Chapter 1

What is the Quality of Growth? Sustainability and Inclusiveness

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1. Introduction

The world is in the grip of a three-dimensional crisis: financial, social and ecological. This lingering crisis provides a warning that the finance-led growth regime dominant since the early 1980s is now 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 financialised 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 precipitated deep havoc in every part of the market economy. Shareholder value has given rise to extravagant concentrations of wealth, made the cost of capital prohibitive for many firms and has diverted profit from productive investment. 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 follows that a longer-term view of the future of our economies is necessary to provide a basis for overhauling the basic principles that underlie failing modes 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 worthy of pursuit, a process of social choice must provide guidance in the selection of relevant policies. In democratic societies that rest on principles of market economies, welfare theorists might wish that social choice could be based on individual preferences. However this endeavour is a dead end, because it encounters 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 of aggregating heterogeneous individual preferences in any meaningful social welfare function. It is why neo-standard models in macro economies are usually 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 that permits interpersonal comparisons. One cannot rely on a 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 formulas, 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 of as part of the social sciences without any pretence to supremacy.

In order to address social welfare issues, it is impossible to bypass ethical principles, as they provide a linchpin for social justice. To this end, John Rawls has set up a cardinal principle regarding access to the basic resources of society: primary goods of which no one should be deprived. It follows that social development should be measured according to improvements in the 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

1. See Arrow (1963) for more on the theorem, its meaning and the substance of the demonstration.

threshold (less than 1.25$ a day) in 30 years. Should this not also be considered one of the highest achievements for human rights?

Rawls (2001) understands primary goods as a broad set of public resources: material, educational and 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.

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. Ethnic discrimination, gender discrimination in social roles, structural unemployment, power relationships in corporations and institutions are all levers exploited in present-day capitalist societies. They help in shaping labour markets so that real freedoms of many people are subordinated to the paramount objective of shareholder value: extracting maximum rent for the benefit of an elite, with the main outcome the extravagant rise in income inequalities over the past 30 years.

Defining sustainability

Sustainability is an intergenerational concept. It is the conservation and possible improvement over time of social welfare as 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

2. In 2001, Rawls revisited his theory and clarified the link between social justice and equity (see Rawls 2001). Freedom of speech and of vote are formal liberties that pertain to primary goods. But freedom for people that are starving and illiterate does not mean much. This is the kind of problem that the "largest democracy in the world" encounters.

finance. When one is evoking finance, one is confronted with 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 leading up to the devastating financial crisis and its costly 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 in 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 to be 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. Causal time is 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 markets that the market reveals. Such an assertion is the result of a confusion in regard to the notion of time. It is postulated that the causal time of objective processes is 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:

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

where VF is 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 Pt =VFt, x must be known. However this equation is just an arbitrage saying that in an efficient market there cannot be excess returns. An arbitrage is just a condition equating the returns on two assets. It can be used to determine the price of an asset only if the return on 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 pre-existing 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 kinds of processes can occur in financial markets. A particular convergence of expectations defines a value and, as a result, an economic equilibrium can ensue. A different

belief that gives rise to another focal point might also produce equilibrium. Beliefs about 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. Indeed regulators were not willing to look inside the intricate web of counterparty risks, because they assumed that finance was self-regulating by nature. They were not upset by the extreme of the momentum in the real estate market, believing that the extravagant levels reached by property prices were fundamental prices. It follows that the turnaround of the momentum surprised them. Indeed the precise date of the turnaround was unknowable, even if the burst of the bubbles was certain!.

This phenomenon points to the theoretical distinction between risk and uncertainty[3]. 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 one based on 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

3. Hyman Minsky was the author that most forcefully elaborated on Keynes's conception of uncertainty. See H. P. Minsky (1992) for more on the theoretical formulation of his thinking.

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.

2. 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' (1940) memorandum to the British Chancellor of the Exchequer on May 4, 1940, followed by another paper by Colin Clark (1940), the conceptual and measurement work to create national accounting began because the British government wanted to know what were the resources the country could muster for the war and how much they were worth. The research program achieved the first consistent system in the 1945 memorandum published by the UN in 1947 (Stone 1947). As a result, 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, and the fear that the great depression would resume after the war on the other. 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 sustainability, it is just lip service. The sense of urgency is nowhere apparent in the West. Public opinion is indifferent at best, and rather hostile in countries like France. Powerful vested interests in energy-producing and electricity-using industries pay armies of scientists to spread climate-scepticism. A related scepticism 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, and "fundamentalist" ecologists on the other hand (Oreskes and Conway 2010). Both consider that persistent and strenuous efforts to internalize externalities are not worthwhile.

