Perverse and virtuous feedbacks between inequality and innovation: Which role for public institutions and public investment?

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Abstract: In this paper, we deal with the complex relationship connecting inequality to innovation, and the ways through which public investment, in particular public participation to R&D initiatives, may affect it. We first stress that multiple different equilibria may exist in the inequality-innovation space. The positive link that part of the economic theory often assumes between (initially) rising inequality and improving innovation performances emerges as only one among many other far less virtuous dynamics. We then analyze the specific case of the US. We put emphasis on the possible perverse effects that the financialization of the US economy may induce on the inequality-innovation nexus. We also note that the US developmental State that is very often neglected by the economic literature may effectively mitigate such undesirable outcomes. According to our interpretation of recent developments in the US economy, the widespread belief in the positive pro-innovation effects of fierce cutthroat remuneration systems may prove to be ungrounded.

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1. The complex relationship between innovation and inequality

Any economist would doubt about the existence of at least an *indirect* relationship between inequality, innovation and public investment. The economic literature has likely written thousands of pages on the effects that each of the above factors has played and still plays on economic growth. The analysis of the relationship between inequality and growth dates back to the pioneering contribution by Simon Kuznets (1955), and the supposedly "inverted" U-shaped curve linking income inequality to the level of economic development. More recently, both theoretical and empirical works have reconsidered such a topic and attempted to define a clear positive or negative relationship between inequality and growth. Despite several efforts, a consensus is far from emerging even though "the statistical evidence generally supports the view that inequality impedes growth, at least over the medium run (Ostry, Berg and Tsangarides, 2014, p. 8)". As to the innovation-growth nexus, the enormous amount of Schumpeterian growth models, being them of the supply-side mainstream typology or coming from the evolutionary approach, all put innovation at the center of the growth process (Verspagen, 2006). Even more, radical innovations and changes in the prevailing technological paradigm are considered as the in-depth sources of creative destruction, economic fluctuations and long waves in the development process (see Cajani, Godin and Lucarelli, 2014). Last but not least, there is an abundant and mostly controversial theoretical

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and empirical literature on the effects public investment may have on economic growth by crowding-in or crowding-out private investment and, therefore, influencing productivity dynamics (Aschauer, 1990; Romp and de Haan, 2005).

More recently, an interesting and heterogeneous strand of analysis has developed trying to assess the existence of a *more direct* connection between inequality and innovation on the one side[1], and between public investment and innovation on the other side. As to the first topic, some authors have focused their research efforts on the possible effects innovation may induce on inequality. Once again results are not uniform. Antonelli and Gehringer (2013), for instance, find out that higher innovation performances (as measured by patent counts) tend to reduce income inequality as captured by the Gini Index. According to them, innovation may first reduce income inequality because, by supporting economic growth and rising productivity, it allows wages to rise and rentiers' income to decrease (due to a larger availability of capital which, in turn, reduces its remuneration). Second, and perhaps more relevantly, in the long run a highly innovative economic environment may reduce inequality by increasing competitive pressures on good and service markets, by making them more dynamic and, as a result, by squeezing the duration and amount of monopolistic rents accruing to innovators. This evidence notwithstanding, Antonelli and Gehringer's logic can be easily reverted. Indeed, at least on a short-term horizon, innovation may temporary raise inequality by providing innovators with those monopolistic rents that subsequent innovations will eventually discard (Cozzens, 2008; Cozzens and Kaplinsky, 2009)[2]. Further, the argument advanced by Antonelli and Gehringer stands out in stark contrast with the analysis developed by Aghion (2002) and Acemoglu (2002), according to whom the skill-biased nature of (process) innovations taking place in the last decades has been the main driver of increasing wage and (hence) income inequality. Last but not least, into a broader development perspective, it may well happen that innovation, when it takes the radical form of the structural change of developing countries' productive systems, may initially increase inequality by leading a modern high-productive industrial sector to emerge aside to traditional low-productive industries[3].

The picture gets even more complicated if one thinks that the innovation-inequality nexus does not necessarily run one way from innovation to inequality. Indeed, there are good theoretical reasons to believe that inequality may feedback on the innovation performances of an economy through several possibly conflicting ways. On the one side, there is a long-standing conviction according to which income differentiation and wealth inequality are necessary requirements in order to stimulate and provide right incentives to innovate (Lazear and Rosen, 1981; Lippmann, Davis and Aldrich, 2005). In this vein, Acemoglu, Robinson and Verdier (2012) argue that a "cutthroat" remuneration system like the US one is somehow necessary to push ahead the

[1] In this paper, I do not consider the relationship connecting cross-country differences in innovation capabilities to ensuing inequalities in their level of economic development. This is a well-known and widely debated topic in the economic literature. One could mention, among others, the abundant literature on national innovation systems (Freeman, 2002), or the large variety of technology-gap models relying, alternatively, on a mainstream or heterodox approach (see Castellacci (2007) for a survey). In this paper, I find as much more intriguing to provide a broad perspective on a different and perhaps less extensively investigated issue. I refer to the link between *intra-region* or *inside-country* inequality and the ensuing regional or national innovation performances.

[2] Of course, the different time horizon adopted by various empirical analyses on this theme may contribute to explain the conflicting results and mixed evidence they come to.

[3] Indeed, this is the logic behind the well-know dualistic development model proposed by Arthur Lewis (1954). According to Lewis: "Development must be inegalitarian because it does not start in every part of the economy at the same time.... There may be one such enclave in an economy, or several; but at the start development enclaves include only a small minority of the population (Lewis, 1954, p.56)."

technology frontier and trigger off innovations that, in the end, will also benefit more equitable foreign social systems thanks to international technology externalities. In a sense, Acemoglu, Robinson and Verdier build up their model on the "varieties of capitalism" theory originally put forward by Hall and Soskice (2001), according to which liberal market-based and relatively unequal economies perform better than cooperative countries as to the introduction of radical innovations[4]. On the other side of the spectrum, however, Hopkin, Lapuente and Moller (2014) provide empirical evidence at odds with Acemoglu, Robinson and Verdier support to cutthroat remuneration systems. According to them, among OECD countries, if innovation performance is measured through a complex and multidimensional "Global Innovation Index" (henceforth GII)[5], highly equitable social systems like Scandinavian economies perform better than the US. Consistently with Taylor (2004), the US economy once again seems to emerge as a sort of outlier. Even further, Hall and Soskice (2001), as well as Acemoglu, Robinson and Verdier (2012), focus their enquires on industrialized countries only. Weinhold and Nair-Reichert (2009) observe that, from 1994 to 2000, in a larger sample including developed, emerging and backward economies a more equitable income distribution (as capture by a larger middle class income share) seems to be positively (rather than negatively) correlated to innovation via its positive effects on the quality and well functioning of domestic institutions. Some other analyses also adopt a broader perspective on economic development and compare the successful development experience of newly industrialized East Asian countries with respect to lagging-behind Latin American economies. What they stress is that a more equal income and wealth (in particular land) distribution in East Asian countries has favored human capital formation, technological knowledge accumulation, structural change and, in the end, innovation (Arocena and Sutz, 2003). Strong elites and extreme income and wealth concentration in Latin America, on the contrary, have contributed to give rise to a perverse economic environment featuring structural inertia, persistently low R&D efforts, eventually disappointing innovative performances (Cimoli and Rovira, 2008).

