What is the quality of growth?
Sustainability and inclusiveness

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Abstract

The purpose of the paper is threefold. First, it follows the UN conceptual and measurement approach to provide a welfare theoretic framework to sustainability. The intergenerational condition for sustainable development involves shadow prices that are social marginal contributions to social welfare, allowing to determine inclusive wealth and to compare countries according to its variations over time.

Second, the inclusive wealth model can guide sustainable development policies provided that shadow prices can be estimated. They are not revealed by markets because of the many externalities that impinge upon inclusive wealth, not least the interactions between ecological and economic processes. To improve inclusive wealth, the structure of capital that composes it must be transformed through investments that capture the relevant externalities. Since investment projects are made by decentralized firms, they need the right incentives, which depend on the prospective structure of shadow prices along the expected future path of the economy. The measurement tools to promote inclusive wealth-friendly investments involve an overhaul in both national and business accounting as well as a deep change in corporate governance from shareholder value to inside and outside stakeholder participation.

Third, the main externality threatening sustainable development is climate change that is not substitutable to existing real assets that are part of social wealth. Climate change should be handled urgently via policies dedicated to both GHG reduction and adaptation. Clean investments concern all sectors of production; therefore incentives depend on carbon pricing and require massive reorientation of financing. The paper shows that an international agreement among countries on a notional price of carbon, applicable to new investments and differentiated according to the development needs of countries, can provide the right incentives. It should be complemented by a new financial intermediation with monetary backup to overcome the inability of financial markets to provide the huge amounts of credit needed to reorient the production system.

JEL: I31, O11, M41

Introduction

The world is grasped into a tri-dimensional crisis: financial, social and ecological. This lingering crisis teaches that the finance-led growth regime lasting since the early 1980's is worn-out. It is plagued by ever-widening inequalities in income, the huge rent levied by finance on the economy, the dearth of productive investment, the crumbling social systems and the degradation of ecosystems. The magnitude and persistence of the problems mean that the in-built mode of regulation of financialized capitalism is unable to correct the distortions in the market economy.

Shareholder value, efficient market hypothesis and "fair value" accounting are the principles that have made deep havoc in every part of the market economy. Shareholder value has given rise to extravagant concentration of wealth, has made the cost of capital prohibitive for many firms and has diverted profit from investing productively. The efficient market hypothesis, supposed to reveal objective fundamental values as a linchpin for market price adjustment, has been invalidated by the financial cycle, much studied by the BIS, which has led to the global financial crisis. Mark-to-market accounting has exacerbated ample and long financial cycles driven by momentum and interspersed by devastating financial crises, triggered by the reversal of debt-induced asset price bubbles. It ensues that a long-run view of the future of our economies needs to overhaul the basic principles underlying the failing mode of regulation.

It is now more and more accepted that the growth regime must be overhauled in the direction of inclusiveness and sustainability.

- ***Defining inclusiveness***

On a theoretical level any relevant and useful understanding of society cannot escape a definition of social welfare. If inclusiveness is a social end worth to be pursued, a social choice procedure must provide guidance to relevant policies. In democratic societies resting on market economies, welfare theorists might wish that social choice be based on individual preferences. However this endeavor is a dead end because it meets Arrow's impossibility theorem[1]. There is no non-arbitrary social choice procedure regarding minimal conditions of consistency in choices. This sweeping and very powerful achievement stems from the impossibility to aggregate heterogeneous individual preferences in any meaningful social welfare function. It is why neo-standard models in macro economy are dynamic stochastic general equilibrium models based upon a single representative agent. They ipso facto ignore distribution problems. It follows that neither absolute poverty nor relative inequalities can be considered in such a framework.

To overcome this dead end, equity must be defined in a way permitting interpersonal comparisons. One cannot trust majority vote to enact a fair rule of income sharing. It excludes underrepresented minorities, as much as the market excludes people with no access to money. One cannot be content with abstract and empty formula, like so-called "human rights" much praised by Western politicians. Individuals are embedded in civil society with multiple belongings. A collective expertise of social interdependencies, where economists shall have their say, is needed, However, to contribute valuably, economics must be thought as part of social sciences without any pretense to supremacy.

To deal with social welfare issues an ethical principle is impossible to bypass as a linchpin for social justice. For that matter John Rawls has set up a cardinal principle regarding the access to the basic resources of society: primary goods whose no one must be deprived of. It follows

[1] The theorem, its meaning and the substance of the demonstration can be read in K.Arrow, Social choices and individual values, NY, Wiley, 2°ed, 1963

that social development should be measured according to improvement in accessibility of primary goods amongst the most disadvantaged people. In this respect China has succeeded in raising 400 million people over the UN absolute poverty threshold in 30 years. Isn't it one of the highest achievement to human rights?

Rawls understands primary goods as a broad set of public resources: material, educational, institutional. They encompass the accessibility and quality of public health, primary education, basic civil rights and environmental goods, all of which are not market commodities. Therefore, in setting his principle of justice, Rawls asserts forcefully that equality between human beings worth to be pursued is far from being only formal[2]. It is a plain rejection of utilitarianism attached to *homo economicus*. Inequalities can be justified only if they help raise productivity in such way as to expand accessibility to primary goods. The market can contribute if it is embedded under development policies dedicated to that end.

Amartya Sen praises Rawls's huge achievement to social choice. However he points out that accessibility to primary goods is not the single impediment to that people meet in their attempt to elaborate and realize their life project. Sen develops the concept of "capabilities" and makes it fit for analyzing concrete inequalities. Capabilities are the real opportunities of choice people enjoy to transform their resources (including their access and assimilate the use of primary goods) into life achievements they have reason to value. He calls functioning these transformation capacities. The capability of a person is the range of functioning processes one can realize along one's life. It can be equated to one's real freedom[3].

Therefore the key concept of capability goes beyond Rawls's principle as far as policies aiming at inclusiveness are concerned. He emphasizes the conversion factors of primary goods into life achievements. Indeed equality in the space of primary goods cannot prevent *per se* serious social inequalities, all of which can be magnified by runaway market expansion. A few of them are evils of contemporaneous societies. Ethnical discriminations, gender discrimination in social roles, structural unemployment, power relationships in corporations and institutions, all are levers exploited in present-day capitalist societies. They help shaping labor markets so that real freedoms of many people are subordinated to the paramount objective of shareholder value: extracting maximal rent for the benefit of an elite whose outcome is the extravagant rise in income inequalities over 30 years.

- ***Defining sustainability***

Sustainability is an intergenerational concept. It is the conservation and possible improvement over time in social welfare defined above. A society cannot be sustainable if it is not inclusive. As we will see in the next section, sustainability cannot be measured by GDP paths.

Because it involves time, sustainability is intrinsically intertwined with finance. When one is evoking finance, one is confronted to the sacred core of market fundamentalism in its most dogmatic belief: the efficient market hypothesis in its strongest form. It stipulates that financial markets reveal fundamental values of assets, i.e. the marginal contributions to social welfare of all types of capital. If it were true, the moving price system in financial markets over time would be the most relevant expression of what society values in pursuing its own perpetuation.

The problem raised with this assertion is profound indeed. Upheld by most powerful financial interests, fostered by the ever-lasting deregulation and globalization over more than 30 years, it has led to dramatic policy failure up to the devastating financial crisis and its costly

[2] John Rawls revisited his theory in 2001 and clarified the link between social justice and equity in the following book; J.Rawls, *Justice as fairness: a restatement*, Cambridge, Mass., Belknap Press, 2001

[3] A.K.Sen, Development as Freedom, Oxford University Press, 1999

aftermath. Indeed, finance has moved under a momentous dynamic for so long and generated a financial cycle so huge and long-lasting that the efficient market hypothesis cannot stand under Karl Popper's reality principle. What is at stake is a much more fundamental question than market imperfections, asymmetrical information and bounded rationality. It is the implicit assumption about what constitutes economic time and what value means.