The first group, the industrial and financial lobbies, follows its own interests and disguises them under the claim that markets cannot fail. To enhance private profitability it is better to deny that more costs should be taken account of in pursuing its own activities. This is the usual divorce between private and social ways of assessing values while there are market failures. The second group, the "fundamentalist" ecologists, pretends that ecosystems are so radically alien that their impact on human beings, regardless of damage or benefits, cannot be intrinsically measured in value terms. This is pure nonsense because any factor that impinges upon wellbeing always has a social marginal value or cost. Yet what is true is that this social marginal value is not always revealed by a market price, often by a wide margin. Renouncing the quest to evaluate those social values amounts to denying that a global strategy for sustainable development is possible. This is not the way responsible governments and vivid civil societies should behave. Measuring social values is the best and most rational way to define and deliver common goods and therefore to detect the best capital assets in which 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 have been 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. Some possible ways forward have been explored in the Stiglitz report (Stiglitz, Sen and Fitoussi 2009). Enriching GDP from a public policy perspective would need 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, and developing a 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 endeavours 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 a 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 inescapable problem of incentives. Although social values are not reflected in market prices, they should be. In one way or another, they 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 reformed to become consistent with social accounting conditions. The literature on business accounting ignores the problem entirely. 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.

3. A social welfare-theoretic approach of sustainability

The present paper is not the place for a survey of the different approaches for 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 (2012) explores a weak condition of sustainability with its genuine saving concept. 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) (High Level Panel 2012). 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 trans-generational. Its productive base is economic development. Sustainability is defined as a pattern of development that 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 comprising social wealth are measured at their social marginal values in terms of welfare (shadow prices) and that the shadow prices can be taken as constants to get a measure of the "volume" of the growth in wealth. Another way to look at it is by 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 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
Ki(t) =stock of i asset in t. K(t)={K1(t),…., Ki(t),…Kn(t)} vector of capital assets.

V(t)=V[K(t),t] function of intergenerational wellbeing
Shadow price of time: Q(t)=dV(t)/dt
Shadow prices of capital assets: Pi(t)=dV(t)/dKi(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: $W(t) = tQ(t) + \sum_i P_i(t)K_i(t)$

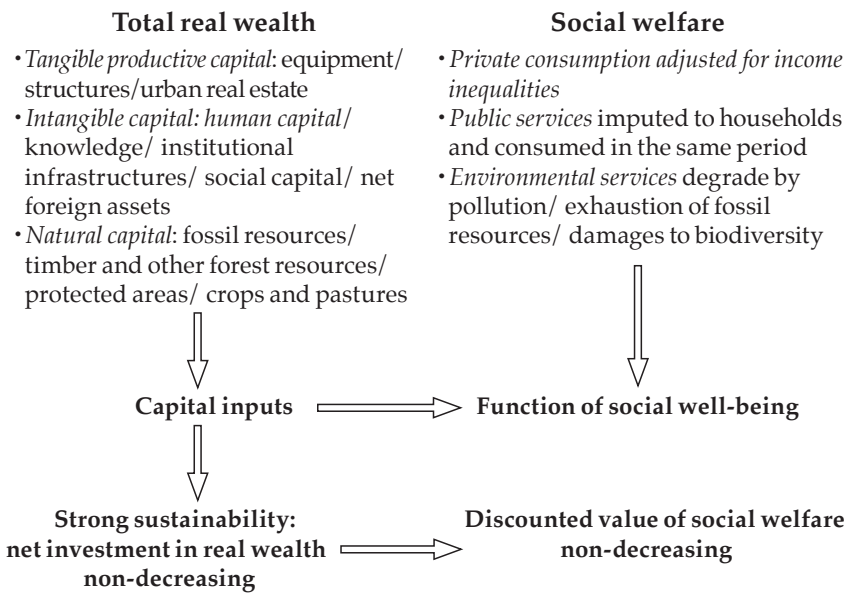
And the sustainability condition: if shadow prices are constant, the duality theorem gives the following condition:

$$\frac{dV(t)}{dt} = Q(t) + \sum_i P_i(t)\frac{dK_i(t)}{dt} = dW(t)$$

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 (Mishra and Peiris 2013). 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 better

understand 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 tropical rainforests). Some of the regimes may induce global systemic crises, massively destroying real wealth and decisively transforming human civilization as we know it (e.g.an increase in average world temperature over 5°C) (Oreskes and Conway 2014). 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 (Stern 2007) 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 (Weitzman 2009).

