SEEDS
Sustainability Environmental Economics and Dynamics Studies

Working Paper Series

Contextualising Sustainability: Socio-Economic Dynamics, Technology and Policies

by

Marianna Gilli, Massimiliano Mazzanti

04/2019

SEEDS Working Paper 04/2019
March 2019
By Marianna Gilli, Massimiliano Mazzanti

This is a pre-print document of the article that has been published in the book Cultures of Sustainability and Wellbeing: Theories, Histories and Policies (1st Edition), available at DOI: https://www.routledge.com/Cultures-of-Sustainability-and-Wellbeing-Theories-Histories-and-Policies/Spinozzi-Mazzanti/p/book/9781138234543

Contextualising Sustainability: Socio-Economic Dynamics, Technology and Policies.[1]

Massimiliano Mazzanti and Marianna Gilli

I. Conceptual Background

Gross domestic product (GDP) indicators are limited in their capacity to completely reflect socio-economic performances and need either alternative or complementary indicators (van den Bergh and Antal; Jones and Klenow).[2] [3] While alternative indicators to GDP might be useful, this chapter focuses on complementary ones, namely theories and empirical indicators that attempt to integrate GDP with other measures of welfare. Human development, stemming from the work of the Nobel Prize winner Amartya Sen, is one such indicator. In 2009 the French government established the 'Stiglitz-Sen-Fitoussi' Commission to develop an updated conceptual framework. Other indicators beyond GDP have emerged out of environmental and ecological economics (Perman et al.; Turner and Pearce), such as sustainability-oriented genuine saving accounts (Costantini and Monni, "Sustainability"; Costantini and Monni, "Environment") and hybrid environmental-economic accounts (European Environment Agency, *Resource-Efficient Green Economy*; Marin et al.; Marin and Mazzanti; Mazzanti and Montini; Costantini and Mazzanti).

Genuine savings highlight the necessity to continually invest in economic and natural resources to ensure sustainability. Hybrid accounts (e.g., integrated and coherent GDP, employment, emission data) are useful for elaborating upon economic-environmental efficiency-oriented indicators such CO_2/GDP and waste production/GDP in order to promote data-informed policymaking and socially efficient firm/sector resource management.[4] This synergistic view of economic and environmental factors and objectives (e.g., reducing emissions while creating more jobs) is coherent with the relatively recent notion of a green economy (European Environment Agency, *Resource-Efficient Green Economy*; Barbier and Markandya).

The objective of this chapter is to offer both a conceptual and empirical overview of the factors that might positively correlate with positive human development (HD) and sustainable development (SD) performance, particularly innovation investments, knowledge transfers and environmental policy. Our analysis falls within the beyond GDP and sustainability-oriented conceptual realms.

In summary, social and environmental indicators are necessary for complementing GDP analysis for two main reasons. First, GDP, although an important and iconic indicator in our society, is only an instrument for reaching the goal of higher social welfare. Defined in either strictly economic utilitarian terms (Jones and Klenow) or broader conceptions of welfare, prices for market goods as reflected by the GDP represent only a fraction of value. Social value is also attributed to goods that are public and extra-market in nature (e.g., environmental externalities such as pollution and greenhouse gases, innovation and knowledge spillovers, health, education, etc.), to which we may assign a price (e.g., a carbon tax defines a price for pollution). Relevant socio-economic dimensions go beyond what GDP can capture in terms of efforts to increase welfare that are strictly linked to poverty reduction, pollution reduction and increasing the quantity and quality levels of both private and public goods. Economics, political economy, public economics and economic development issues thus extend well beyond profits, finance and mere growth. Those are important, but only as components of a larger picture in which proper economic 'management' incorporates all relevant social resources (economics as oikos-nomos). By relevant, we mean resources that have a social value due to absolute or relative scarcity and because economic agents (consumers, taxpayers, firms) are willing to pay for increasing levels of consumption.

II. Economic Development and Sustainability

In the model of long-run economic development, human capital accumulation and innovation (R&D as input, patents as formal outcome, tangible and intangible knowledge diffusion, etc.) drive income (GDP) per capita. GDP is thus the basis for measuring enhanced HD and sustainability performance (higher GDP levels might be used to fund strategic public goods, health, education and environment quality).[5] It is worth noting that economic performance in the short run does not automatically lead to positive long-term dynamics. The issue is 'how we spend' and 'on what we spend' our current income as a society.[6] Again, to establish a sustainable society (using broad conceptions of sustainability), the notion of 'investments' should be placed at the centre.

Investment (compared to consumption) is the only factor that jointly increases current economic demand (what we need today to escape stagnation) and generates new foundations for capital forms. A sustainable society is an 'investing society' that is able to (more than) compensate for its natural erosion of capital (natural, manmade, human)[7] and transfer to future generations at least the same stock of total/natural/human/technological capital that it received.[8] The potentially different strategies which countries implement in terms of investments and policies assign importance to analysis of convergence in relation to GDP and overall welfare. Much of the current economic turmoil and imbalances stem from improper public policies and lack of income distribution that have generated poor convergence, notwithstanding the important achievements by emerging and developing countries over the past 20 years. Convergence is an empirical fact and is a pre-condition for a sustainable economic and political global community. The lack of convergence risks creating political turmoil, excessive migration and economic imbalances within integrated areas.

A sustainable society is thus a society that properly invests and introduces 'well designed' policies (Costantini and Mazzanti, "The Dynamics"; Costantini and Mazzanti, "On the Green") that correct for the various market failures and encompass environmental, knowledge and health components, among others. In those realms, markets 'fail' when policies and/or state intervention are necessary to increase social welfare. In addition to socio-environmental goals, environmental policies may provide support to economic performances if 'well designed policies' (Baumol and Oates; Porter and van der Linde; Porter; Ambec et al.) are able to spur adequate (environmental) innovation[9] dynamics. Nevertheless, this is a general statement that should be verified case by case at the macro-, meso- and microeconomic levels (Borghesi et al. "Carbon Abatement"; Mancinelli et al.). Among others, Albrizio et al. have recently showed that a tightening of environmental policy is associated with a short term increase in industry level productivity growth in the most technologically advanced countries.

III. Environmental Policies and Ecological Taxes

Among environmental policies, ecological tax reforms (ETR) comprise a factor that could characterize a country's approach to enhancing welfare. Ecological tax reform serves as an umbrella under which market-based instruments can be optimally designed and coherently implemented. In *The European Environment - State and Outlook 2005* published by the European Environment Agency it is explained that:

> Tax reform can contribute to a more sustainable, healthy environment. A gradual shift of the tax base away from taxing 'good resources' such as investment and labour and towards 'bad resources' such as pollution and inefficient use of energy would also help to internalise external costs into service and product prices. This would in turn create more realistic market price signals. (22)

ETR follows the work of Arthur Cecil Pigou, a mentor of John Maynard Keynes, who formally demonstrated about a century ago that environmental taxation enhanced social welfare. The only tax in microeconomics that increases net social welfare is a green (Pigouvian tax) because its economic costs are lower than the social benefits (reduced pollution) it generates. In addition, a tax – broadly a market-based instrument – provides a price incentive. Firms are continuously incentivised to reduce pollution in order to decrease tax expenditures. Firms are thus 'forced' to innovate and be more efficient. Such green innovations may produce win-win scenarios in which economic and environmental performances are jointly increased through innovation. The 'social' role of innovation is then explained as a major driver of economic growth in the long run and enhances the possibility to transition to a greener, more sustainable society.[10]

For a comprehensive conceptual and empirical examination of ETR's political economy arguments, we rely on Ekins and Speck. Ecological/environmental tax reform (ETR) is an essential element in long-term sustainable growth/development. During strong (social) crises, ETR may serve to call into question the entire (social) 'model of development'. ETR modifies relative prices by targeting resource scarcity and externalities and relaxes burdens on factors such as labour and/or using revenues to support public investments in R&D, technology, shaping green consumption options, energy saving choices/investments and measures for direct environmental protection. ETR could be used to reduce labour taxes, eventually targeting the weak part of the labour market: young people, women, the long-term unemployed, etc. ETR can fund education and training, finance direct public expenditures for increasing demand and green features (technology and infrastructure) and subsidise prices and interest rates in the market to rebalance relatively static and inter-temporal prices in favour of greener options. The increase in revenues might be substantial over the long term. The 2014 *Study on Environmental Fiscal Reform Potential in 12 Member States* calculates 101 billion € from environmental taxes in 2025, given current figures of 35 billion €. Especially in the EU, which still faces less than full employment production levels and very low inflation, ETR could easily gain momentum (European Environment Agency, *Environmental Taxation*).

Building upon the aforementioned conceptual background, with roots in the realms of political economy, environmental economics and public economics, this chapter attempts to serve as a vehicle for engaging with other disciplines along the wellbeing-sustainability 'fil rouge'. It explains the broad potential of economic discourse for future inter/multi/trans-disciplinary projects. It links conceptual analysis with updated macro-empirical figures, thus presenting an applied economics way of thinking; the empirical analyses take a global or more restricted European/OECD perspective, depending on data availability for key indicators. Finally, it offers some policy recommendations that are useful for policymakers who operate in economic or more hybrid departments, as well as for researchers seeking to develop projects that span disciplines.

The following sections present descriptive and quantitative evidence. First, recent data are used to describe some macro trends about (green) innovations, environmental policies and human development trends and to develop a new framework. Second, sustainability arguments are addressed by presenting a global picture about greenhouse gas increases and their socio-economic drivers, namely innovation/efficiency, economic composition and growth. Convergence is finally addressed by looking at European HD trends. The final comments summarise the main issues and point to future inter/multi/trans-disciplinary projects.

IV. Innovation, Policies and Human Development: Macro Trends

We present updated macro trends based on available data on the key sustainability-oriented socio-economic indicators presented and discussed above. On the innovation and knowledge side, trends about inventions (patents), innovation adoption of environmental innovations and R&D are presented. In a typical 'innovation function' framework, R&D is the input, while patents and adoption are the outputs. Environmental policies and ETR trends are presented both worldwide and at the EU level, where ETR has been a major issue since the publication of the European Commission white paper back in the 1990s under the presidency of Jacques Delors (Commission of the European Communities). It remains an innovative political agenda oriented towards growth, job creation and sustainability. We support the hypothesis that stronger innovation investments and more stringent environmental policies might increase future wellbeing (Brunel and Levinson).

