Beyond traditional measures of productivity. The challenge of defining, conceptualizing and measuring sustainable productivity

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Abstract

This paper outlines the meaning and role of productivity, in terms of its definition and conceptualization, presents some debated points on the various components of productivity (labour, capital and total factor productivity) and underlines the importance of contextual conditions (political context, institutions, geography and market integration).
To go beyond the narrow GDP measurement should mean to rethink productivity as a measure of the developmental process of production. Development is conceived as a combination of quantitative and qualitative dimensions of the nested concept of sustainable development: economic growth, social development, environmental sustainability, conducive to political transformation. Al that implies a critique extended to economic productivity as the very and narrow principle and process of translating inputs into outputs and results.
Some key questions are specifically presented and discussed with reference to agriculture and, adding usual caveat, general concluding remarks can be deducted from the HDI, DEA and MuSIASEM measures as possible sources of inspiration on sustainable productivity.

keywords: Productivity; Sustainability; Accounting; Measurement; Development; Agriculture; GDP.

1. Introduction

Far more than at any previous point in the last decades, the search for a new, different and better measure of progress, development and quality of life seems to be at the top of the international political agenda. Academic, international civil society organizations, business and political communities share a common interest in measuring progress beyond GDP.
But "Our words are never neutral", to cite the title of a paper written by Sana Nawaz and her colleagues (Nawaz et al., 2013). To cut a long literature review very short, one of the most influential scholars of the Critical Discourse Analysis (CDA), Teun Adrianus van Dijk, recommends helpful precautions in using keywords, as political ideologies are largely reproduced by discourse and words

(van Dijk, 2006). Therefore, we should be very careful in using and confounding progress, development and quality of life: not only according to the Pasolinian specific vocabulary there is a clear distinction between (the Marxian term of) "progress" and (the bourgeois term of modernization called) "development" (Pasolini, 1999), but the so called post-development critique is a loose term describing an heterogeneous and wide-spread corpus of theories that existed prior to current epigones, influenced by Ivan Illich and post-colonial literature (Ziai, 2011).

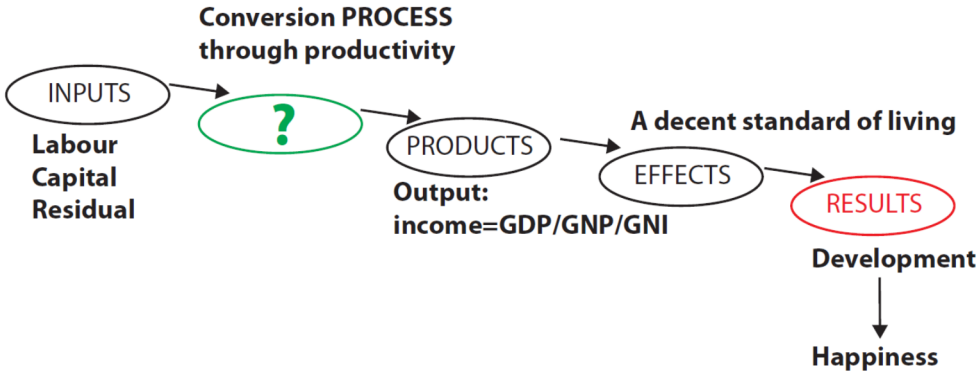
However, even if the importance of rethinking synthetic indicators and batteries of disaggregated indicators on economic growth, development and performance measurement was underlined in the past, as on the eve of the 1995 World Summit for Social Development (UNESCO, 1995), it is undoubtedly true that criticism of the GDP (and, by extension, GNP, GNI and disposable GNI) measure has multiplied over the past ten years. Again, there is abundant theoretical and empirical literature exploring this issue, so that we can simply refer the readers to an article written by Enrico Giovannini - who did relevant work during his term as OECD Chief Statistician - for further information (Giovannini, 2013).

We now have a broad consensus on going beyond GDP. At international level, the new 2030 – so called universality and transformative – United Nations Agenda for Sustainable Development Goals (SDGs) was agreed on September 2015. On March 2016, the United Nations Statistical Commission's Interagency and Expert Group on SDG Indicators (IAEG-SDGs) agreed on some preliminary 230 individual indicators to monitor the 17 goals and 169 targets of the SDGs (UNECOSOC, 2016).

Around half of the 230 indicators lack acceptable country coverage, agreed-upon methodologies, or both. In any case, such a wide SDG agenda to "Leave No One Behind" includes targets relating to broader systems of capital accounting, looking beyond GDP and incorporating social, human, and environmental capital in viewing poverty and development.

In the light of this debate, we start from the premise that the expected output of the developmental process of production is more than just GDP. The conventional causal chain of mainstream economic theory (mainly, the marginalist theory of value and neo-classical economics, still prevailing at level of micro-economics) is built on very strong assumptions: over time, production or output of final goods and services leads to a virtuous cycle of employment, capital accumulation and economic growth and, by virtue of a trickle-down effect percolating through the social fabric, the engine of growth is automatically transformed into the improvement of living conditions for the whole population, and this is conceived as the best practical means to promote the favorable conditions to approach the ultimate end of individual and collective happiness.

Fig. 1 - The conventional causal diagram expected to promote development through GDP



There is no escape from two critical points - related to the topic of this paper - in the belief behind such a conventional causal chain. First, the causal relationships depicted in the graph of Fig. 1 considers that the variable of primary interest is the output (=Y) and that the causal effect to be estimated is the effect of resources or inputs on Y through the conversion process represented by the "miracle" linked to higher productivity. Even in such a narrow and linear mechanism, productivity is a rather elusive concept. Better than anything else, we can cite two famous quotes: "... the marginal productivity theory of distribution is all bosh" (Robinson, 1961) and that the (large) residual usually called Multi-Factor Productivity (MFP) or Total-Factor Productivity (TFP) is at best "a measure of our ignorance" (Abramowitz, 1956).
In practice, after many decades of empirical work economists are still none the wiser as to what causes growth (Easterly 2002). Recent empirical studies, conducted through cross-country regression models, have investigated no fewer than 145 variables and most were found to matter (Durlauf, Johnson, Temple, 2005). Xavier Sala-i-Martin found that at least 62 different variables have been included in the production function to explain growth, in addition to the growth of capital and labor (Sala-i-Martin, 1997). William Easterly and Ross Levine pointed out that TFP refers to the something else besides physical factor accumulation, so that it does not provide a clear guidance (Easterly and Levine, 2001).
Second critical point on the conventional causal chain, in wider terms change always has its own environmental, social, political, cultural and historic dimensions which go beyond the narrow GDP measurement that incorporates the monetary value of final goods and service – that is, those that are bought in the market by the final user –, without including, for example, unpaid work (such as that performed in the home or by volunteers). Therefore, if the Beyond-GDP approach holds true, then we have to move from the idea of productivity as the key engine to more (and - only implicitly - better) output and lower prices as a boon to consumers (as cost per unit decreases and elastic demand leads to an increase in employment) to productivity as a measure of the developmental (in

terms of a combination of quantitative and qualitative dimensions of the nested - rather than additive - concept of sustainable development: economic growth, social development, environmental sustainability, conducive to political transformation) process of production as a boon to empower all the citizens, without exception (in particular the disadvantaged and vulnerable ones).
This implies a critique extended to productivity as the very principle that induces the ongoing commodification of nature and social relations (Rist, 2011).
GDP is just the result of the mode of production. The key technical mechanism of such a mode of production is productivity. If the idea of sustainable development is not just lip service, then a new paradigm for development is needed. Managing the interlinkages among rural and urban areas, natural resource conservation and the environment must be an integral part of a transformative agenda. According to economist Alain de Janvry (A. de Janvry, 2010), until now land expansion has been the main source of growth in cereal production in Africa, contrary to other developing regions where rising yields have been the main source. Land expansion is not a long-term sustainable strategy, and land scarcity is already on the rise. And the cost in terms of contamination of soil and water due to the (ab)use of chemical fertilizers and pesticides is just a negative externality, which is not taken into account in the productivity calculation.
This is the main idea of the paper. If we recognize that economic growth is instrumental in character and welcomed only if social, environmental and economic objectives are harmonized and made favorable for the most vulnerable groups in order to become politically transformative and environmentally sustainable, then it is difficult to continue arguing the relevance of productivity per se as a measure of economic efficiency. Rather, productivity has to be conceived as the measure of the critical transformative and comprehensive process of inputs in a given context into progress in the political, social, economic and eco-system spheres, combining individual and collective well-being and regarded as the very objective of development reconciled with progress.
The implications of this for re-conceptualizing and measuring sustainable productivity in terms of developmental relevance, impact, effectiveness and sustainability rather than efficiency will be great, and oriented to be translated into operative terms both at macro level (to revise national accounts) and micro level (to identify and evaluate small scale initiatives) of indicators. These implications require a note of caution: although micro- and macro-levels are interrelated, the fallacy of composition - what is true for micro-level is automatically true for macro-level - is a common pitfall to be avoided and the micro and macro analysis must proceed in parallel; this holds particularly true in the case of production function (Felipe, McCombie, 2013).
All this is a very sensitive topic, politically speaking. The interactions between long-term processes of transformations and short-term changes both at national and international levels bring to the surface persisting structural difficulties and,

at the same time, new opportunities to be seized. National development and international policies are grappling with a highly vexing conundrum: an urgent focus on short-term crisis responses tends to be detached from the medium/long-term socioeconomic dimensions of development. This despite the fact that it is essential to define emergency policy solutions with long-term prospects, looking towards sustainable development. Otherwise, any solution we may find is doomed to fail.

We are all living through a crisis period following the 2015 Paris Agreement on climate change and the agreement on the SDGs. From one side, the planetary future is at risk, at different scales, from localized deforestation to air pollution from cars, hits the planetary ceiling (WWF, 2016).

From another side, in 2015, the number of unemployed people reached almost 200 million (at the same time, 244 million people, or 3.3 per cent of the world's population of 7.4 billion people, lived outside their country of origin). Based on the most recent growth projections, global unemployment is expected to rise by nearly 2.3 million in 2016 and by a further 1.1 million in 2017. Vulnerable employment – the share of own-account work and contributing family employment, categories of work typically subject to high levels of precariousness – accounts for 1.5 billion people, or over 46 per cent of total employment. In both Southern Asia and sub-Saharan Africa, over 70 per cent of workers are in vulnerable employment. And there are also significant gender gaps in job quality: women face a 25 to 35 per cent higher risk of being in vulnerable employment than men in certain countries in Northern Africa, sub-Saharan Africa and the Arab States. In 2015, an estimated 327 million employed people were living in extreme poverty (those living on less than US$1.90 a day in PPP terms) and 967 million in moderate or near poverty (between US$1.90 and US$5 a day in PPP terms) (ILO, 2016).

In 2015, the number of working-age individuals who did not participate in the labor market increased by some 26 million to reach over 2 billion. Falls in the working-age population and labor force participation rates as well as rising inequality, vulnerable employment and poor job quality do not appear to be cyclically induced. In China itself, unemployment remains relatively steady but it reflects state-sector dominance and prevalence of low-end, "low-productivity" activities, with a considerable hidden unemployment in China's state sector and many informal jobs characterized by high turnover. If government will continue to be under great pressure to pursue state-sector restructuring, unemployment will rise.