As to the role of public investment in supporting and steering innovation, we think as extremely interesting the emerging evidence about the so-called "entrepreneurial State" (see Mazzucato, 2013). Indeed, Mazzucato (2013) clearly shows through an anecdotal analysis of the US innovation history that a significant amount of private sector's innovations could never come to light without initial public financial support, and without direct state engagement in path-breaking innovative activities. This is the case of new information and communication technologies (ICT), for instance, which were initially thought for military applications. The same could be said as far as the biotech sector is concerned. Mazzucato is also very keen in stressing that in these cases state intervention did not fix any market failure. Rather, it envisaged a radically new technology and, by putting efforts in such a revolutionary technology search, it created new markets that would have never

[4] The analysis carried out by Hall and Soskice has sparked an intensive debate on the empirical solidity of their results and propositions. Taylor (2004), for instance, finds that Hall and Soskice's findings mostly depend on the inclusion of the US economy in the set of "liberal market-driven" economies. Should the US economy be dropped out of the sample and considered as an outlier, the "varieties of capitalism" argument would loose much of its explicative power. Akkermans, Castaldi and Los (2009) also confute Hall and Soskice hypothesis as a "general law" distinguishing "liberal market-based" economies from "cooperative" more egalitarian ones. In particular, they find that a country's capacity to radically innovate should be assessed by taking into account industry-specific factors and according to the sectorial specialization of the economy under observation. Indeed, a "cooperative" economy like Germany turns out to be highly effective in generating radical innovation in those sectors that historically represent the staple of its own productive system.

[5] All the information concerning how the GII is computed can be recollected on the Global Innovation Index initiative website at https://www.globalinnovationindex.org/content.aspx?page=GII-Home.

come to existence through private initiatives due to excessively high risks unaffordable to private actors. In a way, state intervention created profit and "value-extraction" opportunities that, eventually, have been often unevenly exploited by private agents (Lazonick and Mazzucato, 2013). In terms of the present paper, such a new strand of analysis is important on a twofold level. First, it can help to explain why the US economy recurrently emerges as an outlier, at least with respect to other "liberal market-driven" economies, in terms of innovation capacity. Second, it can contribute to more seriously take into account some other institutional factors with respect to those considered in the "varieties of capitalism" literature that may be decisive to better understand countries' differences in innovation performances, as well as the much controversial inequality-innovation nexus.

The present work does not want to add to the existing largely inconclusive empirical literature on inequality and innovation. Rather, it simply tries to provide a general theoretical perspective through which one can frame the several ways inequality and innovation interact among each other. In this sense, we intentionally keep our model as simple as possible and depart from any detailed or elaborated microfoundation of inequality and innovation dynamics. We do so in order to privilege an easy intuition that the complex link between innovation and inequality may eventually give rise to multiple equilibria and radically different results in terms of domestic inequality standards and innovation capacity. The simplicity of our model also intends to make as immediate as possible the analysis of the way through which some institutional changes will affect innovation-inequality equilibria. In this regard, our analysis takes inspiration from the abovementioned literature on the entrepreneurial state, as well as from the complementary research field on the so-called "risk-reward" nexus and the financialization of US corporations (Lazonick, 2012a; 2012b). According to the facts narrated by this expanding body of literature, our model provides a sketchy representation of the peculiar US innovation pattern. Even more importantly, it tries to show how high innovation and rising inequality in the US may not depend on each other (as could erroneously appear from spurious regressions), but actually emerge as (at least partially) coincidental consequences of third omitted variables, i.e. past committed public efforts in the R&D sector, and more recent institutional changes in the financial sphere of the economy. Should this tale of the story gets part of the ongoing inequality-innovation pattern, it would cast serious doubts on the stability and sustainability of such new institutional arrangements, as well as on the asserted virtues of unequal but (supposedly) highly innovative liberal market-driven economies.

The remaining of the paper is organized as follows. Section 2 presents our simple inequality-innovation model on the base of the conflicting theoretical and empirical literature cited above. In particular, we show how different (and multiple) equilibria may emerge in the innovation-inequality space depending on the prevailing forces shaping the relationships between these two phenomena. Section 3 brigs into the picture the "entrepreneurial state" and the "risk-reward nexus" theories that, following Lazonick and Mazzucato (2013), may explain current rising inequality in the US. Section 3 provides a formal and graphical presentation on these arguments according to the building blocks of our model. Section 4 concludes and discusses some policy implications in light on the current inequality-innovation pattern and its main causes.

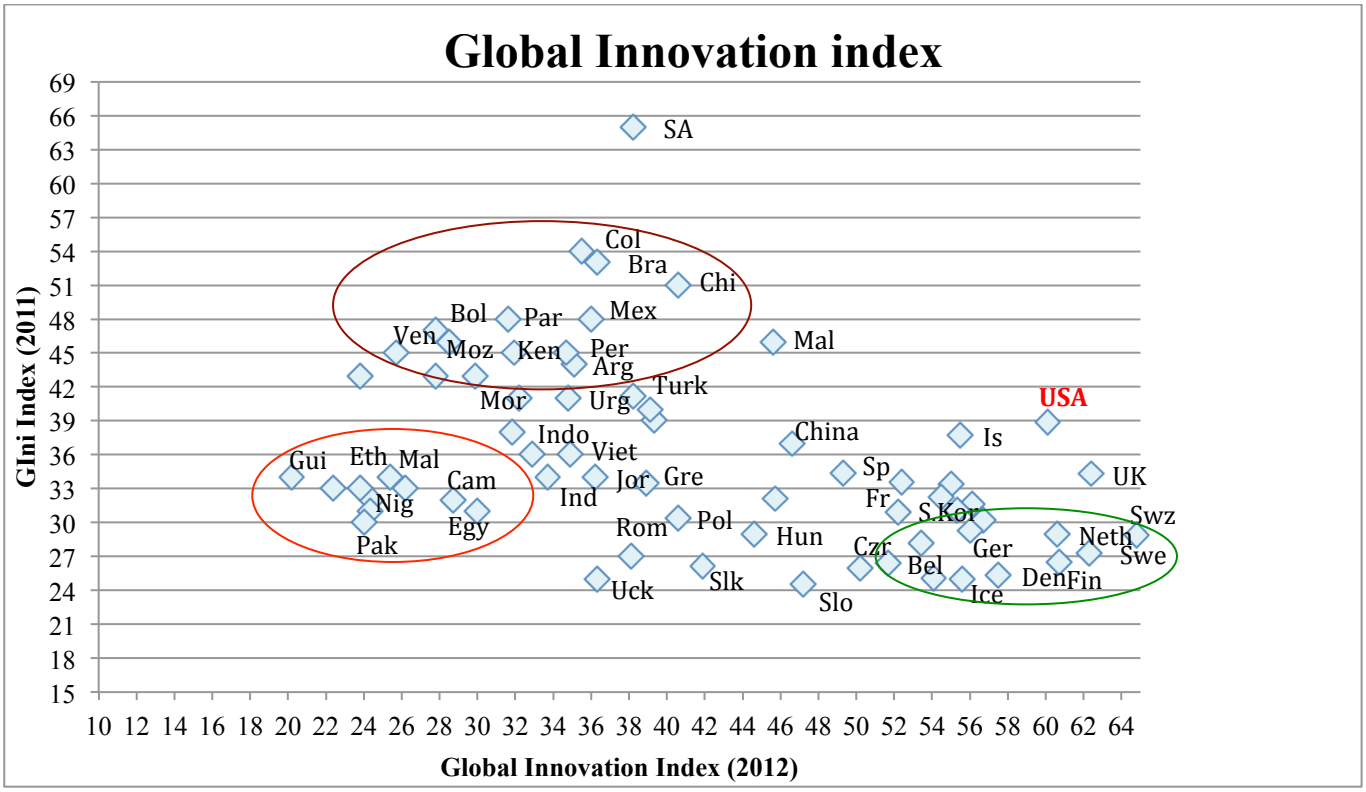
2. A simple model on inequality-innovation clusters