IV.1 Innovation and Invention: Towards a Green Economy

Figure 1 shows the trend for patents filed under the PCT (Patent Cooperation Treaty) from 1977 to 2013. For one group of countries, namely Germany, France, the United Kingdom, Italy, Japan and the United States, the trend has arisen over the period. In particular, the filing of patents has dramatically increased in the US since the end of the 1980s, reflecting the significant funding for R&D and inventions. By the 1990s, the quantity of patents had increased by over four times what it was in 1985 (2,559.47). The trend escalated until the 2000s, when it encountered some difficulties, probably due to the economic and financial instability caused by the Internet bubble of 2001 and the more recent crisis of 2009. In addition, Japan experienced fast growth in the number of patents, especially from 1998-1999, when 10,895 patents were filed. Before the economic crises (less than 10 years later), around 30,000 patents were filed annually. The effect of the crisis on Japan's inventory flow has been minor compared to the United States, with 1,000 fewer patents filed compared to the previous year. Germany is a leader in patenting activity in Europe. Since the second half of the 1980s, the growth in the number of patents filed has increased exponentially in comparison with other EU countries. In 2007, the number of patents filed under the PCT by Germany was approximately six times higher than the number of patents filed by Italy, the country with the lowest growth in patenting activity (18,743.48 for Germany; 3,361 for Italy). As with Japan, Germany, France, the United Kingdom and Italy experienced less of an effect of the economic recession compared to the US. Overall, the trend is more volatile in the US than in the EU, possibly a product of two different capitalism models: the Anglo-Saxon market base and the 'continental' one (comprising Germany, France and Italy, among others) in which the state plays a greater role as an economic player and regulator. The role of the state as innovation funder is in any case strong in the US. It is finally worth noting that the EU has not reached the 3% target for GDP expenditure set by the Lisbon agenda for growth and jobs in 2000.

FIGURE 1 HERE

FIGURE 2 HERE

Figure 2 presents the R&D figures for some major countries (GERD is the total R&D spending). The global role of the US is clear. Germany is the leader of the EU, though it does not meet the 3% R&D/GDP Lisbon agenda target. Figure 3 focuses on the EU and depicts the variation of R&D expenditures in the EU in 2005-2013. It is worth noting that eastern European countries are the most dynamic, likely due to their wider access to European-financed programmes for technological improvements. Northern countries such as Norway, Sweden, Germany and Austria are leaders in the development of new productive processes and products, so the positive growth in their R&D expenditures is not surprising (Gilli et al., "Sustainability and Competitiveness"). Notice that France, which can also been included in the group of the innovation leaders, did not notably increase its investment in R&D during the period. Among southern European countries, the only noticeable increase in R&D was in Portugal. Those are significant changes. The R&D investment is still at 2% of GDP in 2014, versus a target of 3%. Northern European countries present higher R&D investments as a share of GDP.

FIGURE 3 HERE

Moving back to the global picture in Figure 4, it is worth noting that in the majority of BRIC countries the growth of patents filed under the PCT was close to 0 until the early 2000s, with the exception of Russia, where patenting activity has been growing since the mid-1980s, and Brazil, where patenting activity slightly increased during the 1990s.

Since the late 90's India and China have experienced a very fast increase in patenting activity. Since 1999, the number of patents filed in China increased from 579 to 22,184 in 2013, a growth of 3,731%. In India, the number of patents increased from 203 in 1999 to 1,970 in 2013 (844% growth). These numbers are driven, among other factors, by the quick economic growth that most Asian countries have experienced over the last two decades.

Looking at the specific segment of *green patents* in Figure 5 four global players emerge (OECD, *Invention and Transfer*): the USA and Japan (typical patent developers), Germany (the EU leader) and South Korea (in an emerging role). South Korea serves as a stunning case study for growth and HD performance. It has a strong role in invention as well, affirming the link between growth and innovation. It is worth noting that South Korea devoted the bulk of its 2009-2012 fiscal recovery packages to green investments (30 out of 38 billion), part of the global strategy set at the 2009 G20 summit in London to tackle the economic and financial crisis through public investments.[11]

Green patents by GDP further highlight the astonishing South Korean performance, which overtakes the US in 2005 and then continues to move further up. The green invention performances by Germany, the UK, France and Italy are notable too in relative GDP terms (Figures available on request). Germany, by far the EU leader for the entire period, interestingly, and perhaps worryingly, has recently had a declining pattern. The gap with respect to the US has widened. One explanation is due to the different economic policy directions the two countries have taken after the recession, with an expansion of the public budget in the USA and the opposite in Germany. This might be one reason, given the importance of public spending in innovative capacity (Mazzucato). In addition to the problems deriving from insufficient demand in the short run, 'austerity' measures might generate lower innovation performances. In fact, innovation and invention depend largely on basic funding (R&D) and market expectations (GDP growth).

FIGURE 4 HERE

FIGURE 5 HERE

IV.2 Environmental Policy Stringency and Ecological Taxes

Figure 6 shows the trend of the OECD Environmental Policy Stringency indicator, a country-specific and comparable measure of the stringency of environmental policies.[12] Among the considered countries, most of the variation occurs in Italy, Japan, the United Kingdom and the United States, while China, Brazil and Russia present a stable trend throughout the period. India shows a slight increase in stringency after 2005, when the index increased from approximately 0.6 to 1. As regards the first group of countries (Italy, Japan, the United Kingdom and the US), the variation in the stringency is quite hectic, in some cases increasing and decreasing from year to year. Despite the yearly variation, the trend has been generally increasing since the second half of the 2000s, with a peak of 3.65 in 2010 by the United Kingdom. Overall, then, there is evidence that stringency positively correlates with income levels. As with many other public goods, the environment is economically speaking a ‘luxury good’, with its ‘consumption’ increasing more than proportionally with income. Two issues are thus at play. First, emerging and developing countries can imitate and follow strategies adopted by more advanced countries. This has happened in the EU with the compulsory EU policy implementation for recent members (primarily eastern EU countries). This might happen today if we look at the increasingly important role of China in global environmental policy, especially climate change policy (Mazzanti and Rizzo). China, again due to increasing income levels and high pollution, has started implementing policies that are more stringent. Second, in the ‘Trump era’, with the US playing possibly an even weaker role in climate policy, China can emerge as the new big player, alongside the EU. For example, China has set a new strategy regarding emission trading systems for carbon emissions (Borghesi et al., “The European Emission”).

FIGURE 6 HERE

Ecological tax reforms are important elements of environmental policy implementation, especially in the EU (see European Environment Agency, *Environmental Taxation*, for a wide analysis of trends). Figure 7 shows the yearly change in total environmental taxation from 2005 to 2013 (environmental taxation revenues are presented in current prices). We thus focus mainly on comparative figures (across countries and ET categories). Figures 7 and 8 depict the change in total environmental taxation and per capita environmental taxation, respectively.

Looking at Figure 7, it is worth noting that environmental taxation[13] in northern as well as southern European countries has changed less than in eastern European countries. Once again, eastern European countries have been among the last to join the Union and probably did not have a well-developed environmental fiscal system prior to the introduction of the minimum excise tax rates by the Energy Taxation Directive (2003/96EC). Consequently, they might have needed to introduce environmental taxation to comply with the European Union legislation. The average environmental taxation in eastern European countries is well below the average taxation elsewhere: 19,640,000 €, compared to 128,324,700 € in southern EU countries and 180,131,600 € in northern ones (figures and data are available on request).

In line with the results depicted in Figure 7, Figure 8 shows that per capita environmental fiscal pressure has increased the most in eastern European countries, especially Estonia, Latvia, Romania and Bulgaria, testifying to the importance of focusing on total and relative changes as well. Income and population dynamics are heterogeneous across EU countries.

FIGURE 7 HERE

FIGURE 8 HERE

V. Innovation, Knowledge Transfers and Sustainability

Innovation and economy composition effects drive environmental and economic performances (Quatraro; European Environment Agency, *Resource-Efficient Green Economy*; Gilli et al., “Sustainability and Competitiveness”). Societies evolve by introducing new technologies that improve efficiencies in the use of resources and introduce new goods and services. Innovation and knowledge development complement the changes in the ‘content’ of the economy (moving from industry to services, changing the mix of industry and services, etc.). High-income countries have naturally a very high share of services, while developing and emerging countries are today's global manufacturers. Within high-income countries, Italy and Germany are outliers in terms of industry relevance, but the industry share today does not exceed 20% of GDP. Thus, two important issues emerge.

The first is linked to the more innovative contents of manufacturing with respect to services. The increased share of services might generate reductions in income per capita. For this reason, the EU has launched a 'manufacturing strategy' so that industry makes up 20% of the GDP by 2020. It is worth noting that in the short term these strategies increase emissions. On the other hand, the innovation contents of manufacturing might then reduce emissions. This testifies to the fact that environmental sustainability in some ways depends on the capacity of 'innovation' (technological, behavioural) to more than compensate for the scale effect of growth.

Second, stronger globalization and economic integration lead to lower 'national' thinking, even in terms of environmental policies and accounting. If it is true that technological improvements drive emissions reductions, part of the reductions we observe could be dependent on the delocalization of production (Levinson, "Technology"). This means that both the sustainability of production and consumption would be at stake. High-income regions activate production in other areas of the world: the derived environmental emissions are shared in terms of responsibility. National emissions figures only capture the 'production perspective', not the consumption side (e.g., imports from China that embody emissions and are activated by the demand of the US and EU) (European Environment Agency, *Resource-Efficient Green Economy*; Marin et al.; Gilli et al., "Sustainable Development"). The toy global industry is a stunning case study. The UNIDO Industrial Development report (2015) is a key reference for understanding the global relevance of innovation and structural change as sources of economic growth, development and sustainability (for a more analytical extract see Gilli et al., "Sustainable Development").

