Dealing with structural inequalities can help address pressures from the adverse effects of climate change by increasing resilience and preparing citizens to adapt to unexpected negative shocks. This paper evaluates sources of climate change uncertainty through the lenses of a long-term macro-micro simulation framework and shows that despite the rapid convergence in average per capita income across countries, within-country inequalities are likely to play a more important role in defining climate policies in the decades ahead. Globalization and technological change decoupled with other mega-trends, such as demographic transition, urbanization, and climate change would impose pressures towards increasing inequalities within countries. To effectively address the emerging face of inequality within a sustainable development pathway will hence require international coordination and innovative policy-designs working at a more granular local level.

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1. Introduction

Human welfare is greater now than almost any time in history. During the last centuries, living standards have increased by many times, life spans have more than doubled, and individuals live better lives than ever before. Without doubt, nowadays more people are richer and fewer people live in absolute poverty in comparison with pre-Industrial Revolution times (Deaton 2013). Yet millions still experience harsh economic conditions, destitution and premature death. Many of the great episodes of human progress have left behind them larger inequalities. The Industrial Revolution, for instance, initiated the economic growth that has been responsible for hundreds of millions of people escaping from material deprivation. The other side of the same Industrial Revolution is what historians call the “Great Divergence” when Western Europe and North America, pulled away from the rest of the world (Pomeranz 2009). A gap that has not closed this day (See Figure 1). Today’s global inequality was, to a large extent, created by the success of modern economic growth. For the centuries ahead, future inequality will be largely determined by our capacity to address planetary challenges, particularly our efforts to mitigate and adapt to the negative effects of climate change.

The interaction between climate change and its effects on inequalities is extremely difficult to unravel, not only because of the intertwined association between the state of nature and the economic, technological, and even the political forces it unleashes; but also because of the very high levels of uncertainty on long-term developments, the unknown unknowns of the process of change. Admitting this, this technical paper echoes on the idea that there exist complementarities between equity and long-term prosperity (as in World Bank, (2005)); nevertheless, it stresses that coping with the effects of climate change requires much stronger and far-reaching global and domestic agendas. In this regard, multilateral coordination would be strictly required to effectively address environmental imbalances and take advantage of emerging global economic, demographic, and technological opportunities. Even if strong policies aimed to achieve greater equality and high-economic growth are set in motion across countries, progress over the long-term will be undermined if greenhouse emissions reach planetary unsustainable levels.

In the same line of thought, this paper agrees that dealing with structural inequalities can help address pressures from the adverse effects of climate change by increasing resilience and preparing citizens to adapt to unexpected negative shocks. Domestic policies that favor structural inequalities are well-known (see for instance Hallegatte et al., 2015; World Bank, 2005), and include increasing access to credit and insurance market for the poor, less cyclical sources of income, better skills to participate in labor markets, strong political voice to implement changes, low inflation and macroeconomic stability, to name a few. In the decades ahead, nonetheless, policy makers and the society in general should be aware that if global trends on demographics, technological change, and globalization persist (Berman and Machin 2000; Paul and Siegel 2001; Caroli and Reenen 2001; Autor, Katz, and Krueger 1998), inequalities are likely to become increasingly urban and polarized (Gornick and Jantti
To effectively address the emerging face of inequality will hence require innovative policy-designs working at a more granular local level.

This background paper is organized as follows. Section two documents the evolution of inequalities at the global level. This section shows areas of progress, mostly in basic health and education coverage, and highlights areas on which low- and middle-income countries are lagging behind. Section three shows that low- and middle-income countries are more susceptible to the negative effects of climate change. This section discusses sources of climate change uncertainty through the lenses of a macro-micro simulation framework and shows that despite the rapid convergence in average per capita income across-countries, within-country inequalities are likely to play a more important role in defining climate policies in the decades ahead. Globalization and technological change decoupled with other mega-trends, such as demographic transition and climate change would impose pressures towards increasing inequalities within countries, shaping the type of interventions needed to address inequalities and promote environmentally sustainable growth.

The last section includes policy recommendations to address global poverty and reduce inequalities in line with a sustainable climate change agenda. Coordinated policy on climate change requires a rebalancing of public and private investment funds towards human capital, green innovation, and resilient infrastructure. More specifically, this paper argues in favor for a redirection of public and private long-term savings towards the much needed early investments in adaptation, resilience and mitigation, particularly in areas that benefit the global bottom 40.