When one tries to figure out how inequality and innovation interact, he immediately understands how such a relationship could be extraordinarily intricate. Individually taken, inequality and

innovation themselves are complex multidimensional phenomena. One the one hand, there are different types of inequalities. Income and wealth inequality are the most cited and studied ones, and very often strictly connected each other. But we could also think about the uneven distribution of learning and knowledge capabilities. Recorded inequality may present specific spatial, gender, ethic characters, or a mix of them[6]. On the other hand, innovation can be radical or incremental, tacit or patented, most of the time hard to measure. On top of their intrinsic complexity, inequality and innovation are simultaneously influenced by myriads of institutional factors, which also shape how they coevolve all along the development process and directly affect each other. It is probably this messy tangle of factors that makes the abovementioned empirical literature mostly inconclusive as to the definition of who determines whom, and in which direction.

Figure 1 is a very simple snapshot of current huge cross-country differences in terms of innovation-inequality patterns. On the horizontal axis we report the values of the 2012 GII index computed for 67 countries. We then match them with the most recent available data on the Gini inequality index as provided by the World Bank World Development Indicators dataset and by the OECD poverty and inequality database. Most of the data on inequality refers to 2011.

Figure 1 – Current inequality (Gini Index) and innovation performances in 67 countries



Source: Data on inequality from World Bank World Development Indicators Report dataset (2014) and OECD poverty and inequality indicators dataset. Data on GII from the 2012 Global Innovation Index Report.

Such a rough international comparison between differently developed countries does not detect any clear relationship between inequality and innovation. Rather, what seems to emerge is a sort of clustering of different countries into different sub-groups according to some broadly common features. In the bottom-left part of figure 1, we first find some backward economies in which lack of

[6] See Cozzens and Kaplinsky (2009) for a review of the several forms of inequality it could be worth taking into account when one addresses the inequality-innovation nexus.

development, persistent difficulties to ignite a sustained growth process and scarces innovation capacities are associated to fairly low level of inequality. On the contrary, most of Latin American economies are grouped in the top-left section of figure 1. Here, although innovation performances remain disappointing, inequality reaches much higher levels, actually the highest worldwide (with the only exception of South Africa, i.e. "SA" in figure 1). Finally, most of developed (European) economies are clustered in the bottom-right section of figure 1. In this case, high domestic innovation capacities combine with the lowest level of inequality worldwide. Close to developed European countries we also find South Korea. In turn, a fast-growing emerging economy such as China is located somewhere in the middle among the above clusters. It performs much better than the least developed countries and many other developing economies, Latin American ones in particular, as far as innovation capacities are concerned. Nevertheless, inequality in China is still much higher than that observed in most developed countries. Following Taylor (2004) and Hopkin, Lapuente and Moller (2014), figure 1 also confirms the peculiarity of the USA among the set of developed nations. As expected, the USA is among the most innovative economies worldwide (even though not the most innovative one according to the 2012 GII index), but domestic inequality is much more pronounced than that observed in other similarly developed economies. We will devote specific attention to the case of the USA in section 3 of this paper.

Figure 1, of course, is overly simple and does not pretend to provide any definitive empirical validation of any specific theory on the links connecting inequality to innovation. Yet, it might suggest that alternative innovation-inequality patterns exist and persist at worldwide level, each of them presenting some regularities. These differences may certainly be influenced by the different level of development characterizing most of the economies taken into account, as well as by country-level or regional policies targeting domestic inequality.[7] Nevertheless, there is the sensation that they do not represent transitory phases of an ongoing common development process, but rather positive or perverse equilibria or, if one prefers, signs of significant degrees of hysteresis in the long-run dynamics of the variables at hand. This seems to be the case of Latin American countries, for instance, in which deep inequality, unsatisfactory innovation performances (despite of the adoption, from time to time, of radically different economic policy regimes), and evidence of uncompleted development processes stand out as widely recognized facts. Let us address this point in more details through a very simple theoretical model.

Despite of the various contrasting perspectives highlighted above, yet there exists a general agreement on the fact that inequality and innovation mutually interact, and that such a relationship likely evolves and changes at different stages of economic development. As to the effects innovation may induce on inequality, it may be reasonable to think about a positive relationship unfolding in backward developing countries. In poor economies, some simple and isolated innovations can initially enable a few innovators to gain higher rewards from their economic activity. The reinvestment of such rewards may then trigger off a self-sustaining process of capital accumulation, improving productivity and even rising incomes. In the initial stages of the development process, this mechanism may certainly induce an increase in wealth and income disparity.[8] Nevertheless, if strong and widespread enough, this process boosts economic

[7] See Lusting *et al*. (2011) on the role played by more generous pro-poor governmental transfers and support to the spread of education as examples of policy measures prompting a reduction in inequality in several Latin America countries from 2000 to 2009.

[8] Kanbur (2012) makes a review of the validity of the inverted U-shaped Kuznets curve in the last two decades. He stresses that "[…] the tendency for increasing inequality in growing economies has been present, unless actively

development and the structural change of the domestic economy. The accumulation and diffusion of technological knowledge, the adoption of better productive techniques, the emergence of wider innovation opportunities, and the ensuing traverse towards middle-advanced stages of development eventually alter the former innovation-inequality nexus. A negative link now takes form[9]. Historically, this shift in the innovation-inequality pattern hinges on technological spillovers from industry to agriculture, changing balance of bargaining power between antagonist factors taking part in the production process, and on the spread of innovation opportunities that makes markets more competitive and dynamic, monopolistic positions more contendable and monopolistic rents short-lived. Whatever reason we may raise to give sense to the above dynamics, we can model it through the very simple equation (1) below:

$$iq_{t+1} = f\left(\underbrace{in_t}_{+/-}\right) \qquad (1)$$

With $\frac{\partial iq_{t+1}}{\partial in_t} > 0$ if $in_t < \overline{in}$; $\frac{\partial iq_{t+1}}{\partial in_t} < 0$ if $in_t > \overline{in}$

In equation (1), we assume a time lag to divide the occurrence of some innovations (in_t) from their effects on domestic inequality (iq_{t+1}) to emerge. Further, $\overline{in}$ stands for the "Lewis-type" turning point from which on further progresses in the innovation capacity and the ensuing development process of an economy will reduce rather than increase domestic inequality.

