The Complex Inequality-innovation-public Investment Nexus: What we (Don't) Know, What we Should, and What we Have to Do

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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, can affect it. We first stress that various different equilibria may exist in the inequality-innovation space. The positive relation that part of the economic theory often assumes to exist between (initially) rising inequality and improving innovation performances emerges as only one among many other far less virtuous dynamic trajectories. 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 have on the inequality-innovation nexus. We also note that the US developmental State – very often neglected by the economic literature – can 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.

Keywords: Inequality, Innovation, Financialization, Public Investment, Developmental state

JEL classifications: O15, O16, O31, O38

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1. The complex relationship between innovation and inequality

No economist would ever doubt about the existence of a relationship between inequality, innovation and public investment. Thousands of pages in the economic literature analyze the effects that these factors have 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 this topic and attempted to establish the existence of a direct or indirect relationship between inequality and growth. Yet, a consensus is far from being reached 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 regards the innovation-growth nexus, all the various Schumpeterian growth models put innovation at the center of the growth process (Verspagen, 2006). Even more, radical innovation 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 (Cajani, Godin and Lucarelli, 2014). Last but not least, there is an abundant and mostly controversial theoretical and empirical literature on the effects that public investment has 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, a heterogeneous strand of analysis has developed trying to assess the existence of a *more direct* connection between inequality and innovation[1] and between public investment and innovation. As for the first point, some authors focus on how innovation can affect inequality. Once again, results are rather diverse. Antonelli and Gehringer (2013) 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 reduces income inequality because it fosters productivity and economic growth, so that wages increase and rentier's income decrease (as a larger availability of capital tends to reduce the remuneration of capital). Second, in the long run a highly innovative economic environment may reduce inequality by increasing competitive pressures on good and service markets, making them more dynamic and then squeezing the duration and amount of monopolistic quasi-rents accruing to innovators.

This evidence notwithstanding, Antonelli and Gehringer's logic can be easily reversed. In fact, innovation can temporarily raise inequality if innovators dispose of quasi-rents; this holds at least in a short-time horizon, before subsequent innovations are introduced (Cozzens, 2008; Cozzens and Kaplinsky, 2009). Aghion (2002) and Acemoglu (2002) claim that the skill-based nature (process) innovations introduced in the last decades has been the main driver of increasing wage and income inequality. Finally, innovation can also lead to the structural change of the economy – particularly

[1] In this paper, I do not consider the relation between cross-country differences in innovation capabilities and the ensuing inequalities in the level of economic development. This is a well-established fact in the economic literature. See for instance the abundant literature on national innovation systems (Freeman, 2002), or the large variety of technology-gap models (see Castellacci (2007) for a survey). This work develops a broad perspective on a different and perhaps less extensively investigated issue, focusing on the relation between *intra-region* or *inside-country* inequality and the ensuing regional or national innovation performances.

in developing countries, increasing inequality as a modern highly productive industrial sector emerges alongside traditional low-productivity activities.[2]

The picture gets even more complicated if one thinks that the innovation-inequality nexus does not necessarily run one way from innovation to inequality. There exist sound theoretical reasons to believe that inequality can feedback on the innovation performances of an economy through several conflicting channels. On the one side, a long-standing conviction claims that income differentiation and wealth inequality are required in order to stimulate innovation (Lazear and Rosen, 1981; Lippmann, Davis and Aldrich, 2005). Acemoglu, Robinson and Verdier (2012) argue in fact that a "cutthroat" remuneration system like the US one is somehow necessary to push ahead the technology frontier and trigger off radical innovations that will ultimately increase the welfare of more equitable foreign social systems thanks to international technology externalities. In a sense, Acemoglu, Robinson and Verdier build their model on the theory of "varieties of capitalism" originally put forward by Hall and Soskice (2001), according to which radical innovations are more likely to be introduced in liberal market-based and relatively unequal economies than in cooperative countries.[3]

On the other hand, Hopkin, Lapuente and Moller (2014) provide empirical evidence at odds with the supposedly pro-innovation properties of cutthroat remuneration systems. Taking into account OECD countries, they show that highly equitable social systems like Scandinavian economies perform better than the US in terms of innovation performance, measured by the multidimensional "Global Innovation Index" (henceforth GII).[4] Consistently with Taylor (2004), the US economy once again seems to be a sort of outlier.

Both Hall and Soskice (2001) and Acemoglu, Robinson and Verdier (2012) only focus on industrialized economies. Weinhold and Nair-Reichert (2009) analyze a larger sample also including developed, emerging and backward economies from 1994 to 2000, concluding that a more equitable income distribution (seen as a large share of the middle class' income [5]) seems to be

[2] This is the logic behind the 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)."

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

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

[5] There is no general agreement on what could be defined as middle class income share. Deininger and Squire (1996) define middle class income share as the cumulative income pertaining to the third and fourth quintiles. Weinhold and Nair-Reichert (2009) take into account the cumulative income of the second and third quintiles. Finally, Palma (2011, 2014) suggests a broader concept since that middle class income share is computed on the interval from the fifth to the ninth decile. This difference is not trivial. It is on this last definition that Palma (2011, 2014) construes his analysis of cross-country middle class homogeneity and cross-country heterogeneity in the tails, this last fact being reflected in large cross-country differences in the so-called "Palma ratio".

positively (rather than negatively) correlated to innovation via its positive effects on the functioning of domestic institutions.