In the last five years, sustained and rapid economic growth in many African economies has generated a debate led by the IMF on the persistence of a so-called 'African growth miracle'. But if we look at the World Bank dataset on per capita income level and compare 1990 and 2014, there was no miracle. Twenty-five countries languished and still languishes in poverty (that is, they were and still are low income economies); one country (Zimbabwe) has fallen into

poverty; seven countries have been lifted from poverty but still live around the poverty line; three Western African countries are now above the poverty line; eight countries have been lifted out of poverty and are now in the upper-middle income brackets; eight countries have always been middle-income countries; and there is just one country that moved from the middle-income to the high-income group (Seychelles). If we look at the twelve countries with an average growth rate above 3% in the 2011-14 period, the underlying structure is not new. Valuable natural resources – oil, minerals and commodities – provide the bulk of wealth, without distribution and employment. Informal economy and under-employment still prevail. Between- and within- countries inequality are dealing with these problems all the time.

The key political challenge that world policy must face up to is that short-term emergencies and long-term issues are not aligned and they may look like alternative options. It should be obvious that 'business-as-usual' is not the recommended option for policies.

If decent employment for all is considered a key goal (is it really feasible and sustainable in the long run? What about the 'gig economy' on a global scale?) and biodiversity conservation another unquestionable goal, we should recognize that increased value of labor productivity may be translated into fewer hours worked (more unemployment to get the same output value) and not necessarily into increased wages for workers. And the same thing happens to an increase of cultivated land: each worker produces more outputs as each one has more land to cultivate and the value of the marginal product of labor rises at any given level of employment. Here we should also consider the issue of environmental degradation and resource depletion as a concrete trade-off between more quantity of output and worse quality of environment.

But a dethronement of productivity in the name of conceptualizing (and, much more difficult, measuring) a new sustainable productivity destroys the overarching paradigm for mainstream growth at global level. This means rethinking economies so as to reflect new societies and territories, as well as the challenges and opportunities represented by new technologies and automation. It is also a way to reconsider the trade-off between labor, capital and natural resources, to determine whether and how economic growth is embedded into development, without the simple shortcut of de-growth. However, when you think about it, if there is no war at home, it is much easier for development policies to be led by emergencies, and to looking at short-term reactions and at ways to and think how to reduce migration flows as a goal in itself (like in Europe right now).

The paper is organized as follows. Section 2 outlines the meaning and role of productivity, in terms of its definition and conceptualization. Section 3 presents some debated points on the various components of productivity and Section 4 underlines the importance of contextual conditions. Section 5 details some stylized facts and key questions applied to agriculture, as a practical example.

Section 6 offers a brief description and discusses sustainable productivity in terms of measurement. Some conclusions are drawn in Section 7.

2. Productivity: definition and conceptualization

During the last decades, the micro-foundation approach to economic theory and modeling has become dominant. A tendency toward the reconciliation of opposites seemed to prevail as a consequence of a net dominance of the associated concepts and assumptions of rational agents, uncertainty, the removal of "Walrasian auctioneer" that instantaneously finds the wages (and prices) that clear all markets, contestable markets (rather than pure or perfect competition), market failure (transaction cost, information asymmetry, externalities, public goods), policy ineffectiveness. Notwithstanding this dominance, it can be argued that two alternative approaches to economic growth and productivity have continued to fight in conceptual terms as alternative ways to think about the market relationships (exchange values or prices) between commodities produced for sale.
The mainstream marginalist or neoclassical theory (Mankiw, 2012) argues that a country's standard of living depends on its ability to produce goods and services and productivity refers to the quantity of goods and services produced for each unit of a given input, called factor of production or resource.
In the classical political economy - in the late eighteenth and early nineteenth - the factors of production were labor, capital and land, corresponding to the labourers (wage-earners), the capitalists and entrepreneurs who own the stock or capital (profits-earners) and the land owners (rent-earners). Today the neoclassical inputs are the following:

i. labor,
ii. capital, divided into physical capital (or simply capital, consisting of manufactured resources such as equipment, buildings, and machines), human capital (education and knowledge embodied in the workforce), and natural capital,
iii. technological knowledge.

Following this conceptualization, a nation's standard of living is determined by the productivity of its inputs, because the factors of production directly determine productivity: output per worker (Y/L), which is the typical measure of productivity (i.e., the quantity of goods and services that a worker can produce from each hour of work), depending on physical capital per worker (K/L), human capital per worker (H/L), natural resources per worker (N/L), and the state of technology (A).

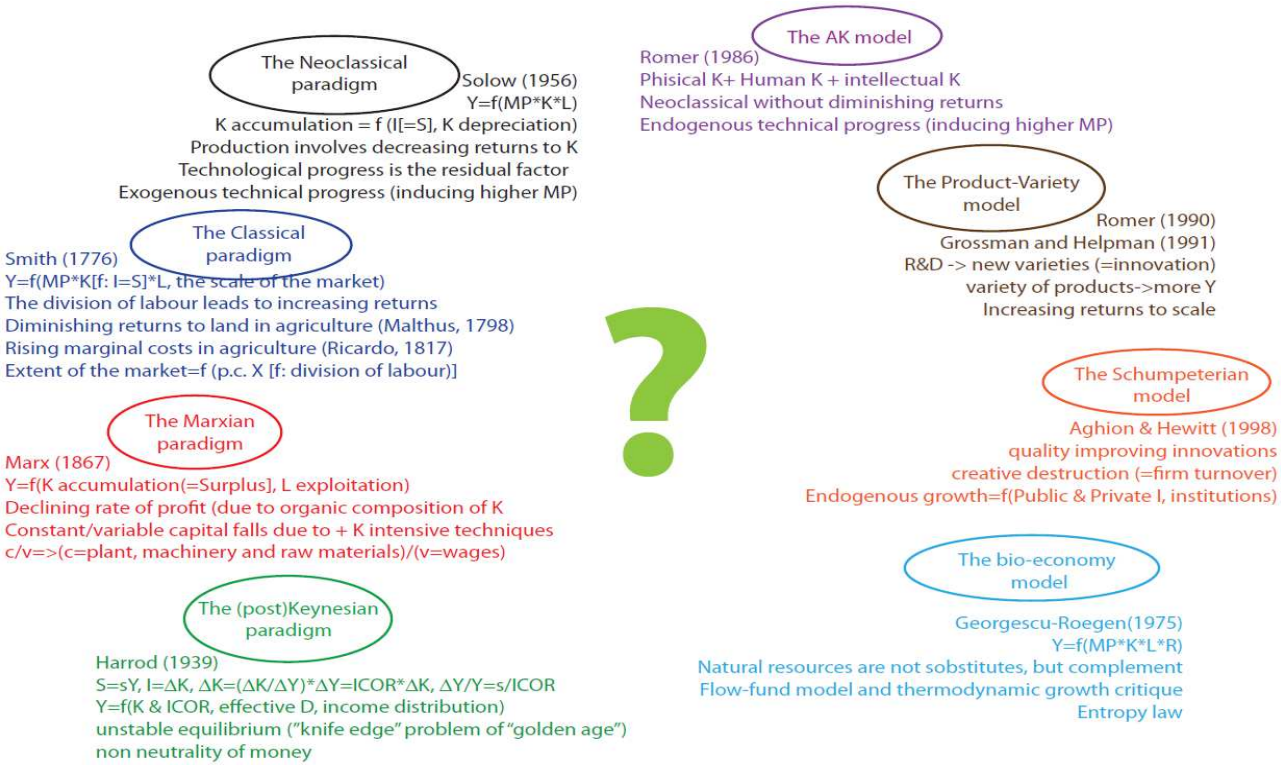
It is a set of crucial assumptions that forms the foundation of the marginalist theory:

1) production is considered as a purely technical process within which factors of production are employed in certain technically determined proportions to produce goods;
2) the factor of production prices correspond to marginal productivities (productivity at the margin), and marginal productivity is a diminishing function of factor supply: the law of diminishing returns (diminishing marginal returns or increasing relative cost) states that in all productive processes, adding more of one factor of production while holding all others constant (the so called *ceteris paribus* assumption), will at some point yield lower per-unit returns;
3) the presence of a negative association, or inverse relationship, between the rate of profit and the capital labor ratio (and the capital-output ratio);
4) as a consequence, the re-allocation of factors can only reduce the total product, measured at current prices, and so the total utility (the disutility of additional effort is the other side of the principle of productivity at the margin). Thus any intervention in the pricing or allocation of factors or products that disturbs the attainment of competitive equilibrium is bound to reduce (or at least cannot increase) total utility;
5) competitive forces operate through variation in relative prices and factor substitution (considering the so called Marginal rate of technical substitution or MRTS, that is the rate at which one factor can be substituted for another while holding the level of output constant), that is, in response to variations in demand prices rise and fall, as they are flexible in both directions and an inverse relation between the quantity of factors of production employed and their relative rates of remuneration is ensured by a regular substitutability between the factors of production;
6) in equilibrium, if the price of the factors of production corresponds to their marginal productivity (with downward-sloping marginal productivity curves) and to their utility cost or marginal disutility, then market solution is considered socially satisfactory and morally and legally correct (optimal allocation), and the general price is found also to be the just, or equitable, price;
7) the sum of wages, rent and profit exhausts the total product and the theory of distribution is simply derived from the initial distribution of resources and the correlated analysis of prices, by explaining the returns to the various factors of production without any consideration of historically specific frameworks of conflictual social relations or ecosystems and social systems interactions.

It was mainly during the 1960s and 1970s that a radical critique of the marginal productivity theory of distribution acquired an important place in discussions of economic theory. Much was written by Piero Sraffa, and then by Richard Kahn, Nicholas Kaldor, Joan Robinson, Luigi Pasinetti and Pierangelo Garegnani. They developed the so called Sraffian and Post-Keynesian theory of growth and distribution, and even if they did not comprise a unified body of theory, it is also useful to mention Kaleckian, Marxian and radical views (including the bio-economy model) as alternative views to the mainstream marginalist school.
Basically, they represent a radical departure from neoclassical theory, because of the importance of changes in the social relations of production (that is, power relations) and in technology, rather than in factor substitution. In 1966, the validity of the famous Sraffian critique on capital theory and on the full Arrow-Debreu general equilibrium model was acknowledged by an important neoclassical economist - Paul Samuelson - who admitted the inconsistency of the traditional belief according to which, by virtue of the substitution principle, production techniques that are more capital intensive will become optimal as the rate of interest is lowered, and accepted the so called general case of occurrence of capital-reversing (the fact that a less productive, less capital intensive technique may be associated with a lower value of the rate of profits or interest rates) and reswitching (there is no simple monotonic relationship between the nature of the techniques of production used and the rate of profit) results.
It is interesting to note that, despite the fact that Cambridge capital controversy was conclusive on the impossibility to conceive a single capital magnitude in the required terms of independence of distribution and prices, and on the necessity to include both demand and supply and not just supply to measure economic performance, the mainstream theory has proceeded since the 1980s as if this critique never existed, rather than opening the space for the alternative conflictual and surplus-founded classical theory of distribution of the classical political economists, by contesting a direct relationship between capital intensity and real-wage rates and a theory of distribution completely absorbed in a general theory of prices (Garegnani, 2010 and Finn, 2013).
In practice, there are two opposite views, summarized by the nineteenth-century classical conflictual analyses of Ricardo and Marx from one side, and the twentieth century optimistic analyses of Simon Kuznets and Robert Solow of a “balanced growth path”, according to which output, incomes, profits, wages, capital, asset prices progress at the same pace, so that every social group would benefit from growth to the same degree (Piketty, 2014).
We must admit that this oversimplification of two alternative views ignores the more complex reality of different paradigms such as those showed in the graphical representation (Fig. 2). Nevertheless, the reader may be surprised by the fact that if the standard methods for measuring (total factor) productivity were invalidated by the above mentioned critiques, then it did not affect mainstream theoretical and empirical works on aggregate production function,

as clearly demonstrated by the endogenous growth theory, the new generation of contemporary short period or neo-Walrasian inter-temporal and temporary general equilibrium models and the fact that neoclassical economics is still dominant.

