor, 1961; Kalecki, 1954, 1991) as well as at the heterodox area of institutional economics (Kapp. 1950; 1963). These schools and scholars, although being very heterogeneous as far as their theoretical

bases, methodological apparatus and research interests, share some very basic common heterodox traits the most important being: a) the acknowledgment of the intrinsic instability of capitalism conceived as a specific and historically determined socio-economic system; b) an analytical focus on the factors, forces and conditions which alter economic equilibrium conditions; c) the idea that perfect competition is a rather abstract and irrelevant theoretical reference point, and a market structure which conflicts with both dynamic and static efficiency; d) the endogenous character of technological change a phenomenon and force strictly linked to the more general processes of capital accumulation, institutional, social and structural change.

As already mentioned the neo-classical approach has been largely dominant in the last 150 years. Keynesian theories, emerged after the great depression, have reached their maximum consensus in the few decades just before and after the second world war, loosing most of their appeal and political consensus in the 70s, in concomitance with the end of the post-war golden age of economic growth. Even more limited and residual has been the influence of Marxism. Interpreting the causes of the declining parabola of Keynesianism, as well as the misfortune of Marxism as a scientific discipline, would go much beyond the scope of this paper. It is nonetheless worth to remark that in all scientific disciplines, and especially in social sciences, the evolution and success of different schools and views are dependent not only on their “objective” explicative power but also (and perhaps in more stringent way) on the support they receive by the dominant ideological, economic and political establishment (Henry, 1990). This is even more true in the case of a scientific discipline such as “political economy”, given its strong and normative character, and its direct social and political implications. In the light of this, it is plausible to state that, much beyond its objective scientific values, the re-affirmation of the neoclassical apparatus is not independent from the change of the political and cultural climate we have been witnessing over the last three decades, with the widespread introduction of new-liberal policies and reforms, the increasing bargaining power of capital (vis à vis labour), especially in its dominating financial and transnational form (Bellofiore, 2013).

It is in this sort of “neoclassical counter-reform climate” that Schumpeter has started to be re-discovered becoming a cultural heterodox reference point for a new field of research

specifically dealing with the “economics of technology and innovation”. The holistic methodological approach of the Austrian economist, his out-of-equilibrium, dynamic, historical view of economic processes, his interest on the role of innovation seen as the engine of competition, structural change and growth, have represented a strong source of attraction and inspiration for a new generation of economists and scholars. The acceleration of the rate of technological and scientific change, the paradigmatic change brought about the emergence and diffusion of ICTs have also contributed in the 70s and 80s to the rapid growth of this new discipline variously labelled as “Economics of technological change”, “Economics of innovation”, “Schumpeterian economics”, “Evolutionary economics” (Dosi et al., 1988; Dogson and Rothwell, 1994; Stoneman, 1995; Fageberg et al., 2005; Hall and Rosenberg, 2010). For the sake of simplicity (and with a great deal of approximation) in this paper we label this rapidly growing research area, and related literature, as “neo-Schumpeterian”, focussing in particular on that branch dealing with the analysis, determinant and effects of technological change and innovation (Winter, 2014).

### **3. Merits and shortcomings of the neo-Schumpeterism**

There is no doubt that the neo-Schumpeterian literature has had the fundamental merit of bringing back (after Marx and Schumpeter) technology and innovation at the centre of economic theory and analysis. This stream of literature has in fact filled an important gap in economic theory, providing for the first time a systematic array of analyses, theories and evidences on a complex and multiform phenomena such as technological change and innovation. This line of research has been opened up in the 70s by the pioneering contributions of Christopher Freeman, Nathan Rosenberg, Richard Nelson and Sidney Winter, followed by other influential scholars on both sides of the Atlantic ocean, and by the setting-up of think-tank research institutes such as the Science Policy Research Unit (SPRU) in the UK, the Maastricht Economic Research on Innovation and Technology (MERIT) in The Netherlands (Fageberg and Verspagen, 2009; Fageberg et al., 2012).