Some other works adopt a broader perspective and compare the successful development experience of newly industrialized East Asian countries with respect to lagging-behind Latin American economies. A more equal income and wealth distribution in East Asian countries (particularly as regards land) has favored human capital formation, technological knowledge accumulation, structural change and, finally, innovation (Arocena and Sutz, 2003). On the contrary, strong élites and polarized income and wealth concentration in Latin America have contributed to create an unfavorable economic environment characterized structural inertia, persistently low R&D efforts, and disappointing innovative performances (Cimoli and Rovira, 2008).

As regards the role of public investment in supporting and steering innovation, we deem the growing evidence on the positive effects of the so-called "entrepreneurial State" particularly interesting. 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 direct state engagement in path-breaking innovative activities. This is for instance the case of new information and communication technologies (ICT), which initially had an application in the military field. The same could be said for the biotech sector.

Mazzucato is also very keen in stressing that in these cases state intervention did not fix any market failure, but rather put effort in research on a potentially revolutionary technology that the private sector would never take into consideration because of the high risks at stake. In a way, state intervention created profit and "value-extraction" opportunities that were often unevenly exploited by private actors (Lazonick and Mazzucato, 2013). The importance of this strand of literature is twofold. First, it helps explain why the US economy is recurrently an outlier - at least with respect to other liberal market-driven economies - in terms of innovation capacity. Second, it stresses the necessity to take into consideration other institutional factors that are neglected by the theories on the "varieties of capitalism" but could prove decisive to better understand the different innovation performances around the world.

The aim of this work is not to contribute to the empirical literature on the relation between inequality and innovation, which has been discussed to be largely inconclusive and contradictory. Our attempt is rather to build a general theoretical perspective that encompasses the different ways through which inequality and innovation interact.

We intentionally keep our model extremely simple and do not resort to any complicated micro-foundation of inequality and innovation dynamics. We do so in order to guarantee an easy understanding of the multiple equilibria and radically different results that may result from the complex innovation-inequality nexus. The simplicity of our model also intends simplify the analysis of the way through which institutional changes affect the various possible innovation-inequality equilibria.

In this regard, the paper takes inspiration from the abovementioned literature on the entrepreneurial State, as well as the connected works on the so-called "risk-reward nexus" and the financialization of US corporations (Lazonick, 2009 and 2013). Our model provides a schematic representation of the peculiar US innovation pattern. It shows how high innovation and rising inequality in the US are not necessarily correlated (as could appear from spurious regressions), but actually result from (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. This 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) more innovative liberal market-driven economies.

This work is organized as follows. Section 2 presents our simple inequality-innovation model on the basis of the conflicting theoretical and empirical literature cited above. 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 introduces the "entrepreneurial State" and the "risk-reward nexus", which, following Lazonick and Mazzucato (2013), can help explain current rising inequality in the US. Section 3 provides a formal and graphical presentation of these arguments according to the building blocks of our model. Section 4 concludes and discusses some policy implications in light of the current US inequality-innovation pattern and its main causes.

2. A simple model on inequality-innovation clusters

As it has already been said, the interaction between inequality and innovation – two complex multidimensional phenomena - is extraordinarily intricate. One the one hand, there exist different types of inequality. Income and wealth inequality are the most cited and studied, and are very often interconnected. We could also think of the uneven distribution of learning and knowledge capabilities.[6] On the other hand, innovation can be radical or incremental, tacit or patented, most of the time**s** 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 complicate tangle of factors that makes the abovementioned empirical literature mostly contradictory in its results.

Figure 1 is a snapshot of current huge cross-country differences in terms of innovation-inequality patterns for a sample of 67 countries. We plot the 2012 values of the GII index[7] (horizontal axis) with the most recent data available of the Gini Index as provided by the World Development Indicators and the OECD database (vertical axis).[8]