The apparently straightforward long-run positive outcome of the above process is all but inevitable. Indeed, it will also be affected by inequality feedbacks on innovation. According to the literature reviewed in section 1, we may conceive many different scenarios, the prevailing one likely depending on the initial level of inequality and its main causes. Let's first assume a pretty equalitarian economy on the onset. Further, following Acemoglu, Robinson and Verdier (2012), assume that "technological innovations require incentives for workers and entrepreneurs [so that], from the well-known incentive-insurance trade-off captured by the standard moral hazard models, this implies greater inequality and greater poverty (and a weaker safety net) for a society encouraging innovation (Acemoglu, Robinson and Verdier, 2012, p.4)". On the base of these hypotheses, the economic relationship running from (current) inequality to (current) innovation may take a monotonic upward sloping form. This is what we assume in equation (2.a) below:

$$in_t = g(\underbrace{iq_t}_{+}) \qquad (2.a)$$

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counteracted by policy. The increasing inequality has been seen for example in India […], in China […], in South Africa […], in Ghana […], in Bangladesh […], and in Latin America before 2000 […]. The causes of this increasing inequality are being debated, but the opening up of opportunities as a result of globalization, which only a few can access initially, has been stressed by some contributors. For example, the surging ahead of regions close to markets, and regions with good infrastructure in place, has been identified as a major cause of rising spatial inequality within countries (Kanbur, 2012, p.11)."

[9] Once again, Kanbur notes that: "the dynamics of development identified by Kuznets and Ahluwalia continue to be present in the actual experience of individual countries, and are being confirmed by the time series evidence that has accumulated since the work of these two pioneers. It is these forces, and the policy interventions that shape them, which are central to the evolution of inequality during the course of development (Kanbur, 2012, p.12)." As far as the specific case of China is concerned, Zhang, Yang and Wang (2010) significantly entitle their paper "China has reached the Lewis turning point."

Notwithstanding incentives to innovate provided by greater income differentiation, the constant increase in the innovation capabilities of an economy likely requires the wide diffusion and spread of technological knowledge. Indeed, following Castellacci and Natera (2013), innovation and absorption capabilities are positively cointegrated all along the development of national innovation systems. The diffusion of technological knowledge and the improvement of a country's absorption capability in turn imply significant households' investment in higher education. Quite reasonably, this could take place only if a fair degree of equality is achieved inside the economic system[10]. In terms of our analysis, such an eventuality implies that, from a certain point on, a reduction rather than an increase in inequality may be eventually required if we want to foster innovation even further. Following Hatipoglu (2012), it seems that "firms tend to innovate more as a result of a decrease in inequality when inequality is too high […and] that there are significant non-linearities [between inequality and innovation] at mid- to high-range levels of inequality (Hatipoglu, 2012, p. 243)". In the end, a non-linear backward-bending inequality-to-innovation curve may emerge. Such an eventuality is formalized in the equation (2.b) below:

$$in_t = g(\underbrace{iq_t}_{+/-}) \qquad (2.b)$$

With $\frac{\partial in_t}{\partial iq_t} > 0$ if $iq_t < iq^*$; $\frac{\partial in_t}{\partial iq_t} < 0$ if $iq_t > iq^*$

Last but not least, we also have to take into account the case of many developing economies that have inherited from the past persistently high level of income and wealth inequality. Take the case of Latin American countries, for instance, in which current high inequality standards find their roots back in the colonial period (see Acemoglu and Robinson (2012) among others), and derive from the concentration of wealth, originally lands, and of the control of abundant natural resources in a few hands. In these contexts, innovations have been aimed at satisfying the demand for luxury goods coming from domestic economic and political elites (Taylor and Bacha, 1976; Arocena and Sutz, 2003), without paying attention to the needs of a much broader set of potential consumers. At macro level, whilst the overreliance on natural resource exports has failed to address recurrent shortages of foreign hard currency, domestic industrialization is far from incomplete or, even worse, episodes of premature de-industrialization have occurred in the last two decades. Accordingly, the room for innovation-induced social mobility remains narrow, and opportunities for social progress skewed and available to a restricted bunch of people. In the end, a full-fledged middle class is still to come.

In such a scenario it turns out reasonable to assume a throughout negative relationship between current inequality (iq_t) and innovation at time t (in_t). This fact is formalized in equation (2.c):

$$in_t = g(\underbrace{iq_t}_{-}) \qquad (2.c)$$

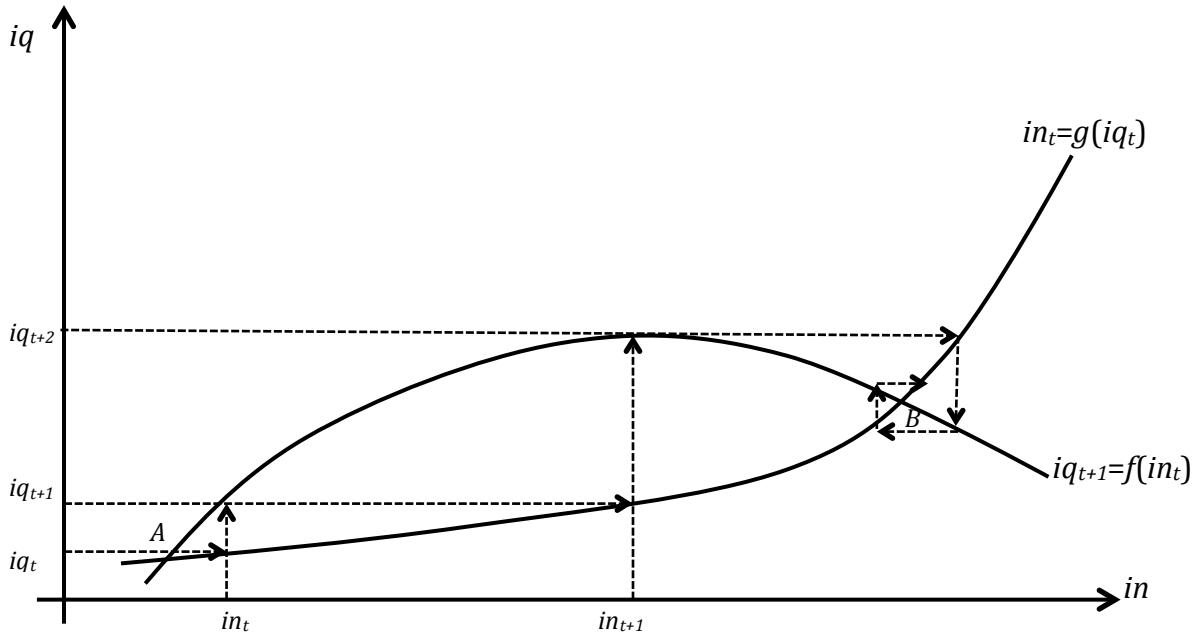
[10] See, for instance, Galor and Zeira (1993), who stress the "importance of having a large middle class for the purpose of [supporting] economic growth (Galor and Zeira, 1993, p. 51)" through the ensuing larger opportunities to accumulate human capital. See also Galor and Moav (2004) on the relevance of human capital as driving factor of growth in relatively advanced stages of the development process.