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**Figure 1 The Great Divergence**

Source: The Maddison-Project
2. Evolution of inequalities

There has been strong interest in the study of the consequences of inequality on long-term development, and this might be particularly relevant for understanding possible ways to cope with the negative effects of climate change in the decades ahead. While it is well accepted that inequality might often be a consequence of progress, there is too a fundamental agreement that equity is complementary, in some fundamental respects, to the pursuit of long-term development (The World Bank, 2005). Harsh inequality can undermine progress in essential development outcomes such as health and education; weaken the business climate by creating political and economic instability, and demoralize social cohesion required to adjust in the face of major shocks (Persson and Tabellini 1994; Easterly 2007; Berg, Ostry, and Zettelmeyer 2012). It is mainly through human capital accumulation that harsh inequality can undermine the resilience of the social fabric to climate change. Education can directly influence risk perception, improve health, indirectly reduce poverty, and promote access to information and resources (Muttarak and Lutz 2014). Hence, when facing climate risks, more educated and healthier individuals, households and societies are assumed to be more empowered and more adaptive in their response to negative shocks.

It is well known that inequities result from a variety of socioeconomic trends and policy decisions. Scholars have argued that inequality depends on natural endowments, geography, culture, religion, institutions, historical trajectories, changes in technology, and returns to capital (Acemoglu and Robinson 2012; Collier 2007; Stiglitz 2012; Piketty 2014). Emerging evidence also suggests that a country’s productive structure might play a fundamental role behind changes in income inequality (Hartmann et al. 2015). Most would agree, nonetheless, that institutions and policies that reduce inequality by promoting a level playing field – where all members of society have similar chances to become socially active, politically influential, and economically productive – would contribute to long-term sustainable development.

For some time, it was thought that the basic fact of modern economic history was an increase in divergence in per capita income across countries (Pomeranz 2009; Pritchett 1997). Nevertheless, recent developments have changed that perspective. During the last quarter of the 20th century, low- and middle-income countries have made significant progress in addressing developmental disparities for large segments of the population. In 1970, for instance, the global distribution of per capita income still showed a clear divide between richer and poorer countries and these between-country differences were equally applicable to other development conditions (van Zanden et al. 2014). Marked differences between groups of countries, as shown in the global distribution of income in the year 2000, have disappeared (Figure 2). As a result, the binary distinction between developed and developing countries is rapidly becoming outdated.
The process of average convergence across-countries applies not only to income, but also to other development outcomes, especially in basic health and education. For example, Figure 3 below compares two important health indicators across countries: child mortality and fertility rates. In 1970 there were two groups of countries. The first group was formed by low-and middle-income countries where people were living in large families and experienced high child mortality rates. The other group was formed by high-income countries where people lived in small families and had lower child mortality rates. A fundamental turn in development occurs with demographic change when families are able to raise healthy children to adulthood and women start having less children (Schell et al. 2007; Rosling and Zhang 2011). By 2010, shown in the right-pane, children mortality had fallen and many countries had family sizes and child-mortality rates that corresponded to those of high-income countries in the 1970s. Countries that are lagging behind are mostly located in Sub-Saharan African where large families are still the norm despite having largely reduced incidence of child mortality.
During the last decades, low- and middle-income countries have made significant progress in a variety of development outcomes, especially in basic health and education. This technical paper provides evidence of progress in key indicators by anchoring them to GNI per capita (as in Gable, Lofgren, & Osorio-Rodarte, (2015))\(^1\). Despite the simplicity, this method offers an intuitive approach for benchmarking development progress. For a group of 110 development outcomes, most of them related to health and education outcomes, cross-country elasticities with respect to GNI per capita are obtained by estimating the \(\beta_1\) parameter in the following log-on-log specification:

\[
\ln(\text{SDG}) = \beta_0 + \beta_1 \ln(\text{GNIpc}) + e
\]

where SDG refers to each development outcome, \(\text{GNIpc}\) is Gross National Income per capita, and \(e\) is an error term\(^2\).

\(^1\)This method is simple and transparent, drawing on the observation that many development indicators, including development outcomes and their determinants, are highly correlated with GNI per capita. For such indicators, GNI per capita is viewed as a summary indicator of the basic capacity of a country to bring about outcomes. This does not translate into GNI being a direct or a single determinant of outcomes — it is merely a benchmark and starting point for how a country performs relative to others at its income level.