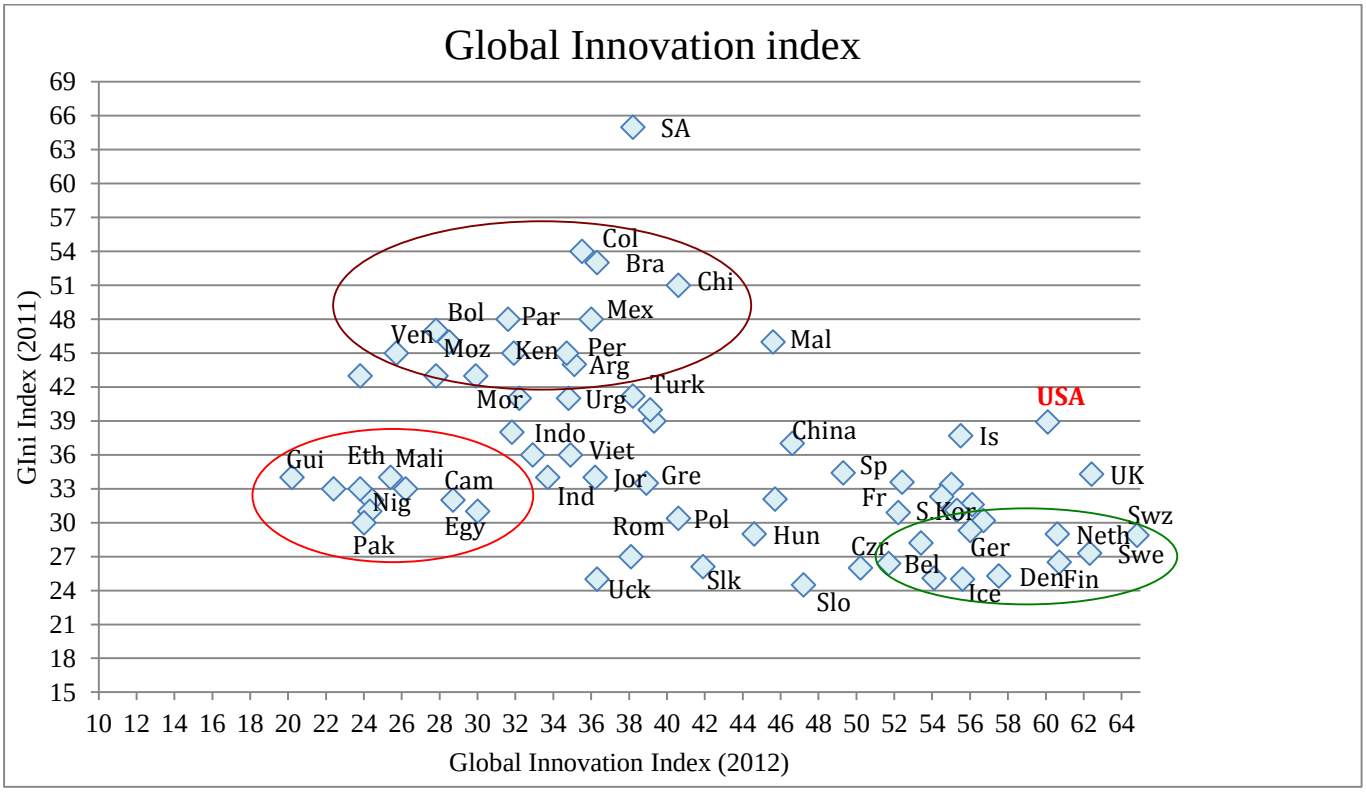
We can observe in the graph a sort of clustering around a number of sub-groups. In the bottom-left part of Figure 1 lie some backward economies where lack of development, persistent difficulties to ignite a sustained growth process and scarce innovation capacities are associated to basically low levels of inequality. Most of Latin American economies are in the top-left section of the graph. Although innovation performances remain disappointing, inequality reaches much higher levels, actually the highest worldwide (with the only exception of South Africa, "SA"). 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. South Korea belongs to this group too, whereas a fast-growing emerging economy like China lies in the

[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.
[7] See Table A.1 in Appendix A for the full list of countries reported in Figure 1.
[8] Most data on the Gini Index refer to 2011.

middle. In terms of innovation, it performs better than the least developed countries and other developing economies, Latin American ones in particular. However, inequality in China is still much higher than in most developed countries.

Following Taylor (2004) and Hopkin, Lapuente and Moller (2014), Figure 1 confirms the peculiarity of the USA among the set of developed nations. As expected, the USA belongs to the most innovative economies worldwide (even though it is 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.

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



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

Figure 1 is obviously overly simple and does not intend to provide an empirical validation to any specific theory on the links connecting inequality to innovation. Yet, it seems to suggest the existence of alternative innovation-inequality patterns exist. These differences may certainly be influenced by the different level of development characterizing most of the economies taken into account, as well as by national or regional policies targeting domestic inequality.[9] It may be reasonable to assume that such differences are not the mere result of transitory phases of the same

[9] See Lusting *et al.* (2011) on generous pro-poor governmental transfers and public support to sustain and promote education as examples of policy measures contributing to the reduction in inequality in several Latin America countries between 2000 and 2009.

development process, but rather represent signs of hysteresis in the evolution of the variables at stake or of the institutions that contribute to jointly determine them.[10]

This is for instance the case of Latin American countries, where high inequality, unsatisfactory innovation performances (despite of the adoption of radically different economic policy regimes), and evidence of an uncompleted development processes stand out as widely recognized facts.[11] The same line of reasoning could apply to European continental and Northern countries, in which the income share of the richest 10 percent of the population, although slightly increasing, has not followed the path of the Anglophone economies, USA above all, since the 1970s (Piketty, 2014, ch. 9; Galbraith, 2012, ch. 6). Let us address this point more in detail focusing on the theoretical model described here below.

In spite of the various contrasting perspectives highlighted above, a general agreement exists on the mutual interaction between inequality and innovation, which evolves and changes at different stages of economic development. As for the effects that innovation can have on inequality, it may be reasonable to think of 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 can subsequently trigger off a self-sustaining process of capital accumulation, improving productivity and even rising incomes. At the incipient stages of the development process, this mechanism is likely to determine an increase in wealth and income disparity.[12] Nevertheless, if strong and widespread enough, this process will boost economic development and the structural change of the domestic economy. The accumulation and diffusion of technological knowledge, the adoption of better production 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.[13] Historically, this shift in the innovation-inequality pattern hinges on technological spillovers from industry to agriculture, the changing balance of bargaining power between antagonist factors taking part in the production process, and on the spread of innovation

[10] Stating that the inequality-innovation nexus is characterized by various long-run equilibria does not require these variables to be stable and not to change along time. We rather mean that the relationship between inequality and innovation **is** certainly affected by the kind of institutional path-dependence Acemoglu and Robinson (2012) identify in their analysis of diverging cross-country development paths. Institutional shocks and structural breaks, however, can give rise to new inequality-innovation patterns. This might be the case of the US economy after the beginning of the neo-liberal era since the mid-1970s.

[11] Following Palma (2011, 2014), Latin American countries, as well as South Africa, persistently rank amongst the most unequal economies worldwide from 1985 to 2012 (as measured by the Gini index).

[12] Kanbur (2012) reviews 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 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 such increasing inequality are 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)."