By combining equation (1) with the different versions of equation (2) that may rule according to the specific institutional setting we deal with, we get a wide range of dynamics in the innovation-inequality space. They are portrayed in figures 2.a, 2.b and 2.c below.

Figure 2.a portrays the kind of virtuous interaction between inequality and innovation envisaged by Acemoglu, Robinson and Verdier. In figure 2.a, two equilibria exist as defined by the intersections between equation (1) and equation (2.a). Point *A* represents an equilibrium featuring a pretty even distribution of economic resources but, correspondingly, poor innovation capacities. Point *B*, on the contrary, features a relatively higher degree of inequality (at least with respect to point *A*) but also a significant improvement in domestic innovation performances. The relative slopes of equations (1) and (2.a) in the neighborhood of the equilibria will determine their stability properties. In figure 2.a we assume the initial trait of equation (2.a) to be flatter than the positively-sloped section of equation (1), meaning that a modest increase in inequality is more than enough to stimulate remarkable innovation efforts. In light of the above arguments, equation (2.a) subsequently gets steeper (i.e. the stimulating effects of higher inequality on innovation tend to vanish) albeit its slope never reverts into negative. In this context, the conditions for equilibrium *A* to be unstable and equilibrium *B* to be stable read:

$$\left|\frac{\partial in_{t+1}}{\partial in_t}\right|_A = \left|\frac{\partial g(.)}{\partial f(.)}\frac{\partial f(.)}{\partial in_t}\right|_A > 1 \text{ and } \left|\frac{\partial in_{t+1}}{\partial in_t}\right|_B = \left|\frac{\partial g(.)}{\partial f(.)}\frac{\partial f(.)}{\partial in_t}\right|_B < 1$$

Figure 2.a – Virtuous dynamics in the inequality-innovation space



In figure 2.a, we show the case in which these conditions are fulfilled. Two points are worth stressing in this regard. First, in such an environment, equilibrium *B* becomes an attraction point. Accordingly, provided that an inequality level slightly higher than iq_B exist on the onset, the economy will naturally converge towards point *B* and give rise to the virtuous "technology

traverse" from equilibrium *A* to equilibrium *B*[11]. Second, during such a traverse, consistently with the well-known inverted U curve hypothesis originally put forward by Kuznets, inequality will first increase and then decrease along the convergence process towards point *B*.

Figure 2.b – A (relatively) low inequality-low innovation trap

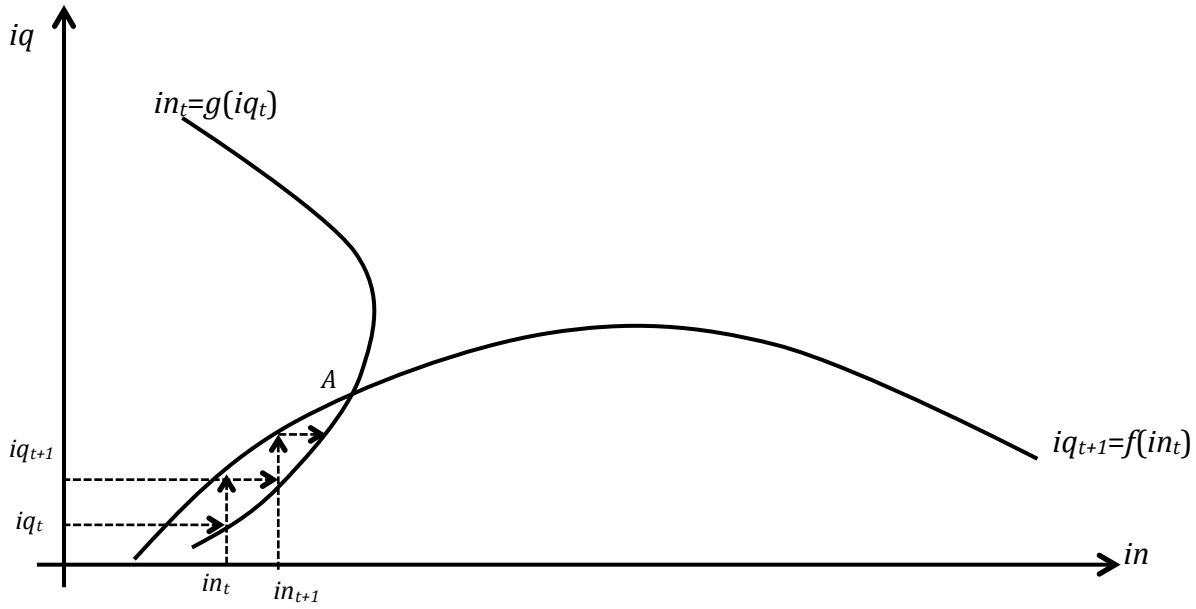
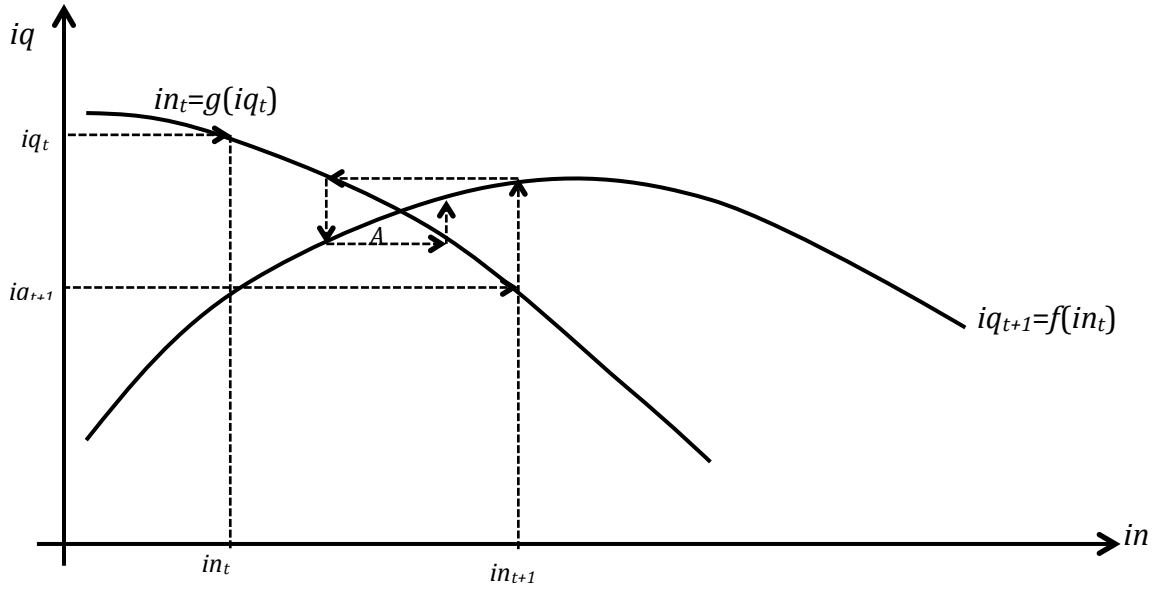


Figure 2.c – A Latin American-type high inequality-low innovation trap



The possibly virtuous dynamics described in figure 2.a is not an inevitable outcome of the innovation-inequality nexus. Indeed, figure 2.b depicts a different scenario. This takes place in the

[11] Interestingly, the instability characterizing point *A* also means that, on the left-hand side of this equilibrium, an extremely egalitarian economy will do not provide any incentive to innovate. Innovative impulses will rather drop to zero. In such an environment, if we put innovation at the heart of the economic progress, any development would in the end take place, and an egalitarian poverty trap will eventually emerge.

event that, first, equation (2.b), and the corresponding economic rationale, replace equation (2.a); second, equation (2.b) is initially steeper than equation (1). In this case, a unique and stable equilibrium *A* does emerge. As a result, such an economy will remain locked in a state of (relative) technological backwardness. Any transition towards a dynamic and innovative economic system will take place.