Fig. 2 - Alternative views on growth accounting



If Keynes suggested that productivity growth, in the absence of sufficient aggregate demand, may become a social problem and lead to long-term unemployment, an additional radical critique to the narrow vision on development based on productivity growth comes from a bio-economy perspective, according to which labor productivity growth has historically been supported by an increase in the proportion of material and energy inputs to labor inputs (N/L and, more specifically, the energy labor ratio E/L), leading to an increased environmental degradation (Harris, 2009).

A broader view of productivity and production should reframe them by adopting a nested concept, combining various goals, including environmental sustainability, social mobility, economic redistribution and political empowerment of the most vulnerable groups, in particular women.

To concentrate on environmental sustainability component, the fact that rising labor productivity (and per capita income) has been usually correlated to an

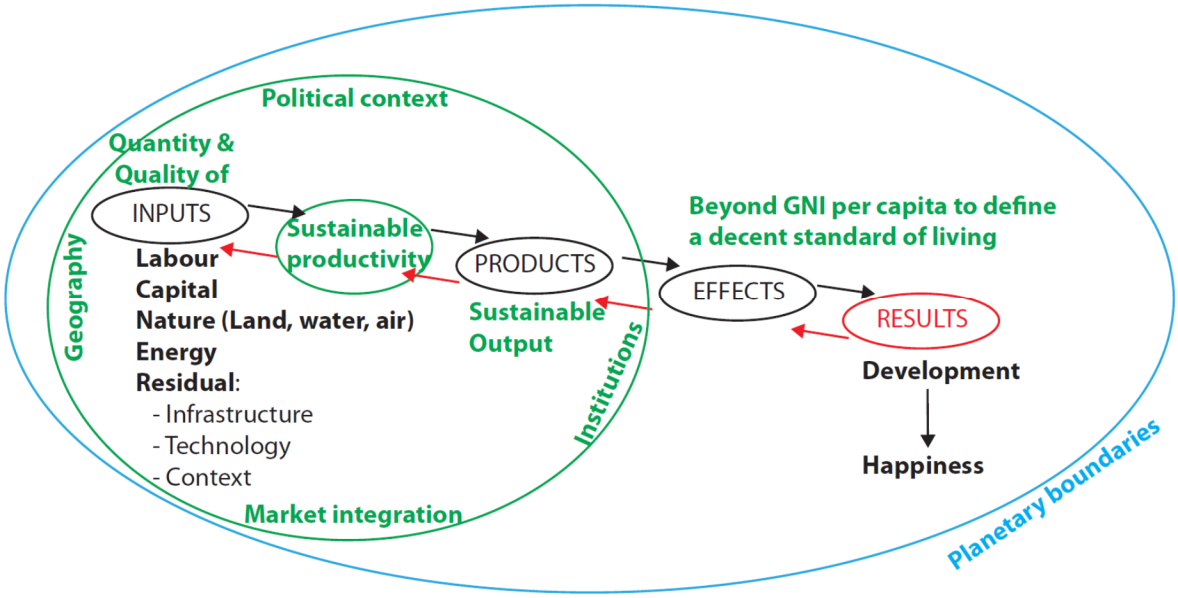
increasing use of energy (with fossil fuel and biomass being the larger fraction and the most responsible source of carbon dioxide - CO2 - emissions per unit of energy) implies that the production-environment trade off has to be investigated and structurally incorporated into analysis.
One implication may be that lower carbon dioxide emission levels - the main driver of global warming - may be due to a more efficient utilization of energy sources, but also to a shift to a massive usage of renewable hydro, solar and wind power, and to a drastic cut on per capita and per unit of economic output energy use, that is through a really transformative Green mode of production (coupled with increasing resilience and biodiversity preservation), with a lower intensity of resource use (Taylor, 2009). Adopting the so called "planetary boundaries" analysis, nine Earth-system processes must be included:

(1) climate change,
(2) rate of biodiversity loss,
(3) interference with the nitrogen and phosphorous cycles,
(4) stratospheric ozone depletion,
(5) ocean acidification,
(6) global freshwater use,
(7) change in land use,
(8) chemical pollution, and
(9) atmospheric aerosol loading (Griggs et al., 2013).

If the neoclassical idea to accept the Say's Law, which states that supply creates its own demand, is wrong and the Post-Keynesian Kaldor-Thirlwall growth model of effective aggregate demand is correct (i.e., the increase of investment is an injections of new demand for goods and services into the circular flow of income stimulating further rounds of spending - a multiplier effect - and this accelerates capital accumulation), then it is not true that from higher marginal productivity we can automatically earn more output or product (Y), which determines more sell and more export, that is a solution or vent for surplus (products are paid for with products and "general gluts or excess cannot exist").
What really occurs is quite the opposite: the so called Thirlwall's Law (1979) says that output growth depends on sell and trade (i.e. on effective demand) and Verdoorn's Law (1949) says that growth in output increases productivity due to increasing returns. This is the basic idea of the so called cumulative causation models of growth, in which demand (and structural change) rather than supply leads the pace of accumulation (Thirlwall, 2006). Therefore, a key question is: what type of demand has to be encouraged to promote long-term development and not just short-term economic growth?
A broader view of productivity and production should imply the importance of cultural values, beliefs and attitudes that motivate citizens behaviors (including when they behave like savers and consumers) to pay attention to environmental sustainability, social mobility, economic redistribution, political empowerment

and agency of the most vulnerable groups (according to which individuals and groups should decide what matters for themselves as active participants in change, rather than passive recipients of aid: D. Crocker and I. Robeyns, 2009). Governments and public policy can do many things to orient society, State, market and the agents (by introducing sanctions, incentives and rules) and to disseminate and promote a culture of sustainability and solidarity, in order to raise a sustainable productivity-led rather than just productivity-led perspective.
If the above mentioned assumptions hold true, we should move from the idea of productivity as the key engine to more output (and lower prices) to productivity as a measure of the complex and nested developmental process of production, considering the various inputs and the specific context (at least in terms of market integration, geography, political and institutional dimensions) as part of the residual. This idea has direct implications on both macro and micro levels, leading to dethronization of efficiency from the economic development throne.

Fig. 3 - The sustainable causal diagram expected to promote development through GDP



The dethronization argument presented here can remind the reader somewhat similar to the words used some twenty years ago by Paul Krugman (1994) against the rhetoric and obsession of competitiveness diffused by Michael Porter (1990) and Lester Thurow (1993), according to which to maintain or increase the standard of living a country has to learn to compete in an ever tougher world marketplace and high productivity, product quality have become essential and the high-value sectors are those that will generate jobs for the future: "The only meaningful concept of competitiveness at the national level is national productivity" and "A new theory must move beyond comparative advantage to

the competitive advantage" (Porter, 1990). Krugman reacted by saying that "competitiveness would turn out to be a funny way to saying “productivity” and would have nothing to do with international competition" (Krugman, 1994). Here, our attempt is to demystify economic productivity conceptually.
As Krugman once said, "productivity isn’t everything, but in the long run it is almost everything" (Krugman, 1990). In practice, the limitation encountered in the definition and conceptualization of productivity is coupled with measurement difficulties.
We can briefly summarize some points, considering that output growth accounting by definition is decomposed into its sources: changes of quantity as well as of productivity of labor, capital, and the residual (the TFP or MFP dynamics). And as the same holds true for many basic economic concepts, both productivity growth and productivity levels (that is, the value of output per hour worked, in case of labor productivity) are important.

3. Debatable and debated points on partial and total productivity

Product is a key concept, but it is extremely difficult to define it and agree upon. It can be a service or a good, in physical or in a virtual form, based on different production technologies. As well, productivity is a key concept, causally linked to product and difficult to measure.
Technically, there are different components, factors, resources or inputs, to be considered as determinants of final product, and their productivity is determined by the available know-how and a complex interaction of key ingredients for converting resources into outputs.
Such a multifactor productivity is commonly estimated using growth accounting. In mainstream economics, labor and capital are the key inputs, intermediate products are the outputs and the multifactor or total factor productivity is the measure to assess the residual output growth that cannot be explained by the rate of change in the key inputs.

(i) Labor productivity

At aggregate level, the first productivity component to be considered is labor productivity, which is often called productivity and equals the output per worker (Y/L). It is (or should be) measured by dividing output by the total number of hours worked in a year by all the employees. In such a way, productivity is conceived as the amount of output produced by the average work (the unit input) or the efficiency and intensity with which resources (labor in this case)

are utilized. As the output is a proxy of the effectiveness of the results achieved in terms of quantity of market value of goods and services produced in a given period, then labor productivity (Y/L) can be perceived as the arithmetic ratio between the effectiveness (Y) and the resources utilized (L), that is the level of performance or efficiency reached by using the given amount of resources.
A key concept in economic theory is the extra value of output (Y) that is generated by employing one more unit of labor (L); this concept is known as the marginal product of labor, and its value is obtained by multiplying the marginal product of labor by the price per unit of output (P). The general rule is that a profit-maximizing price-taking producer employs each factor of production up to the point at which the value of the marginal product of the last unit of the factor employed - even if we should know that there is heterogeneity among workers - is equal to that factor's price (Krugman, Wells, 2013).
If the price of the good that is produced with labor changes, then the value of the marginal product of labor - that is a linked but different concept from marginal productivity - changes as well: when the price of strawberries grown in Burkina Faso increases, then the value of the marginal product of agricultural labor in Burkina Faso rises at any given level of employment and this increase implies that the profit-maximizing level of employment rises when agricultural wage rate remains unchanged. As a consequence, increased value of the labor productivity may be translated into more profits or fewer hours worked (more unemployment, in case of lower production of strawberries to get the same output value) and not necessarily into increased wages for workers (that is labor cost, by considering that in a perfectly competitive economy each worker - and not only the last worker - should be paid its equilibrium value of the marginal product). And the same thing happens to an increase of cultivated land: each worker produces more strawberries as each one has more land to cultivate and the value of the marginal product of labor rises at any given level of employment. However, the latter increase of the value of marginal productivity should be attributed to land rather than labor, as the value of the additional output will be generated by employing an additional unit of land. Here one should also consider the issue of environmental degradation and resource depletion as a concrete trade-off between more quantity of output and worse quality of environment. But, in terms of single factor productivity, the key element to measure is whether a change of output (ideally, an improvement of quality and quantity at the same time) per labor hour, output per single machine, or output per unit of land occurs.
In theory and practice, we know that non-marketed (or non-traded) goods and services, which do not go through a market, are not counted as part of GDP (or GNP or GNI), even if they can be a significant part of what is produced and consumed by the given country's total population. Moreover, most of those working on the land in poor countries are either subsistence farmers (producing only for themselves), tenant farmers (with no land rights and no incentive to

increase output), or landless laborers (selling their labor in a daily labor market). As a consequence, much of what is produced is never be counted as part of output if one follows the rule and labor productivity is inferred from limited historical information available to help evaluate labor performance.

Even more so, much of what is called labor compensation (such as wages) is really a return on human capital, so that the distinction between labor and human capital is rather fuzzy; huge wage differences among men and women or ethnic groups don't reflect real differences in marginal productivity and if these differences arise from differences in human capital they are not necessarily fair, as they simply reflect different opportunities, capabilities, contextual environments.