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 (High Level Panel 2012). 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 a 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 pioneering work by Pearce and Atkinson (1993). Development depends on total wealth defined in a

restrictive way compared to UN methodology, e.g. 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 the 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 increase 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 the 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 becomes 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 well they can value intangibles and they both also 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 supposedly 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.

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

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

Based on these terms, the case of China is striking: massive expansion of fixed productive capital, fuelled 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 damage is 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 it is no longer considered 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 time. 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 measurement of intangible capital, something that has become the most important factor of growth since the ICT revolution. However what is striking is that the WB indicator veers toward GDP, rather than 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. In the US, public health is appalling in terms of life expectancy, morbidity and obesity, while costs are prohibitive. This 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 has 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, as opposed 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.

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

As was 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, and the elaboration of policies for inclusiveness in societies impacted by multiple conflicting interests on the other, 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 raises enterprises to 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 has become most influential in financial elites and popular among academics and politicians, that firms are agents of their shareholders[4]. Meanwhile the average holding time of business equities in OECD countries has dramatically declined from five years in the late 1960s to five months in 2010. The reason is the spread of the Anglo-Saxon model

4. In 2001, Hansmann and Kraakman (2001, p.89) wrote that the rules of corporate governance were being uniformed under shareholder value. The principle according to which firms must be exclusively run for the sake of their shareholders had already reached a very large normative consensus. They added that the dominant ideology of shareholder value would not be challenged in the future. According to their opinion, it amounted to the "end of history" in corporate governance. Hansmann H. and Kraakman R. (2001), "the End of History for Corporate law", Georgetown Law Journal, vol.89, pp.439-468.

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 the interest nor the 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 should 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. Contemporary societies must overcome the mutation from the failed growth regime of financialised capitalism to bring their economies onto a sustainable growth track. In Section 1, the basic reasons grounded in the very nature of finance were 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

idealised 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 an entity in its capacity to make commitments on behalf of the enterprise. Excluding slavery, the enterprise 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 in 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 shareholder ship being replaced by a much larger stakeholders hip in corporate governance (Mayer 2013). 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 the cooperation, individual marginal productivity cannot be measured in full. Correlatively individual marginal productivity cannot be measured entirely.

Stakeholders have multiple interests. With 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 within 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, and objective criteria need to be 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 due to the participation of employees, not only by redistribution that was a principle of the post-war growth regime labelled "Fordism". They will be actors of sustainability if their strategies are shaped by investments that conform to 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, and 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, whether this is comprised of 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 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 at the present time: the development of 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 financialised capitalism makes it self-evident that a narrow view of property rights legitimates incentives of firm managers to maximize shareholder value.

While sustainable growth has gained momentum as a primary finality in the political debate, the need for consistency between the macro accounting of total real wealth and business accounting should become a requirement in order to fulfil incentives embodying environmental and societal objectives in corporate governance. Under those new incentives it will 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 to whom must the firm be accountable? Which performance criteria must be accounted for? Under which procedures must they be accounted for? 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 each 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 valorisation are integrated in standard financial accounts. Extra-financial accounting would have to be experimental in any 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 (Schoum, de Saint-Front and Veillard 2012).

Considering social responsibility, since the capabilities of workers acting as a team comprise the main productive asset of the firm, expenditures to reproduce and expand them must not be treated as operating costs, but as investments 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 a wage policy as a cost to compress as much as possible, wage policy would become investment policy to be anticipated as an integral part of investment projects.

6. Long-term finance and sustainable growth: How to finance climate policy?

Both the scope of possible human and material damages and their irreversible character if the average temperature increases above 2°C (compared with pre-industrial times) are arguments in favour of urgent and strong action by 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 2014") indicates that the emissions from human origins have increased during the years 1970-2010 at a rate higher than 2% per year, and that the last decade 2000-2010 has known the biggest increase in human history[5]. Past climate policies, which do not allow the increase in temperatures to be reversed, have thus been largely insufficient.