\(^2\)Cross-country elasticities are reported in an external statistical annex (available here) for two distant points in time for a group of development outcomes, among them, 55 indicators can be traced back to the early 1980s. A simple interpretation of the cross-country elasticity parameter, \(\beta_1\), is the following: a statistically-significant coefficient indicates a strong association between changes in a country’s GNI per capita and changes in development outcomes. If the cross-country elasticity is not statistically different that zero, income levels do not determine progress.
Figure 12 to Figure 20 in the annex show cross-country, constant-elasticity regressions to benchmark current development outcomes. It can be seen that low- and middle-income countries have advanced on basic health and education development indicators. Nowadays there are much higher rates for immunization of diphtheria, pertussis, and tetanus than in 1980; and contraceptive prevalence in women aged 15 to 49 has increased for the majority of countries with available data. Primary education enrollment rates in low-income countries have reached similar levels to those of middle- and high-income countries. This has particularly benefited girls living in low-income countries. Benefits in early health and education are reflected in a higher transition to lower secondary education and on higher average years of schooling in low- and middle-income countries.

Despite having achieved significant progress in basic outcomes, less has been possible in terms of creating comprehensive health care and education systems in low- and middle-income countries. A symptom of this can be seen in the practically lack of improvement in the ratio of physicians per 1,000 people after controlling for GNI per capita. The quality of education systems is lagging behind more acutely in low-income countries, mainly due to the fact that some middle- and most high-income countries are advancing rapidly – helped by the decline in the relative number of students and by improving their education standards. As a matter of fact, lower pupil-teacher ratios, which is a trend commonly related with improvements in the quality of education, has constantly declined in high-income countries during the last decades.

Infrastructure-related development outcomes are areas where development face serious drawbacks. Globally there are 1.2 billion people without access to electricity; 7 of 10 of them are located in Sub-Saharan Africa. A similar alarming picture resonates with the 2.4 billion people without access to improved sanitation facilities (World Health Organization 2015). Not only greener, but also inclusive and resilient infrastructure is a pre-requisite for addressing the developmental challenges ahead and coping with the possible negative effects of climate change. As in many catastrophes, the negative effects of climate change will be felt more drastically by the economic, social, and the political disadvantaged members of society. It is well recognized that despite the closing gaps in few but important development outcomes, more needs to be done in order to share the benefits of progress widely. It is also well recognized that going forward, there are high levels of uncertainty and risk associated with the environment, economic, and sociopolitical systems. The following section contributes to our understanding on the role that uncertainty about the dynamics of inequality impose on our capacity to implement sustainable climate change policies.

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3 A health-indicator that is usually related to a health system’s overall capacity
3. Climate Change and Deepening Inequality

In the decades to come, it is expected that inequities at the local level will persist and be largely influenced by continuing mega trends such as demographics, urbanization, globalization, and technological progress. The emerging face of inequality for the 21st century is one of coexisting discrepancies at the local level. Atkinson, Piketty, and Sæz (2011), for instance, show a marked and persistent concentration of wealth on the top tail of the income distribution, particularly in the United States, other English speaking countries, India, and China; while Lakner and Milanovic (2013) report a long-term and continuously increase in the within-country component of global inequality. For India, Dreze and Sen's (2011) describes the drastically uneven development progress achieved across its states, while Gangopadhyay, Lanjouw, Vishwanath, and Yoshida (2010) document India’s pockets of poverty at the narrower district level.

Inequality at the local level extends to other aspects of human wellbeing, exists in all countries, and is marked by polarization. Homeless people living by the side of modern highways are common sights in metropolises from Tokyo to Mumbai to Sao Paolo. Life expectancy in the poorest neighborhoods of Baltimore is below 69 years, the same as in Iraq (Baltimore City Health Department 2016; World Bank 2016b). Similar examples of coexisting unequal development outcomes are evident in Nogales, Arizona and Nogales, Sonora, spotlighted in Acemoglu and Robinson (2012) as an example of drastically unequal economic development. This new face of inequality requires active and comprehensive combination of social and growth enhancing policies that target the bottom quintiles of the income distribution more than ever. Changing circumstances dictate that governments must not sit back and rely solely on economic growth to transform the living conditions of the underprivileged.

It is key then to set up a mechanism to identify the most vulnerable segments of the population, find innovative policies that target these specific groups, and implement reforms that transform institutions to serve the most affected. In this regard, low- and middle-income countries face higher income inequality and are more vulnerable to climate change [see Figure 4 and Figure 5 below].\(^4\) Despite large variation, there are some specific vulnerabilities that affect mostly low-income countries\(^5\). In some key areas (deforestation, adaptive capacity to climate change, short-term energy security, environmental pressure, food security, exposure to climate event, waste management, and water quality) low and middle-income countries would face larger difficulties to implement adaptation policies. In the other side of the spectrum, high-income countries not only face less environmental pressures, but also have better adaptive capacity to climate change.