As everyone should notice, only the strong form of market efficiency is relevant for sustainability, because that form is required to pretend that market finance achieves the optimal allocation of saving overtime. Only this assumption can amalgamate rational expectations and the fundamental value of assets. The basic question is the feedback of the future (expectations) on the present economic equilibrium. No mechanical or biological system can be said of being determined by the future. Their workings and law of motions proceed from more or less complex linkages that science has the mission to discover more or less accurately. The causal time has an arrow that is not reversible whatever the knowledge mustered on it. Social systems are different because human beings are capable of beliefs about the future. However the reflexivity of financial expectations on observed economic variables cannot be called causal in any meaning of the word causation. However market fundamentalism pretends that fundamental values have a predetermined objectivity (in logical sense of the word) external to financial market that the market reveals. Such an assertion is the result of a confusion on the notion of time. The causal time of objective processes is postulated homogenous to the subjective time of expectations. How can it be so?

Let us look at the fundamental value of an asset when all rational market participants share all the available relevant information. The fundamental value stemming from market efficiency is:

$VF_t = E_t(R_{t+1} + VF_{t+1})/(1 + x)$,with VF the fundamental value, E(R) the future expected income from holding the asset and x the discount rate.

To assume that market participants make expectations in such way that the market is balanced at a price $P_t = VF_t$, x must be known. However this equation is just an arbitrage saying that on an efficient market there cannot be excess returns. An arbitrage is just a condition equating the returns of two assets. It can be used to determine the price of an asset only if the return of the other is known. But the VF equation is a very peculiar arbitrage that equates the return of the asset… with itself. Indeed it can be rewritten:

$$\frac{E_t(R_{t+1}+VF_{t+1})}{VF_t} = (1 + x)$$

The left hand side term is the definition of the asset return. The right hand side is the required return $x = r + \rho$ with r the riskless interest rate and ρ the risk premium of the asset. ρ is as much unknown as VF itself. Therefore the efficiency hypothesis teaches us nothing as far as the determination of fundamental values is concerned, because it encapsulates two unknowns: fundamental value and risk premium. One has to specify a model able to determine x. But it has nothing to do with market efficiency. *There will be as many asset price dynamics as there are a priori beliefs on the future of the economy that embodies those assets*. The core reason is the reflexive nature of the feedback of expectations on market prices. It is so because the subjective time of expectations is *counterfactual*. It bears no logical homogeneity with objective time of past events. *The market creates values; it does not reflect preexisting values*. Values depend irrevocably on beliefs. The relevant question is how beliefs are coordinated through strategic interrelationships, gurus, prophets or market manipulators, focal points, self-generated fixed points in converging mimetic processes. All processes can occur on financial markets. A particular convergence of expectations defines a value and an economic equilibrium can ensue. Another belief giving rise to another focal point would produce

equilibrium. Beliefs on the future are a priori unlimited. Subsequently reflexivity generates multiple equilibria. This is the very nature of the coordination by the future.

Because financial markets have been allowed to get loose in the last 30 years or so, a powerful financial cycle encompassing real estate, equity, fixed income and the associated derivatives has dominated financial valuations. Momentum has been the mode of coordination of expectations fuelled by leverage. The piling up of risky exposures in the balance sheets of both asset owners and financial intermediaries has created an interlocking of fragilities that no supervisor can embrace even if it were willing. It follows that the turnaround of the momentum is intrinsically unknowable.

This phenomenon points out to the theoretical distinction between risk and uncertainty[4]. The latter cannot be dissolved into the former. The future pertains to counterfactual time because finance is nothing but trading promises. It is driven by fluctuating beliefs, migrating from one equilibrium to another. How can a long-term horizon emerge in such a world without strong regulation imposed by a public authority? Therefore the mutation of the growth regime to sustainability and inclusiveness is a daunting collective task that requires an intellectual revolution to re-embed economics into social sciences, a deep social reform to make the firm a locus of participative social contracts between stakeholders, a transformation of finance to allow investors with long-run view, a better say in social choices.

If sustainable growth is to be taken seriously, it will turn economics upside down. Society comes first. There is no longer an axiomatic micro foundation of the macro economy, but a social welfare theoretic approach that derives macro conditions to be implemented by individual agents through proper incentives. This paper can only pinpoint theoretical problems and browse the main results from serious attempts to measure sustainable development by international institutions.

Conceptual issues and measurement problems

A social welfare approach involves a revolution in macroeconomics. It is akin to the revolution in economic thought that was triggered by World War II. After Keynes's memorandum to the British Chancellor of the Exchequer on May 4, 1940, [5] followed by Colin Clark's paper[6], the conceptual and measurement work to create national accounting began. It achieved the first consistent system in the 1945 memorandum published by the UN in 1947[7]. GDP was invented and measured for the first time.

The impulse for this breakthrough was entirely political: the urgent need to muster and mobilize all the economic resources of the country for the war effort on the one hand, the fear that the Great Depression would resume after the war on the other hand. To act efficiently the government needed to measure the aggregate supply and demand of the country, something a decentralized market economy does not provide.

Nowadays climate change is a worldwide peril, threatening the ecological foundation of economies, exacerbating precariousness and inequalities among countries and jeopardizing the welfare of future generations. Nonetheless, even if political elites talk of inclusiveness and

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[4] Hyman Minsky was the author that most forcefully elaborated on keynes's conception of uncertainty. The theoretical formulation of his thinking can be read in H.P.Minsky, "*The Financial Stability Hypothesis*", levy Economic Institute of Bard College, Working Paper n°74, May 1992

[5] Keynes J.M. (1940), *How to Pay for the War*, Mac Millan

[6] Clark C. (1940), *The Conditions of Economic Progress*, Mac Millan

[7] Stone R. (1947), "Definition and measurement of the national income and related totals", in *Measurement of national Income and the Construction of Social Accounts*, UN.

sustainability it is just lip service. The sense of urgency is nowhere apparent in the West. Public opinion is indifferent at best, rather hostile in countries like France. Powerful vested interests in energy-producing and electricity-using industries pay armies of scientists to spread climate-skepticism.[8] A related skepticism arises on the ability to measure linkages between environmental processes and social preferences. On that matter there is a strange de facto alliance between industrial and financial lobbies on the one hand, "fundamentalist" ecologists on the other hand. Both consider that persistent and strenuous efforts to internalize externalities are not worthwhile.

The first group follows its own interests and disguises them under the claim that markets cannot fail. To enhance private profitability one has better to deny that more costs should be taken account of in its own activities. This is the usual divorce between private and social ways of assessing values while there are market failures. The second group pretends that ecosystems are so radically alien that their impact on human beings, either damages or benefits, cannot be intrinsically measured in value terms. This is pure nonsense because any factor that impinges upon wellbeing has a social marginal value or cost. Yet what is true is that this social marginal value is by far not always revealed by a market price. Renouncing the quest to evaluate those social values amounts to denying that a global strategy to sustainable development is possible. This is not the way responsible governments and vivid civil societies should behave. Measuring social values is the best rational way to define and deliver common goods and therefore to detect in which capital assets it is best to invest. In other words it is the indispensable input of social choices.