In figure 2.c, finally, we show what we have labelled a Latin American-type perverse equilibrium. In this case, permanently high levels of inequality and the negative effects they induce on domestic innovation capacity impede any strongly innovative and more egalitarian economy to develop. The historical uneven distribution of economic resources and social opportunities eventually turns out as the most relevant obstacle to innovation.

3. Inequality, innovation and public investment in the US: An alternative story

Inequality and innovation records in the US are often presented as concrete examples of the fact that higher inequality is perhaps the price one has to pay in order to create an innovation-prone economic environment. Large income dispersion and increasing (relative) rewards gained by innovators appear as the most powerful stimuli to radical innovation and to strengthen domestic technological capabilities.

Behind such a clear-cut proposition, there is an equally neat conceptualization of innovation. First, mainstream models usually describe innovation as a risky rather than uncertain outcome of research and development activities. In a way, mainstream economic theory acknowledges to economic actors the possibility to compute first the probability of succeeding or failing in the discovery of new products or processes, and then to estimate expected profits deriving from the commercialization (or adoption) of new technologies. Second, innovation is portrayed as the result of R&D efforts undertaken by single economic actors, say individual entrepreneurs or single firms. Single firms' decisions and involvement in innovation activities respond to economic incentives transmitted through market-determined relative prices, i.e. the relative extra-remuneration accruing to innovators with respect to technology laggards. Into this perspective, institutions affecting the remuneration system stand out as the leading factors boosting or depressing innovation.

Although highly convenient to the purpose of constructing elegant micro-founded models, the mainstream representation of innovation appears as too simplistic and highly debatable. The evolutionary approach to innovation, among others, severely criticizes the fact that mainstream theory overlooks at least two crucial aspects that make innovation a highly complex phenomenon. First, the "happy end" of innovation activities is much more than risky. Actually, it manifests itself as a deeply *uncertain* event, on which, very often, it is almost impossible to build up any reliable probability distribution. This is even more so in the case of radical innovations. The Knightian uncertainty characterizing innovation in turn implies that expected relative prices and rewards can hardly guide (or be the main drivers of) strategic decisions of innovative firms. Second, innovation is a *collective* phenomenon that *cumulates* on and is shaped by the exisitng stock of knowledge (Cimoli et al., 2009; Block and Keller, 2012; Fontana *et al*. 2012). Indeed, innovation derives from the interaction between various stakeholders inside a given firm, i.e. blue-collar workers, engineers, managers, and firms' shareholders; from the interaction among firms in complex production networks; from the interaction between firms and public institutions such as universities and other public R&D agencies. Into such an alternative framework, it is self-evident that we cannot stimulate innovation by simply adopting a more cutthroat remuneration system. Quite the contrary, both the

collective and cumulative nature of innovation make it dependent on a much wider range of institutions, first and foremost those public institutions performing and/or financing breakthrough innovations which are too costly, risky and uncertain to attract the attention and interest of private actors.

Lazonick (2009, 2011 and 2013), Lazonick and Mazzucato (2013), and Mazzucato (2013) use the lenses provided by the evolutionary theory in order to describe the development of the US innovation system in the aftermath of the Second World War, and the evolution of innovative enterprises during the most recent decades dominated by the "financialization" of the economy. They come up with a tale of the story that is significantly different from that purported by "conventional" and "conservative" economists (see Lazonick, 2010). In this regards, two points are worth stressing.

First of all, Lazonick and Mazzucato debunk the widespread belief that the US leadership in (radical) innovation is simply due to the well functioning of unfettered market forces. Quite the contrary, they vigorously stress that public institutions, i.e. federal agencies and local authorities together with high-quality universities, played a crucial role in funding, nurturing and breeding innovation. In the 1950s and in 1960s, for instance, the US government invested huge amount of resources in research and innovation activities functional to military purposes and connected to Cold War perceived national defence needs.[12] The Advanced Project Research Agency (henceforth ARPA) set at the Pentagon at the end of 1950s specifically aimed at developing, supporting and financing a widespread network of universities, research institutes, labs, firms and industrial consortia engaged in research activities on "beyond-the-horizon" technologies. Such efforts created the technological basis that has subsequently allowed for the introduction of myriads of civil innovations in the computer, software, information and communication industries during the 1980s and 1990s. According to Block (2008), "many of the technologies that were ultimately incorporated into the personal computer were developed by ARPA-funded researchers … [and] internet itself began as an ARPA project in the late 1960s (Block, 2008, p.7)". The same line of reasoning can be applied to the National Institute of Health (NIH) as to its aggressive action in support of the astonishing expansion of the biotech industry. In the end, what emerges is that a "developmental state[13]" has been effective and operative in the US as much as (or even more than) it was in many other now developed economies.[14] Interestingly, following Block (2008), whilst such public intervention in the economic sphere has been openly recognized in Europe and in Japan, the developmental approach of US institutions has remained hidden under the rubric of defence expenditures and behind the rhetoric of market fundamentalism advocated by US institutions themselves. Nonetheless, it can be safely said that, very likely, most of the radical innovations in

[12] See Leslie (2000) on the tight links between military contracting, Stanford University research programs, and start-up and established firms' innovation efforts on microwave and communication technologies as fundamental initial steps paving the way to the subsequent burgeoning development of the Silicon Valley.

[13] See Block (2008) for an analysis of the differences between the functioning of the "Development Network State" implemented in the US economy with respect to the "Developmental Bureaucratic State" approach adopted in Asian countries such as Japan and South Korea.

[14] This perspective seems to gain further empirical support from data and arguments developed by Barry Eichengreen (2007) when he compares each other the economic dynamics of European economies and the US since the end of the 1960s. Indeed, whilst in 1963, 1969 and 1971 US business enterprises' gross expenditures (as a share of gross national product) on R&D were in line or sometimes lower than the corresponding figures registered in Europe, US government's expenditures has been extraordinarily more pronounced, ranging from 1,2 to 4 times higher that those observed in Europe (see Eichengreen, 2007, p.258). According to him, "whereas the United States devoted nearly 8 percent of government expenditure to R&D, in no European country was the comparable ratio even half as high (Eichengreen, 2007, p.257)".

the abovementioned sectors would have never come to light without the initial big push provided by domestic US public authorities.[15]