[13] Kanbur writes 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."

opportunities that makes markets more competitive and dynamic, monopolistic positions weaker and monopolistic rents short-lived. This is mathematically portrayed by 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 $in_t < \bar{in}$; $\frac{\partial iq_{t+1}}{\partial in_t} < 0$ if $in_t > \bar{in}$

In equation (1), we assume a time lag to separate the occurrence of innovations (in_t) from their effects on domestic inequality (iq_{t+1}) to emerge. In addition to this, $\bar{in}$ stands for the "Lewis-type" turning point**,** with further progresses in the innovation capacity and the ensuing development process reducing instead of increasing domestic inequality.

The apparently straightforward long-run positive outcome of the above process is all but inevitable. In fact, it will be affected by inequality feedbacks on innovation. According to the literature reviewed in Section 1, many different scenarios are possible, on the basis of the initial level of inequality and its main causes.

Let us start with a rather equalitarian economy on the onset. Following Acemoglu, Robinson and Verdier (2012), we also 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)". The economic relationship then runs from (current) inequality to (current) innovation and may take a monotonic upward sloping form, as shown by equation (2.a) below:

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

Notwithstanding incentives to innovate provided by larger income differentiation, the constant increase in the innovation capabilities of an economy likely requires the widespread diffusion of technological knowledge. Castellacci and Natera (2013) state that innovation and absorption capacity are positively co-integrated all along the development of national innovation systems. The diffusion of technological knowledge and the improvement of a country's absorption capacities imply in turn significant households' investments in higher education.

Quite reasonably, this could take place only if a fair degree of equality is achieved within the economy.[14] As regards our analysis, this possibility implies that, from a certain point onwards, the economy will require a reduction (instead of an increase) in inequality 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

[14] 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 development.

[between inequality and innovation] at mid- to high-range levels of inequality (Hatipoglu, 2012, p. 243)". A non-linear backward-bending inequality-to-innovation curve may consequently emerge, as 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 $iq_t > iq^*$

Finally, we also have to take into account the case of several developing economies that have inherited persistently high levels of income and wealth inequality from the past. Latin American countries, for instance, are characterized by high inequality whose causes date back to the colonial period (see Acemoglu and Robinson (2012) among others), and by long-dated concentration of wealth (originally land) and abundant natural resources in a few hands. In this context, innovation has served to satisfy the demand for luxury goods coming from domestic economic and political elites (Taylor and Bacha, 1976; Arocena and Sutz, 2003), regardless to the needs of a much broader set of potential consumers.

At the macro level, domestic industrialization is far from complete or, even worse, episodes of premature de-industrialization have occurred in the last two decades, whilst the overreliance on natural resource exports has failed to address the recurrent shortage of foreign hard currency. Accordingly, the room for innovation-induced social mobility remains narrow, undermining social mobility. A full-fledged middle class is yet to come in these countries.

It seems thus reasonable to assume a throughout negative relationship between inequality (iq_t) and innovation (in_t). This fact is formalized in equation (2.c):

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

By combining equation (1) with the different versions of equation (2) – depending on the specific institutional setting –, 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 depicts the kind of virtuous interaction between inequality and innovation envisaged by Acemoglu, Robinson and Verdier (2012). 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 fairly egalitarian distribution of economic resources but poor innovation capacities. Point *B*, on the contrary, is associated to a relatively higher degree of inequality (at least with respect to point *A*) but also a significant improvement in the domestic innovation performance. The relative slopes of equations (1) and (2.a) in the neighborhood of the equilibria will determine their stability. In Figure 2.a, we assume the initial trait of equation (2.a) to be flatter than the positive-sloped section of equation (1), meaning that a modest increase in inequality is sufficient to stimulate significant efforts towards innovation. 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

becomes negative. In this context, the conditions for equilibrium *A* to be unstable and equilibrium *B* to be stable read:

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

In Figure 2.a, we show the case in which these conditions are fulfilled. Two points are worth stressing. First, equilibrium *B* becomes an attraction point. Accordingly, provided that an inequality level slightly higher than iq_A exists on the onset, the economy will naturally converge towards point *B* and give rise to a virtuous "technology traverse" from equilibrium *A* to equilibrium *B*.[15] Second, consistently with the well-known Kuznets inverted U curve hypothesis, inequality will first increase and then decrease along the convergence process towards point *B*.