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\(^4\) As annex to this technical paper, a complete set of visualizations for several Climate Change Vulnerability Indicators has been generated and can be accessed at: https://public.tableau.com/profile/publish/ClimateChangeVulnerability/Dashboard2#!publish=confirm

\(^5\) Figure 15 and similar figures accompanying this paper as an annex show how low- and middle-income countries face more serious threats from heat stress, have higher levels of deforestation, and are lagging-behind in terms of energy security
Figure 4 Climate change vulnerability and income inequality

Note: The Climate Change Vulnerability Index (CCVI) evaluates the risk of exposure to climate change and extreme events, with the current human sensitivity to that exposure and the capacity of the country to adapt to, or take advantage of, the potential impacts of climate change. CCVI is comprised of the component indices: Exposure Index (50%) Sensitivity Index (25%) and Adaptive Capacity Index (25%). For consistency, a higher index reflects better conditions and hence has lower vulnerability. Countries have been group according to World Bank Income Classification. For overall consistency, a higher index denotes more favorable conditions; i.e. less climate change vulnerability.

Note: Gini coefficients for 130 countries were calculated using the GIDD database with data from the World Bank’s International Income Distribution Database and Global Micro Database.

Note: The Exposure Index incorporates the risk of a region being impacted by extreme climate related events (drought, wildfires, tropical cyclones and storms, storm surge, severe local storms, precipitation induced landslides, flooding and sea-level rise), as well as the risk posed by the projected changes in baseline climate parameters (air temperature, precipitation and specific humidity). (See Verisk Maplecroft, 2015 p.25)

Uncertainty prevails on the possible ways climate change might interact with other global and country-specific trends over the long-term; and on the way policies and institutions can frame those effects at the subnational and local level. In order to address these uncertainties, the international research community has adopted a proposed set of narratives that consider possible pathways for development, according to a given set of feasible scenarios known as Shared Socio Economic Pathways (Hasegawa, Fujimori, Takahashi, & Masui, 2015; O’Neill et al., 2013; Rozenberg & Hallegatte, 2015). Each development pathway can lead to distinctive economic and environmental circumstances. Each pathway is a reference for describing plausible alternative trends in the evolution of society and ecosystems over a century timescale (See Box 1 below for a definition of each SSP narrative).
Box 1 The Shared Socio Economic Pathways.

Figure 6 The climate change challenges space to be spanned by SSPS, divided into five domains

Source: Authors elaboration based on Kriegler et al., (2012) & O’Neill et al., (2013)

The diagram above has on the vertical-axis, socioeconomic challenges for mitigation and adaptation on the vertical and horizontal-axis, respectively. Challenges for mitigation are defined as (1) factors that tend to lead to higher emissions in the absence of climate policy or (2) factors that would tend to reduce the mitigation capacity of a society. Socioeconomic challenges for adaptation are defined as societal or environmental conditions that, by making adaptation more difficult, increase the risk associated with any given projection of climate change (see O’Neill et al., 2013). The 5 SSPs are defined broadly below:

**SSP1 (Sustainability):** Represents a break with recent history. Policy changes are driven by changing attitudes. The world shifts towards a more sustainable path, even at the expense of somewhat slower long-term economic growth. Inequality is reduced within and between countries. Environmental friendly technologies, good outlook renewable energy, international cooperation, and improvements in human well-being. Low challenges for mitigation and adaptation.

**SSP2 (Middle of the road):** Do not markedly deviate from historical patterns. Slow and uneven development progress with significant heterogeneities between countries. Imperfect global connected markets. Degradation of environmental systems. Reluctance to use unconventional fossil resources. Moderate population growth with low investments in education in low-income countries. Persisting income inequality. Moderate challenges for mitigation and adaptation.

**SSP3 (Regional rivalry – A rocky road):** Poor progress towards
sustainability and development. Resurgent nationalism, focus on domestic or, at most, regional issues. Weak global institutions and international fragmentation. Barriers to trade, particularly in energy resources and agricultural products. Inequality worsens over time. Strong environmental degradation in some regions. Higher challenges for mitigation and adaptation.

SSP4 (Inequality – A road divided): Increasing disparities in inequalities and stratification both across and within countries. On top, an internationally-connected society, with some well-educated groups contributing to knowledge economy. Down, a fragmented collection of lower-income poorly educated groups. Skill-biased technological change, high capital returns, highly unequal investments in education. Concentration of power by elites. Low challenges to mitigation but high challenges for adaptation.