Second, Lazonick (2009, 2010, 2013), and Lazonick and Mazzucato (2013) among others argue that the considerable increase in income and wealth inequality registered in the US since mid-1970s strongly depends on the "financialization" of the domestic economy. Financialization is a very broad, multi-faced, very often elusive and not well-defined concept. However, following Lazonick (2010), when it is applied to the theory of innovative enterprises, it may take the meaning of evaluating "the performance of a company by a financial measure such as earnings per share rather than by the goods and services that it produces, the customers it serves, and the people whom it employs (Lazonick, 2010, p.18)". More practically, Lazonick (2009) underlines that the financialization of the US economy and the diffusion of the "shareholder-value-orientation" ideology has induced US corporations to move from an "old business model (OBM)" to a "new business" one (NBM). In the old business model, a central pillar of corporations' management was reinvesting retained profits in R&D activities and in the accumulation of physical capital and technological knowledge. The main goal was the *creation* of value through in-house innovation taking the form of new higher-quality products and/or more efficient production processes. The fruits of innovation were in turn distributed among firms' stakeholders. On the one side, firms' shareholders may get dividends. On the other side, workers may benefit of higher real wages[16], stable employment, and career opportunities. In the "new business model (NBM)", the search for capital gains on financial markets has become the new mantra of top executives. In the case of new innovative start-ups, this goal has been first pursued through Initial Public Offers (IPO) through which initial innovators and start-up owners could easily *extract* value from innovation, if any, and perhaps quickly exit from the initial investment (see Lazonick and Mazzucato, 2013). In the case of listed companies, the deregulation of financial operations has allowed top executives to search for capital gains by increasingly recurring to stock buybacks.

The consequences of these practices and of increasing financial alchemy have been various and profound. First, the loosing regulation of stock buybacks has permitted top managers to speculate on financial markets and to manipulate equity prices. Top managers have in turn exploited these opportunities in order to gain enormous amounts of money by opportunistically exercising granted stock options. Indeed, the rise in top executives' rewards thanks to the realization of astonishing capital gains explains a great deal of deeper income inequality in the US. To this fact, also adds the perverse dynamics registered on the labour market, which has been signed by jobless recoveries, the increasing instability of employment opportunities, and the rising precariousness of both skilled and unskilled workers. Second, and perhaps more relevantly in the long term, there is an expanding body of literature documenting and empirically testing that corporations' resources diverted towards financial markets have crowded-out R&D activities and productive investment (Stockhammer, 2004; Orhangazi, 2008; van Treek, 2008)[17]. In a way, the *extraction* rather than the *creation* of

[15] Block (2008) notes that, perhaps surprisingly and despite of its proclaimed aversion to public interference with free market forces, it is George W. Bush administration itself to emphasize how several technologies the Apple's Ipod relies upon are long-run results of federally funded research programs.

[16] See Setterfield (2012) on the closely related evolution of labor productivity and workers' compensation characterizing the US economy until the beginning of the 1970s. See also the subsequent stagnation in workers' compensations even in presence of increasing labor productivity.

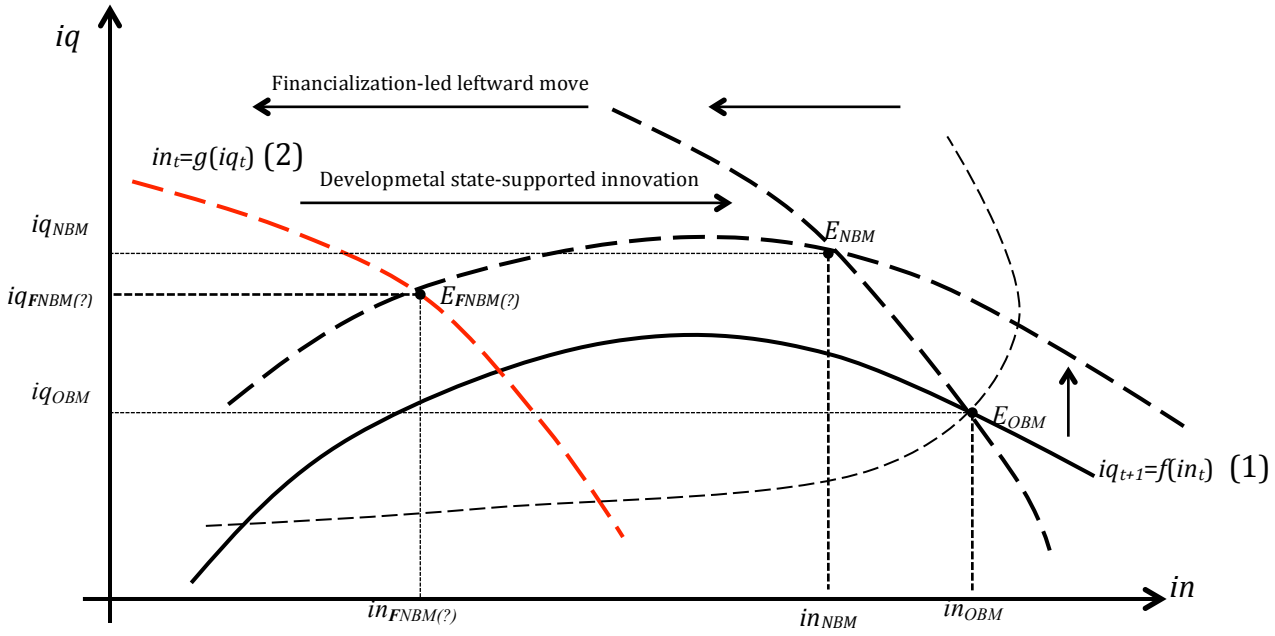
[17] Interestingly, Block and Keller (2012), and Fontana *et al*. (2012) stress that, since 1970s, records from annual awards acknowledged by R&D Magazine to the best 100 annual innovations demonstrate a remarkable reduction in the degree of big corporations' successfulness. On the contrary, an increasing share of prizes has been recognized to governmental

value has now become the target of corporations' top executives (Lazonick and Mazzucato, 2013). There is no doubt that misplaced corporations' emphasis on financial speculation and manipulation rather than on physical investment, the accumulation of technological knowledge, and the support of innovation activities can ultimately undermine the long-run competitiveness of the US economy.

In terms of the present paper, the above arguments can be easily incorporated into our simple theoretical model. Perhaps more relevantly, this exercise may contribute to explain why still high innovation performances of the US economy and the recent increase in inequality should not drive to the misleading conclusion that inequality favours innovation.

Take first the effects that financialization of innovative enterprises may trigger off on the two-way relationship connecting innovation to inequality. Financialization, by affecting income and wealth inequality, as well as the allocation of corporations' resources between unproductive financial purposes and productive investment, may likely entail multiple consequences. First, in a highly financialized economy, equation (1) may shift upward (see figure 3 below). Indeed, for any given level of innovation, the level of (next year) inequality inside the economic system will likely be higher due to the current prevailing institutional settings and economic philosophy favouring an uneven distribution of economic resources and downplaying workers strength on the labour market.

Figure 3 – Possible effects of financialization on inequality and innovation.