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

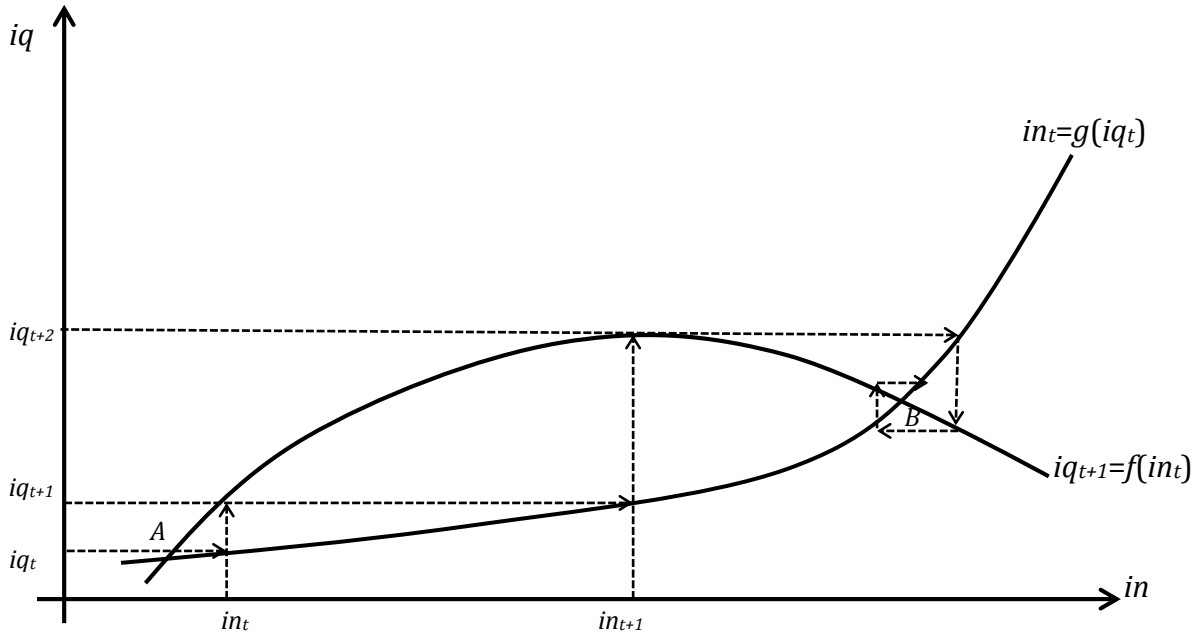
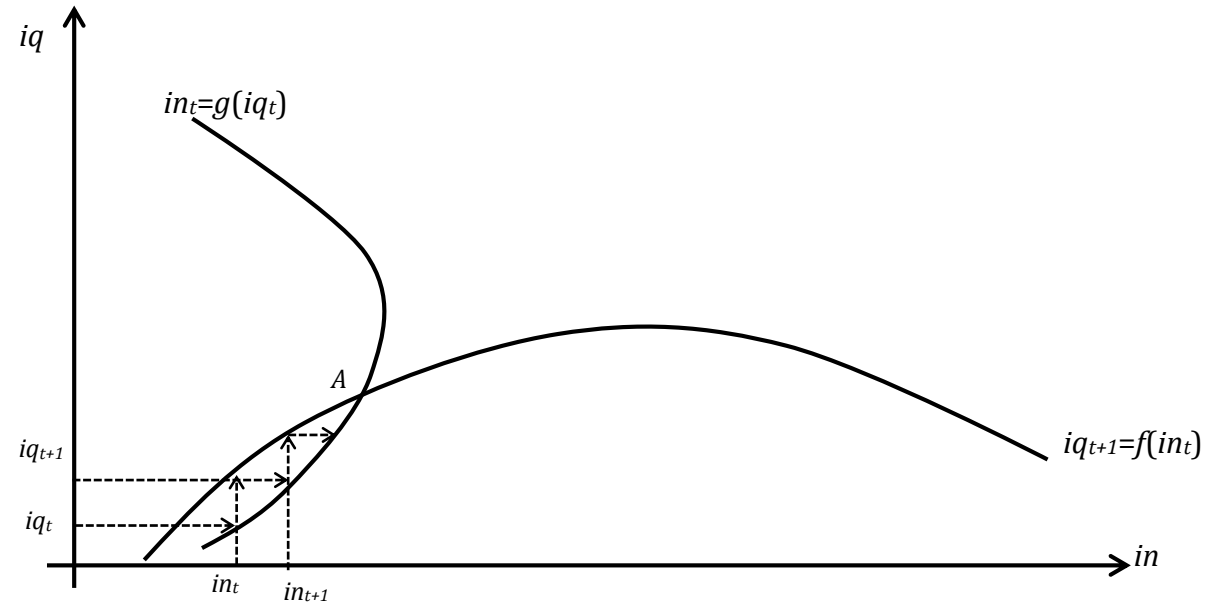


Figure 2.b depicts the scenario associated to equation (2.b), which is also initially steeper than equation (1). In this case, a unique and stable equilibrium *A* does emerge. As a result, the economy remains stucked in a state of (relative) technological backwardness. The transition towards a dynamic and innovative economic system will not take place.

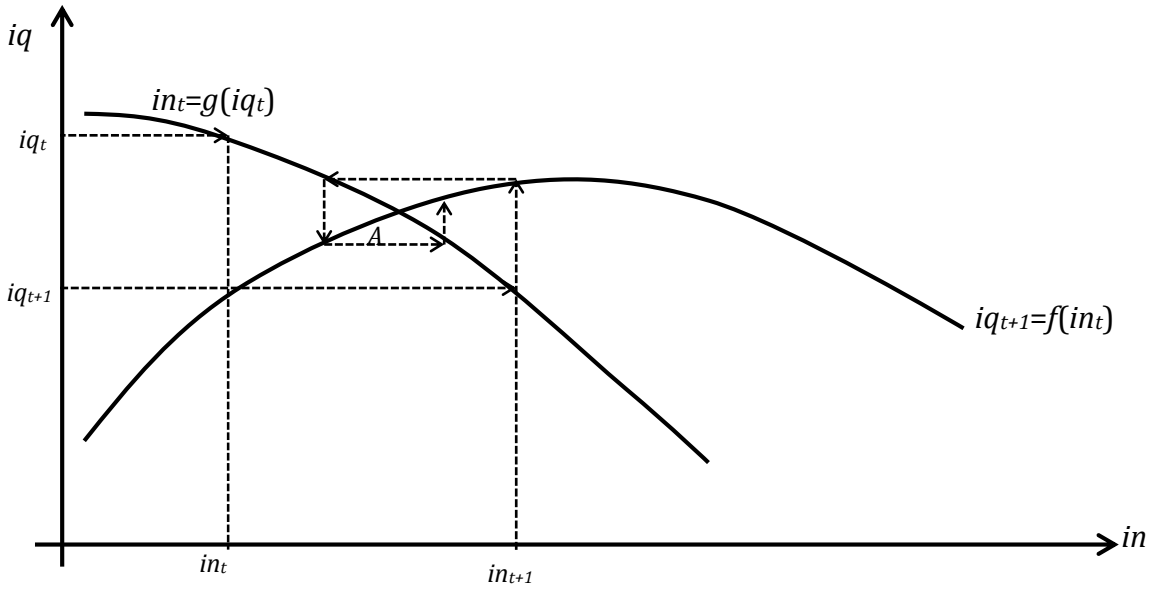
[15] Interestingly, the instability characterizing point *A* also means that, on the left-hand side of this equilibrium, an extremely egalitarian economy will do not provide any incentive to innovate. Innovative impulses will rather drop to zero. In such an environment, economic development will never take place, and an egalitarian poverty trap will eventually emerge.