Figure 9 shows an interesting analysis of how environmental performance can be disentangled, looking closer at innovation (efficiency), composition, and growth effects. We decompose environmental pressures per capita of the manufacturing sector (either direct or 'consumption-based') into various components: level of value added per capita (scale), share of production or consumption of a specific manufacturing sector over total production or consumption (composition); environmental pressures per unit of production or consumption (intensity). The analysis is based on EORA data (Lenzen et al. "Mapping the structure", "Building EORA").

Striking differences appear globally across the four different groups of countries. First, we note that industrialized countries are the only group associated with a negative trend for CO_2 emission in the analysed period (1995-2013), while the other three groups registered a significant increase in emissions. Among the three components, the wealth effect always has a positive impact on total emission with the exception of the 'least developed' countries, where it is negative. On the other hand, the composition effect has a similar and negligible impact on the four income groups, while the efficiency/technical effect (intensity of emissions in GDP) shows some important heterogeneity. In particular, technical improvement has reduced total emissions in all income groups with the exception of the 'least developed' countries in which the emission associated with this effect grew in the analysed period.

The picture is extremely interesting, given the critical economic and environmental situation of the least developed countries that have suffered economic stagnation, even within a positive period of growth for developing and emerging countries, taking into account the 2008-2009 downturn. Developing countries instead grew but did not sustain efficient economic activities. With composition still negligible, the compensation effect of efficiency factors remains marginal. In the post-Kyoto era, notwithstanding the diffusion of Clean Development Mechanisms projects worldwide (Costantini and Sforna), low income and developing countries have not taken advantage of either policy-induced effects or technological diffusion. The new global carbon fund (CGF) should take this evidence into serious consideration when financing mitigation and adaptation projects. The GCF derives from the conference of the Parties in Cancun. It is a key pillar of climate change policy after the COP21 in Paris and should fund adaptation and mitigation strategies at an expense of around $100 billion a year by 2020. The sources of funding might be international donors and the usual government taxation, including long-term debt accumulation, or more specific and innovative solutions such as carbon taxes and emission trading auction revenues.

Emerging countries show an expected growth-led emission path, with some signs of efficiency compensation (innovation offsets), a signal that internal innovation mechanisms and international transfers of technologies have affected overall emissions trends.

Within a more stable composition of the economy, industrialised countries have succeeded in compensating scale effects with higher efficiency. The striking differences in emission intensity call for knowledge transfer, not just in terms of north-south (namely, richer northern areas selling technologies to poorer countries), but south-south and south-north feedback as well. In fact, knowledge should be transferred through various channels in which the emphasis is on the co-creation of knowledge and mutual feedback from the involved parties. It is worth noting that the effectiveness of knowledge transfer depends on the capacity of recipients to absorb knowledge, a product of the aggregate level of R&D investments, but also on the coherence between developed technologies and the cultural-institutional systems that host and adopt it. In addition, technological change is always effectively implemented if integrated with education and training investments.

Within this global integrated discourse, two innovation issues are pivotal: the role of frugal and grassroots innovations and non-codified knowledge. The key element linking them is the necessary expansion of the meaning of innovation to understand the real innovation phenomenon. Innovation is much more than (patented) technology, consisting of both (i) tangible and intangible knowledge flows and (ii) complementary technological advances, organizational change and training in terms of human capital formation, skill redevelopment, etc. In fact, better social, environmental and economic performance, namely greater wellbeing and enhanced capabilities to create welfare and income, arise from the complementary use of diversified forms of innovations. Small innovations are as important as large-scale innovations: the effect is crucial to understanding its value for society and people. The central factor of interest is the context for adopting the innovations and the synergies that are present, which of course are also highly dependent on the context, such as geography, the sector, etc. Questions such as ‘which innovation(s) and how and where they are to be adopted’ must be conceptually and empirically addressed. Education and training play a special role in the process. Though often overlooked, the formation of (new) skills and competences always complements techno-organizational innovations, given the primary relevance of human capital across development levels. Human capital is the necessary factor for achieving a sustainable society where technology increasingly transforms into social values and capabilities through enhanced access to resources.

FIGURE 9 HERE

VI. Convergence in Human Development

This section provides an example of a convergence analysis using HD indicators. Other indicators and areas can be used to replicate the exercise. Convergence analysis is a simple and effective tool that shows how economic theories are quantitatively tested. It is worth recalling the policy and political flavour of convergence/divergence analyses. The ultimate goals of our societies are (i) to increase wellbeing in terms of (human) development (as a whole and in its specific components) and sustainability, defined in terms of ‘investing society’,[14] and (ii) to increase those indicators with an eye to the equitable allocation of resources worldwide and in sub regions. It is clear within economics that ‘equity’ is not just a social aim (Picketty). Inequality can in fact hamper economic growth, which is based on a proper balance between wages and profits (Kaldor; Pasinetti). Excess profits might mean a lack of demand, which leads to a typical capitalistic crisis. Sustainable economic growth thus depends on a balanced increase of investments, demand and profits.

The motivations behind investigating convergence in this realm relate to the striking differences in the trends of HDI and other variables among the different geographical areas considered, namely Northern Europe, Southern Europe and Eastern Europe. Convergence analysis will evaluate HDI in countries with variable speeds of economic and social development. In other words, we assess whether the human development gap between more and less developed countries is closing.

As outlined in Barro and Sala-i-Martin, convergence analysis is an important tool to assess various aspects of economy. They originally applied it to the rate of growth of an economy (i.e., the growth of GDP) and identified two concepts of convergence, β-convergence and σ-convergence. According to their definition, β-convergence exists when “poor economies tend to grow faster than the rich ones” (Sala-i-Martin 3), while σ-convergence exists when “the dispersion of the real per capita GDP levels tends to decrease over time” (Sala-i-Martin 3). Thus, according to the authors, β-convergence relates to the mobility of the different economies within the given distribution of world income, while σ-convergence concerns whether the cross-country distribution of world income shrinks over time.

The two definitions are certainly related; in fact, if a poor economy grows faster than a rich one (β-convergence), their GDP levels will become more similar, therefore causing a reduction in cross-country variability of income (σ-convergence). It is tautological that if the levels of two economies become similar over time (i.e., the dispersion of GDP decreases in time and there is σ-convergence), the poor ones grow faster than the rich ones (β-convergence).

The methodology proposed by Barro and Sala-i-Martin for income growth rate can be applied to the HDI growth rate. Variables that may influence the process of convergence are included as drivers, such as GDP, environmental taxes, R&D expenditure and capital and labour. The results are depicted in Figure 10.

Less developed European countries are actually catching up with the most developed ones; moreover, environmental taxation, especially for transportation, appears to have a positive and effective role in favouring this process. R&D expenditures are also of vital importance, bearing relevance across the various convergence analyses). Income, capital and labour do not have a significant role in fostering β-convergence. These comments relate to econometric estimations, which are available upon request.

FIGURE 10 HERE

To investigate σ-convergence, we computed for each year the standard deviation of HDI across countries. The results plotted in Figure 11 are that for each year the value of the y-axis corresponds to the standard deviation, that is HDI variability within the sample of countries. As expected, the variability of DI is reduced over time, meaning that economic and social development have levelled off throughout the European Union.

FIGURE 11 HERE

In summation, different areas of the European Union vary in terms of economic and social development, with the northern countries being more advanced than the southern and eastern ones. Moreover, while southern European countries seem less able to overcome the obstacles and the challenges posed by the economic crisis, Eastern Europe has responded more readily and has been able to sidestep the trends of 2008-2010. The convergence analysis shows that (i) less developed countries are catching up with more developed ones; (ii) both environmental taxation and R&D expenditures are relevant in this process and can therefore be used as means to favour social and economic cohesion. Finally, (iii) the level of development among European countries is actually levelling off, as shown by the presence of σ-convergence.

This is possibly unexpected news, considering the high political turmoil the EU has experienced due to the economic downturn and the (unsolved) consequences of ineffective economic and social policies. Overall, the EU integration process, with all of its drawbacks, seems to have generated a convergence in development. Policy integration is a main driver behind that trend. Replications of the analysis can be provided on a global level and for specific regional subsystems (Marin, "Closing the Gap?").

VII. Economic and Policy Implications

GDP is an important but limited indicator of welfare and economic development. The higher the value societies assign to the environment, income equality and access to resources, health and other public goods, the more urgent is the need to use and exploit complementary theories and ways to measure socio-economic welfare performances. In essence, complementary, or satellite, indicators are necessary to enrich and measure core GDP performance in a hybrid fashion. Human development indexes and hybrid economic-environmental accounts move towards this direction. The environment and other public goods can be integrated in the economic sphere by monetising or merging. Non-market goods such as the environment might be monetized by analysing the social willingness to pay (e.g. for enhancing the environment, or increasing public goods). Hybrid accounts such as 'CO_2 emissions on GDP' are useful.

One of the main conclusions to be drawn from discussions on economic development and sustainability is the need for a balanced pattern based on consumption and investments. Economic agents and societies tend to under-invest and over-consume available income due to inter-temporal myopia and short-term looking incentives. Sustainability can be defined as a society's willingness to invest in the future; these investments are necessary to sustain current economic demands towards full employment and compensate for the intrinsic erosion of capital stocks. Investments in human capital, intangibles such as education and innovation, manmade capital and renewable natural capital are needed to transition to a more equitable, greener and therefore sustainable society.

The second noteworthy takeaway is that investments in innovation and knowledge capital are essential for creating the preconditions for a more sustainable and equitable society. Innovation is the main driver of long-term economic growth; it can increase the efficiency of natural resource use (eco-innovations), open new markets for new and existing firms and, if adopted in synergies with human capital, enhance the skills, capabilities and wages of the workforce. In a word, innovation and, broadly, knowledge are at the basis of balanced and sustainable growth of profits and wages. To be most effective, technological development should be adopted as a complement to behavioural changes and human capital investments.