Over the last few decades this research area has expanded at an exponential rate consolidating itself as a new autonomous discipline around a visible and highly



interconnected college of scholars, grown-up outside or the very margin of mainstream economic departments (Fageberg and Verspagen, 2009). The research topics investigated have also progressively expanded. In extreme synthesis the scholars active in this new field of research have devoted their efforts mainly at: a) exploring the “black box” of technology, investigating sources, procedures, purposes of innovation activities; b) collecting data on science, technology and innovation and identifying appropriate indicators to be used for empirical research and policy purposes; c) investigating the effects technology and innovation exert on the key economic performance variables at any possible level of aggregation; d) drawing from all these theoretical contributions evidences and stylized facts, hints and lessons for policy action (Fageberg, 2013b).

The neo-Schumpeterian literature resumes from Schumpeter the idea that technology and innovation (along with diffusion) are the distinctive and most important drivers of competition, the real fuel of the process of economic change, that is the birth(death) of firms, the emergence(decline) of markets and industries as well as the dynamic performance of economies at large. However, the “evolutionary metaphor” synthesised by the Schumpeterian “process of creative destruction” has been conceptualized and analyzed in very different ways and namely: at different levels of the analysis (micro, meso, macro); within different time scale frameworks (short versus long-term processes of structural change); looking at different type of actors and institutions (entrepreneurs, firms, industries, national innovation systems). This clearly emerges looking at the tables of contents of the main handbooks of technological change and innovation published over the last three decades (Dosi et al., 1988; Dogson and Rothwell, 1994; Stoneman, 1995; Fageberg et al., 2005; Hall and Rosenberg, 2010) as well as by recent reviews of the state of art of the evolutionary literature (Fageberg et al., 2012; Fageberg, 2013a; Dosi, 2013; Winter, 2014).

An important point we want to make in this paper has to do with the specific long-term trajectory shown by the innovation studies over the last 30 years, highlighting some important differences between the works and perspectives of early neo-Schumpeterian contributions and the most recent stream of innovation studies; a trajectory that has also marked an increasing distance of recent neo-Schumpeterian literature with the ways previous heterodox schools used to look at the role of technology in the economy and

society. It is precisely with reference to the characterizing features of the neo-Schumpeterian literature in the last two decades that we want now turn our attention, highlighting three (interdependent) broad trends in this research stream:

- a) the first trend consists of having progressively shifted the focus of the analysis of the technology-economy relationships from a macro to a micro-economic level;
- b) the second trend is a progressive reinforcement of a supply-side view of the relationships between the generation, diffusion and use of technology and the main economic phenomena, with the role of demand largely neglected;
- c) the third element (in our opinion, logical consequence of the previous two points) is the emergence of an (implicit) positivistic view of the economic and social role technology plays in market economies.

#### **4. Towards a supply-side and micro-founded view of technology**

There is no doubt that when compared to the views of classical economists and even more to the post-Keynesian tradition, the neo-Schumpeterian literature looks at the relationships between technology and economy from a somewhat different perspective. The main differences have to do with the level of aggregation of the analysis, the level of generalization of the relationships examined, the relative importance given respectively to demand and supply-side drivers of growth. In fact, since its origin, the neo-Schumpeterian literature has shown little interest in the traditional macro-economic variables and dynamic mechanisms taken into account in the post-Keynesian tradition, with the latter revolving around the dynamic interplay between investment, capital accumulation, productivity growth, income distribution and effective demand. It is however in the last two decades that the emphasis has clearly shifted towards a fully supply-side view of the dynamics of macroeconomic forces with a key role played by intangible investments (Evangelista, 1999), and with technology seen as the ultimate source of all sort of economic performances variables, and in particular the factor explaining the observed cross-country disparities in productivity growth and international competitiveness. In particular, the role of demand, and its relationship with rate and direction of technological change, has been largely neglected. In fact, in most of the theoretical and empirical neo-

Schumpeterian literature economic growth (associated to the process of creative destruction) is never constrained by aggregate demand, and the latter is automatically expanded by technology through the emergence of new markets, new industries and products.<sup>1</sup> In the evolutionary literature the technology-economy relationships become highly dependent on contextual conditions. It is in fact the idiosyncratic nature of knowledge accumulation and innovation processes that explains why economies, as well as regions, industries and firms, differ from each other in their technological capabilities and economic performances. As a result, the “growth issue” has been progressively reduced to a “competitiveness matter” based on “absolute competitive advantages” with both gross domestic product (GDP) and employment growth depending on the country-specific capabilities of economies, industries and firms to increase their market shares within the broader process of creative destruction.<sup>2</sup>