Starting from a very imperfect situation it is understandable that several methods are advocated to handle the problem. They differ in scope: macro or micro, all-encompassing or digging into specific questions and using partial economic analysis. They also differ in their time span: dealing with urgent questions and setting specific objectives or elaborating the theoretical basis of a sustainable growth regime in the long run. The possible ways forward have been explored in the Stiglitz report[9]. Enriching GDP from a public policy perspective to take account of inequalities, completing GDP with an array of physical indicators without measuring their social marginal values, broadening the scope of capital assets in an extended accounting registered in satellite accounts, new integrated social accounting system based upon a generalized version of capital

In the next section I will follow the way forward explored in the UN project in improving the measurement of an extended definition of capital and its link with social welfare. I will also acknowledge the proximity and differences with the World Bank project. Both approaches are endeavors to link the theoretical framework of social welfare to sustainability conditions. They differ in their dealings with externalities to measure marginal social values. Then I will introduce the problem left aside in the Stiglitz report. On one side, a macro model of social capital growth is necessary to frame a long-run policy of sustainable development. On the other side, capitalism will still prevail in allocating resources for the foreseeable future. Therefore processes to achieve social incentives will still be shaped by the pursuit of private returns in decentralized firms. Therefore there is an unescapable problem of incentives. Although social values are not reflected in market prices, they should one way or another impinge upon the prospective rates of return of the firms, which will invest in the types of capital that might produce those social values. It follows that firm accounting must also be

[8] Naomi Oreskes and Eric Conway, "*merchant of doubts*", Bloomsbury Press, NY, 2010

[9] Stiglitz J., Sen A. and Fitoussi J.P. (2009), *Rapport de la Commission sur la Mesure de la Performance Economique et du Progrès Social,* Paris

reformed to become consistent with social accounting conditions. The literature on business accounting ignores entirely the problem. Corporate management is content with the rhetoric of social responsibility, an empty discourse without any meaningful impact on the business model of the firms. Setting the problem has only one virtue for the time being: displaying how far we are from the beginning of a transition to sustainable growth. Correlatively, I will sketch the conception of long-run financing investments driven by sustainability conditions, focusing on climate policy.

A social welfare-theoretic approach of sustainability.

The present paper is not the place for a survey of the different approaches dealing with sustainability. As explained above, it takes the view of those who base measurement upon monetary value, hence who are concerned with valuing environmental and intangible assets, as well as ecological services with no market values. International institutions lead the investigations. The World Bank explores a weak condition of sustainability with its genuine saving concept[10]. The high level panel set up by the general secretary of the UN explores a strong condition summed up in the inclusive wealth indicator (IWI)[11]. However both derive the sustainability condition from the concept of social welfare not decreasing over time.

Let us first understand the theoretical underpinning of the measurement methodology based upon an extended concept of social capital. Many forms of this all-encompassing concept of capital are public goods that boost the productivity of privately-owned capital. Those relationships imply interdependence, viewed as strong or weak depending on the way one defines social marginal productivity, between public choices and private property rights. Measurement is controversial because those social marginal productivities are shadow prices, i.e. expected marginal contributions to social wellbeing of the different forms of capital. Shadow prices are not observed; they are counterfactual by their very nature, because they depend on the future path of the economy.

Because society is a collective that pervades over time, well-being is transgenerational. Its productive base is economic development. Sustainability is defined as a pattern of development along with intergenerational well-being does not decline. There must be an aggregate measure of the productive base of a national economy, called total national wealth. Social well-being is produced by its productive base. There exists a generalized production function relating them. Aggregate net investment is a measure of the rate at which the marginal intergenerational well-being changes over time, provided that the different types of capital composing social wealth are measured at their social marginal values in terms of welfare (shadow prices) and that the shadow prices can be taken constant. Another look at it is saying that aggregate wealth is the shadow value of the stocks of all assets available in the economy. Box 1 sketches the basic model used by the high-level UN panel.

Therefore the strong condition of sustainability is the following*: a long-run economic policy is sustainable if and only if aggregate net investment measured at shadow prices is positive over time.*

Box 1. Definition of the sustainability condition

$V(t)$ = intergenerational well-being

$K_i(t)$ =stock of i asset in t. $K(t)=\{K_1(t),\ldots, K_i(t),\ldots K_n(t)\}$ vector of capital assets.

[10] "*Where is the wealth of nations*?", 2006 report and "*changing wealth of nations*", 2012 update.

[11] « *Inclusive wealth report. Measuring progress to sustainability* », UN report, 2012

V(t)=V[K(t),t] function of intergenerational wellbeing

Shadow price of time: Q(t)=dV(t)/dt

Shadow prices of capital assets: $P_i(t)=dV(t)/dK_i(t)$ if the economy does not cross a tipping point. If not, dV(t) is a finite step that must be estimated directly

Because of externalities in the V function, shadow prices are not market prices. Estimating them implies ethical values, which in turn depend on the conception of equity, theories on environmental/social interactions, info on asset size, their distribution and their substitutability.

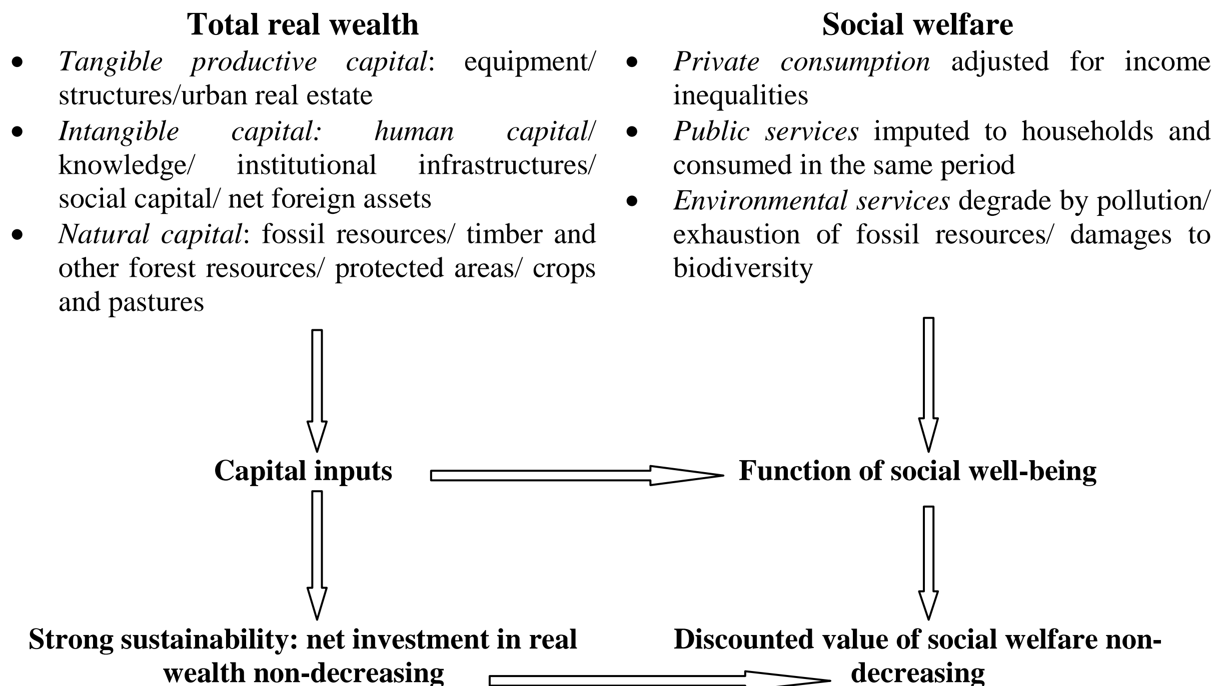
One can define inclusive wealth: $W(t) = tQ(t) + \sum_i P_i(t) K_i(t)$

And the sustainability condition: if shadow prices are constant, the duality theorem gives the following condition: $\frac{dV(t)}{dt} = Q(t) + \sum_i P_i(t) \frac{dK_i(t)}{dt} = dW(t)$

On a time line short enough so that shadow prices can be held as constant, social welfare does not diminish if and only if inclusive wealth does not diminish.

Figure 1 gives a stylized view of the approach.

Figure 1. National wealth and social well-being: strong concept of sustainability



To adjust private consumption for inequality of income for the purpose of tracking inclusive growth, the social welfare function must be increasing in average income growth and satisfy

the transfer property: any transfer from a richer person to a poorer one increases the value of the function[12]. It can be measured this way:

Inclusive income growth= average income growth + (average income) (Δ median/average income).