The third consideration refers to the role of policies, namely environmental and innovation policies. Public policies are the key to human development and sustainability for three main reasons. First, they correct the effects of private markets that are not capable of producing public goods, as market prices do not capture non-market values. Therefore, the quality and quantity of environmental goods remain under-delivered. Second, market-based environmental regulations, such as ecological taxes and emissions trading, are potentially able to incentivize continuous innovation in more efficient production. Cost-minimising households and firms seek to reduce their tax payment. The current situation is undergoing an evolution determined by political resistance to, but also gradual acceptance of, ecological taxes. Emissions trading is also being diffused worldwide following the establishment of the EU carbon market by the 2003 EU ETS Directive. The main economic appeal of economic instruments is that, in addition to providing incentives for using the environment better, they generate revenues that can fund other objectives (labour, innovation) and specific projects. Carbon taxes at a national or global level, congestion and pollution charges at an urban level are among the most relevant examples.

Empirical evidence shows that green innovation and environmental policies might positively correlate with economic development. Innovation and invention patterns indicate that high-income countries still possess a competitive advantage, but the gaps have decreased and new players are coming from the emerging and developing world. Innovation capacity is one of the main drivers behind sustainable development. Besides China, South Korea is probably the most striking example. The commitment of South Korea to green investment is an example of how a technologically-oriented green strategy is synergic to growth and development. Larger gaps are present with respect to the stringency of environmental policy and adoption of ETR. It is necessary for emerging and developing countries to move towards environmental policies. These policies may nevertheless be transported through international trade, since greater economic integration requires playing by similar rules of the game. It is worth noting that trade exchanges facilitate pollution but also knowledge flows that are necessary to closing the existing efficiency gaps. Multilateral and bilateral north/north, north/south and south/south exchanges will transfer green knowledge, eco-innovations and sustainable practices on a global scale. The sustainability of production and consumption is a new framework to which we must adapt; it is a product of the increasing global integration of markets and knowledge. Countries are no longer self-sufficient nor are they islands unto themselves; along with sectors, firms and consumers, they are highly interconnected and mutually integrated. We all share a global responsibility for sustainability. It is not only an ethical statement but also an economic fact. Economies are integrated, knowledge quickly moves worldwide, problems and solutions are global.

In this global picture composed of many regional areas, convergence is key. It is desirable for economic reasons, since the ultimate goal of human societies is to enhance welfare and create convergence mechanisms across the globe. It is politically valuable, since countries and regions that diverge – or do not catch up – are at risk of cultural and economic isolation. Convergence is not manna from heaven; it stems from well-designed macroeconomic policies, sound objectives, recognition of regional specialization, and investments in technology and human capital across income levels. To extend convergence beyond mere economic growth, societies need to widen the policies they adopt, including environmental policies. The world in which we live is full of global and regional convergences and divergences that researchers and policymakers need to continuously assess. Convergence of welfare and sustainable development is a concrete possibility. We have the knowledge and the financial resources to do this more frequently. The construction of bridges in the scientific world helps to improve the sources for applied research and our understanding of the facts we observe.

References

Albrizio, Silvia, et al. "Environmental Policies and Productivity Growth: Evidence across Industries and Firms." *Journal of Environmental Economics and Management*, vol. 81, 2017, pp. 209-226.

Ambec, Stefan, et al. "The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness?" *Review of Environmental Economics and Policy*, vol. 7, no. 1, 2013, pp. 2-22.

Barbier, Edward B., and Anil Markandya. *A New Blueprint for a Green Economy*. Routledge, 2012.

Barbieri, Nicolò, et al. "A Survey of the Literature on Environmental Innovation Based on Main Path Analysis." *Journal of Economic Surveys*, vol. 30, no. 3, pp. 596-623.

Barro, Robert J., and Xavier Sala-i-Martin. *Economic Growth.* 2nd ed., MIT Press, 2003.

Baumol, William J., and Wallace E. Oates. *The Theory of Environmental Policy.* 2nd ed., Cambridge UP, 1987.

Borghesi, Simone, et al. "Carbon Abatement, Sector Heterogeneity and Policy Responses: Evidence on Induced Eco Innovations in the EU." *Environmental Science and Policy*, vol. 54, 2015, pp. 377-388.

Borghesi, Simone, et al. *The European Emission Trading System and Its Followers: Comparative Analysis and Linking Perspectives*. Springer, 2016.

Botta, Enrico, and Tomas Kozluk. "Measuring Environmental Policy Stringency in OECD Countries: A Composite Index Approach." *OECD Economics Department Working Papers* no. 1177, 4 December 2014. OECD Publishing, doi.org/10.1787/5jxrjnc45gvg-en.

Brunel, Claire, and Arik Levinson. "Measuring the Stringency of Environmental Regulations." *Review of Environmental Economics and Policy*, vol. 10, no. 1, 2016, pp. 47-67.

Carson, Richard T. "The Environmental Kuznets Curve: Seeking Empirical Regularity and Theoretical Structure." *Review of Environmental Economics and Policy*, vol. 4, no. 1, 2010, pp. 3-23.

Commission of the European Communities. "Growth, Competitiveness, and Employment. The Challenges and Ways Forward into the 21st Century." Commission of the European Communities, 1993.

Costantini, Valeria, and Giorgia Sforna. "Do Bilateral Trade Relationships Influence the Distribution of CDM Projects?" *Climate Policy*, vol. 14, no. 5, 2014, pp. 559-580.

---, and Massimiliano Mazzanti, editors. *The Dynamics of Economic and Environmental Systems: Innovation, Policy and Competitiveness*. Springer, 2013.

---, and Massimiliano Mazzanti. "On the Green and Innovative Side of Trade Competitiveness? The Impact of Environmental Policy and Innovation on EU Exports." *Research Policy*, vol. 41, no. 1, 2012, pp. 132-153.

---, and Salvatore Monni. "Sustainability and Human Development." *Economia Politica*, vol. XXV, no. 1, 2008, pp. 11-32.

---, and Salvatore Monni. "Environment, Human Development and Economic Growth." *Ecological Economics*, vol. 64, no. 4, 2008, pp. 867-880.

Costantini, Valeria, et al., editors. *Hybrid Economic Environmental Accounts*. Routledge, 2012.

D'Alisa, Giacomo, et al. *Degrowth: A Vocabulary for a New Era*. Routledge, 2014.

Ekins, Paul and Stefan Speck. *Environmental Tax Reforms*. Oxford UP, 2011.

European Commission, DG Environment. *Study on Environmental Fiscal Reform Potential in 12 Member States*. European Commission, 2014.

European Environment Agency. *Environmental Taxation and EU Environmental Policies*. European Environment Agency, 2016.
---. *Resource-Efficient Green Economy and EU Policies*. European Environment Agency, 2014.
---. *The European Environment - State and Outlook 2005 - Synthesis Report*. Office for Official Publications of the European Communities, 2005.
Gilli, Marianna, et al. "Sustainable Development and Industrial Development: Manufacturing Environmental Performance, Technology and Consumption/Production Perspectives." *Journal of Environmental Economics and Policy*, 2016, http://dx.doi.org/10.1080/21606544.2016.1249413.
---, et al. "Sustainability and Competitiveness in Evolutionary Perspectives: Environmental Innovations, Structural Change and Economic Dynamics in the EU." *Journal of Socio-Economics*, vol. 45, 2013, pp. 204-215.
Jones, Charles, and Peter K. Klenow. "Beyond GDP? Welfare across Countries and Time." *American Economic Review*, vol. 106, no. 9, 2016, pp. 2426-2457.
Kaldor, Nicholas. "A Model of Economic Growth." *Economic Journal*, vol. 67, no. 268, 1957, pp. 591-624.
Kemp, Rene. "Eco-innovation: Definition, Measurement and Open Research Issues." *Economia Politica*, vol. 3, 2010, pp. 397-420.
Lenzen, Manfred, et al. "Mapping the Structure of the World Economy." *Environmental Science and Technology*, vol. 46, no. 15, 2012, pp. 8374-8381.
---, et al. "Building EORA: A Global Multi-regional Input-Output Database at High Country and Sector Resolution." *Economic Systems Research*, vol. 25, no. 1, 2013, pp. 20-49.
Levinson, Arik. "Technology, International Trade, and Pollution from US Manufacturing." *American Economic Review*, vol. 99, no. 5, 2009, pp. 2177-2192.
Marin, Giovanni. "Closing the Gap? Dynamic Analyses of Emission Efficiency and Sector Productivity in Europe." *The Dynamics of Environmental and Economic Systems. Innovation, Environmental Policy and Competitiveness*, edited by Valeria Costantini and Massimiliano Mazzanti, Springer, 2013, pp. 159-177.
---, and Massimiliano Mazzanti. "The Evolution of Environmental and Labour Productivity Dynamics." *Journal of Evolutionary Economics*, vol. 23, 2013, pp. 357-99.
---, et al. "Linking NAMEA and Input Output for 'Consumption vs. Production Perspective' Analyses: Evidence on Emission Efficiency and Aggregation Biases Using the Italian and Spanish Environmental Accounts." *Ecological Economics*, vol. 74, 2012, pp. 71-84.
Mazzanti, Massimiliano, and Ugo Rizzo. "Diversely Moving towards a Green Economy: Techno-Organisational Decarbonisation Trajectories and Environmental Policy in EU Sectors." *Technological Forecasting and Social* Change, vol. 115, 2016, pp. 111-116, doi:10.1016/j.techfore.2016.09.026.
---, and Anna Montini, editors. *Environmental Efficiency, Innovation and Economic Performances*. Routledge, 2010.
---, et al. "Firm Surveys Relating Environmental Policies, Environmental Performance and Innovation. Design Challenges and Insights from Empirical Application." OECD Environment Working Paper no. 103, 12 April 2016. OECD Publishing, doi: 10.1787/5jm0v405l97l-en.
---, et al. "Carbon Dioxide Reducing Environmental Innovations, Sector Upstream/Downstream Integration and Policy: Evidence from the EU." *Empirica*, vol. 42, no. 4, 2015, pp. 709-735.
Mazzucato, Mariana. *The Entrepreneurial State*. Anthem Press, 2013.
Musolesi, Antonio, et al. "A Panel Data Heterogeneous Bayesian Estimation of Environmental Kuznets Curves for Co2 Emissions." *Applied Economics*, vol. 42, no. 18, 2010, pp. 2275-2287.