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



In Figure 2.c, finally, we show what we have labelled a "Latin American-type perverse equilibrium". 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.

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



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

The inequality and innovation profile of US has often been presented as significant example of why higher inequality may be the price to pay in order to create an innovation-prone economic environment. Large income dispersion and increasing (relative) rewards reaped by innovators appear as the most powerful stimuli for radical innovation and to strengthen domestic technological capabilities (see Figure B.1 in Appendix B to the paper).

However, such beliefs lie on a very specific conceptualization of innovation. First, mainstream models usually describe it as a risky rather than uncertain outcome. In a way, mainstream economic theory acknowledges to economic actors the possibility to first compute the probability of succeeding or failing in the discovery of new products or processes before estimating the expected profits from their commercialization (or adoption). Second, innovation is deemed as the result of R&D efforts undertaken by single economic actors, namely individual entrepreneurs or single firms. Their 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. Under this perspective, institutions affecting the remuneration system stand out as the leading factors boosting or depressing innovation.

In spite of being highly convenient to the purpose of constructing elegant micro-founded models, the mainstream representation of innovation is rather 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 it is often impossible to build up any reliable probability distribution. This holds true especially in the case of radical innovations. The Knightian uncertainty characterizing innovation 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 existing stock of knowledge (Cimoli et al., 2009; Block and Keller, 2012; Fontana *et al*. 2012). Indeed, innovation derives from the interaction between different 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. Within this alternative framework, it is evident that we cannot stimulate innovation by simply adopting a more cutthroat remuneration system. On the contrary, both the collective and cumulative nature of innovation makes it dependent on a much wider range of institutions, first and foremost those public institutions performing and/or financing breakthrough innovations that are too costly and uncertain to attract the attention and interest of private actors.

Lazonick (2009, 2011 and 2013), Lazonick and Mazzucato (2013), and Mazzucato (2013) adopt 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 provide a version of story of innovation that is significantly different from that purported by "conventional" and "conservative" economists (see Lazonick, 2010).

First, 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. 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, the US government invested huge amount of resources in research and innovation activities functional to military purposes and connected to Cold War national defence needs.[16] 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[17]" has been effective and operative in the US as much as (or even more than) it was in many other now developed economies.[18] Following Block (2008), while 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 most of the radical innovations in the abovementioned sectors would have never come to light without the initial big push provided by domestic US public authorities.[19]

Second, Lazonick (2009, 2010, 2013), and Lazonick and Mazzucato (2013) 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, often elusive and not well-defined concept. According to Lazonick (2010), when applied to the theory of innovative enterprises it refers to "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)". Lazonick (2009)

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

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

[18] 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 than 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)".

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

also 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 former, a central pillar of corporations' management was the reinvestment of 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 results of innovation were in turn distributed among firms' stakeholders. On the one side, firms' shareholders got dividends. On the other side, workers benefitted from higher real wages[20], 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~~ the increasing financial alchemy have been various and profound. First, the loos**e** 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 (Galbraight, 2012; Piketty, 2014). In addition to that**,** the perverse dynamics observed in the labour market has been characterised by jobless recoveries, increasing instability of employment opportunities, and rising precariousness of both skilled and unskilled workers. Second, and perhaps more relevantly in the long term, there exists 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)[21]. In a way, the *extraction* rather than the *creation* of 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 to innovation activities can ultimately undermine the long-run competitiveness of the US economy.

These points can be easily incorporated into our simple theoretical model. 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

[20] 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.

[21] 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 organizations, spin-offs emanating from universities' research centres, as well as collaborations including public institutions.

innovation.

Let us first take into account the effects that the financialization of innovative enterprises can 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, is likely to entail multiple consequences. First, in a highly financialized economy, equation (1) may shift upwards (see Figure 3 below). Indeed, for any given level of innovation, the level of (next year) inequality inside the economic system will probably be higher due to the current prevailing institutional setting and economic philosophy favouring an uneven distribution of economic resources and downplaying workers' bargaining power in the labour market.