The uncertainties of the costs resulting from climate change cover several types of realities: uncertainty regarding the scope of climate damage with respect to the increase in temperatures; uncertainty about the scope of technical change, also mostly irreducible, allowing us to reduce the costs of abatement activities; uncertainty on the discount rate to be used today to evaluate damages that could occur in the very long run.[6] These different forms of uncertainties provide compelling reasons for societies to take early action against climate change, and eschew all forms of delay. The fifth evaluation report of the IPCC, published in 2013-2014, strongly called for increases in the level and the changes in structure of annual productive investment in the period 2010-2030 to help mitigate climate change. These included a reduction of the investments in fossil fuels, an increase of around $150 billion for investments in renewable and nuclear energy, as well as capture and storage of carbon emissions; and an increase of around $340 billion for investment in increasing energy efficiency in transport, housing and industry. According to the International Energy Agency (IEA), the annual investments in energy efficiency and low carbon technologies should reach $790 billion in 2020 and $2300 billion in 2035 in order to limit the temperature increase to 2°C.

5. According to a new analysis by the UN Wprld Meteorological organization, CO2 concentration rose 2.9 parts per million (ppm) between 2012 and 2013, the biggest annual increase sinc 1984. The IPCC 2014 report (part 1) states that the last three decades have been successively warner at the earth's surface than any preceding decade since 1850.In the Northern Hemisphere, 1983-2012was likely the warmest 30-yearperiod of the last 1400 years.

6. This uncertainty has polarized the debates on the costs of climate change after the Stern report (Stern 2007.) There has been criticism of the choice of a very low pure time preference that is not reflected in the discount values emerging from market prices (Nordhaus 2007).

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 giving 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, circumventing the equity principle. Emissions per head should be equalized in the very long run.[7]

Such an objective provides direction to the principle proposed by India at the Cancùn Conference, that of "equal access to sustainable development" (soon to be called the 'Cancùn paradigm shift'). Logically, this will require a massive increase in help from developed countries to developing ones. In this regard, the Cancùn Conference of Parties (COP-16) can be understood as a real shift, translating international negotiations from a top-down and insufficiently cooperative approach (a unique carbon price linked to a world market between states for emission reductions and burden sharing) based on the obligations of states towards an international climate regime based on the responsibility of states to voluntarily promote nationally appropriate mitigation actions[8].

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 Emission Trading Scheme", or EU ETS) are among those. If future damages due to GHG emissions were knowable with certainty, -, taxes and permits would be equivalent. In certain economic conditions 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; tax gives it on prices. The tax is more predictable only if the government has a well-defined climate policy in the medium run,

7. As Stern (2007) clearly states, if the world must emit less than 20 billion tons of CO2eq in 2050 and the planet will 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.

8. Nationally appropriate mitigation actions (NAMAs) for developing countries and Nationally Determined Contributions (NDCs) for all countries.

associated with a trajectory of carbon prices on which it is credibly engaged. On the other hand, the emission rights market is an asset market, and is thus accompanied by chaotic price trajectories, as the European market has well illustrated. A market that is affected by multiple externalities cannot be efficient. 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 is oblivious to weak environmental policies that are reached without any conviction, and prone to unpredictable changes of direction, amplifying the risks linked to the investments. They generally are 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 put in place seriously, they impose immediate transition costs on entire sectors of the economy, early and indifferently depreciating parts of the installed capital of the economy to give value to a capital that is yet to come, and they have certain redistributive effects that are hard to quantify. The political economy arguments do not play in favour 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, nationally appropriate mitigation actions, (NAMAs) could lead to an emphasis on national objectives of development: tightly linking low carbon technologies and the local environment, investing first in human capacities and R&D using the macroeconomic policies to lower the arbitrages between technical and social costs. There are several potential bottom-up initiatives here. The compatibility between many decentralized actions and the global goal of containing climate change becomes crucial (Guesnerie and Stern 2012). The NAMAs allow the governments of developing countries to integrate the governmental objectives into 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 global climate change can thus be insured.

Of course the installed "dirty" capital must be depreciated in order to make room for "clean" technologies. But this must be done at the margin by new investments accumulating over time. Developing a new direction for the current investments and the investments to come is a priority that can be compared to the revaluation 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 that 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 on these investments can be adjusted through the acquisition of carbon assets produced against monetary emissions. Money is indeed something that 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 favour of the carbon externality.