Neumayer, Eric. *Weak versus Strong Sustainability: Exploring the Limits of Two Opposing Paradigms*. Edward Elgar Publishing, 1999.

Organization for Economic Cooperation and Development. *Patents by Main technology and by International Patent Classification (IPC), OECD Patent Statistics (database).* OECD Publishing, 2017, Doi: doi.org/10.1787/data-00508-en.

---. *Gross Domestic Spending on R&D (Indicator).* OECD Publishing, 2017, doi:10.1787/d8b068b4-en.

---. *Invention and Transfer of Environmental Technologies*. OECD Publishing, 2011.

Pasinetti, Luigi L. "Rate of Profit and Income Distribution in Relation to the Rate of Economic Growth." *The Review of Economic Studies*, vol. 29, no. 4, 1962, pp. 267-279.

Perman, Roger, et al. *Natural Resource and Environmental Economics*, 4th ed., Pearson, 2011.

Picketty, Thomas. *Capital in the 21st Century*. Belknapp Press, 2013.

Porter, Michael E., and Claas van der Linde. "Green And Competitive: Ending the Stalemate." *Harvard Business Review*, no. 73, vol. 5, 1995, pp. 120-134.

Porter, Michael. "America's Green Strategy." *Scientific American*, vol. 264, no. 4, 1991, p. 168.

Quatraro, Francesco. *The Economics of Structural Change in Knowledge*. Routledge, 2013.

Turner, R. Kerry, et al. *Environmental Economics: An Elementary Introduction*. Johns Hopkins UP, 1993.

United Nations Industrial Development Organization. *Industrial Development Report 2016. The Role of Technology and Innovation in Inclusive and Sustainable Industrial Development*. UNIDO, 2015.

Van den Bergh, Jeroen, and Miklós Antal. "Evaluating Alternatives to GDP as Measures of Social Welfare/Progress." WWWforEurope Working Paper no. 56, March 2014. WWWforEurope, http://www.foreurope.eu/fileadmin/documents/pdf/Workingpapers/WWWforEurope_WPS_no056_MS211.pdf.

Van den Bergh, Jeroen. "Environment Versus Growth - A Criticism of 'Degrowth' and a Plea for 'A-Growth'." *Ecological Economics*, vol. 70, no. 5, 2011, pp. 881-890.

Vona, Francesco, et al. "Green Skills." NBER Working Paper no. 21116, April 2015. The National Bureau of Economic Research, http://www.nber.org/papers/w21116.

Tables and Figures

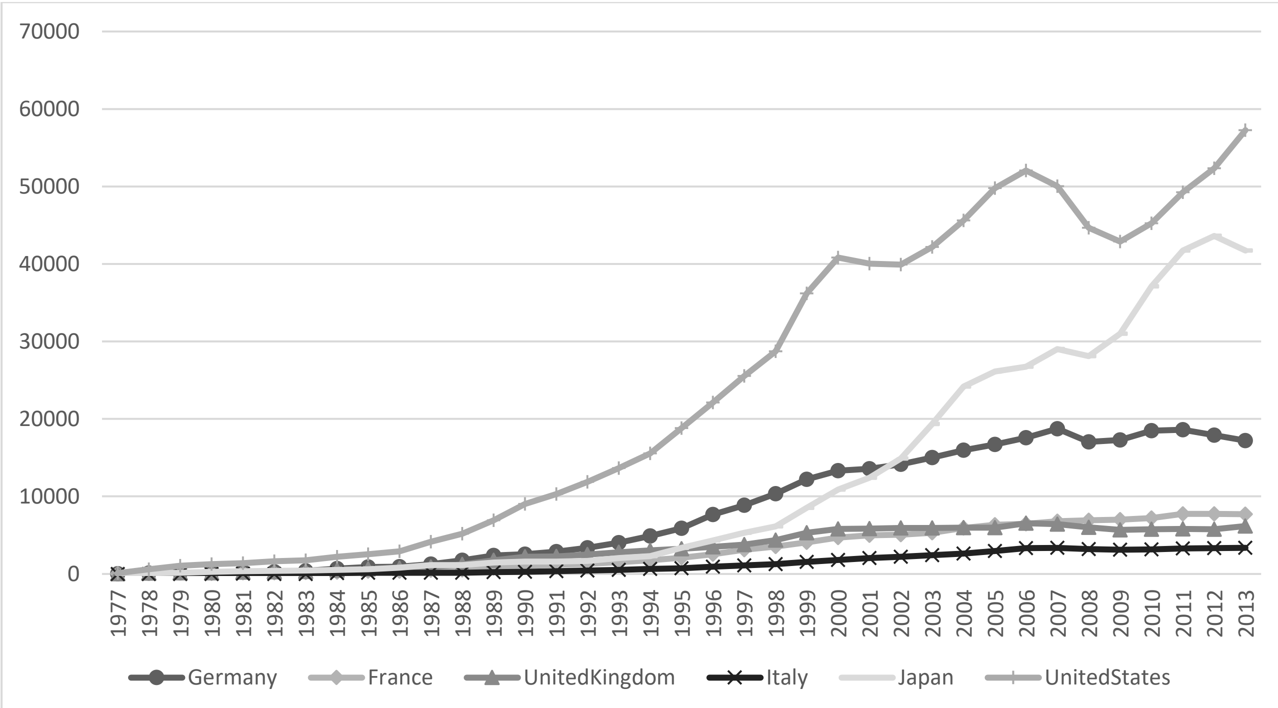

Fig. 1. Total patents filed under the PCT, 1977-2013, based on the inventor's country of residence. Source: Authors' elaboration of data from the OECD Patent Statistics in the public domain, https://stats.oecd.org/Index.aspx?DataSetCode=PATS_REGION.

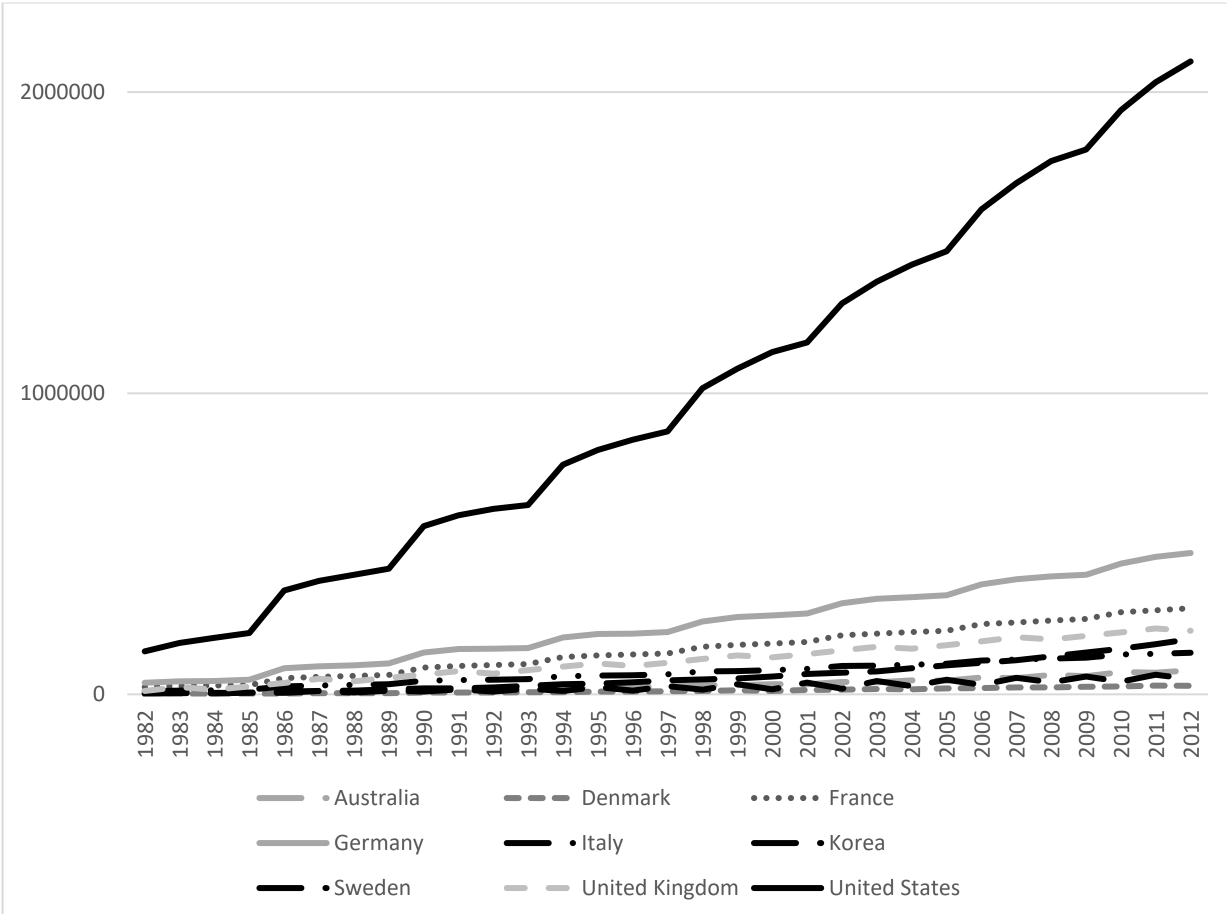

Fig. 2. R&D expenditures in selected OECD countries. Source: Authors' elaboration of data from the OECD database in the public domain, http://www.oecd-ilibrary.org/content/indicator/d8b068b4-en.