In this supply-side (competitive-based) view of the technology-economy relationships the micro-level mechanisms governing the fabric of innovation processes have become a key area of investigation and theoretical concern. This explains why the analytical and empirical focus of innovation studies has progressively shifted from a macro to a micro level.<sup>3</sup> The exploration of the sources, procedures and effects of innovation at a micro and industry level has been considered of crucial importance, in order to qualify the specific behaviors and mechanisms governing the processes of *variety generation* and *market selection*, to find proper micro-economic theoretical foundations (and empirical support) to the evolutionary models of competition, economic growth and industrial dynamics (Dosi, 1988; Dosi and Nelson, 2010).<sup>4</sup>

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<sup>1</sup> Among the few exceptions see Dosi et al., 2010.

<sup>2</sup> The literature on National systems of innovation, emphasizing the role of institutions represents in this respect a notable exception (Nelson, 1993; Edquist, 1997; Fagerberg and Srholec, 2008; Soete et al., 2010)

<sup>3</sup> The micro-economic shift of innovation studies is clearly visible looking at the index of the main handbooks of the technological change and innovation published over the last two decades where the macro-economic analyses of the determinants and effects of technological change, especially in a long run perspective, find only a limited space (Dogson and Rothwell, 1994; Stoneman, 1995; Fagerberg et al., 2005; Hall and Rosenberg, 2010).

<sup>4</sup> There is no need to say that the “microeconomic foundations” of evolutionary economics are antithetic to the neoclassical ones. In particular, the evolutionary school rejects most of original micro-economic neoclassical assumptions such as the idea of representative agents, the presence of full rationality of economic behaviors, the public nature of technology as well as the assimilation of technology to pure information (Dosi, 1988).

The heterogeneous nature of innovation and its role in fueling economic change has in fact become the main core of neo-Schumpeterian studies (Evangelista and Mastrostefano, 2006). The areas explored by this literature is very large and the contribution provided by these new research stream to our understanding of innovation, firms' behaviors and industrial dynamics can hardly be underestimated (Dosi, 2013; Winter, 2014). However, an argument can definitely be made on the fact that the supply-side perspective and the micro-economic focus adopted by the bulk of these studies have also contributed to the rising of a deterministic and positivistic vision of the role technology plays in the economy and society, with innovation playing a sort of thaumaturgic role, being able to explain almost everything: the performance of firms, industries, regions and countries as well as the destiny of individuals and workers.<sup>5</sup> This almost un-conditionally positive and socially progressive role played by technology in our economies and societies is in turn based on two basic assumptions:

- a) the first one is the existence of a strong pervasive (Schumpeterian) nexus between technology, growth and employment with the positive economic effect of technology being inseparably linked to the capacity of firms, industries and economies of winning the competitive race relying upon their superior technological capabilities;
- b) the second (often implicit) one, is that technological competition consists always of a positive economic and social sum game, and that this has been true in the past, holds in the present times and will continue to be true also for the future, and this independently from the macro-economic conditions in which the process of creative destruction takes place, the specific techno-economic regime, the broad social and institutional context in which technological competition takes place.

An important point we want to make is that the combination of these two assumptions has contributed to convey a rather simplified picture of the social and economic perspectives linked to the advancements of technologies and their socio-economic use in the context of market economies, that is in an institutional context in which the decision processes regarding the rate, direction and use of technology are largely dominated by un-

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<sup>5</sup> This has also favoured a sort of techno-centrism and an auto-referential character of this discipline. As indicated by Bart Verspagen "...evolutionary economics so far by and large lacks a clear theory of other economic phenomena than technological change, e.g., the interaction between trade and growth, or the theory of labour or financial markets" (Verspagen, 2002. p.3).