We should also take into account that developmental implications of increased or decreased labor productivity are not obvious, even if we don't consider the broad notion of sustainable development. Labor productivity can increase by reducing labor cost. But if real wages are neither determined by the level of the marginal productivity of labor (neoclassical assumption) nor by the technology of production and if labor and capital remuneration as well as their productivity are inseparable and determined by a political conflict, then the reduction of labor cost is not necessarily an objective to be reached.

This is particularly true in a context in which income and wealth unequal distribution has worsened and polarized between and within most countries. As output per capita equals productivity times hours per capita, if output increases with workers who work fewer hours, then labor productivity rises more rapidly than output, but an hour not worked because of longer vacations or a shorter work week has different developmental implication from an hour not worked because higher unemployment or lower labor-force participation (Fitoussi ed., 2013). The entry of females and of marginalized groups (such as migrants) into the labor force can induce an increase of output per capita faster than productivity, but it does not automatically create the same developmental effect as the entry of children of forced labor into the labor force, even if the effect on output per capita and on productivity may be the same. The assumption according to which the various factors of production are viewed in the abstract as homogeneous entities is a serious pitfall.

In the light of the classical-Marxian theory of value and surplus value in the exploitation of productive labor (Foley, 2013), as well as of the need to re-conceptualize productive labor in terms of environmentally sustainable productive labor, the quality and quantity of jobs is the key factor to be considered and assessed:

i. to create decent jobs and improve the quality of existing jobs in line with the pillars of the decent work agenda (that is to guarantee access to full and productive employment with rights at work, social protection and the promotion of social dialogue),
ii. to bring inequality down to nationally and internationally defined

levels (that is to reduce the widening gap between the top class and the most vulnerable groups - women, but also migrants and refugees, small-holder farmers, ethnic and national minorities, indigenous peoples, children and young people, elderly persons, disabled persons - by transferring income, wealth and power),

iii. to promote structural transformation of the economy and enabling business environment (by supporting an economic, business and political empowering process to enable the most vulnerable people's active involvement in self-determined development of their lives and environment),

iv. to end all forms of legal discrimination against women and girls and improve their economic and social opportunities (by prioritizing gender equality and women's rights to land, property, inheritance and control of natural resources and business activities).

v. to develop a society in harmony with nature, shifting from a merely environmental approach to one that is genuinely ecological (Kovel, 2007), avoiding a narrow economistic interpretation of environmental resources or inputs and talking in terms of ecosystems conservation.

(ii) Capital productivity

The second single factor to be considered is capital productivity. Capital is often conceived in its narrow sense of as the sum total of non-human assets that can be owned and exchanged on some markets: all forms of real property (including residential real estate) as well as financial assets (including bank accounts, mutual funds, bonds, stocks, financial investments of all kinds) and non-financial assets (land, dwellings, buildings, machinery, plants, infrastructure, patents, and other directly owned professional assets), physical and immaterial, used by firms and government agencies.

Capital is also conceived as an input into the production process that in the past was an output from the production process (a produced factor of production). It is defined as the stock of equipment and structures that are used to produce final goods and services (physical capital), the knowledge and skills that workers acquire through education, training, and experience (human capital, that is an individual's labor power, skills, training, and abilities) and renewable and non-renewable environmental resources used in production that are provided by nature, such as land, rivers and mineral deposits (natural capital, by using a narrow economistic interpretation of environmental resources or inputs).

In practice, if land per person dominated income determination before the XIX century, land rents have fallen to a minimum share of total output in modern OECD economies (Clark, 2007), so that natural resources are not considered anymore necessary per se for an economy to be highly productive in producing

goods and services, whereas technological knowledge is the understanding of the best ways to produce goods and services (and this understanding is transmitted to the labor force through human capital). Moreover, it is difficult to distinguish between the value of virgin land and the value of improvements due to human intervention or between the value of dwellings and the value of the land on which they are built. Thereafter the concrete and practical measurement of factor productivity is rather difficult at both micro and macro levels.

Post-Keynesians and neoclassical economists share the view according to which growth is basically driven by capital investment, but the former considers investment endogenous to aggregate demand and assume that growth may itself generate forces making for oscillation.

In particular, at the end of the 1930s Roy Harrod defined the Incremental capital-output ratio (ICOR) as the reciprocal of the marginal productivity of capital (the output-capital or output-investment ratio). The higher the ICOR, that is the higher the amount of capital required to produce a single unit of output in the economy (K/Y or $\Delta K/\Delta Y$) the lower the productivity of capital, so that the ICOR can be thought of as a measure of the inefficiency with which capital is used (Harrod, 1939).

Following the Harrod model, which assumes no substitution between labor and capital and also shows constant returns to scale, the rate of growth of GDP ($\Delta Y/Y$) is determined jointly by the national saving ratio (s) and the national capital-output ratio: the more an economy save and invest out of a given GDP, the greater the growth of that GDP will be. By multiplying the rate of new investments (I/Y) by its productivity, the rate by which national income will increase is obtained. The demand for investment is given by the accelerator principle, that is the required amount of extra capital (or investment) to produce a unit flow of output at a given rate of interest, determined by technological conditions. This model has both descriptive and prescriptive value and this is why it is a topic still and widely discussed and cited in economic growth and economic development theory, even if this early Post-Keynesian model was replaced by new generations of growth models such as those presented in Fig. 2.

Some examples include the widely cited estimates of a $50 billion need in additional annual aid to meet the Millennium Development Goals (MDGs), which were largely based on two studies, one by a group known as the Ernesto Zedillo Commission (Zedillo Commission, 2001) and another by Shanta Devarajan and his co-authors at the World Bank (Devarajan, Miller and Swanson, 2002). They were both based on another study (UNCTAD, 2000), which adopted the Harrod model by assuming that, if capital flows were to somehow be sufficient to raise investment to 22 percent of GDP in Sub-Saharan Africa, real GDP growth in that region would necessarily be 6 percent per year. Based on some simplistic assumptions, without any empirical support, such as that in Africa all aid becomes investment and all investment becomes growth, this model estimated roughly a $10 billion capital 'need' for Africa, which the Zedillo report simply

doubled to account for other developing regions and then, it settled on $30 billion for the rest of the goals, for a total of $50 billion, and used this final figure throughout its text.

Jeffrey Sachs and the UN Millennium Development Project also anchored the MDG framework to the need of increasing investment in development, by assuming that the poorest countries save too little to achieve economic growth, and aid is too low to compensate for the low domestic saving rates. Detailed data on actual saving, investment, aid, and growth rates differ greatly by region and by income level, but the authors presented a report with specific policy recommendations, which were based on the adoption of the Harrod model (UN Millennium Project, 2005).

In general, the capital coefficient in the process of economic growth has been the pivotal parameter. A fundamental property of the aggregate production function is that there are diminishing returns to the accumulation of capital. Given the ceteris paribus assumption, that is holding all other factors of production constant, in general an additional unit of capital has difficulty in "cooperating" with the other inputs. For example, the use of inorganic or synthetic fertilizer improves crop production on farms, but if one continues to equip farmers with more and more of the same fertilizer without adopting new uses for it, then a point will be reached where the extra-capital goods become redundant and additional fertilizer improves the yield less per unit of fertilizer (the marginal product of capital is negligible), and excessive quantities can even reduce the yield, so that fertilizer pollution should be treated as an environmentally detrimental input. In formalized terms, the marginal product of capital is decreasing in the stock of capital: $F'(K) > 0$ and $F''(K) < 0$ for all K (Aghion and Howitt, 1998).

Overall, excessive quantities of fertilizer tend to be negative particularly in the long-run, so that one should also take into account the discrepancy between the (positive) short-term effects of capital on output and the (negative) effects in the long run.

One should also consider the law of diminishing marginal utility, meaning that the first unit of consumption of a good or service such as a strawberry yields more utility than the second and subsequent units, with a continuing reduction for greater amounts. Both diminishing (marginal) returns and diminishing (marginal) utility of capital are expected to be taken into account in planning development strategies.

At the same time, costs of capital projects are known to be subject to economies of scale: the cost of a unit of capacity of many types of equipment, such as electric motors, pumps and gasoline engines, decreases as size increases; therefore, also the efficiency increases with size, leading to lower variable cost as well, because cost per unit of output generally decrease with increasing scale as fixed costs are spread out over more units of output.

From a demand side perspective, also positive network externalities are

becoming more and more important, in the case of network technologies, such as the sitting of mobile phone masts: the more masts are installed and the more valuable the masts already installed are, as the value of the technology is determined by the dimension of the network, by creating a so called bandwagon effect among the customers.
A comprehensive understanding of the complex and dynamic interaction across diminishing (marginal) returns, diminishing (marginal) utility, economies of scale and positive network externalities is judged as a pre-requisite for analyzing capital productivity.
Moreover, one should also consider the effect of an increase of all inputs and not only of capital in the long run. In mainstream micro-economics, the long-run returns to scale are purely technologically imposed and are not influenced by economic decisions or by market conditions. This is why a firm's production function could exhibit different types of returns to scale in different ranges of output at different stages of development: there could be increasing returns (with output increasing by more than that proportional change in inputs) at relatively low output levels, decreasing returns (with output increasing by less than that proportional change in inputs) at relatively high output levels, and constant returns at one output level between those ranges.
In general, the mainstream economics' assumptions – according to which financial and real capital are identical, the return to the first is the return to the second, all resources are fully employed and the economy is on its production possibility frontier – are not realistic hypotheses. From a Marxian perspective, the neoclassical idea of capital as an agglomeration of physical objects has to be rejected in favor of the theory of capital as the means of control of the means of production, the dominant class power and authority to extract surplus from the worker class, that is to make decisions.
From this point of view, capital is conceived by Marx as a social, political, and legal category, rather than a physical or financial one. However, the confusing neoclassical view is still dominant and the famous economist Thomas Piketty persists in such a neoclassical approach to capital, too. As emphasized by James Galbraith, in his book entitled "Capital in the Twenty-First Century" Piketty adopts a financial measurement and valuation of capital rather than physical quantity. He measures physical capital equipment with all forms of money-valued wealth, excluding human capital, and estimates the market value of that wealth, so that he still repeats the neoclassical fallacy - made clear by the Cambridge critique in the 1960s - to deploy an empirical measure to calculate a capital input in the growth model that is unrelated to productive physical capital and is based on the assumption that a the technological return on capital, depending on its marginal productivity, has usually averaged a certain value (Galbraith, 2014).
At aggregate level, more than fifty years ago Simon Kuznets analyzed the proportions of gross capital formation to GDP (K/Y). He found that such a

marginal ratio of K/Y registers a sequential evolution, passing through an initial stage of low level, a second stage of rapid increase, and a final maturity stage with an intermediate level (Kuznets, 1961). Interpretations abounded: the common view is that K/Y declines with the transformation of productive structure (that is with sector with a lower K/Y ratio that gain weight) and when the economy moves to the more efficient threshold or take-off stage, but then declines after having reached high efficiency, in the maturity stage, when scale economies are fully exploited and product reaches market saturation.