The main problem is the measure of the services of ecosystems whose substitutability to private consumption is low. Estimating shadow prices is a tricky problem, while there is no market price equivalent because of externalities. *Shadow prices* must be approximated with *notional prices.* They are the outcomes of agreements among people with a social consciousness to internalize particular externalities. Getting agreements involves debates between partners concerned by the costs of negative and the advantages of positive externalities to be shared. Those debates will extend into a considerable time line while people understand better the challenge of ecological degradation for their life style. While social preferences are going to change through experience, better information and more political debates, improved valuation will be reflected in national accounts.

One challenge concerning the value of the services of ecosystems and of valuing natural capital more generally is their non-linear dynamic. Unknown thresholds can induce unknown discontinuous changes. There are different regimes when tipping points are crossed (e.g. destruction of fisheries and of the rainy tropical forests). Some of the regimes can induce global systemic crises, destroying real wealth massively and transforming decisively human civilization as we know it (e.g.an increase in average world temperature over 5°C)[13]. The IPCC has argued convincingly about the non negligible probability of this catastrophic scenario by the end of the century. Discontinuities in ecological processes should be reflected in shadow prices because the latter capture the substitutability between capital assets in the present and the future. Crossing a tipping point entails a discontinuous slump in substitutability between natural and other capital assets. It will provoke a violent surge in the shadow prices associated with these assets, making it uneconomical to draw further on them and forcing an immediate reinvestment in the worst possible economic environment because societies will have suffered the losses of a systemic crisis. This is why the Stern review[14] has advocated the use of a quasi-zero discount rate and some authors have shown that there is a strong rationale to apply the precautionary principle[15].

The high-level panel of the UN Secretariat has been following this path in the Inclusive Wealth Report that will be progressively reviewed every two years. However there are other less demanding ways. The World Bank has settled for a criterion of *weak sustainability* drawn from a more restrictive view of total real wealth, called *comprehensive wealth* that leads to a criterion of sustainability based upon an extended measure of national net saving, called genuine saving. Such measure is a weak criterion because it avoids the estimate of shadow prices. It is essentially a revised measure of GDP.

The World Bank has drawn upon a pioneer work by Pearce and Atkinson[16]. Development depends on total wealth defined in a restrictive way compared to UN methodology, e.g.

[12] Anand R., Mishra S. and Shanaka Peiris J. (2013), Inclusive growth revisited: measurements and determinants, *Economic Premise*, n° 122, July

[13] Naomi Oreskes and Eric Conway, (2014), "collapse of Western civilization", Columbia Univ. Press

[14] Stern N. (2007), *the economics of climate change. The Stern review*, Cambridge University Press

[15] Weitzman M. (2009), « On modeling and interpreting the economics of catastrophic climate change », *Review of Economics and Statistics,* vol. XCI, n°1, February.

[16] Pearce D.W. and Atkinson G. (1993), "capital theory and the measurement of Sustainable development: an Indicator of Weak Sustainability", *Ecological Economics*, n°8, P.103-108

produced, human, social and natural capital. Sustaining total wealth is the key for viable growth regimes. For the World Bank the different forms of capital are defined in the following way:

Produced (tangible) capital= equipment + structures + urban land

Intangible capital= human capital +institutional infrastructures + social capital + net foreign financial assets

Natural capital= subsoil assets + Timber resources + non-timber forest resources +protected areas + crop land + pasture land

The sum of the three components is the real wealth of the nation. The change in real wealth has been named adjusted net saving (or *genuine saving*). If the different types of capital that make up the productive base of the economy in a general ecological and economic sense can be measured, the variation of total wealth per capita is the sum of the growth of total factor productivity and the growth in the aggregate growth in the volume of the different types of capital. Since the variation of total net real wealth or *genuine wealth* is net investment of society, the condition of sustainability is that society does not destroy its wealth in mustering enough adjusted saving or genuine saving to match net investment. Therefore the sustainability condition becomes the following: *the development path of an economy is sustainable if, at every date, adjusted social saving (or genuine saving) is non-negative.* If it gets negative, it means that society is destroying its wealth.

The definition of genuine saving is the following:

Genuine saving = economic gross saving of the nation – fixed productive capital depreciation + change in value of human capital + change in value of social capital – depletion of mineral and energy fossil resources – net reduction of forests – damages due to pollution in ≈ CO2

How do inclusive wealth and comprehensive wealth compare methodologically? They have in common the intent to measure total wealth. Both introduce estimates of how much intangible they can value and they also both try to measure the degradation in natural capital. However they have differences too.

In inclusive wealth accounts, wealth is measured directly from its productive base while notional prices have been estimated. No pre-assumption is made on sustainability. Unsustainable trajectories are included. Inclusive wealth tries to disentangle ecosystem services (fisheries and water-related ecosystems). Furthermore population is a critical factor of sustainability. Population changes are directly estimated.

In comprehensive wealth accounts population is supposed stationary or increasing at a constant growth rate. Furthermore the social welfare function is only related to private consumption that is supposed to grow at a constant rate. Wealth is its present value. A given path of consumption is deemed unsustainable if adjusted net saving is negative for this path.

Comparing three measures of development: gross domestic product, comprehensive wealth, inclusive wealth.

Table 1 compares for some advanced and emerging market countries the evolution of the three indicators over long-run periods. In doing so they improve markedly the picture given by GDP, which is definitely an irrelevant indicator to frame long-run policies.

For all but advanced countries the WB indicator is *grosso modo* between GDP and IWI. For the emerging market economies (EMEs) it is closer to GDP than to IWI. The reason is that natural capital weighs much more in total wealth in EMEs than in advanced countries where the weight of intangibles and their impact on development is much larger. However, the WB underestimates the losses in wealth due to the destruction of ecosystems that the UN panel tries to capture. This is why the former undervalues ecological losses.

Table 1. Different measures of development

Countries	**GDP/individual** (% annual growth rate 1990-2008)	**Real wealth/indiv** (WB, % annual growth rate 1995-2005)	**IWI/individual** (UN, % annual growth rate 1990-2008)
Advanced countries:			
Germany	1.5	1.3	1.8
France	1.3	1.7	1.4
US	1.8	2.3	0.7
UK	2.2	2.8	0.9
Japan	1.0	1.5	0.9
EMEs:			
Brazil	1.6	0.9	0.9
China	9.6	6.9	2.1
India	4.5	3.6	0.9
South Africa	1.3	1.3	-0.1
Oil-exporting countries:			
Nigeria	2.5	-1.5	-1.9
Russia	1.2	-	-0.3
Saudi Arabia	1.3	-0.8	-1.1
Venezuela	1.3	-1.3	-0.3

Regarding this issue the case of China is striking. Massive expansion of fixed productive capital, fueled by over accumulation of capital in infrastructure and heavy industries, has produced outstanding growth in GDP. According to the gauge of comprehensive wealth the performance is reduced, but by not that much, because depreciation is taken into account (it is a net and not a gross concept like GDP) and because massive environmental damages are somewhat accounted for, but less than in inclusive wealth, which looks at the losses due to the deterioration of the regulatory properties of ecosystems. The IWI still attributes the best performance to China over the 30-year period or so, but no longer an outstanding performance. On the positive side the achievement is the eradication of absolute poverty. 400 million people have been taken out of absolute poverty in 30 years, the best performance worldwide of all times. Investment in human capital has also advanced substantially but it is still lagging in the rural sector. However, China is the country where the negative gap (IWI-GDP) per capita is the largest. It means that intensive growth in fixed capital has entered a stage of fast-decreasing marginal return and that the degradation in natural capital is destroying real wealth alarmingly. The new Chinese leadership has pledged to link the new urbanization drive with environmental policies and has issued detailed directives to guide the strategic planning for an overhaul of the growth regime . In India the situation might be worse since the political system seems to be unable to invest in infrastructure and in basic education

for the larger masses of the population, while keeping enshrined crippling social discriminations, not least against women. However bottom-up frugal innovations are well under way, which save energy use and broaden the range of goods affordable by the nascent middle class.