coordinated profit-seeking behaviors and incentives and asymmetric economic power, the dominating logic of financial markets. Furthermore, while the first assumption is based on sound theoretical and empirical bases, as far the second assumption is concerned one finds very few theoretical arguments and limited empirical support. The opinion of the author of this contribution is that this analytical deficit and simplification of the macro-economic nature of the determinants and effects of technological change is largely the result of an unduly transposition at a macroeconomic level of relationships and mechanisms holding at a microeconomic level. As a provocation, one could argue that most of the neo-Schumpeterian literature somehow conveys a sort of Schumpeterian version of the neo-classical Say law which could be re-phrased as follows: “each technology creates its own demand”, and this is deemed to be true at a micro as well as at a macro level. In fact, macro-economic demand conditions necessary to absorb the increased levels of output or new types of productive outputs are usually not taken into account or incorporated in the analysis. More specifically, this type of approach neglects or underplays crucial macro-economic issues addressed in the heterodox field of economics (especially in Marx’s writings and in the post-Keynesian tradition) and concerning the possible mismatch, between interrelated phenomena such as dynamics of investment and technology, the corresponding changes in supply forces (productivity), changes in income distribution and demand conditions (Courvisanos, 2012). These mismatches are at the basis of possible or potential phenomena of over-capacity, under-consumption, misallocation and waste of resources (human, tangible and intangible), static and dynamic efficiency losses, all aspects largely neglected in the neo-Schumpeterian literature.

#### **4. Heterodox themes marginalized in the neo-Schumpeterian research agenda**

The methodological and theoretical traits of the neo-Schumpeterian literature highlighted in the previous section have led to the marginalization of broad macroeconomic and socially relevant themes concerning the role and socio-economic impact of technological change. In what follows we list four of such neglected themes in a rather sketched and un-systematic fashion, as they are merely exemplificative of the change of perspective of this stream of literature when compared to the other major heterodox schools both in the classical tradition as well as in the post-Keynesian one.

*Technology and employment.* This is a topic and a social issue placed at the center of theorizing since the beginning of the political economy discipline. Surprisingly enough, after the pioneering contributions of early neo-Schumpeterian scholars such as Freeman, Clark and Soete (Freeman et al., 1982; Freeman and Soete, 1994) this theme has been progressively marginalized in the following neo-Schumpeterian literature.<sup>6</sup> The main reason of this disinterest is an (implicit) belief that technology is potentially able to foster economic growth at a pace sufficient to warranty full employment. Of course the existence of labour displacing effects is not ruled out but for most of the existing literature (both mean-stream and neo-Schumpeterian) this phenomenon affects low skilled jobs while the overall impact is thought to be positive. However, there is no empirical evidence supporting this optimistic view given the difficulty of modelling and estimating the net long term aggregate effect of technological change on employment (Vivarelli 2013). The functioning and strength of the so-called compensation mechanisms (Vivarelli, 1995; Vivarelli and Pianta, 2000) crucially depends on rather axiomatic conditions such as the existence of perfect competitive markets, a perfect and continuous inputs' substitutability, the validity of the so-called Say's law which guarantees that changes in 'supply conditions' (i.e. productivity growth and supply of new products) always generate corresponding (market clearing) changes in demand. The net aggregate employment impact of technological change becomes even more difficult to be assessed in the case of the diffusion of Information and Communication Technologies (ICT). This is because of the pervasiveness of these technologies and their widespread impact on almost any domain of our economic and social life (Evangelista et al., 2014). In the light of all this, the still dominant optimistic and supply-side view of the relationship between technological change and employment, as well as the little attention given to this crucial and socially relevant theme by neo-Schumpeterian Scholar is somehow surprising.

*Technology and socio-economic progress.* The intertwined relationships between technological change and the long term transformation of economic and social conditions (socio-economic progress) is another broad theme present in the research agenda of early evolutionary economics, but marginalized in the recent neo-Schumpeterian literature. In fact, despite this topic has been dealt with by some of the pioneers of the neo-