(iii) Technological progress (and TFP in general)

A third crucial component, additional to labor and capital (which absorbs environmental inputs as well), is technological progress, which means more output produced from the same level of K (including natural capital and energy) and L inputs. Following mainstream theory, we can measure technological progress indirectly by observing increases in capital, labor, and output; that is, through the residual, which can be conceived as a measure of technological progress, but also of the role of externalities, the change in sectoral composition of production and so on.
A reductionist view on that "something else", which is commonly considered as the most important factor in explaining GDP growth (much more than diminishing returns, factor accumulation, and constant returns to scale), emphasizes the role of technological progress as the key component of that "something else".
Recent growth-accounting analyses consider the Information and Communication Technology (ICT, that is technology linked to Computers and Internet) as the main source of the OECD productivity growth. According to a Schumpeterian view, ICT applications have been characterized by high growth of patenting activity, high rate of entry of new innovators, high concentration of technological activity across firms, a diversified knowledge base in terms of technological domains and actors involved (Corrocher et al, 2007).
Innovation and the exploitation of inventions are crucial for economic growth and for catching up, as the technological frontier provides developing countries with technologies that should be copied.
Automation and digitization are directly contributing to the diffusion of part-time and temporary jobs, with an increasingly mobile workforce around the world, and to a decrease in jobs by replacing some types of work (the so-called gig economy). This may also question the idea that a society is built on the concept of employment, pushing us to think about a future with new forms of work (not necessarily paid jobs). Some people may think that such a scenario might even lead to development and a better life for all; but the key question always remains the same: is this an agenda for action to start delivering on the

promise 'to leave no one behind', that is what about the lives of the poorest and most discriminated?

However technology as well as capital and labor is not homogenous in terms of quality. For example, short-lived capital goods like PC have much faster depreciation rates than long-lived capital goods like structures. Therefore, they earn higher profits per dollar of investment and, as a consequence, it should be better to give more weight to short-lived capital, as recommended by Jorgenson and his colleagues (Jorgenson, 2008).

Technology is rarely neutral in terms of implications on other inputs: productivity impact of computers tends to involve a substitution of capital for labor. The problem of potential non neutrality of technology might be undermined by changing business models associated with the use of new technologies, in terms of imposing some conditionalities of sustainable process of production (in terms of productive, decent, inclusive and sustainable jobs, conducive to political transformation), but in practice it is extremely unlikely.

A puzzle in the growth accounting derives from the fact that the marginal productivity is assumed while holding other inputs constant in quantity (and quality): in practice, this assumption is not realistic, as the marginal productivity of an input depends on how much of the other inputs are used. In other terms, the marginal productivity generally depends on all the inputs, that depend on changes in other inputs. We should thus consider contextual conditions as well, given the importance of holistic and nested view.

For example, labor productivity and work hours are inseparable: what makes labor more expensive reduces also the demand for labor. In theory, as if we had gender equality, workers who lose their jobs are presumed to be those who are least productive and those who are not fired are more productive, and so average labor productivity is artificially raised. The shrinking demand for labor may be accompanied by a rapid increase in the capital-labor ratio, as the rise in the cost of labor created an incentive to substitute capital for labor.

But also the assumption of labor and capital productivity occurring independently of innovation and context does not hold. Rather, the various sources of growth accounting are complementary and not mutually exclusive (Fitoussi ed., 2013).

From this perspective, there is nothing new in it: Kaldor stressed that capital accumulation and technical progress go together, as most technical progress requires capital accumulation for its embodiment and new capital accumulation depends on more technical progress (Thirlwall, 2003).

One should also split the quantity and quality of different inputs (and context): the level of skilled labor, the quality of raw materials, intermediate products, but also other inputs (land, water, energy, infrastructure, technology…) and context.

It is difficult to separate the contribution of factor inputs to growth from the contribution of increases in output per unit of inputs (increases in TFP) and there are other factors (such as economies of scale) which are due both to

technical change and to increases in factor supplies.
It is also difficult to distinguish between some factors that may contribute to increases in the productivity of factors, such as education, improvement in the quality of capital and economies of scale.
Basic principles of mainstream economic theory say that increases in factor supplies, increasing returns (technological economies of scale, with which output rises more than proportionately to the increased in combined inputs), and technical progress (anything that increases the productivity of factors other than increasing returns) are three broad sources of growth. Technical progress is also artificially divided into exogenous (not dependent on capital accumulation) and endogenous (introduced by new investment).
Traditionally, technical change was viewed as factor-neutral. For example, Robert Solow - as well as the pioneering Roy Harrod - defined TFP advancement as an increase in output without changing marginal rates of transformations for L and K inputs (Solow, 1957). In practice, the proportion of K/L is constant after technology progress is realized, but technology progress can also be seen as transformation of production function: it is capital-saving when the proportion of K/L is lower after technology progress is realized to produce a given output level under the same factor price vector; it is labor-saving when the proportion of K/L is higher than before.
In theory, as stressed by Nicholas Kaldor, a higher K/L ratio will not automatically lead to higher unemployment rates (with negative impacts on later wages), if higher output growth brought about by technological progress embodied in new capital investments generates greater employment opportunities (Kaldor, 1960). In practice, the idea that the higher the rate of capital investment, the greater will be technological progress, which in turn will lead to higher aggregate output growth, resulting in additional demand for labor, has to be empirically verified.
Ranald Taylor found that unemployment rates declined significantly in Malaysia when the country switched from a labor-intensive production technique to a capital-intensive and labor-saving one, because the addition of new capital equipment to the existing stock of equipment accelerated technical progress, which in turn induced higher labor productivity, resulting in increases in demand (in terms of higher quality and lower prices), and drove production and employment upwards (Taylor, 2004). This means that new technical changes made in terms of improved technology can be embodied in investment (the so called embodied technological progress), but it is also possible that improved technology, which allows increase in the output, is produced from given inputs without investing in new equipment. Hence, technological progress may or may not be sufficient to generate additional employment growth; and this is also true in terms of total energy consumption, use of resources and environmental impact in general.
To sum up, conceptually growth accounting is a straightforward decomposition,

and it has given rise to a large literature. But one has to be very careful in interpreting such decompositions because accumulation and productivity growth are themselves endogenous. The relationship is expressed with a questionable economy-wide production function, with the residual factor that should captures the technical efficiency level of the economy due to unmeasured inputs or human capital (the stock of knowledge and expertise measured through education and Research and Development) and inducing factor productivity increases, that is output growth not due to inputs increases - efficiency or quality combination and use of inputs rather than quantity of inputs -, or a measure of allocative efficiency with which resource are distributed, economies of scale.

4. The importance of context

It is impossible to measure and aggregate heterogeneous capital goods in physical units. In practice, aggregate models are rough tools.
As a consequence, almost all the key terms of current glossary of development studies can be placed on the intersections of the three sets representing the developmental objectives areas (economic, social and environmental ones), with the afore-mentioned risk to have the night in which all cows are black: what dimension comes first in the conundrum of these multiple capital puzzles to promote development?
Contexts shape values and opportunities, whereas autonomy is an individual capability (feasible to be exercised). Capability is determined by three main factors: entitlements (= access to resources), agency (=competences and pro-active and empowered participation) and multilevel structural contexts, which are to be studied individually and in interaction.
We can identify four contextual dimensions of interest at least: geography, market integration, institutions and political context. They are the inescapable and interrelated prerequisites influencing the attainment of the three interlocked goals via various ways.
Geography (and climate) relates to the advantages and disadvantages posed by a zone or country's physical location (latitude, proximity to navigable waters, climate, presence of important disease vectors, and so on). To recognize geography as determining the limits of economic growth is not a new phenomenon: classical economists did it. More recently, Jared Diamond explained how climate differences, geographical advantages and economies of scale have long played a powerful role in the differences in worldwide income (Diamond, 1998). Disease environments and agricultural productivity are directly dependent on geographic conditions: only three tropical economies –

Hong Kong, Singapore, and Taiwan – are classified as high-income by the World Bank, while all countries within regions zoned as temperate had either middle- or high-income economies. Geography is also the only exogenous contextual factor, not co-evolving with economic performance, influencing growth. However, the interaction between geography, labor and technology abound: when population is very small and there is a lot of fertile land for each person to work with, new technology is not required and used as it does not take advantage of the abundant factor. Geography matters a lot for identifying investment needs; however, any attempt to apply general rules of thumb, despite the relevance of heterogeneity across cases and countries, risk to be counterproductive.

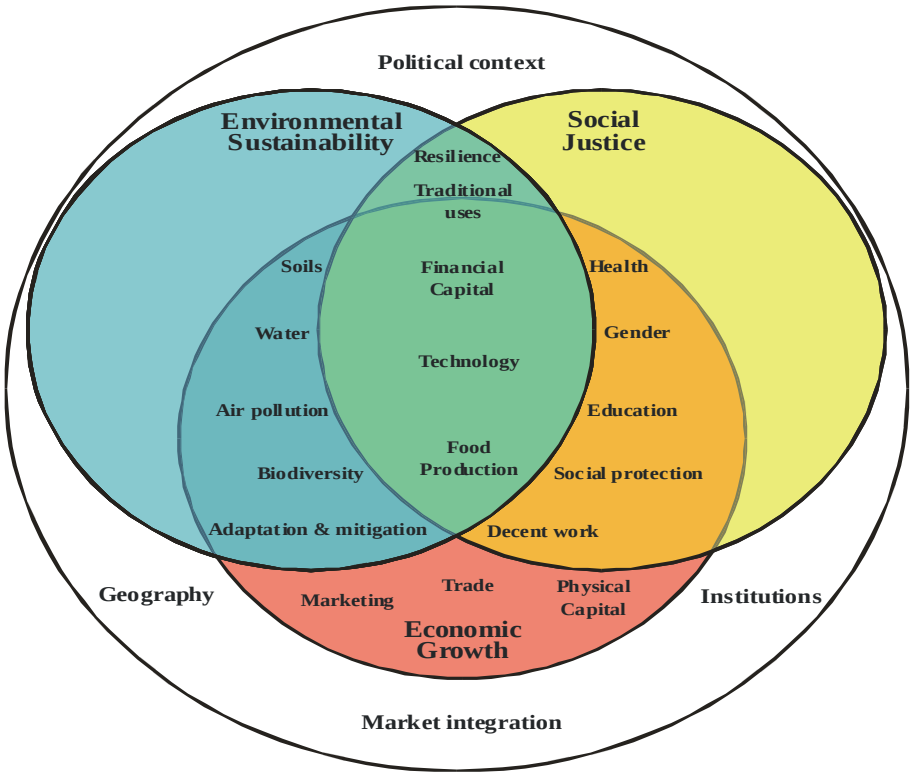
Institutions refer to the quality of formal and informal socio-political arrangements – ranging from the legal system (including the extent of legal protection of property and how well such laws are enforced) to broader political institutions (including the limits placed on political leaders) – that play an important role in promoting or hindering economic performance. Almost fifteen years ago, Daron Acemoglu, Simon Johnson and James Robinson reacted to geography determinism, by arguing that geography affected growth in a indirect way, through institutions, which play a crucial role: countries in which the European settlers faced greater mortality are the countries in which they chose not to settle and adopted extractive institution, whereas when colonizers could adapt to local climate and geography, they chose to settle and adopted good rule of law and institutions created during the colonization period persist after independence (Acemoglu, Johnson, Robinson, 2001). Following a Post-Keynesian view, institutions develop as a result of a specific cultural framework, that is, social experience and social norms, and by local characteristics, so that institutions should be conceived as a path-dependent process that necessitates readjusting existing institutions to the changing economic framework since institutions are both outgrows and reinforcers of routinised thought, and they impose form and consistency on the activities of human beings (Hodgson, 1993).

Market integration relates to market size, and the benefits (as well as costs) of participation in international trade in goods, services, capital, and possibly labor. This is another channel by which a specific type of institution (the linking of capital, labor, and goods markets within wider markets) can change the dynamics and behavior of required investment: the promotion of economic integration as well as market concentration could orient investors towards different strategies. The study of the economics of international trade in agricultural and food products, under imperfect competitive setting dominated by multinational corporations and agribusiness, is perhaps one of the biggest challenges facing agricultural investment in developing countries and demanding governmental interventions, but this topic would clearly require much more space than a short mention.