In advanced countries the comprehensive wealth indicator usually depicts better performance than GDP, essentially thanks to its measuring of intangible capital that has become the most important factor of growth since the ICT revolution. However what is striking is that the WB indicator leans on the side of GDP, opposite to the IWI in the comparison between advanced countries. In particular, the performance of Germany and France compared to the Anglo-Saxon countries is reversed. The latter fare much better in GDP and much worse in IWI. Remember that IWI is a measure of well-being. And consider the US where public health is appalling in terms of life expectancy, morbidity and obesity, while costs are prohibitive. It boosts GDP per capita since wages must be higher than in other countries just to pay for the rents drawn by the medical and the insurance sectors on the population. Therefore what is counted as a plus in GDP deteriorates IWI. Add to it that the US have not invested sufficiently in their public infrastructures, impairing the stock of public capital in the UN IWI. As for the UK, that share largely with the US the non-inclusive character of their growth model, especially the extreme inequality of income and the inefficiency of their health care, the exhaustion of oil fields has not been redeployed in real capital but in elusive foreign financial assets.

Furthermore, both the WB indicator and the IWI, opposite to GDP, concur to show that non-advanced oil-producing countries are on an unsustainable path. This is the well-known curse of primary resource ownership for development. Be they increasing or decreasing in population, densely or sparsely populated, those countries have governments that impoverish their people. This is because the appropriation of the scarcity rent is squandered or redistributed according to the feudal (Saudi Arabia) or populist nature (Venezuela) of the political systems of the countries. In any case it is not invested enough in wealth-producing forms of capital to offset the exhaustion of fossil resources.

From macro to micro: how can firm accounting provide the right incentives to contribute to sustainable development?

As has been acknowledged at the beginning of this paper, sustainability is a problem that stems from the dynamic of complex systems. The interactions between economy and ecology on the one hand, the elaboration of policies for inclusiveness in societies impacted by multiple conflicting interests on the other hand, raise the questions of the incentives of economic agents that will make collective objectives come through. Because externalities are not exceptions but are dominant in environmental problems, because market prices are massively incomplete and finance has proved to be more than inefficient but systemic risk-prone, the macro micro problem is both inescapable and daunting. The welfare-theoretic approach and the generalized wealth accounting build tools for strategic planning to formulate societal long-run objectives. However in countries with vibrant civil societies, lifelong goals come from the bottom and economic implementation of those goals raise enterprises on the fore. Innovations in measurement in macro accounting must impact measurement in business accounting for policy goals to be conveyed into the right incentives. This is all the more challenging as the present business model of most firms is still based upon shareholder value, which is alien to the theoretical foundation of sustainable development.

- ***Shareholder value, market finance and the social interest***

It has been commonly said, since the implicit contract view of the firm had become most influential in financial elites and popular among academics and politicians, that firms are agents of their shareholders. Meanwhile the average holding time of business equities in OECD countries has dramatically declined from 5 years in the late 1960's to 5 months in 2010. The reason is the spread of the Anglo-Saxon model of dispersed ownership in continental European countries where diverse forms of governance used to prevail: insider, family or block-ownership control. Obviously dispersed and tieless owners, obsessed with liquidity, have neither interest nor means to control firm strategies. Therefore the principal agent relationship is irrelevant as far as individual shareholders are concerned. Dispersed ownership and controlling power are contradictory.

The basic question remains: how must firms be managed and to achieve what? The goal looks fairly obvious: maximizing the total return of shareholders via share buybacks, dividend distributions and M&As. The entity capable of disciplining firm management to conform to those predicaments is the Stock market. As long as the circulation of property rights is frictionless, the Stock market is the principal of the firms since the liquidity of shares homogenize shareholders. Firm managers are under the threat of potential owners on the one hand and are induced to conform to shareholder value by the distribution of Stock options on the other hand.

Therefore, if and only if equity markets are perfectly efficient, the anonymous control they exert achieves the social interest because all types of productive capital are represented and the equilibrium market returns are equal to their marginal social costs. If one buys these axioms, one must accept the conclusion: shareholder value is relevant in matching the macro micro problem. Moreover the financial structures of the firms are meaningless because all financial assets are perfect substitutes in their risk-adjusted returns.

It is enough to spell out those conditions to understand how much they are irrelevant for the macro micro problem that contemporary societies must overcome to bring their economies on the track of the mutation from the failed growth regime of financialized capitalism to sustainable growth. In section 1 basic reasons grounded in the very nature of finance have been provided to reject the strong efficiency hypothesis. Correlatively, the assertion that the firm has no existence as an autonomous entity, being a knob of implicit contracts, does not hold.

- ***Stakeholdership, the social interest and responsible shareholders***

The failing of the implicit contract theory in equating shareholder value and societal responsibility has two flaws regarding the firm on top of its idealized view of finance. The first is its inability to recognize that the corporation is a legal entity of its own. In this respect the corporation is the entity in capacity of making commitments on behalf of the enterprise. Excluding slavery, the latter is not an object that can be possessed by anyone. It is a human gathering dedicated to the production of social values. Its productivity depends crucially on the complementarity and cooperation of talents, as much as they are able to develop collective tacit knowledge. All bearers of intangible assets that contribute to the productive capacity of the firm and that have no directly marketable property rights are stakeholders on the social value produced by the enterprise. They should be as much entitled to have their say in the strategy of the corporation and to share the profit as the shareholders. They have even more stake since they do not enjoy the liquidity of the assets they own. As a consequence, they are more interested in long-run strategies that consider the corporation as a going concern.

Therefore, the quality of growth at the macro level depends on shareholdership being replaced by a much larger stakeholdership in corporate governance[17]. Stakeholders are all the people bringing productive assets, be they tangible or intangible, to the collective productive strength of the enterprise. Since the productive capacity of the enterprise lies in cooperation, individual marginal productivity cannot be measured in full. Correlatively individual marginal productivity cannot be measured entirely.

Stakeholders have multiple interests. The Stock market being unable to determine the business model that aligns the corporation governing the enterprise on the social interest, the business model must be the outcome of a strategy debated and decided by an organ of a political nature, the Board of Directors. The Board is not only a controlling body working as the agent of a predetermined end, shareholder value. It must define the finality of the corporation and its associated strategy to make account of the multiple relationships of the enterprise both inside the organization and with its environment. In a stakeholder corporation, the Board must gather the delegates of all stakeholders to elaborate the common interest. To establish the responsibility of management, checks and balances must be embedded in the structure of governance: separation between the chair of the Board and the chief executive officer, equal participation of employee delegates in the Board, pay and audit committees protected from the pressures of management, objective criteria linked to the strategic objectives defined by the Board to assess the performance of management.

Such a structure might be able to link the participation of human capital to innovative investment projects, i.e. to make the achievements of individual "capabilities" fit with the larger finalities of the quality of growth. Stakeholder corporations are inclusive by participation of employees, not only by redistribution that was the principle of the post-war growth regime labeled "fordism". They will be actors of sustainability if their strategies are shaped by investments that conform with environmental and societal criteria. Those investments aim at curbing the trends that are degrading the life of people: climate change, scarcity of resources, giant inequalities, discriminations, structural unemployment, financial fragilities.

Those bad trends have noxious effects on long-run capital return because externalities develop over time and are loaded with irreversibility. They are intrinsically non-linear. Therefore they generate extra financial risks that must be converted into financial values. It is why business accounting and economic calculus of investment returns must be overhauled. The recognition of such needs requires long-term investors acting as responsible shareholders in stakeholder corporations.