Schumpeterian school such as Christopher Freeman and Carlota Perez, in the last two decades it has been progressively expelled from the research agenda of innovation studies. The effects of technology on the economy and society have in fact been investigated more and more in a linear, deterministic and quantitative way, shifting the focus from the technology-development issue, to a mere quantification (econometric estimation) of the effects of technology on GDP and productivity growth or on international competitiveness. This technology based perspective of economic growth and socio-economic progress reveals increasing difficulties to interpret what might be regarded as one of the major macro-economic paradox materialized over the last decades: the mismatch between on the one hand the incredibly large opportunities offered by technology achievements and, on the other hand, the increase of economic and social inequalities, the large amount of un-satisfied social and human needs, the un-sustainable pressure that our economic model put on natural resources and the natural environment (Pagano and Rossi, 2011). Technology interpreted in the neo-Schumpeterian literature as the key driver of growth (and social progress) has determined macroeconomic and (more broadly) social outcomes much below the expectations (Gordon, 2012). In the last three decades the world economy has grown at pace which is almost half of the one experienced in the first two second post-war decades and this despite we have witnessed what has been labelled as the third industrial and technological revolution, that is the one connected to the widespread diffusion of ICT in almost any domain of our economies and societies. An interpretation given to this paradox by neo-Schumpeterian scholars such as Freeman and Perez (Freeman and Perez, 1988; Freeman and Louça, 2001) has consisted in highlighting the inertia and the limited capacity of the broader socio-institutional system (skills, education system, institutions, labour practices and organizations) to keep-up with the paradigmatic nature of the ICT revolution (the mismatch hypothesis). The same type of argument is put forward by Paul David in connection to the “general purpose” nature of ICT (GPT) (David, 1991; David and Wrights; 1999; Bresnahan, 2010). Using David and Wrights words “...an extended phase of transition may be required to fully accommodate and hence elaborate a technological and organizational regime built around a general purpose digital computing engine” (David and Wrights, 1999, p. 16). There is no doubt that these are rather powerful arguments highlighting the presence of socio-economic and institutional inertial factors characterizing transition phases between

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<sup>66</sup> The works of Vivarelli and Pianta represent in this respect relevant exceptions (Vivarelli, 1995; Vivarelli

different techno-economic paradigms and GPT. However, this line of argument is progressively losing its explicative power and plausibility taking into account the considerable time past since ICT have first appeared and the pervasive role nowadays they play in our economies and societies.

*Technology and income distribution.* This is another theme central among Classical economists, an issue somewhat dealt with by post-Keynesian scholars and somehow surprisingly expelled by the Neo-Schumpeterian research agenda. In the perspective of Classical economists as well as in the views of Kalecki the rate and direction of technological change are heavily influenced by the social and economic relationships shaping the structure and functioning of capitalism (Courvisanos, 2009, 2012). In particular for Marx and Kalecki within capitalist economies technological change has an ultimate (overall and long-term) capital deepening and labour-saving nature, and this has obvious implications in terms of income distribution, and consequently on the composition and volume of aggregate demand. The cyclical occurrence of phases of over-production, unemployment, under consumption, skewed income distribution and insufficient demand are strictly inter-connected phenomena associated to the very nature of capital accumulation, inter-capital competition and the non-coordinated nature of investment decision. In this perspective technological change simply amplifies the contradictory nature of this process fuelling the divergence between the development of production forces (labor productivity), distribution relationships and the capacity of market (in particular final demand) to absorb all production output. Both Marx and Kalecki makes clear this point by stressing the structural asymmetry between capital accumulation and demand with the latter constrained by an insufficient dynamics of wages (Sebastiani, 1989). For both of them this asymmetry is at the core of the contradictory and cyclical nature of capitalist development. According to Marx "...the more productivity develops, the more it comes into conflict with the narrow basis on which the relations of consumption rests" (Marx, 1981, p. 353). Kalecki expresses a similar point stating that the most remarkable paradox of the capitalist system has to do with the fact that "...the expansion of the capital equipment. i.e., the increase in the national wealth, contains the seed of depression in the course of which the additional wealth proves to be only potential

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and Pianta, 2000; Pianta, 2005).



in character” (Kalecki, 1935, p. 32). Despite some of these views might be criticized as encompassing a certain degree of socio-economic determinism there is no doubt that they highlight an important issue and namely the one concerning the role that capitalist social relationships play in shaping the rate and direction of technological change as well as its economic impact.