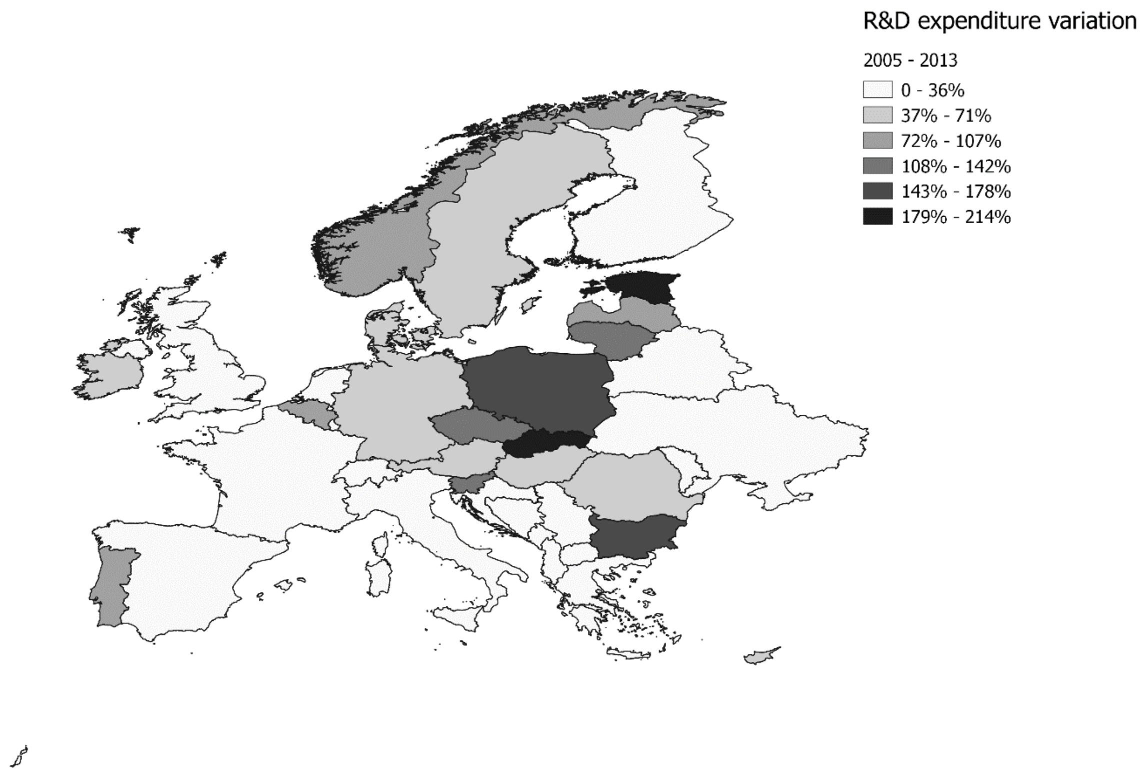

Fig. 3. Total R&D expenditure variation in Europe (2005-2013). Source: Authors' elaboration of data from the EUROSTAT database in the public domain, http://ec.europa.eu/eurostat/web/products-datasets/-/t2020_20&lang=en.

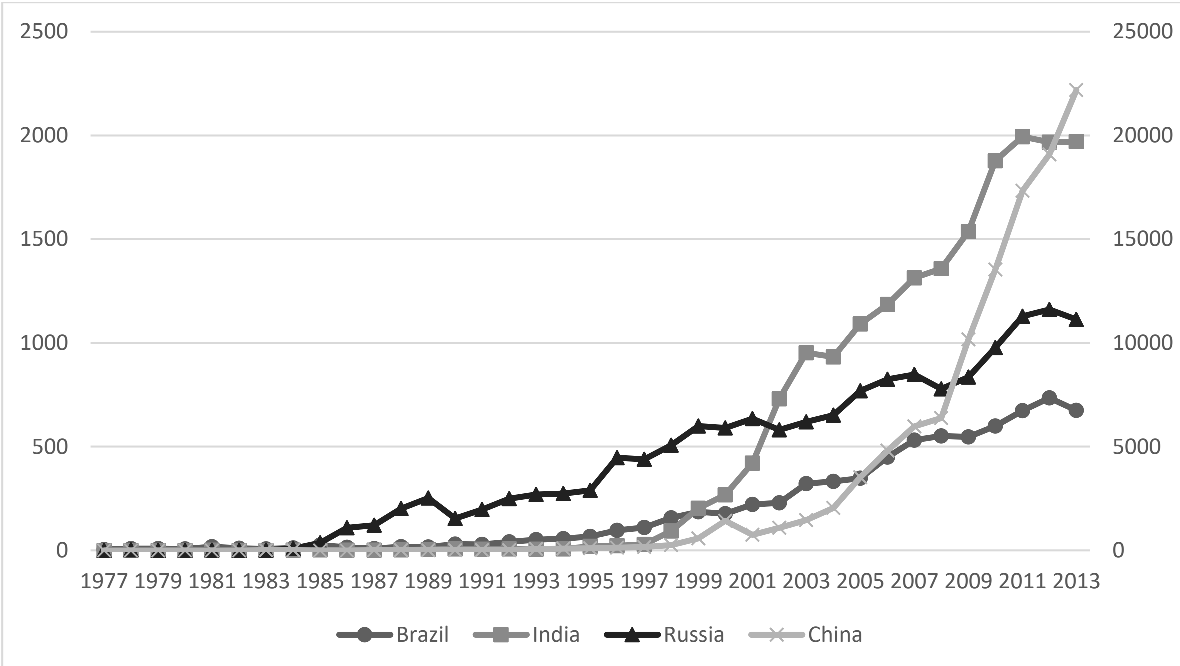

Fig. 4. Total patents filed under the PCT, 1977-2013, by inventor's country of residence (China on the right axis). Source: Authors' elaboration of data from the OECD Patent Statistics, http://www.oecd-ilibrary.org/science-and-technology/data/oecd-patent-statistics/patents-by-main-technology-and-by-international-patent-classification-ipc_data-00508-en.

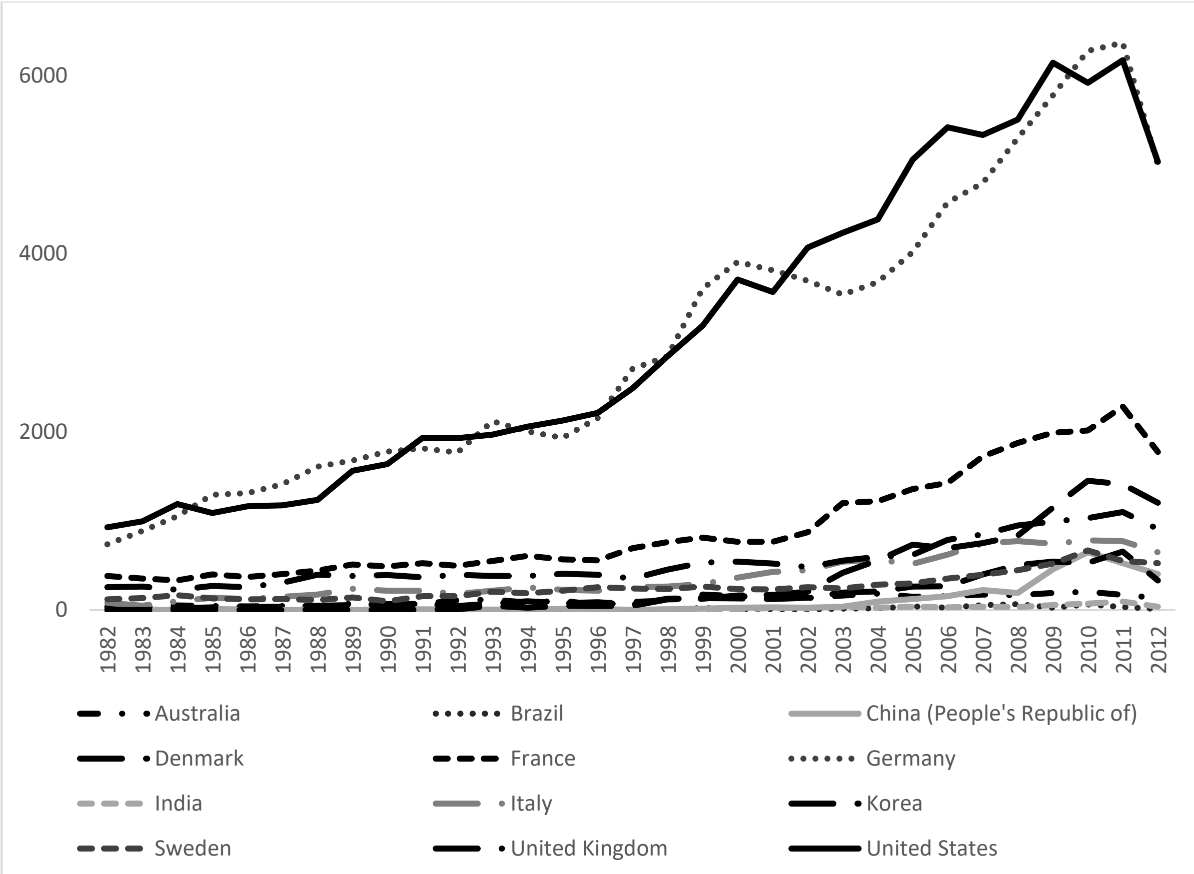

Fig. 5. Green Patents trends in selected countries. Source: Authors' elaboration of data from the OECD Patent Statistics in the public domain, https://stats.oecd.org/Index.aspx?DataSetCode=PATS_REGION.