- ***Governance matching corporate interests and social involvement needs an overhaul in business accounting***

Investment projects are selected according to their *internal rates of return* (IRR). The IRR of a project is the discount rate that cancels the net present value of future cash flows stemming from all revenues and expenditures up to the horizon of the project. This measure does not take account of the positive and negative externalities that impinge upon the social value linked to the project. The social value of an investment is the net present value of all costs and benefits entailed by the investment, be they money flows accruing to the investment or external impacts (positive or negative). This is for instance crucial for clean projects that abate a computable amount of greenhouse gases. They generate positive externalities in the amount of abated GHGs. These externalities can be valued if society recognizes that avoided GHG emissions are something of value and institutes a notional price, the social value of carbon, for

[17] See Colin Mayer, *Firm Commitment*, Oxford University Press, 2013

a unit of avoided carbon-equivalent. Therefore externalities must be valued from notional prices that should be agreed upon in non-market social procedures. Rigorously the notional prices to guide investment choices of firms must be the shadow prices of the different types of capital on a sustainable trajectory, computed as the shadow prices associated to this trajectory. This is the macro micro consistency. Practically such a consistency is out of reach in present time to get numerical estimates of shadow prices that can be used in computing expected rates of return. However this normative consistency teaches a lot of what a price is all about.

Indeed, true market prices, i.e. prices whose determination follows a Walrasian adjustment, exist only in centralized asset markets. A price is much more general than a market price. This is an implicit, tacit agreement between two or more parties in sequential trade, when for instance consumers buy products at prices that are already posted in shops or stores. Or it is the product of negotiations between intermediaries (e.g. wages decided in collective bargaining), or it is notional like transfer prices between sub companies of a multinational corporation, or it is purely conventional like accounting prices used in analytical accounting.

Therefore the argument that it is impossible to value what has no market is empty of meaning. If pollution is not valued it is because public authorities have not instituted a carbon price and obliged firms to compute pollution costs in their operating accounts. The reason why they do not do it is because the political dominant influence in financialized capitalism makes it self-evident a narrow view of property rights that legitimates incentives of firm managers to maximize shareholder value.

While sustainable growth had gained momentum as a primary finality in the political debate, the need of consistency between the macro accounting of total real wealth and business accounting would become a requirement to fulfil incentives embodying environmental and societal objectives in corporate governance. Under those new incentives it would become necessary to correct the IRR and compute an *integral internal rate of return* (IIRR), valuing the externalities produced by firms' activities according to a generalized view of valuation. Such a view rests on the stakeholder view of the corporation where the board must answer the following questions: who are the stakeholders whom the firm must be accountable to? Which performance criteria must be accounted for? Under which procedures must they be accounted?

In stakeholder corporate governance, corporations would have to report to their different stakeholders, so that it would be possible to identify and measure the global imprint of the firm on its natural social and economic environment. In particular there should be a reporting towards socially responsible investors who need to assess the potential of investment projects according to IIRR.

In the first stage of implementing the new paradigm one should not aim at a unified reporting where extra-financial valorization are integrated in standard financial accounts. Extra-financial accounting will be experimental in a first stage. There should be satellite accounts whose ability to feed the extended calculus of the IIRR must be tested. *The enlarged accounting must be built as a new metric of societal responsibility.* But a metric it should be which means prices defined in money as the universal unit of account. Business accounting must check whether particular firms contribute to sustainable development, e.g. create at least as much resources as they consume. To define prices that guide strategic investment decisions capable of attracting long-run investors, consultations between stakeholders interested by a particular domain of externalities must be organized[18].

[18] Schoum G., de Saint-front J.and P. and Veillard M. (2012), *Manifeste pour une comptabilité universelle*, L'Harmattan

Considering social responsibility, since the capabilities of workers acting as a team make the main productive asset of the firm, expenditures to reproduce and expand them must not be treated as operating costs, but as investment in human capital. Discounted inflows and outflows of future wages due to the mobility of workers and revalorization of wages due to expenditures in vocational training would appear much more valuable in such accounting. Instead of dealing with wage policy as a cost to compress as most as possible, wage policy would become investment policy to be anticipated as an integral part of investment projects.

Long-term finance and sustainable growth: how to finance climate policy?

Both the scope of human and material possible damages and their irreversible character if the average temperature increases above 2°C (compared with pre-industrial times) plead in favor of an urgent and strong action of societies against climate change. The intervention should be much more energetic than what has been accomplished during the last 40 years to reduce the sources of emissions and increase the absorption wells. The last report of the Intergovernmental Panel on Climate Change (IPCC, report entitled "climate changes, 2014") indicates that the emissions from human origins have increased during the years 1970-2010 at a rhythm higher than 2% per year, and that the last decade 2000-2010 has known the highest increase in human history. Past climate policies, which do not allow to revert the increase in temperatures, have thus been largely insufficient.

The uncertainty on the costs of climate change covers several types of realities : uncertainty on the scope of the climate damages with respect to the increase in temperatures; uncertainty about the scope of technical change, also mostly irreducible, allowing to reduce the costs of abatement activities ; uncertainty on the discount rate to be used to evaluate today damages which could occur in the very long run[19].These different forms of uncertainties act today in favor of an early action against climate change, and against all forms of delay.

The fifth evaluation report of the IPCC, published in 2013-2014 insists on the increase of the level and the changes in structure of annual productive investment in the period 2010-2030 to help mitigate climate change: reduction of the investments based on fossil fuels; increase of around $150 billion of the investments in renewable, nuclear, capture and storage of carbon emissions; increase of around $340 billion of the investment to increase the energy efficiency in transport, housing and industry. According to the International Energy Agency (IEA), the annual investments in the energy efficiency and the low carbon technologies should reach $790 billion in 2020 and $2300 billion in 2035 in order to mitigate temperature increase to 2°C.

- ***From Kyoto to Cancùn : a paradigm shift***

Guiding the climate negotiations according to an ethical principle – leading the northern countries to finance the climate mitigation in the southern countries, does not amount to give equal emission rights to everybody, The allocation of emission permits is just a form of allocation of financial assets. In a world where wealth inequality reaches extreme levels, the richest have soon bought their desired amount of permits on the market for emission rights,

[19]This uncertainty has polarized the debates on the costs of climate change after the Stern report (Stern, Nicholas, ed. *The economics of climate change: the Stern review*. Cambridge University press, 2007.) and its criticized choice of a very low pure time preference which is not reflected in the discount values emerging from market prices (Nordhaus, William D. "A Review of the" Stern Review on the Economics of Climate Change"." *Journal of Economic Literature* (2007): 686-702.). .

circumventing the equity principle. The emissions per head should be equalized in the very long run[20].

Such an objective gives a direction to the principle proposed by India at the Cancùn Conference of an « equal access to sustainable development » (soon to be called the « Cancùn paradigm shift ») and logically leads to a massive help of developed countries to developing ones. To this regard, the Cancùn Conference of Parties (COP-16) can be understood as a real shift, translating the international negotiations from a top-down and insufficiently cooperative approach (a unique carbon price linked to a world market between States of emission reductions and a burden sharing) based on the obligations of the States towards an international climate regime based on the responsibility of States to voluntarily promote nationally appropriate mitigation actions[21].

Among the economic instruments allowing the correction of the distortions due to externalities, we usually distinguish between the price policies (taxes or subsidies) to control the prices paid by polluters and the quantity policies pretending to control the quantities of emitted GHGs. The markets for the emission permits (such as the « European Trading Scheme », or ETS) are among those. In a certain world, taxes and permits would be equivalent .It is always possible to determine the quantities of permits such that the market price is equal to a certain tax level. But the uncertainty of the real world makes the equivalence disappear. The market gives certainty on quantities; the tax gives it on prices. The tax is more predictable only if the government has a well-defined climate policy in the medium run, associated with a trajectory of carbon price on which it is credibly engaged. On the contrary, the emission rights market is an asset market, thus accompanied by chaotic price trajectories, as the European market has well illustrated. A market which is affected by multiple externalities cannot be efficient. The price flexibility is a benefit only for the speculators, except if the market is regulated by a public entity able to insure a medium run trajectory in line with what would give a tax in a credible abatement scenario on 5 to 10 years. The tax is thus a priori better than the market, which was not the reasoning of the Kyoto Protocol. This advantage only exists however if the announced evolution of the value of the tax is considered credible by all the actors. And we know by experience that this is not the case. The political cost is so high that if a tax is put in place, its level can only be too weak to direct the new investments in a significant way.