Second, financialization practices may radically reshape equation (2), i.e. the incentivizing or dis-incentivizing effects inequality may exert on current innovation efforts. In the virtuous scenario portrayed in figure 2.a, we assumed a slightly positive equation (2.a) to model such an inequality-to-innovation nexus. Alternatively, we could assume equation (2.b) to replace equation (2.a). Should equation (2.b) be initially (relatively) flat and its backward-bending arm emerge only in presence of pretty high levels of inequality, nothing relevant would change as to the main properties

organizations, spin-off emanating from universities' research centres, as well as collaborations including public institutions.

of the stable long-run equilibrium (see point *B* in figure 2.a). According to the above arguments, however, there is the concrete possibility that financialization, and the ensuing exacerbating inequalities, eventually play an overall negative effect on innovation. Indeed, the concentration of financial wealth in a few hands, and the ensuing vested interests of a restricted financial-political elite, induce it to obstacle any possible innovation-led creative destruction to take place. Even more, common financial practices to further increase existing financial wealth through the diversion of corporations' resources away from R&D activities towards financial operations likely jeopardizes corporations' capability to introduce in the near future new products with higher quality standards and lower costs. Thus, in figure 3, a throughout negative and leftward-displaced inequality-to-innovation nexus may emerge in the US (see the dashed downward-sloped red line). It may closely resemble that perverse inequality-to-innovation relationship that lays behind equation (2.c), and that seems to characterize highly unequal developing (Latin American) countries.

It goes without saying that the above changes in the US economy may induce tough consequences on its long-run development potential. In figure 3, the US economy may eventually move from the virtuous "old-business-model" equilibrium (E_{OBM}) to a much worse "*future* new business model" equilibrium ($E_{\boldsymbol{F}NBM}$). In equilibrium $E_{\boldsymbol{F}NBM}$, it is easy to see that higher inequality does not contribute to better innovation performances. Quite the opposite, innovation capacity of the US economy appears as significantly lowered. Luckily enough, such an undesirable outcome of the current prevailing US business model is not here to come. It seems to be mitigated and compensated by persistently strong public investment and participation to the R&D sector (see Blocker and Keller, 2012; Fontana *et al*. 2012). In the end, should public involvement in innovation activities continue to perform the pro-active role it has historically played, then the much disregarded US developmental state may help to *maintain* the technological leadership that the myopic logic of part of the private sector actually put at risk. In figure 3, the positive effects of past and present public-funded innovation efforts on domestic innovation capabilities are mirrored by the position of equation (2). Although private sector forces would naturally tend to shift it to the left, public innovation policies may contribute to preserve its rightward position (see the dashed black downward-sloping curve). Accordingly, for any given level of inequality, and despite of the negative effect inequality now plays on innovation, US innovation capacity may maintain appreciably high standards. The US economy will end up in the "intermediate", let's say, "second best" equilibrium E_{NBM} (with respect to the "first best" equilibrium E_{OBM}).

4. Policy Options

If one gives a superficial look at the data reported in figure 1 and focuses on the US experience, he might be persuaded that there exists a positive link between rising inequality and the US leadership in radical innovations. In this paper, we show that such a link might well be the result of a spurious relationship. On the one hand, the constant rise in income and wealth inequality observed in the US over the last three decades may largely depend on the financialization of the US economy among several other factors.[18] By itself, the financialization of innovative enterprises would primarily discourage (rather than foster) innovation by dragging corporations' resources away from productive investment into unproductive financial ones. On the other hand, despite of the so much

[18] Lazonick (2011), for instance, also mentions the processes of rationalization, marketization and globalization that in the last decades have pervasively affected the functioning of both labor and good markets.

blustered virtues of free market forces, the US leadership in radical innovations may hinge upon past and present public support to a widespread network of innovators and start-ups emerging from close collaborations with universities' research centres, government labs and federal agencies. In the end, it is what Block (2008) defines as the US developmental network State that forged in the past and now helps to maintain the US upfront position in the worldwide technological frontier.

Should our interpretation of current dynamics be at least partially correct, this implies that it would be highly disruptive for long-run economic progress to attack and perhaps dismantle the US developmental state (i.e. one of the targets of conservative market fundamentalists), and to export the financialized version of the US economy to other developed and developing countries. If innovation still stands out as the main source of economic development, social progress and social mobility, then a very broad set of recommended policy measures should aim at improving the functioning of developmental State's institutions while, at the same time, constraining the financialization of innovative enterprises.

More in details, positive or perverse economic behaviours respond to positive or bad economic incentives. The pervasive spread of financialization-linked practices such as IPOs, massive stock options and stock buybacks depends on the current deregulation of financial markets, and on the ensuing opportunities to get much higher rewards from financial operations rather than from real-sector investment. Policies aiming at challenging financialization should thus re-regulate financial markets and squeeze financial markets' yields. As to the re-regulation of financial markets, the launch of IPOs should aim at gathering fresh funds on financial markets in order to support the creation of higher value through new rounds of innovations. Actually, IPOs are mostly used to favour the extraction of existing value by allowing initial innovators and venture capitalists to sell their own shares at very high prices. Accordingly, financial market discipline should forbid initial innovators and venture capitalists to sell their shares in the aftermath of IPOs. Regulators should impose initial investors to hold their shares for a relatively long time span. The purpose here is to avoid financial speculation and to favour the return to long-term committed finance. The same logic applies to stock buybacks. Following Lazonick (2011, 2013), large stock repurchases should be banned. If allowed, they should be accurately documented. Top executives should inform authorities about the precise amount and timing of these operations. The provision of such detailed information is meant to avoid the strategic implementation of stock repurchases to manipulate market prices and allow top executives to realize high capital gains by exercising their own stock options.

The possible incestuous relationship between stock buybacks and stock options reminds us a second point of the above policy agenda, i.e. the need to reform the existing remuneration system. Actually, the current system disproportionally favours profits from financial market operations with respect to "genuine" rewards from innovation activities and the participation to production processes. Our reform agenda should first significantly downsize the allowed amount of top executives' stock options. On top of this, a highly progressive taxation system should be implemented, in which the highest marginal tax rate is levied on capital gains. The main purpose of this reform strategy is twofold. On the one hand, it aims at delinking top executives' remunerations from the dynamics of financial markets. Gains from financial markets should represent a modest and far minority component of top executives' income. Hopefully, this would also help to overcome the "shareholder-value-orientation" paradigm that currently dominates and guides the management of big corporations. On the other hand, the tax move against enormous capital gains may reduce income inequality and favour the emergence of a more egalitarian economy.

Funds recollected through the above progressive taxation system should then be used to strengthen governmental support to innovation activities. In particular, we think about a conspicuous increase in funds provided to start-ups, and small and medium-size innovative firms. In the specific case of the US, we may think about expanding the Small Business Investment Research Program. Further, the logic of the governmental funding strategy should be redistributive. Funds recollected by taxing capital gains from established innovative firms' financial operations should be bestowed on new research programs and start-ups emerging in those same sectors. Once again, a central purpose of this policy is to deter the "waste" of firms' resources in unproductive financial operations. Indeed, the more established firms divert resources away from research activities, the more seriously they risk to *indirectly* fund upcoming competitors and to be exposed to rising competition from new governmentally-supported enterprises. Last but not least, it is worth stressing that these measures do not undermine in any way the well functioning of market forces, and do not imply any governmental detrimental interference with market mechanisms. Quite the opposite, they may improve market mechanisms insofar as governmental support is distributed among a wide range of decentralized research and innovation initiatives competing each other and challenging established market positions. Contrary to most market fundamentalists' misplaced beliefs, the activity of developmental network State's institutions may eventually nourish (rather than depressing) a highly competitive, innovative and dynamic market economy.

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