In the most recent neo-Schumpeterian the role that technology and innovation play within a socio-economic context characterized by potentially conflictual capital-labour relationships is clearly underplayed, as well as there is little concern on the specific influence that such institutional setting can exert on the “distribution outcome” of technological change (Smith 2010). In the neo-Schumpeterian literature technological change ceases to have a dominant labour saving nature. The process of creative destruction is in fact conceived as associated first of all to the rise and expansion of new products and industries. It is somehow implicit in this literature the idea that productivity gains obtained via technological change are so large and widespread that “income distribution” becomes a marginal issue or an issue which has little to do with the rate and direction of technological change. As already pointed out, the distributional effects of technological change have been mainly associated to the skill-biased nature of innovation, with the latter leading to an increasing income polarization between skilled and unskilled workers. A key issue which has not been investigated by both main-stream and Neo-Schumpeterian literature is the extent to which the long term changes in income distribution from labor to capital observed in most industrialized countries is associated (along with the dominant role played by financial capital) to the nature of the new technological regime or the way ICTs are used in both manufacturing and service industries, as well as within society at large. Despite the great emphasis of innovation literature on intangible investments and human capital existing statistics show that the capital to labour ratio keeps increasing both in manufacturing and service industries and both in OECD as well as in emerging economies (Basu and Vasudevan, 2013). As already mentioned these trends and processes have clear implications on income distribution and aggregate demand, connections and implications not investigated by the neo-Schumpeterian literature.

*Technology and the dynamic efficiency of markets.* As already anticipated a common trait of most heterodox economic schools consists of acknowledging the intrinsic instability of capitalism and that the un-constrained and un-regulated functioning of markets is far from guarantying full employment, a path of steady growth and a socially acceptable allocation of resources. Despite the “market failure” concept has been first introduced and theoretically treated by neoclassical economists – also with reference to the public good nature of knowledge and innovation (Arrow, 1962) - its relevance has been clearly downplayed within mainstream economics being considered an exceptional case and having only a micro-economic nature. Evolutionary theories have partly corrected the mainstream view of technology and innovation assimilated to pure public goods, emphasising the tacit component and the sticky nature of most technological knowledge developed and used by firms (Metcalf, 1995). Evolutionary scholars have further enriched the analysis on the factors enhancing or impeding innovation shifting the focus on other types of “failures” namely those referring to the structure and functioning of innovation systems, that is to the mechanisms facilitating or hampering the complex and cumulative nature of innovation and learning processes as well as the circulation and sharing of knowledge and the connectivity between firms and institutions (Lundvall and Borras, 2005). This has represented a substantial advancement that has opened up a new perspective on the role and scope of science and technology policies (Smith, 2000; Chaminade and Edquist 2006). However almost ignored in the current evolutionary literature is the very basic issue concerning the extent to which, and the conditions under which, the modus operandi of market economies, and in particular an institutional context characterized by un-coordinated investment decisions, strong technological rivalry, and the dominance of a profit seeking rationale - are able to assure long-term dynamic efficiency and a path of socially desirable, labour and environment friendly technological development (Frigato and Santos-Artega, 2012). Addressing this type of issue would imply to further enlarging the concept of “systemic failure” adopting an historical and macro-institutional view of the structure, modus operandi and “social performance” of capitalist economies and on the role technological change plays in this institutional context. This is the perspective one can find once again in both Marxian and Kalecki writings, in Schumpeter’s late work *Capitalism, Socialism and Democracy*, as well as in the works of heterodox institutional scholars grown up in the Veblen-Kapp tradition (Ramazzotti et al., 2012). Most of the current debate within and outside main-stream

economics is on the contrary a-critically squeezed on a positivistic view on the economic and socially progressive role that technology plays in our economies and societies (Soete, 2013) and on the widespread belief that profit-seeking private incentives and free worldwide competition represent the best institutional framework in which technologies can be developed and used for social purposes. More specifically, there seem to be little concern, and empirical analysis, on the “net world-wide effect” of the current process of creative-destruction, especially and weather in periods of prolonged economic crises and stagnant demand destruction is prevailing upon creative accumulation (Archibugi and Filippetti, 2011a, 2011b). Similarly, there seem to be little theoretical concern and investigation of the long-term effects produced by the changes taking place in most industrialized countries in the structure, funding and orientation of science and technology systems as a result of the overwhelming share of total R&D activities carried out by private corporations, the processes of privatization and liberalization of sectors characterized by dynamic efficiency and strong externalities, the pro-market orientation of public research, the short-term rational dominating financial markets, managerial strategies and investment activities (Mazzucato, 2013).