The world of the perfect market forgets that environmental policies are weak, reached out without any conviction, and affected by unpredictable changes of direction, amplifying the risks linked to the investments ; they are generally not very popular when they take the form of a tax or a carbon market establishing a price from one day to the other ; when they are seriously put in place, they amount to immediate transition costs to entire sectors of the economy, early and indifferently depreciating parts of the installed capital of the economy to value a capital to come; they have certain redistributive effects which are hard to quantify. The political economy arguments do not play in favor of these traditional tools, which do not seem to be preferred at a political level, compared with regulations, sector subsidies or other forms of industrial policies.

In developing countries, the NAMAs could lead to the emphasis on national objectives of development: tightly linking the low carbon technologies and the local environment, investing

[20]As Nicholas Stern clearly states, if the world must emit less than 20 billion tons of CO2eq in 2050 and the plane twill have around 9 billion inhabitants at that time, this means that emissions should be limited everywhere to 2 tons of CO2eq per head in 2050.

[21]Nationally appropriate mitigation actions-NAMAs for developing countries and –Nationally Determined Contributions- NDC for all countries.

first in human capacities and R&D using the macroeconomic policies to lower the arbitrages between technical and social costs. There is here potentially several bottom-up initiatives. The compatibility between many decentralized actions and the global goal to contain climate change becomes crucial[22]. The NAMAs allow the governments of developing countries to integrate the governmental objectives in their national development policies. But the GHGs emissions are a global externality. As Roger Guesnerie puts it, a global coordination for a global control of quantities must be created. For that matter countries must agree on a global emission level.

An international permits market would regulate the gaps between the permits allocated to countries and emissions, creating an international coordination at the margin *(and not on each carbon unit emitted as in the Kyoto Protocol), while the States and the regional groupings of States would look for their internal objectives with the help of taxes and investment public policies. The compatibility between several decentralized actions and the global climate change can thus be insured.*

Of course the installed « dirty » capital must be depreciated in order to give room for "clean" technologies. But this must be done at the margin by new investments cumulating through time. A new direction for the current investments and the investments to come is a priority compared to the valuation of the whole stock with a disruptive price. It can be done through a valuation of carbon through a notional price applied to investment categories which produce an abatement of GHGs, which independent agencies could validate.

We call such a level of abatement a carbon asset. Because it is not (or too partially) raised by a tax incorporated into the price of the produced goods, the return of these investments can be adjusted through the acquisition of carbon assets produced against monetary emissions. Money is indeed what is universally acceptable and thus validates the product of all economic activities. It can answer the question of the financing of public investment policies in favor of the carbon externality.

- ***Confronting the funding gap***

There is a huge funding gap to achieve a low-carbon transition. To assess the funding gap one should not confuse the flow of payments over the duration of the projects to cover capital and operation costs and the upfront costs, i.e. the cash necessary to cover the cost of the equipment before it enters into operation. The latter might be two or three times the former. Furthermore the financing need is not only what will finance net investment flows to accumulate capital in clean technology. It must cover the redirection from old production capacities in existing energy systems to new ones in low-carbon energy systems. If for instance a renewable energy plant produces electricity at a cost 30% higher than a coal plant, the real amount of investment to replace coal-fired electricity is 130%. Finally the total incremental costs of the changeover form one energy system to another must account for redirecting investment in building and transportation for higher energy efficiency and lower energy demand permitted by changes in consumer behavior. For around $500bn incremental investment costs in 2020, a back-of-the-envelope calculation gives about $4100bn of redirected investment[23].

Confronting this huge need for finance, the cash flow generated by the clean development mechanism is utterly insufficient. Moreover it yields cash at the end of the project and thus is

[22]Roger Guesnerie and Nicolas Stern, deux économistes face au changement climatique, Le Pommier, Paris, 2012

[23] M.Aglietta, J.C.Hourcade, C.Jaeger and B.Perrissin Fabert, « *Financing transition in an adverse context: climate finance beyond carbon finance*",INEA, to be published 2014

not designed to reduce the upfront investment cost. The Public Finance Mechanisms do bring funds during the incubation phase of the investments, but they cover only the extra costs of low-carbon technology, not the bulk of the investment projects. Not considering the uncertainty in the time line of the new industrial revolution, they assume implicitly that without the extra incremental costs the projects would spontaneously yield positive internal returns.

Climate finance is fragmented for several reasons: the international market for polluting rights does not exist; the resources must be mobilized on a much larger scale and must borrow on much diverse financing channels; climate change must be integrated into the development strategies of each country, so that financing is predictable and sustainable contrary to the volatility of carbon finance. Only the appropriation of needs by the beneficiary countries will allow avoiding the financing of too narrow and too divided projects to be efficient, because they are defined from the outside by international institutions or donating countries.

However market instruments are not available. The availability of savings can be found in public and private institutional investors. But they usually hold easily tradable assets, what infrastructure and green bonds are not. These are alternative assets the institutional investors almost do not possess (<1% of their portfolio for the pension funds in countries of the OECD)[24], because these instruments have the triple handicap of not being liquid, having high levels of risks, and depending on hesitant policies. So the energy policies in Europe are chaotic and contradictory. The subsidies for new sources of energy can be excessive and then suddenly disappear with devastating effects on the cash flows of the ongoing projects. *From the point of view of the financing sources, a strong diversification of instruments and a change of scale are vital.*

Political uncertainty and the weakness of market structures to invest in environmental infrastructures are a double handicap. The obstacles to alternative investments are well-known : the competition of asset managers for the quarters' prize lists values only short term ; most of the investors face regulatory restrictions in long term assets ownerships ; competition policy separates grid producers and service producers force the investors to choose the property rights they want to own without being able to incorporate the synergies in their investments; while the activities are technically and economically integrated, there is no history of prices and no benchmark, forcing to internalize completely (with supplementary costs) the management of assets. The green investments have supplementary handicaps. The most crippling argument is the inadequacy or even the non-existence of the carbon price determined on the market for polluting rights. This handicap is all the more striking that the innovations in the "low carbon" investments bear both technological and ecological risks. Without a sufficiently credible valuation of carbon, guaranteed by the governments and increasing over time, and without the stop of fossil fuel energies, these investments are dominated by the existing infrastructures.

As a conclusion, these binding constraints force to find a cutting-edge equilibrium. Engaging in industrial policies to mitigate climate change requires reorienting several billions from energy and soil without any existing cheap substitute to fossil fuels. To reorient savings in low carbon investments, risk profiles must be lowered without supplementary charges on the taxpayer. For that matter, the abatement of emissions has a monetary value growing over time. But this monetary value cannot be obtained at present by a tax or a market that

[24]« Institutional investors and green infrastructure investments", OECD Report, October 2013

weakened economies after the crisis could not bear[25]. One must thus think in a different way. The base of the financing of the transition towards a low carbon economy can only be monetary.

A carbon-based financial intermediation backed by money

- ***Fundamental principles of the proposal***

The first principle is an international agreement instituting a social value of carbon. Better to do it at the COP21 in Paris 2015. The IPCC defines the social cost of carbon as the price which equalizes the marginal cost of reduction of the emissions and the marginal gain of avoided climate damages, along a sustainable growth trajectory. It is neither a price determined by a carbon market, nor a tax incorporated into the price of current goods. It is a notional price, defined as the value of the avoided ton of equivalent $CO_{2,}$ and applied to new investments, and not to the existing stock of capital. The estimations of the available models indicate that the social value of carbon is highly uncertain, because it relies on a large ensemble of parameters among which some are unknown[26].This is the reason why it should be defined by a political agreement. We know that it should increase with time according to predefined agenda, which could be revised every 5 years.