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). If equation (2.b) is initially (relatively) flat and its backward-bending arm emerge only in presence of significantly high levels of inequality, nothing relevant would change as to the main properties of the stable long-run equilibrium (see point *B* in Figure 2.a). According to these arguments, however, there is the concrete possibility that financialization, and the ensuing exacerbating inequalities, eventually will negatively impact on innovation. The concentration of financial wealth in a few hands and the vested interests of a restricted financial-political elite can in fact represent an obstacle to any possible innovation-led creative destruction to take place. Moreover, common financial practices diverting corporations' resources away from R&D activities towards financial operations likely jeopardizes corporations' ability to introduce new products with higher quality standards and at lower costs. 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 closely resembles the perverse inequality-to-innovation relationship that lays behind equation (2.c), and that seems to characterize the highly unequal Latin American countries.[22]

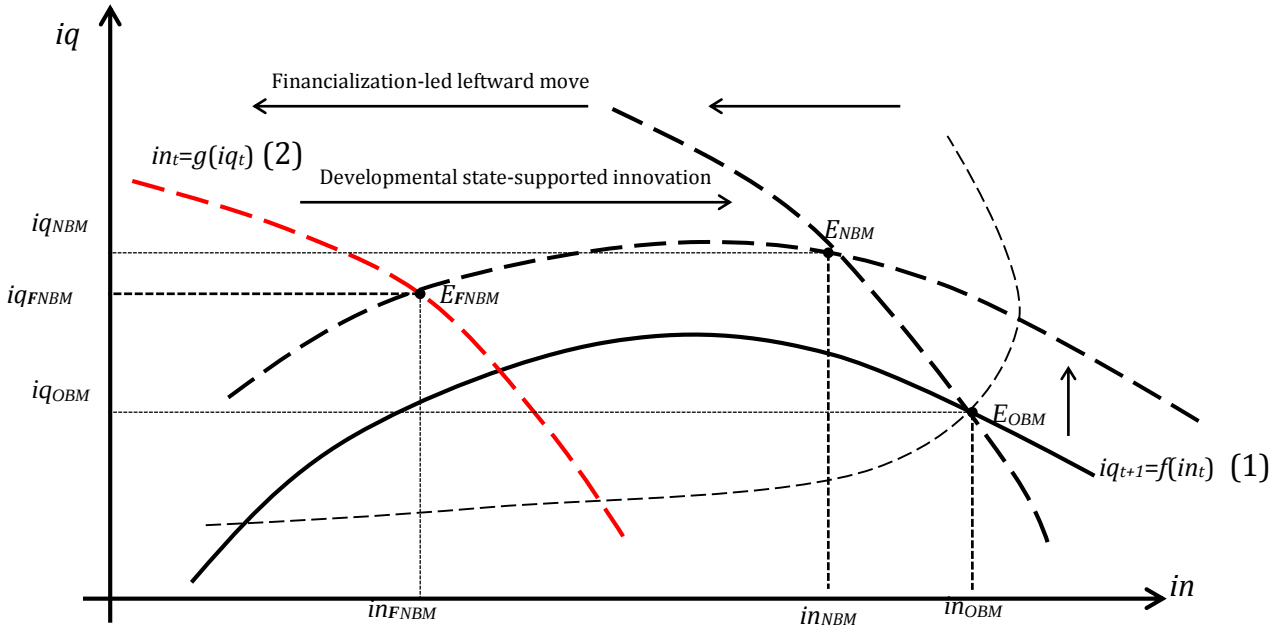
It goes without saying that the above changes in the US economy can have harsh consequences on its long-run development potential. In Figure 3, the US economy may eventually move from the virtuous "old-business-model" equilibrium (E_{OBM}) to a less favourable "*future* new business model" equilibrium (E_{FNBM}). In equilibrium E_{FNBM}, it is easy to see that higher inequality does not contribute to better innovation performances. On the contrary, the US innovation capacity is significantly lower.

Luckily enough, such an undesirable outcome of the current prevailing US business model is not here to take place. 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). If public involvement in innovation activities continues 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 puts at risk.

[22] Interestingly, while commenting recent inequality dynamics in Latin America and in the US, Palma (2011) affirms that: "it seems that now, with neo-liberal globalization, there is some distributional 'Latin-contagion' going on. It is fairly clear Latin America is now exporting some crucial features of its political settlement and distributional outcome in the US (Palma, 2011, pp. 125)".

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 will naturally tend to shift it to the left, public innovation policies can contribute to preserve its rightward position (see the dashed black downward-sloping curve). Consequently, for any given level of inequality, and despite of the negative effect inequality now plays on innovation, US innovation capacity will be able to maintain appreciably high standards. The US economy will end up what we can define "intermediate" or "second best" equilibrium E_{NBM} (with respect to the "first best" equilibrium E_{OBM}).

Figure 3 – Possible effects of financialization on inequality and innovation



4. Policy Options

A superficial look to the data reported in Figures 1 and B.1, to the US experience might persuade about the existence of a positive link between rising inequality and the US leadership in radical innovations. In this paper, we show that such a link is most probably 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.[23] By itself, the financialization of innovative enterprises would 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 blustered virtues of free market forces, the US leadership in radical innovations largely depend on 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. This is basically what Block (2008) defines as the US developmental network State that forged, in the past, and now helps to maintain the US upfront position on the worldwide technological frontier.

[23] Lazonick (2011) 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.

If our interpretation of current dynamics holds true, at least partially, this implies that it would be highly disruptive for long-run economic progress to attack and perhaps dismantle the US developmental State, 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 policy recommendations should aim at improving the functioning of developmental State's institutions while, at the same time, constraining the financialization of innovative enterprises.

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 reap much higher rewards from financial operations rather than from real-sector investments. Policies targeting 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 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. Therfore, 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 must inform the 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 gains from financial market operations with respect to "genuine" rewards from innovation activities and the participation to production processes. Our reform agenda primarily intends to significantly downsize the allowed amount of top executives' stock options.