## **6. Final remarks**

In this contribution we have highlighted the dominant positivistic view of the relationship between technology, economy and society permeating not only mainstream economics but also a good deal of the most recent neo-Schumpeterian literature. This positivistic view clashes against one of the main paradox of our times that is the sharp contrast between the acceleration of the rate of scientific and technological change experienced over the last decades and the limited capabilities shown by our socio-economic systems to exploit them in order to answer human needs and secure a path of sustainable development. This paradox emerges even more sharply taking into account the prophecy of John Maynard Keynes in his famous speech on the “Economic Possibilities for our Grandchildren” (1930). In this speech Keynes explicitly forecasted that - thanks to the opportunities offered by technological change within around one hundred years’ time “...for the first time since his creation man will be faced with his real, his permanent problem: how to use his freedom from pressing economic cares, how to occupy the leisure, which science and

compound interest will have won for him, to live wisely and agreeably and well” (Keynes, 1963). As poignantly stated by Giorgio Lunghini in the eighty years past since Keynes speech human kind has not significantly moved in that direction as the combination of high rates of unemployment and the presence of a large amount of unsatisfied needs demonstrates, and this despite the fact that the technological premises to give an answer to these needs exist (Lunghini, 2012).

There seems to be little doubt that explaining this paradox, understanding its deep economic, social and institutional bases, would require to acknowledge first and foremost the complex, non linear and potentially contradictory nature of the relationships between technological progress, economic growth and human-social development, especially in the context of un-coordinated market-based economies, and especially in the current global, un-regulated financial capitalism. This was the perspective adopted by heterodox thinkers such as Marx and Kalecki, a perspective abandoned by the neoclassical school and marginalized by most of the heterodox economic schools of the 20th century.

The main (provocative) argument put forward in this paper is that the recent neo-Schumpeterian literature has further contributed to reinforce a deterministic (one-way) and supply side reading of the relationship between technology, economy and society, with technology being able to guaranty strong economic (GDP) growth and (implicitly) social welfare. This is confirmed by the fact that, contrary to classical economists, and Schumpeter himself, in the recent neo-Schumpeterian literature (especially in the evolutionary stream) technology is only rarely associated to macroeconomic market failures such as systemic crises, structural unemployment, and the growth of social and economic inequalities. It has been argued that this is in turn due to two major traits of this literature and namely the adoption a fully supply side and micro economic view of the technology-economy relationships.

This approach has become dominant also in the policy debate. The latter is often characterized by the reiteration of repetitive refrains on the importance of technology, the need of enhancing the technological potential of firms, industries, countries, the need of orientating public research to the needs and requests of the private business sector. Technology is also seen as one of the key recipe to tackle the current economic crisis, the

lack of growth, and the high unemployment rates most European countries are experiencing. Underlying this supply-side view of the role technology plays in the economy there is an unlimited faith in the economic and socially progressive nature of the Schumpeterian process of creative destruction driven by market forces, as well as the idea that the economic problems of any country, region or industry, can by magic be solved through a “technological jump”.

The positivistic shift of the literature dealing with the economic effects of technology and innovation finds a parallel in the expulsion from the current research agenda of broad and socially relevant themes on which old heterodox schools were used to debate and confront each other such as the relationship between technology and development, the complex interactions between technological change, employment, income distribution and demand. These themes have been traditionally ignored by mainstream economics but also too quickly expelled from the neo-Schumpeterian theoretical agenda. This has contributed to impoverish the theoretical debate, determining a diminished capacity to explore the complex and non-linear relationships between technological progress, economic change and societal development. The final message of this paper is that it would be now very important and useful to go back to these themes and approaches, re-interpret them with the lenses of our times, in particular taking into account the new economic and societal and environmental challenges that the structure and modus operandi of contemporary capitalism rises. This would require to re-open the ground for an open-mind cultural debate on the long-term options regarding the social and institutional mechanisms governing the pace and direction of technological change, going much beyond the boundaries of traditional (micro-level) market-failures or on the “systemic failure” taken into account by the neo-Schumpeterian literature. On a more operational ground, there is the urgency of re-framing the analysis of the technology-economic relationships in a proper macro-economic and institutional framework in which the dynamic interaction between changes in technology, income distribution and demand is put at the centre of the theoretical and empirical agenda.

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