Political context refers to the conditions of (political and macroeconomic)

stability and absence of violence (revolutions, coups). Overall effects of political violence are much higher than just the direct capital destruction: the risk of civil war and violent conflicts, social and ethnic radical fractionalization are frequently associated with rough geographical terrain and have negative and direct effect on economic growth and institutions, mediated by democracy. Sub-Saharan Africa is highly affected by risk of civil war and experienced widening income differential relative to the rest of the world, and this is a disincentive to agricultural investment.

Fig. 4 - The conundrum of different areas of investment in the three pillars of sustainable development embedded in the four contextual dimensions



The importance of context makes the story more complex, also because small changes in the background environment (the planetary boundaries) can yield a significant increase in economic activity (Rodrik, 2007). And the linkages between the investment context and investment are many: for example, human and social capital can be conceived as the on-farm human elements that mediate how policy, institutions, but also technology and infrastructure affect input and physical capital use. Basically, the linkages are uncertain.

5. Some stylized facts and key question on productivity in agriculture

Trying to go beyond GDP is challenging and may be a frustrating task at the macro level, due to the lack of reliable data on regular basis and troubles unraveling variables' complex connections and causal links. Going beyond traditional productivity measures is even more difficult – by combining many dimensions embedded in the specific context – and it has attracted a much more limited interest, if not "no interest" we should say.
Nevertheless, its relevance as a prerequisite for going beyond GDP cannot be circumvented: the (developmental and multidimensional) output, alternative to GDP, depends on the process of conversion of inputs into such a multidimensional output, and identifying critical assumptions and causal links is crucial for specifying appropriate indicators to monitor and evaluate it.
Let us take productivity in agriculture as a practical example.
According to the UN statistics, in the coming years rural population will still represent the majority of the world population and will peak at around 3.2 billion by 2020. So far, increasing outputs have been achieved also by eroding genetic diversity: FAO estimated that 30 plant and 13 animal species provide 90% of our food.
Globally, we have about two billion malnourished people: one million of undernourished and a similar figure of over-nourished. While we struggle to yield more food, often with a negative impact on our ecosystems, almost one third of the total production is lost or wasted.
Given this contextual premise, a reduced version of agricultural productivity is found crucial across alternative theories of economic development. If we defined agricultural "productivity" not as dollar or cereal yield per acre of harvested land, but as the number of people fed (in a proper qualitative and quantitative way as food security and food safety) per that same area (employing vulnerable people on decent and equal conditions, and dynamic ecosystem conservation, including healthy soils, water and air), we would find that the US - the world's third largest agricultural producer - ranks behind the world average, because much goes to animals and biofuels and a capital intensive business model is dominant, with agrochemicals being responsible for the vast majority of the eco-toxicity of freshwater sources (with cotton alone accounting for 40% of the damage), according to a study released by UNEP (UNEP, 2010).
Conventional definitions of agricultural productivity measure the quantity of output relative to the quantity of inputs. Be they yields per hectare for individual crops, global data average productivity measures for land, labor or capital across all agricultural production provide strong evidence of a decline in agricultural productivity for the most recent twenty years. Moreover, productivity growth should be produced by minimising water loss (this is particularly true in developing countries, starting from North Africa and South Asia) and this

situation is likely to worsen as a result of climate change. Natural resource degradation interlinked to climate change accelerates the use/abuse of resources (in particular, demand for energy), while the food imports of developing countries will increase.

Investment on natural resources is considered vital to avoid a drastic fall of land productivity and to guarantee long-term sustainability of the mode of production (the well functioning of capital accumulation). At the same time, it is considered important to invest in the quality of human and social factors (and institutions) as a way to contribute to the increase of labor productivity (against diminishing returns on labor), by focusing on the empowerment of the most vulnerable groups.

Additional problems derive from the fact that the data on factor inputs is most readily available for the non-farm private business sector and Arthur Lewis's assumption of disguised unemployment labor is questionable (as informal sector has expanded), and the number of agriculture workers is not clear (due to the overwhelming role played by the informal sector). As mentioned before, land as a separate factor of production tends to be subsumed into capital, on the basis of the fact that the notion of land as a fixed factor of production (assumed true in the long run, not in the short-run in developing countries) and land without the application of capital is judged of little use, but the consequence is the adoption of an unrealistic homogeneity of capital.

Empirical evidence showed that high-productivity commercial agriculture is a small proportion of total agriculture activity in poor countries, and is unable to contribute to fight effectively against mass unemployment, growing inequality and to promote a sustainable and inclusive mode of production. Nevertheless, high-productivity commercial agriculture and increased agriculture production are quite often defined as specific targets of public policies. Agriculture is also defined as a diminishing returns activity: land is a fixed factor of production and the law of diminishing returns dominates (if a variable factor is added to a fixed factor its marginally product will fall). By adding labor to the land, the marginal product of labor first of all rises (because it requires a certain amount of labor for each unit of labor to work with maximum efficiency), but then declines and could become zero (or even negative).

Another stylized fact in economics is that the demand for most agricultural products and other primary products derived from the land is income inelastic. The rise in demand is proportionately less than the rise in income and less than the growth of supply potential determined by the growth of the labor force plus the growth of labor productivity.

Not surprisingly, if we observe African statistics, despite the impressive economic growth on the continent in general and Sub-Saharan Africa in particular, most of African people live in rural areas, agriculture is still a relevant part of GNI (on average it is 25.5 percent, compared to 3 percent of OCED) and agricultural income is relatively low compared to urban income. Thus

urbanization and migration are two main options: by 15 years the number of urbanized people will double and migration will increase. As a consequence of such shocking pressure, environmental degradation is increasing.
Producing food and increasing agricultural productivity is important but it is only part of the challenge. The struggle for food security and sustainable agriculture must address the disparities that often marginalize rural people – and especially smallholder households, women and rural workers– excluding them from national and even local political, economic, social and cultural developments.
If sustainable agriculture is to be the main way to preserve fertile soil, fresh water, biodiversity and preventing land degradation, desertification, mitigate climate change by preventing deforestation and reforestation, then this can be achieved only through the empowerment of rural people who can preserve the main basis of their livelihoods through climate resilient farming. The discussion on an innovative measurement of productivity should consider the necessity of including a computation of ecosystems' restoration and the provision of services. Local governance and common resources management depend on adaptation to local agro-ecological and social conditions.
If productivity must be sustainable, in agriculture emphasis should go on food (eco-) systems and labor, rather than merely on agricultural or production systems, because sustainability goes beyond the farming or production systems. Sustainability takes into consideration the whole value chain and implies a clearer focus on nutritional, public health, community development and cultural issues in order to achieve broader and longer-lasting results in development.
But the amount of output as well as of labor productivity, even if conceived in conventional terms, is not properly measured in small-holder agriculture. A key question is whether increased average labor productivity decreases agriculture jobs. The most frequent answer is yes, in the long run; no, in the short run if compensated by an expanding market. Therefore, two alternative scenarios can be associated to the integration into the global value chain or to an adherence to the so-called "Km. Zero" or "Farm-to-Table" movement, according to which consumers buy local products directly from the farmer's market, which means that food is produced, distributed and eaten in and around a very limited area.
The FAO estimates on cumulative gross investment requirements make no distinction and have been made without any direct respect to the potential source of the required capital. A clear definition, conceptualization and measurement of sustainable productivity in agriculture is not only a methodological issue, but it becomes also a key means to political and normative judgements.
A first important key question is the following:

A. More sustainable investment in agriculture for food production? By whom? And production of what (quantity and quality), for whom?

The premise may be to recognize that there is an international polarized debate, a matter of intense controversy with, at the opposite extremes:

i. those - including the agribusiness sector, many government agencies and private foundations, such as the Bill and Melinda Gates Foundation - who think that the answer is mainly (or uniquely) through the integration of poor agricultural economies into the world economy (through global value chains and links between TNCs and domestic producers);
ii. those - such as *Via Campesina* (an international movement of peasant organizations of small-scale producers, agricultural workers, rural women, and indigenous communities), but also International NGOs such as Oxfam (Oxfam, 2011) - who think that the only sustainable and fair solution is by reorienting economies toward a local ecosystem and family-farm-based sustainable agriculture and pastoralism, to encourage farming of plants, seeds and livestock characteristic of the local tradition, guaranteeing the right to produce food on one's own territory (food sovereignty).

FAO is not embracing just one of these views, and the same holds true for IFAD that has a strong propensity to consider smallholder agriculture development as the key core mission (IFAD, 2013). In any case, an important key question is to explore the implications (opportunities and threats) faced by small farmers in the context of a scenario dominated by the renewed interest in the global value chains.

The question of "more investment" itself has to be presented on the basis of a given framework based on a definition of sustainable productivity. As the FAO and IFAD have repeatedly declared, the volume of food production cannot explain the persistence of hunger, and it is important to combine three objectives associated to (more) agricultural investment for food production:

i. to reduce poverty and food insecurity (and the fact that poverty is changing geographical profile is relevant),
ii. to improve sustainability and resilience (and there is the risk that an increasing food production will worsen the problem if the mode of production is as always, that is "more of the same"),
iii. to increase productivity and growth in food-crop agriculture, but adopting a broader definition and conceptualization of productivity.

Another element to be considered is that FAO and IFAD are also recognizing that the question is not just to increase agricultural investment for food production, as "one of the first mean to fight imbalances and reduce tensions between the necessary increase in consumption and the challenging increase in production, but it is also to promote food loss reduction which alone has a considerable potential to increase the efficiency of the whole food chain. In a world with

limited natural resources (land, water, energy, fertilizer), and where cost-effective solutions are to be found to produce enough safe and nutritious food for all, reducing food losses should not be a forgotten priority as roughly one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. This inevitably also means that huge amounts of the resources used in food production are used in vain, and that the greenhouse gas emissions caused by production of food that gets lost or wasted are also emissions in vain" (FAO, 2011).
A correlated contextual element is to recognize that an accelerated change in the worldwide geography of poverty and development, together with the urgency of climate change challenges, pose the question of adequate investment strategy in the globalized world under such a new environment with direct consequences in terms of new market opportunities and threats and associated specific strengths and weaknesses for different developing countries.
Moreover, the jurisdictional and geographical coverage gap (as well as legitimate difference of interests) between the main agents of agricultural investment (multinational corporations, governments, domestic firms, households) implies the need to clarify this point, if we recognize the importance of different and conflictual interest among actors.
A sub-question related to the previous point is to explain what type of countries and within-country territorial systems are or can be integrated into high value market chains and what about the rest of the world (marginalized economies and marginal agricultural sectors in integrated economies).
Descending from and correlated to the previous key question is the fact that "agricultural investment for food production does not mean only investment going into agricultural production itself, but into a wide range of small and large scale activities along value chains that involve supplying farm inputs, and processing, storing, distributing, wholesaling, retailing and exporting farm products" (Hazell, Syed, Zupi, Miyazako, 2011). Therefore a correlated question is the following:

B. More sustainable investment by different agents for what type of capital accumulation into this range of value chain activities? And, consequently, where should FAO and IFAD, as well as other national and international organizations, public and private entities, place their focus?

The multi-faceted dimensions of capital means that capital accumulation may be focused on fixed or physical capital, financial capital, human capital, social capital, knowledge capital, institutional capital and, above all, natural capital.