Confronting the funding gap

There is a huge funding gap in achieving a transition to a low-carbon economy. 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 but must also 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 from one energy system to another must account for redirecting investment in building and transportation to achieve higher energy efficiency and lower energy demand permitted by changes in consumer behaviour. For around $500bn of incremental investment costs in 2020, a back-of-the-envelope calculation gives about $4100bn of redirected investment (Aglietta et al. 2014).

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 not designed to reduce the upfront investment cost. 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 will 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 be borrowed on highly 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 financing of overly narrow and divided projects to be avoided, 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 - exactly what infrastructure and green bonds are not. These are alternative assets the institutional investors seldom possess, i.e. <1% of their portfolio for the pension funds in countries of the OECD (OECD 2013), because these instruments have the triple handicap of not being liquid, having high levels of risks, and dependant on tentative 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 on-going 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 means that only the short term is valued, with most investors facing regulatory restrictions on long-term asset ownership. Competition policies that separate 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. And while the activities are technically and economically integrated, there is no history of prices or benchmarks, forcing producers to internalise the management of assets completely (with supplementary costs). The green investments have supplementary handicaps. The most crippling argument is the inadequacy or even the non-existence of a carbon price determined by the market for polluting rights. This handicap is all the more striking given that innovations in "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 cessation of fossil fuel energies, these investments will continue to be dominated by the existing infrastructure.

As a conclusion, these binding constraints force the need 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 for 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 that grows over time. But this monetary value cannot be obtained at present by a tax or a market that weakened economies after the crisis could bear (Hourcade, Shuklaet and Cassen 2014), One must thus think in a different way: the base of financing the transition towards a low carbon economy can only be monetary.

7. 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 that equalizes the marginal cost of reducing emissions and the marginal gain of avoided climate damage, 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 CO2, 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 of which some are unknown (Dumas, Hourcade and Perrissin-Fabert 2010). 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 five 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 related to the high immediate employment impacts 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 CO2-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 a 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 risks due to the production of carbon assets are 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. 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 the value of the guaranteed carbon assets on the asset side of their balance sheets. 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) that 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 a temporary device to launch a wave of innovative investments as much as quantitative easing (QE) has been to alleviate the impact of the financial crisis. As long as those investments are 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 should 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 a 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 may 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 loan 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 savings 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 governments 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 in 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, and lend to development banks.

Table 3. Financial intermediation via Green Funds

<table>
<tr><td colspan="2">Specialized financial investors</td><td colspan="2">Green Fund</td><td colspan="2">Institutional investors</td></tr>
<tr><td>Assets</td><td>Liabilities</td><td>Assets</td><td>Liabilities</td><td>Assets</td><td>Liabilities</td></tr>
<tr><td rowspan="2">Carbon assets from validated projects</td><td>Loans from EGF</td><td>Loans to finance specialists</td><td rowspan="2">Bonds on carbon assets</td><td>Climate Bonds on carbon assets</td><td rowspan="2">Collective saving (retirement contracts, life insurance, state funding of SWFs)</td></tr>
<tr><td>Other loans</td><td>Project bonds</td><td>Other bonds</td></tr>
<tr><td>Other assets</td><td>Capital</td><td>Equities</td><td>Capital</td><td>Equities</td><td>Capital</td></tr>
</table>

Therefore green funds could be established in every country participating in the international agreements on the notional carbon price and related state backing of carbon assets. The funds can mediate the financing of well-diversified investment projects, thereby creating carbon assets. Thanks to the diversification of risk in its interventions and the strong backing of its capital, the European green Fund 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 with a new class of assets weakly correlated with existing assets. Because the specialists financing individual projects can be dispersed throughout 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 dependencies.

8. Conclusion

The paper has emphasized the linkages between a conceptual framework of social welfare improvement that can be called sustainable development, and shown the need for 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 indicated that deep changes in corporate governance and business accounting are required to provide incentives for private firms to correspond with strategic national planning goals. Finally, the paper has taken the view that climate policy could be 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 as well as the commitment of governments to achieve a definite amount of carbon abatement in a finite period of time is a precondition to define and run a new financial intermediation. This will provide the monetary backup necessary to overcome the inability of financial markets to provide the huge amounts of credit needed to reorient the production system.

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