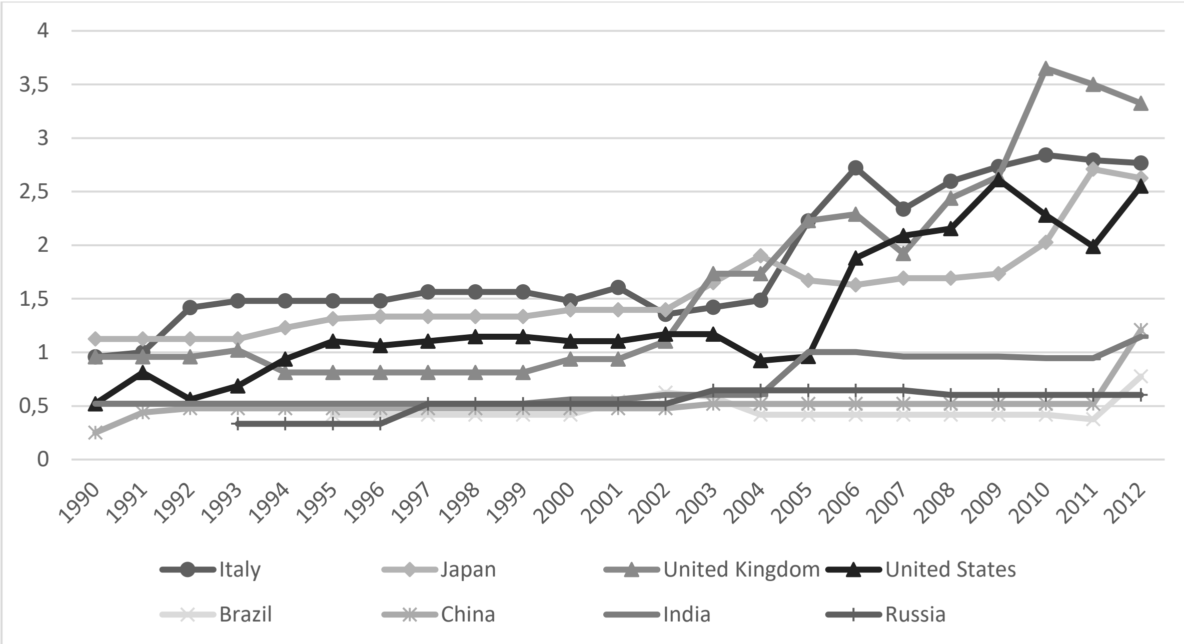

Fig. 6. OECD environmental policy stringency indicator (EPS), 1990-2012. Source: Authors' elaboration of data from the OECD Environmental Policy Stringency Index (EPS), https://stats.oecd.org/Index.aspx?DataSetCode=EPS.

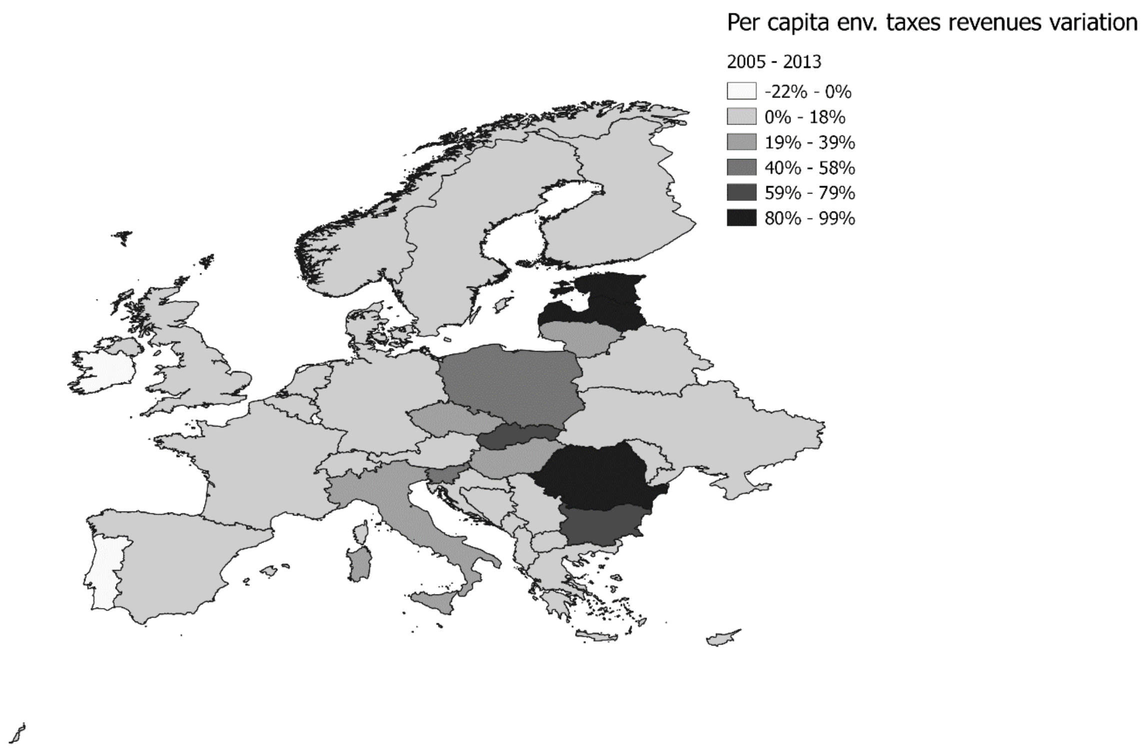

Fig. 7. Variation in total environmental taxes in Europe (2005-2013). Source: Authors' elaboration of data from the EUROSTAT database in the public domain, http://ec.europa.eu/eurostat/en/web/products-datasets/-/T2020_RT320.

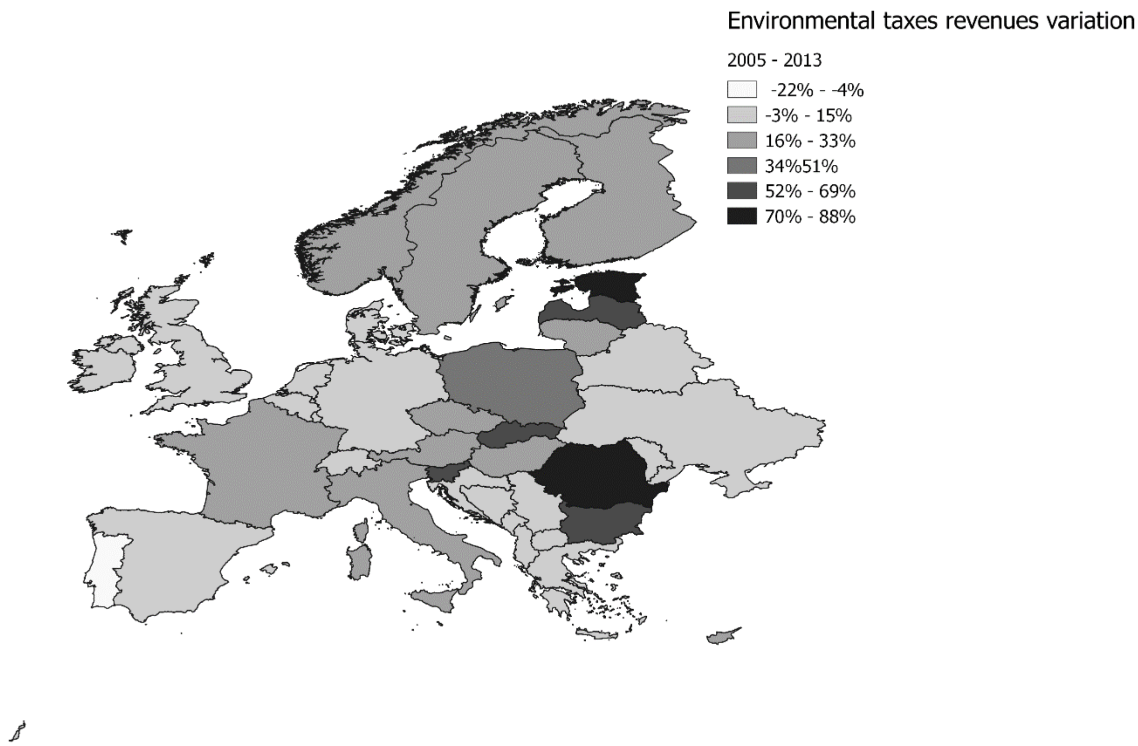

Fig. 8. Variation in per capita environmental taxes in Europe (2005-2013). Source: Authors' elaboration of data from the EUROSTAT database in the public domain, http://ec.europa.eu/eurostat/en/web/products-datasets/-/T2020_RT320.

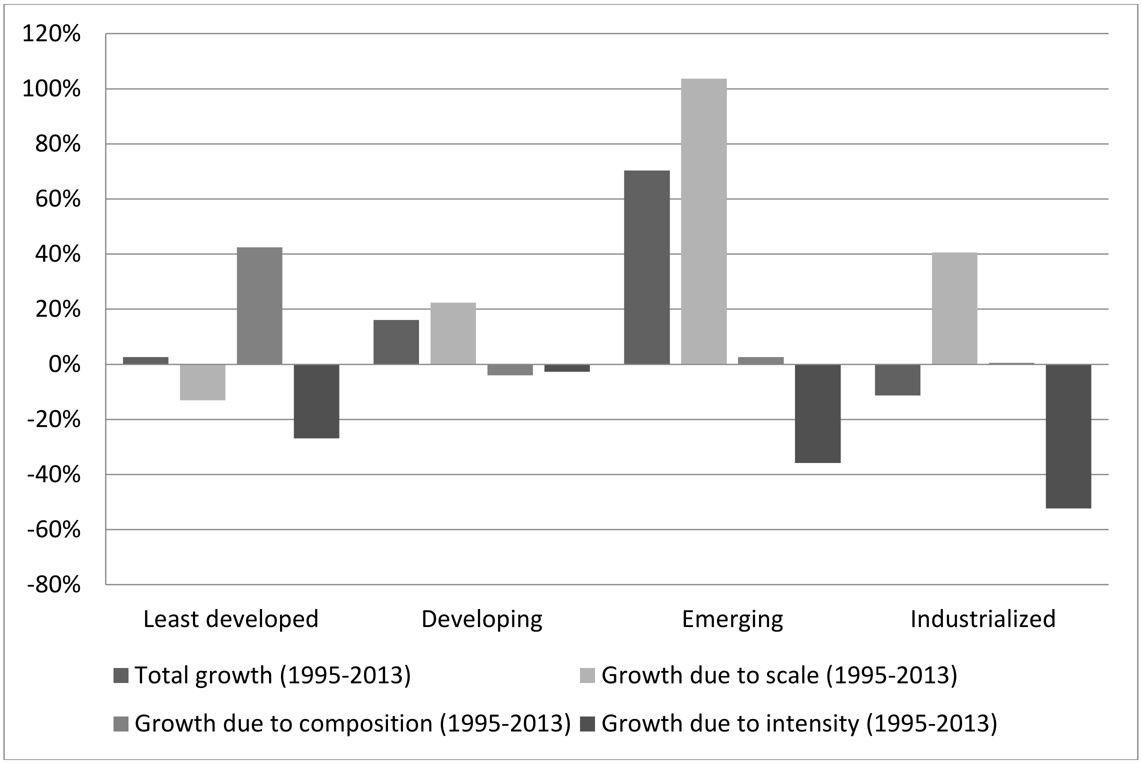

Fig. 9. Production-based CO_2 emissions across income levels. Source: Authors' elaboration of data from the Eora MRIO Database, http://worldmrio.com/.