By focusing in terms of investment results, that is food production (in terms of its quantity and quality), it is important to analyze, for a given type of investment:

C. What are the most appropriate business models (in terms of different arrangements involving large-scale and small-scale farmers into an international or national value chain: see L. Cotula and R. Leonard, 2010) to be encouraged in order to create the appropriate value chains, facilitate integration in local, national or world economy, stimulate sustainable productivity?

Corporate financial structure, technology and innovation, efficiency, labor and land implications (in terms of quality and quantity) affect core productivity measurement.
For what concerns the financial structure of firms' investment, based on a World Bank's survey conducted in 2008, UNCTAD (2009) showed that retained earnings, that is self-funding, is the main financial source for each type of firm (small-, medium- and big-sized) in every country, representing between 60 and 70 percent of total funding. This confirms what "Pecking order theory" (Myers 1984) says: there is a precise hierarchy according to a strategy of financial self-sufficiency. Companies prioritize their sources of financing (from internal financing to equity) according to the principle of least effort, preferring to raise equity as a financing means of last resort. Hence, internal funds are used first, and when that is depleted, debt is issued, and when it is not sensible to issue any more debt, equity is issued. Therefore, another key question to address agricultural productivity is:

D. What are the public policy conditions and reforms necessary to enhance farm-level savings and to mobilize (more and different types of) sustainable agricultural investment and encourage companies to be oriented towards sustainable productivity improvements?

In terms of favorable conditions, it is also important to analyze:

E. What are the institutional conditions and institutional reforms necessary to mobilize a trigger (more and different types of) sustainable agricultural investment?

Institutions mean procedural devices and regulatory frameworks, formal and informal rules governing human interactions: property rights and legally binding contracts, market-regulating institutions, institutions for macroeconomic stability, social insurance institutions and institutions of conflict management.
Another important contextual dimension to analyze is the following:

F. What type of market integration has to be considered as an essential prerequisite to earn the expected gains on sustainable food production by promoting (more and different types of) agricultural investment in the value chain?

And, in terms of favorable contextual conditions to create a competitive advantage that ultimately results in superior value creation, a question is:

G. Is it possible and relevant to classify different types of country's physical location or territories (latitude, proximity to navigable waters, climate, presence of important disease vectors, and so on) to be related to different recommendations?

This may be important against pretensions to have general rules to be always applied.
Finally, in terms of favorable contextual conditions to create a proper environment:

H. What about effectiveness of efforts launched to establish international principles for responsible investment in agriculture – such as the UNCTAD-FAO-IFAD-WB initiative (Principles for Responsible Agricultural Investment that Respects Rights, Livelihoods and Resources, now called the "RAI Principles"), the preparation of Voluntary Guidelines on the Responsible Governance of Tenure of Land and Other Natural Resources, led by FAO, IFAD in a broad partnership with member nations, civil society, and other United Nations agencies, the Santiago Principles adopted by SWFs to improve transparency, and the more general OECD guidelines for Multinational Enterprises – to enhance the benefits of FDI in agriculture while mitigating its potential downsides?

I. What is the practical ways to promote coherence and complementarity between sustainable agricultural investment by international and national private firms, farmers and public sector, and what are the key policy implications?

This is based on the assumption that "private sector investments along value chains are highly complementary to public and private investments made in agricultural production, often enhancing the returns to farmers' own on-farm investments and to public investments in agriculture, making both more attractive".
According to the Committee on World Food Security hosted by FAO, new interest in agro-investment has to match country food security strategies, minimize risks and maximize positive outcomes for local populations; therefore land and natural resource rights of local land users have to be protected and expanded. Public investment in agriculture and rural development, the quality of governance of land tenure (i.e. land tenure policy), the choice of incentive framework (including market and trade policy), together with the level of organization of local farmers in producer groups and cooperatives and the

degree of social responsibility of foreign investors can bring very different patterns of investment in the agricultural sector.
For all the above mentioned questions, the adoption of a more comprehensive measure of sustainable productivity may be essential to avoid an overproliferation of just rhetorical, vague, ambiguous and even contradictory requests for investment in agriculture.

6. Difficulties in measuring what we would like to measure

An appropriate definition and conceptualization of sustainable productivity is critical to address the next point concerning the adoption of a precise set of measures, which are needed to translate the key idea into policy and operative terms.
The choice of measure depends certainly on the conceptualization, but not only that. By definition, measurement of "reality" is very difficult, perhaps impossible.
There are a lot of methodological and technical problems to consider in measuring social, economic, environmental, political and cultural phenomena, in addition to conceptual problems and to the scarcity of the information available.
Measurement of sustainable productivity is a core empirical challenge at both micro and macro levels, and it should be strictly linked to and reflect what the concept and measure of sustainable product implies.
Looked at from this point of view, there is a lesson to be learned from the GDP and beyond-GDP debate and measurement.
GDP (and GNI) is the most important evidence in debates on poor countries economic development and it has a strong political power. Measurement problems affect all countries, but there are particular problems of measuring GDP in poor countries: GDP growth estimates are misleading where informal economy prevails, because only parts of the economy are recorded. In particular some important sectors such as food production often remain unobserved and few individuals, households and farms record or report income, production and expenditure. For example, few African countries have recently conducted a household survey, some of them have never conducted it. Undoubtedly, as reliable statistics are crucial for improving knowledge and policy-making a new agenda for data development is needed (Jerven, 2013).
Developing countries face many challenges to improve data quality for achieving and monitoring sustainable development, as underlined by the UN Secretary-General's Independent Expert Advisory Group (IEAG) on a Data Revolution for Sustainable Development (IEAG, 2014). And the last decade has produced new ambitious demands, from poverty statistics to MDGs and now to a new generation of so called Sustainable Development Goals (SDGs) on weak statistical

offices in developing countries.
In general, the selection and adoption of development goals and targets should take into account (in practice, depend on) a set of existing and available indicators to diagnose the situation and measure the improvement. At any point in time and for any country the goals, targets and indicators are interrelated. Finally, the choice of goals and targets is determined and influenced by existing indicators, affected and being in turn affected by development priorities. If we do not consider the list of available indicators, then the risk is to have an interesting conceptualization of goals and targets that cannot be translated into indicators in a coherent way.
A new SDGs framework should be both simple and comprehensive at the same time. The MDGs, as well as GDP, have been a particularly attractive tool for development policies because of their inherent clarity and associated simplicity: clear about what one should try to achieve (a few social goals: fight against poverty and hunger, equal opportunity - with equality associated to gender issues - and human development in the MDGs case) and how it will be achieved (specific targets and put in place a monitoring system with measurable indicators).
The post-2015 SDGs should still be simple in terms of clarity (effective in communication), but comprehensive (combining three intertwined dimensions: social, environmental and political economic ones).
Viewed over such a perspective, it can be said that today the main objective of development policies must be clear and, in this sense, simple in a complex world of rapid transformations: poverty eradication, well-being and security for all people, communities and countries within the planetary boundaries as an effective slogan and a practical way to promote prosperity and well-being, and in particular to strengthen or empower individual and collective capabilities of the more vulnerable groups and, to this manner, be transformative; to enhance adaptive capacity and resilience of social-ecological systems.
As a consequence, we should recognize that development goals have to increase in complexity rather than in number: the world is not complicated - adding more and more goals, without giving any indication of their priority -, it is complex.
This means to reject the idea of an expansion of the goals area and correlated indicators for development cooperation and to insist on the importance of intertwined dimensions: environmental goals have to be clarified and detailed, but then translated into operative terms as cross-cutting issues.
At the same it is important to reduce the risk of overburdening weak statistical offices in developing countries. The over-proliferation of SDGs can become an unsustainable challenge to be accomplished, being very expensive in terms of time, finance, human resources, institutional capacity.
On the other hand, good indicators have to have several qualities, being an appropriate - rather than a misleading - measurement of the phenomenon under study based on reliable data, having a cost-efficiency ratio, yielding clear

interpretations and being relevant to the formulation of policies (Sachs, 1994).
We do not need to (re-)invent anything, just (re-) design goals. Based on the point 2, what was the idea of RIO MARKERS (expanded to include what, over the course of time, has been given more emphasis) is still convincing if we are able to transform them from a ritualistic to a substantial and cogent prerequisite to development. This can be a practical, simple and effective way to make the work on SDGs convergent with the review of the MDGs. At European level, we have a common framework and this implies Strategic environmental assessment (SEA), that is a "structured, rigorous, participative, open and transparent environmental impact assessment (EIA) based process, applied particularly to plans, programmes and projects": this can be a significant and cogent way to adopt a comprehensive approach to combine the three intertwined dimensions of development.
The combination of SDGs should not be conceived as a sum of different factors defined as uncorrelated components (the silo approach). There is a clear overlapping among interlinked factors: if we consider the geographical maps of conflicts, violence, extreme poverty, environmental vulnerability and degradation, hunger, institutional fragility, immediately we discover a strong overlapping in geographical terms. A holistic and integrated approach is the key paradigm to face the challenge of development in an effective way.
Definitely, food security and nutrition is a priority area of action. It combines local, national and global dimensions, territorial perspective, environmental priority, vulnerability, new dimensions of human security, gender and development, markets and states, focus on extreme poverty, inequality and decent jobs, sustainable consumption and production patterns (involving cultural aspects) and resource efficiency, food and energy prices volatility, mass migrations. The intertwined connection among many economic, social and environmental dimension is clear and also the complexity of development process and its specific political relevance.
Sustainable agriculture is a universal challenge. Water scarcity, over-nutrition and food waste imply that the Minority and the Majority worlds, and all the citizens (poor and rich) in a given country have mutual but differentiated responsibilities, which means goals and targets to accomplish.
Necessarily, sustainable agriculture has to be associated to health, education, children, gender (the main social dimensions of development, summarized within the framework of the MDGs), as well as to SDGs and to a more sustainable mode of production and consumption (linked to the urbanization process), that is a new economic development paradigm. This is the most critical world-wide challenge in an inter-generational perspective and based on the projected world population dynamics with a population expected to rise to 9.1 billion by 2050.
Considering the OWG-SDG proposed process of clustering objectives (crucial and welcome: it represents a critical enduring understanding of development), it is arguable: it seems to be responding more to a need of assigning separated

operating fields to the different institutions involved in discussing and developing the process rather than to the need of better clarifying (Depth of Knowledge - DOK - problem) the whole Millennium Goal architecture in terms of three intertwined and nested pillars (social, economic and environmental) for a unified framework (to promote transformative and sustainable political process of empowerment of the poor).
The weaknesses showed by the two processes above mentioned go back over some of the weaknesses of the setting up of the post MDGs discussion. The focus areas and targets articulation mix general goals (such as poverty eradication, equality, climate, above all, which can also be viewed as conditions without which the other main goals cannot be achieved), and means to achieve them (MoI, but also sustainable consumption and production, for example).
Unfortunately, the integration of sustainability and equality into the SDGs as well as into the consolidated MDGs structure still resembles more an addition of some questions rather than a real change of paradigm. The persistence of focus areas denominated economic growth, industrialization, energy and infrastructure (instead of sustainable human development affecting economic growth, sustainable industrialization, etc.) testifies that it is still conceivable that an unsustainable and unequal economic growth could be a progress for humanity.
The concrete risk is to lose an opportunity to make a really transformative and effective (in terms of empowerment of the poor) new post-2015 development agenda, addressing three dimensions of sustainable development – economic growth, social equality and environmental sustainability, with a more rapid move toward the low-carbon transition and inclusive development (New Climate Economy, 2016).
In such a perspective, it is useful an in–depth analysis and assessment of the SDGs indicators as well as various alternatives and complements to GDP that have been used successfully in various levels of planning and evaluation to measure progress and impact of public policies. In the EU context, reflection on the post-2020 cohesion policy framework has re-ignited the 'Beyond GDP' debate and a European Parliament's policy briefing provides a synthetic and updated review of current literature (European Parliament, 2016). In practice, Eurostat battery of indicators as well as national composite indicators, such as the Equitable and Sustainable Well-being (*Benessere equo e sostenibile*, BES) measurement in Italy, are useful tools to think about an innovative measurement of human wellbeing, looking at development in an effective multidimensional perspective. In the case of BES, that would mean choosing some indicators between the 134 that are proposed and that refer to 12 different sectors or domains of human well-being (ISTAT-CNEL, 2013), in order to individuate some possible indicators suitable for the measurement of the goals and targets and the impact evaluation of public policies that Italy would like to recommend.
In parallel with this 'Beyond GDP' debate, there are other areas of theoretical and measurement debates related to development. The Bejing Platform for Action

(PfA) adopted in 1995 clearly recognized gender equality as the main goal for achieving sustainable development and defined it as equal rights, opportunities and obligations of women and men. The challenge of proper women's empowerment measurement and indices is a concrete example of on-going debates on conceptualizing multi-dimensional issues, with different indices being proposed (M. Zupi, 2015).