This proposal introduces a temporal distinction in climate policy by distinguishing the valuation of new investments, that is the future capital to be produced, and the valuation of already installed capital and the goods and services it produces. This distinction is made because the investments are urgent, uncertain and risky, while the introduction of a tax or a market price at a sufficient level to make these investments profitable is politically out of reach today in most countries. This distinction thus solves a political deadlock which has affected climate negotiations until today, with the argument of the high immediate employment and welfare costs of a carbon price. *The social cost of carbon, defined in monetary units, establishes a new space of commensurability, which is the space of carbon assets.* These assets are the values applied to the volumes of avoided CO_2-eq emissions thanks to « low carbon » investments in all economic activities. Carbon assets are produced when the quantity of avoided GHGs is checked and certified by competent and independent agencies.

The second principle is government guarantee. The government of each participating country guarantees for a period of five years a certain quantity of carbon assets as a contribution to the international climate policy. Effective emission reductions will be validated in kind by independent experts and give rise to monetary value, Thus this financial organization aims at eliminating the divorce between private and social returns of investments, a drawback that plagues investments involving high degrees of externality. The firms bearing the projects will find advantage in the certainty of the rise in the social value of carbon, since it increases the relative value of low-carbon investments. Their lenders find the opportunity of a new source of credit for which the risk due to the production of carbon assets is shared at a level linked to the validated carbon assets. The governments should be interested in giving a guarantee on a certain level of carbon assets for their development policies. However, the process can only be started through an international agreement on the social value of carbon and the identification of carbon assets must be accompanied by the expertise of independent agencies.

[25] J.C. Hourcade, P.R. Shuklaet C. Cassen (2014), « climate policy architecture for the Cancun paradigm shift: building upon the lessons of history », International Environmental Agreement (IAE), special issue, to be published.

[26] P. Dumas, J.C. Hourcade and B. Perrissin-Fabert (2010), « Do we need a zero pure time preference or the risk of climate catastrophe to justify a 2°C global warming target? Policy ResearchWorkingPaper, 5392.

Therefore an international supervision body should be instituted, to monitor the protocol followed by the independent agencies in their investigation. In order to foster a first wave of projects, it would be good that this international supervision body define the framework in which national States would be persuaded to promote investments: the technologies, sectors, temporal horizons. It could also propose the allocation rules of carbon assets, and thus the acceptability of the certificates by project type depending on the anticipation of avoided GHGs. There would be a common guide for the participation of each State.

The third principle allows central banks to register on the asset side of their balance sheets the value of the guaranteed carbon assets. On the liability side, the central bank can register *carbon certificates.* These carbon certificates are reserves or collateral for the financial institutions (development banks, investment funds, private equity funds) which have financed the validated investment projects. The risk for the investor who finances the projects is in a way socialized. It is diminished by the amount of carbon certificates on the guaranteed carbon assets.

The fourth principle has to do with time consistency. Monetary financing can be understood as temporary device to launch a wave of innovative investment as much as QE has been to alleviate the impact of the financial crisis. As long as those investments will be implemented the production structure will change towards clean technology. The consumption structure will change with the use of capital while former "dirty" capital has been replaced. Therefore the resistance against a carbon tax or cap-and-trade market will wane. It would be possible to come back to a form of standard taxation, in the framework of a new international agreement. The exit condition would be the convergence in the long run of the valuation of the carbon externality through the monetary tool, and the one from a future carbon tax (or a carbon market such as the ETS. Without this convergence condition, there would be time inconsistency in the expected return of investments during the transition from one tool to the other. In the long run the proposed financial policy can be institutionalized in a new monetary system or can be thought of as temporary before the introduction of more traditional tools.

- ***Carbon assets in the monetary and financial systems***

The monetary financing proposal for low carbon projects is not akin to QE, which involves the purchase of already existing assets on secondary markets. Our proposal involves the direct financing of new real investments, creating carbon assets by monetization of credit. The monetization only occurs for validated projects by independent and official agencies. There is no endogenous inflation since the price is predefined on the expected abatement trajectory and the counterpart of the monetary creation by the central bank is a real asset for which the State has defined a total maximum amount for a determined period and guarantees its value. *The only risk lies in possible errors from the certification agencies which could accept projects that do not produce the anticipated carbon assets. There would thus be carbon asset destruction, cancellation of the money created and loss for the bank who gave the and/or loss for the entrepreneur who took the risk.*

The balance sheet of this monetary intermediation appears on table 2.

Table 2. Bank balance sheets of a financial intermediation resting on carbon assets

Central Bank		Commercial and development banks	
Assets	Liabilities	Assets	Liabilities
-Foreign exchange -Bills and bonds -Carbon assets	-Currency -Bank deposits -Carbon certificates -Non-monetary items	-Reserves -Commercial loans and securities -Loans on low-carbon investments	-Deposits and ordinary bond issued -Bonds issued on low-carbon investments -Capital

A complementary mechanism can be designed to tap the large pools of saving collected by institutional investors. Indeed, not only banks but also specialized non-bank financial investors can use the carbon-based monetary facility to back climate-friendly financial products. The idea is to create a financial intermediation to match the preference for low risk of the bulk of institutional investors worldwide and the involvement of specialized risk-taking funds. A Green Fund, backed by the government that would provide the core of its capital base, could issue climate bonds on carbon assets transferred by the specialized funds that had contributed to finance the investments. Those bonds would be dedicated to institutional investors. The accounting side of this intermediation scheme is depicted on table 3.

On the asset side of its balance sheet, the Green Fund would finance a large array of financial specialists, which themselves finance diversified projects. It could acquire liabilities of private equity funds; buy project bonds, lend to development banks.

Table 3. Financial intermediation via Green Funds

Specialized financial investors		Green Fund		Institutional investors	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
Carbon assets from validated projects	Loans from EGF	Loans to finance specialists	Bonds on carbon assets	Climate Bonds on carbon assets	Collective saving (retirement contracts, life insurance, state funding of SWFs)
	Other loans	Project bonds		Other bonds	
Other assets	Capital	Equities	Capital	Equities	Capital

Therefore the Green Fund, which could be established in every country participating to the international agreement on the notional carbon price and related state backing of carbon assets, can intermediate the financing of well-diversified investment projects creating carbon assets. Thanks to the diversification of risk in its interventions and the strong backing of its capital, the EGF is presumed to get the highest rating and be able to issue high-rated bonds with a high multiple of about 10 ($1000bn equivalent with a capital of $100bn). Institutional investors worldwide would be able to diversify their asset allocation in a new class of assets weakly correlated with existing assets. Because the specialists financing individual projects can be dispersed in the territories, the scheme can be decentralized. It can finance industrial policy linked to urban development, recycling processes and bio agriculture that can re

territorialize industry reducing heterogeneity and dependence on imported carbon intensity via foreign energy dependency.

Conclusion

The paper has emphasized the linkages between a conceptual framework of social welfare improvement that can be called sustainable development and the deep reform in national accounting to make operational the concept of total national wealth upon which long-run development policies can be implemented. It has also shown that deep changes in corporate governance and business accounting are required for private firms to get incentives fit with the strategic national planning. Finally the paper has taken the view that climate policy is the decisive driver of sustainable development objectives. It is the domain where investment projects must be upgraded urgently. An international agreement on a notional price of carbon cum commitment of governments to achieve a definite amount of carbon abatement in a definite period of time is a precondition to define and run a new financial intermediation with monetary backup to overcome the inability of financial markets to provide the huge amounts of credit needed to reorient the production system.

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