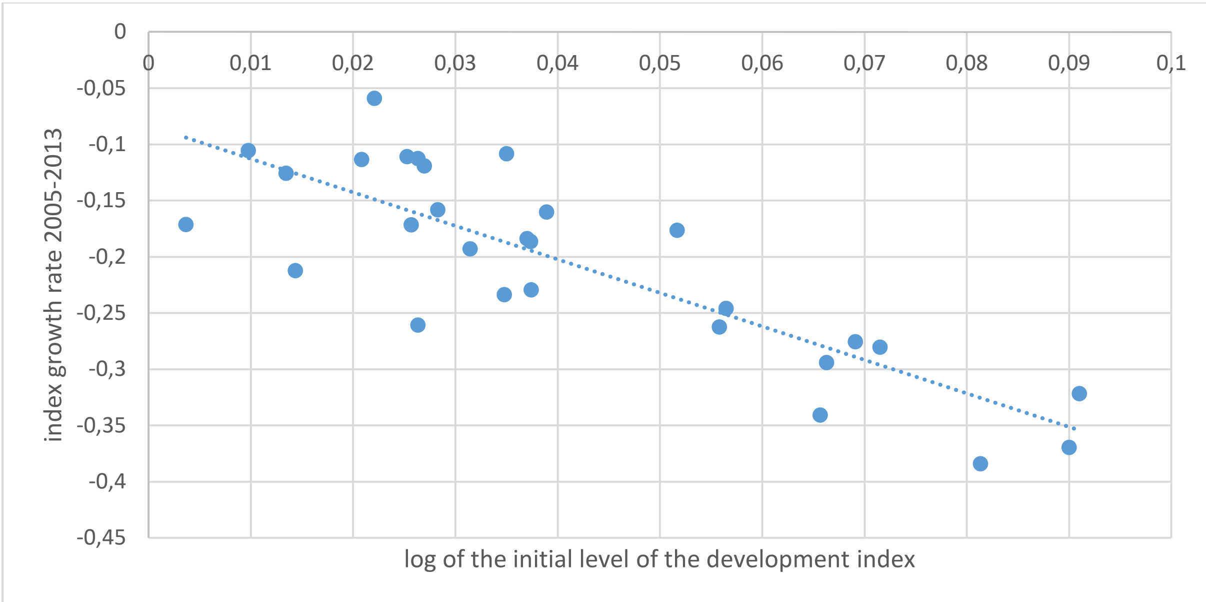

Fig. 10. Beta convergence in the development index in the EU. Source: Authors' elaboration of data from the United Nations Development Programme, http://hdr.undp.org/en/data.

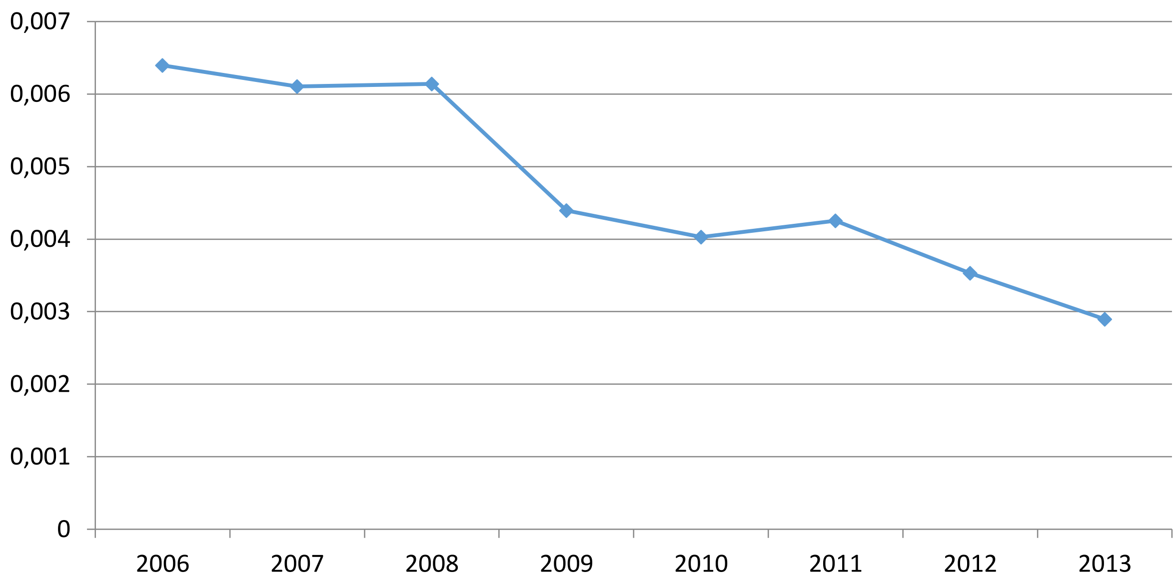

Fig. 11. Sigma convergence in the development index in the EU. Source: Authors' elaboration of data from the United Nations Development Programme, http://hdr.undp.org/en/data.

[1] We would like to particularly thank Roberto Zoboli, Stefan Speck, Giovanni Marin and Nicola Cantore. This chapter follows key research trends we have shared over recent years, and research is always the intended or unintended output of a shared effort. It touches on topics investigated under the umbrella of the European Topic Centre on Waste Material & the Green Economy, 2014-2018 (funded by the EEA) and the H2020 project Green.eu (www.inno4sd.net) of which SEEDS-University of Ferrara is a partner unit. We are grateful to Saptorshee Chakraborty for his support to empirical analysis.
[2] 'While welfare is highly correlated with GDP per capita, deviations are often large' (Jones and Klenow 2426). 'Leisure, inequality, mortality, morbidity, crime and the natural environment are just some of the major factors affecting living standards within a country that are incorporated imperfectly, if at all, in GDP' (Jones and Klenow 2426).
[3] The chapter intentionally avoids addressing the degrowth issue, which is broader but nevertheless originates out of the limits of the GDP approach. We consider it a more general umbrella, while the chapter (empirically) addresses some of the specific issues. We refer the reader to van den Bergh, "Environment Versus Growth", and D'Alisa et al., who offer diversified ideas and comments on the degrowth agenda.
[4] The European NAMEA (National Accounting Matrix of Environmental Accounts) is a key example. WIOD (World Input Output Dataset) is another rich integrated dataset (http://www.wiod.org/home). Hybrid data permits the investigation of the role of innovation and structural change in a dynamic setting.
[5] This theoretical reasoning links development and sustainability through the idea developed by Nobel laureate Simon Kuznets, who studies the existence of a bell-shaped curve linking inequality and GDP per capita. The same hypothesis has been tested for environmental quality and GDP per capita dynamic relationships (Carson; Mazzanti et al., *Environmental Efficiency*).
[6] The UNDP report clearly shows that countries at the same level of income generate different HD performances, depending on how they invest in health, education, poverty reduction, etc. Using different conceptual lines compared to HD indicators, Jones and Klenow show that "average western European living standards appear much closer to those in the USA when we take into account Europe's longer life expectancy, additional leisure time, and lower inequality" (2427). Mortality seems to be one of the most important factors in explaining welfare differences across countries. In fact, "Most developing countries – including much of sub-Saharan Africa, Latin America, Southern Asia and China – are substantially poorer than incomes suggest because of a combination of shorter lives and extreme inequality" (2427-2428). Adding environmental considerations would probably worsen the scenario for those countries (and for the US as well).
[7] The human capital share of the total stock is increasing across income levels. Human capital is the key factor for HD and sustainable development. The importance of its relationship with technological development is often overlooked; technology by itself cannot generate social improvements and therefore should not be its own goal. Enhanced human capital levels are crucial to support higher wages and new inventions; it is now empirically evident that the transition towards a greener society moves along a strict link between new skills and new technologies (Vona et al.).
[8] Whether a society focuses and sets constraints on total or specific forms of capital is a political economy decision that differentiates weak and strong sustainability models (Neumayer). The policy consequences are substantial: weak sustainability (economics-oriented sustainability) implies full substitution between different forms of capital and emphasizes an increase in total stock. In a sustainable society, an increase in the entire amount of capital should ensure increased capabilities to generate income and welfare.
[9] For definitions of eco- and environmental innovations see Kemp; Barbieri et al.; Mazzanti et al., "Firm Surveys".
[10] This adds an 'efficiency view' to the sustainability definition. Theoretically speaking, it refers to the IPAT (Impact Population Affluence Technology) identity (Marin and Mazzanti), common in ecological economics, industrial ecology and contiguous disciplines. It highlights the role of technology/efficiency as a major force that compensates for the detrimental effects of growth on the environment.

[11] The report *Towards a Global Green Recovery* published on April 2, 2009 is available at http://www.lse.ac.uk/GranthamInstitute/publication/towards-a-global-green-recovery-recommendations-for-immediate-g20-action/.

[12] Stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behaviour. The index ranges from 0 (not stringent) to 6 (highest degree of stringency). The index covers 28 OECD and 6 BRICS countries for the period 1990-2012. The index is based on the degree of stringency of 14 environmental policy instruments, primarily related to climate and air pollution (https://stats.oecd.org/Index.aspx?DataSetCode=EPS).

[13] We refer to total environmental taxation. Its three components are: transport taxation, energy taxation, air pollution taxes and resource taxes. The latter are the 'real' environmental taxes if we follow an economic theoretical definition. Those are the smallest in share in the EU and most countries.

[14] Though the HDI and sustainability frameworks are interrelated and could be placed under the 'beyond GDP' discussion, it is also useful to keep them separate. HDI enriches GDP information by adding the key public goods produced by GDP (taxes). Sustainability adds components (the environment) and focuses on the role of investments. A crucial link is the necessity to invest in socially critical public goods to enhance growth, sustainability and wellbeing.