On top of this, a highly progressive taxation system is to be implemented, with the highest marginal tax rate 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 of a conspicuous increase in funds provided to start-ups, and small and medium-size innovative firms. In the specific case of the US, a possible option would be to expand 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. 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. Finally, 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. They rather improve market mechanisms insofar as governmental support goes to a wide range of decentralized research and innovation initiatives competing each other and challenging established market positions. Unlike what most market fundamentalists believe, the activity of developmental network State's institutions can eventually nourish (rather than depressing) a highly competitive, innovative and dynamic market economy.

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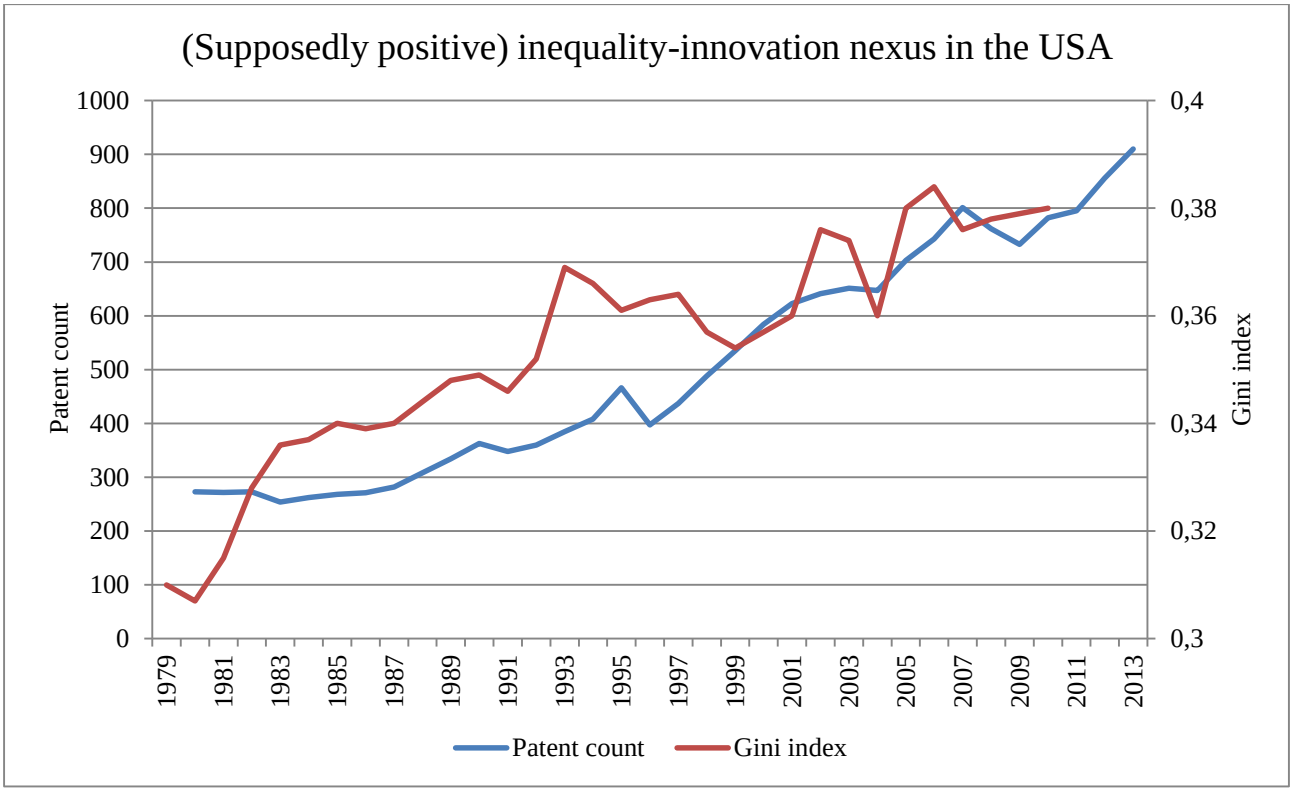
Appendix A

Table A.1 – List of 67 countries reported in figure 1 (with corresponding code when explicit).

Country	Code	Country	Code
Angola	-	Mali	Mali
Argentina	Arg	Mexico	Mex
Australia	-	Morocco	Mor
Austria	-	Mozambique	Moz
Bangladesh	-	Nepal	-
Belgium	Bel	Netherlands	Neth
Bolivia	Bol	New Zealand	-
Brazil	Bra	Niger	Nig
Burundi	-	Nigeria	-
Cambodia	Cam	Norway	Nor
Canada	-	Pakistan	Pak
Chile	Chi	Paraguay	Par
China	China	Peru	Per
Colombia	Col	Philippines	-
Czech Republic	Czr	Poland	Pol
Denmark	Den	Romania	Rom
Egypt	Egy	Russian Federation	-
Ethiopia	Eth	Slovakia	Slk
Finland	Fin	Slovenia	Slo
France	Fr	South Africa	SA
Germany	Ger	South Korea	S.Kor
Greece	Gre	Spain	Sp
Guinea	Gui	Switzerland	Swz
Hungary	Hun	Sweden	Swe
Iceland	Ice	Thailand	-
India	Ind	Tunisia	-
Indonesia	Indo	Turkey	Turk
Ireland	-	Ukraine	Uck
Israel	Is	United Kingdom	UK
Italy	-	United States of America	USA
Japan	Jap	Uruguay	Urg
Jordan	Jor	Venezuela, Bolivarian Rep.	Ven
Kenya	Ken	Viet Nam	Viet
Malaysia	Mal		

Appendix B

Figure B.1 – Gini inequality index and patent counts (per million people), USA, 1979 – 2013.



Source: Data on inequality from OECD poverty and inequality indicators dataset; data on patents' count from World Intellectual Property Organization (WIPO) dataset.