7. Some general concluding remarks. A few leads and suggestions for measuring sustainable productivity

There is an urgent need for a change of approach where the measurement of (sustainable) production and correlated productivity is concerned. One cannot be expected to go beyond GDP without conceptualizing productivity beyond current definition.
The reality is that statistical indicators and measures are just imperfect attempts to translate into operative terms definitions and correlated conceptualizations, and both measures and definitions contribute to confusion (R. Lister, 2015).
On approaches to innovative productivity measurement, here, we are merely reporting some practical suggestions and ideas as possible sources of inspiration. Ideally, the requirements for this kind of measures are simple (G. Dijkstra, 2006): (i) a proper measurement should cover a limited number of indicators, but (ii) these indicators together should cover as many dimensions as possible; (iii) data should be available at micro and macro levels; (iv) it should be simple to calculate and to understand; (v) it should allow comparisons between firms and territories but also over time.
Above all, and this is very important, we are not starting from scratch.
In this respect, we can benefit from the interesting experience of innovative productivity measurement. Here, among other examples, the HDI, DEA and MuSIASEM provide us with some practical suggestions and ideas as possible sources of inspiration.

(i) Human development index

Human development index (HDI) is the first and key source of inspiration, because of its simplicity. HDI a composite index calculated based on three criteria of social- economic indices: Longevity, Educational attainment and Standard of living. Longevity is measured by life expectancy at birth. Educational attainment is the measured by mean of years of schooling for adults aged 25 years and more and expected years of schooling for children of school entering

age. Standard of living is measured by Gross national income (GNI) per capita and a non-linear transformation is applied – by using a logarithmically transformed variable – to take into account diminishing returns of higher incomes (utility adjustment) (UNDP, 2015).
The HDI is the geometric mean of normalized indices for each of the three dimensions, measuring achievements in each dimension. The adoption of the geometric mean as functional form provides indicators that are more discriminating and rewards balanced performance: countries cannot fully compensate for poor performance in one dimension by another. This is important if we conceive sustainable productivity as a nested concept, rather than additive and silo concept, because poor performance in any dimension (economic growth, social development, environmental sustainability) is directly reflected in the geometric mean. A low achievement in one dimension is not linearly compensated for by high achievement in another dimension, as the geometric mean reduces the level of substitutability between dimensions and at the same time ensures that a given percent decline in index of one dimension has the same impact on the index as the same percent decline in another dimension. Thus, as a basis for comparisons of achievements, this method is also more respectful of the intrinsic differences across the dimensions than a simple average.
Indices are calculated according to the general linear transformation:

$$index = (V - MINV)/(MAXV - MINV),$$

where V is the country's actual value for the specific indicator and MINV and MAXV are fixed minimum and maximum values, respectively, set for the indicator.
The HDI captures these basic dimensions of human development, not all the important dimensions of development, so that it is not a comprehensive measure of human development. It cannot provide a complete picture of human development and it has to be supplemented with other useful indicators in order to get a comprehensive view. Moreover, it shares all the limitations of composite measures.
From the perspective of human development, GNI is not the best measurement of real economic gains, but a traditional measure of economic growth is included as a key dimension of HDI. We can think of sustainable productivity in exactly the same way: departing from the standard approach to productivity measurement focusing solely on the amount of output produced by the unit inputs, the efficiency and intensity with which resources are utilized can be considered a component of a comprehensive measure of sustainable productivity. A more comprehensive measure cannot leave out important factors which are increasingly more important to sustainable development. A conventional measure of productivity does not reveal whether that output translates to better

human development outcomes in terms of social and environmental dimensions and cannot be considered as proper means for sustainable development. Therefore, the same approach as in the HDI can be used for sustainable productivity.
It is apparent that equity and sustainability raise complex and difficult questions and that the concept of human development is much wider and richer than what can be caught in the HDI. But the HDI is useful in focusing attention and simplifying the problem, by showing up the inadequacies of GNI (P. Streeten, 1995) and it can be considered the simplest and most suitable index to use for our purpose as well.

(ii) Data Envelopment Analysis

Data Envelopment Analysis (DEA) can offer some other ideas in support of a sustainable productivity direct measurement, by testing its development. DEA is a "data-oriented" approach and a technique of mathematical programming for evaluating the performance of a set of entities called decision-making units (DMUs) whose performance is categorized by multiple metrics. These performance metrics are classified as inputs and outputs under DEA, with DMUs that convert multiple inputs into multiple outputs, by assessing the relative efficiency of a number of entities using a common set of incommensurate inputs to generate a common set of incommensurate outputs (J. Zhu, 2016). From this point of view, DEA has a strong link to what we mean by "efficiency".
In particular, there is a particular kind of efficiency, referred to as "technical efficiency" in economics, on the basis of which a DMU is to be rated as fully efficient if and only if the performances of other DMUs does not show that some of its inputs or outputs can be improved without worsening some of its other inputs or outputs. This definition avoids the need for explicitly specifying the formal relations that are supposed to exist between inputs and outputs. It also avoids the need for recourse to assumptions of weights, which are selected a priori and are supposed to reflect the relative importance of the different inputs or outputs. Moreover, DEA is a methodology directed to frontiers rather than central tendencies and it proves particularly adept at uncovering relationships that would remain hidden from other methodologies. (W. W. Cooper, L. M. Seiford, and J. Zhu, 2011).
In practice, limiting our coverage to the first and basic model introduced in 1978 (A. Charnes, W. W. Cooper, E. Rhodes, 1978), one assumes that there are *n* DMUs to be evaluated and each DMU consumes varying amounts of *m* different inputs to produce s different outputs. We can interpret the basic DEA construction as the reduction of the multiple-output/multiple-input situation (for each DMU) to that of a single "virtual" output and "virtual" input, so that we can compare the ratio of outputs to inputs to measure the relative efficiency of each DMU. For a

particular DMU the ratio of this single virtual output to single virtual input provides a measure of efficiency that is a function of the multipliers. In mathematical programming terms, this ratio, which is to be maximized, forms the objective function for the particular DMU being evaluated and the efficiency of a DMU is measured relative to all (W. W. Cooper, L. M. Seiford, and J. Zhu, 2011).

(iii) Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism

What is known today as the Jevons Paradox simply means that an action taken to conserve resources (i.e. the economical use of fuel) reduces the cost of it to such an extent that entirely different kinds of environmental damage become affordable and new modes of economy will lead to an increase of consumption (i.e. the quantity of coal used will diminish in comparison with the yield, the profits will increase, so that the demand for it will increase). It suggests that efficiency, conservation and technological improvement, the very things urged by those concerned for future energy supplies, may actually worsen our energy prospects (John M. Polimeni, Kozo Mayumi, Mario Giampietro and Blake Alcott, 2008).

The same thing applies to doubt the environmental and social efficacy of the economic efficiency standards. Efficiency increases trigger some additional input consumption, known by the technical term rebound. Using innovative concepts derived from Complex Systems Theory, Mario Giampietro developed an innovative scientific approach called Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM) to integrate different narratives used in quantitative analysis. This approach makes it possible to generate quantitative representations of the viability and desirability of the metabolic pattern of modern societies using simultaneously technical, economic, demographic, social and ecological variables defined on different hierarchical levels and scales (M. Giampietro, 2003).

Originally developed for analyzing the metabolic pattern of energy, MuSIASEM was subsequently adopted as an integrated accounting method to analyze simultaneously the energy-food-water nexus (M. Giampietro et al., 2013).

In practice and differently from input /output analysis, the MuSIASEM approach defines the nature and the size of a given system in terms of flows (e.g., consumption and production of food, energy, water, money) in relation to fund elements (e.g., human beings, cropland, rivers), defined in both qualitative and quantitative terms. For example, the relation between water flow and human beings is qualitatively defined as drinking water (flow) for human beings (fund).

The approach involves the following six steps:

(i) definition of the socio-economic system as a set of functional compartments essential to guarantee its survival, reproduction and

adaptability;
(ii) selection of relevant fund elements and their quantification across the various functional compartments of the system;
(iii) definition and quantification of the various flows (included the losses) used by the selected fund elements associated with the various functional compartments at different levels;
(iv) description of the metabolic pattern across different hierarchical levels and dimensions (e.g. demographic, economic, biophysical dimensions) of analysis;
(v) definition of the internal constraints of sustainability (check of the viability and desirability domain for the metabolic pattern);
(vi) definition of the external constraints of sustainability (check of resource requirement and environmental loading).

The HDI, DEA and MuSIASEM can be some useful and interesting sources of inspiration.
But, based on the above, it is clear that the delivery of a proper measurement of sustainable productivity is far from easy.
One important reason is that a measurement which aims at being comprehensive and fully and detailed representative of the sophisticated and complex reality is likely to be ineffective, too abstract and unfeasible in practical terms. In other terms, there is a potential trade-off between being ambitiously comprehensive and being of little or no practical use (D. Rodrik, 2015).
Ideally, the overarching principles must be that of simplicity (a needed virtue), multi-dimensionality (a proper representation of the complex reality), data availability (the contextual constraint) at micro-level and macro-level, understandability, relevance, reliability and comparability across time and space.
All these principles show how difficult it is to have a practical and ambitious measurement to be translated into operative terms.
By definition, each and every measurement is powerful and useful if it is a stylized abstraction and simplification of the reality.
However, as long as current productivity and output indicators are inadequate to achieve a proper measure of sustainability, we cannot give up our principle of going beyond GDP, which we consider to be fundamental.
These criteria must be met for making planning, monitoring and evaluation feasible, even though we know that the effective capability to evaluate the impact of policies would be very difficult in any case, particularly when the complexity of multi-level and multi-dimensionality accounting is adopted.
At present, there is no perfect measure, but there is no doubt that current measures can and must be improved to reflect new views, principles and political priorities.
And if there were even merely a provocative preliminary proposal, a new trail to

follow, offering a starting point to advance the debate and open to critique, we should accept the challenge and pursue the quest for right and relevant paths. It is necessary, in such a context, to navigate across different alternatives and to figure out which one captures the most relevant features of the reality and principles that allow us to define targets, such as sustainability, and try to reconcile and close the gap between current indicators and ideal examples of measures that fit in with the ideas behind current political principles and priorities. In practice, there is no excuse for tardiness.

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