Investigating the impact of climate change on poverty and inequality requires an approach that focuses on addressing evolving economic conditions of the individuals across the income distribution. This paper uses a top-down modelling framework that combines results from a macro general-equilibrium model with a micro simulation framework to explicitly represent the long-term dynamics of income distribution. Macro-micro simulation techniques of this type (Devarajan et al. 2013; Francois Bourguignon, Bussolo, and Cockburn 2010) are to a large extent possible thanks to large scale efforts of harmonization of household surveys (as in Montenegro and Hirn 2009).

Simulation results come from the Global Income Distribution Dynamics model (for a technical description of the model refer to François Bourguignon and Bussolo 2013; & Osorio Rodarte 2016). Figure 7 shows alternative shapes of the global distribution of per capita income in the year 2050 based on each future SSP narrative. Depending on the path taken, the aggregate global welfare, inequality and level of poverty reduction varies significantly. Additionally, in a scenario where socio-economic challenges for adaptation dominate, as SSP4 (inequality), global poverty and inequality are projected to be higher. The main drivers behind this result are derived from a general equilibrium
solution on which demographic composition, labor force participation, human capital accumulation, comparative advantage, and labor earnings interact.

**Figure 7 Uncertainty on prospects for the global distribution of income in 2050 based on different global narratives**

Simulations also show that if socio-economic challenges for adaptation dominate, as in SSP3 (regional rivalry) and SSP4 (inequality), low-income countries will face much harder conditions to make development progress faster. One of such disadvantages will be seen in a much slower demographic transition toward smaller and healthier families (the transition mentioned in Figure 3). As a result of this drawback, by 2050, Sub-Saharan Africa will have larger families and this will be ultimately reflected in an increasing share of the working age population (Figure 8). By the same token, in SSP1 (sustainability) and SSP5 (fossil-fueled development) Sub-Saharan Africa will have a lower increase in the working age population since countries in the region would be able to make the demographic transition faster.

Simulation results show that scenarios with slow demographic transition in low-income countries, such as SSP3 (regional rivalry) and SSP4 (inequality), imply less accumulation of human capital, and result in lower per capita income growth (Figure 9). In the other hand, scenarios with faster demographic transition, SSP1 (sustainability) and SSP5 (fossil-fueled development), achieve greater benefits in terms of global poverty reduction. Contrasting these last two poverty-reducing scenarios, pursuing the sustainable path, SSP1, would reduce global inequality as a direct result of a higher human capital accumulation in low-income countries.
Figure 8 Working age population in 2050 under different narratives, change with respect to 2010

Note: ECA: Eastern Europe and Central Asia; HIC: High-income countries; MNA: Middle-east and North Africa; R-EAP: Rest of East Asia; R-SAS: Rest of South Asia; CHN: China; IND: India; SSA: Sub-Saharan Africa.
Source: Author estimates using the GIDD model and van der Mensbrugghe (2011)

Figure 9 Per capita income growth by 2050 under different SSP narratives

Note: ECA: Eastern Europe and Central Asia; HIC: High-income countries; MNA: Middle-east and North Africa; R-EAP: Rest of East Asia; R-SAS: Rest of South Asia; CHN: China; IND: India; SSA: Sub-Saharan Africa.
Source: Author estimates using the GIDD model and van der Mensbrugghe (2011)
4. Most damaging climate events

Going for sustainability imply that there are complementarities in addressing climate change that would lead to a more equitable and prosperous planet – the same complementarities of the SSP1 narrative. These complementarities arise from two broad set of reasons (as in World Bank, 2005) that are important to consider at the moment of operationalizing sustainable development strategies. First, there are many potential market failures in international and domestic markets, most notably in the markets for insurance, infrastructure, and human capital. As a result, global and domestic funds may not flow where returns are highest (see Arezki, Bolton, Peters, Samama, & Stiglitz, 2016; Estache & Fay, 2007). In these circumstances, when markets are missing or imperfect, global or domestic investments are more likely to be sub-optimal and be affected by the distributions of wealth or political power.

The second set of reasons why climate change, equity, and long-term prosperity, can be complementary arises from the fact that high levels of economic and political inequality tend to lead to domestic economic institutions and social arrangements that systematically perpetuate the status quo. Policies that shield the economy from the expected negative effects of climate change would require, nonetheless, economic and political institutions with a strong spirit of reform and capable of long-term commitments.

Multilateral and domestics discussions on climate change must be interlaced then with the much broader Sustainable Development Goals agenda. Nevertheless, this paper advocates for operationalizing the discussion by finding multilateral and domestic instruments to rebalance investments in favor of three pillars: 1) human capital for the bottom 40, 2) greener sources energy, and 3) resilient infrastructure investments. A global rebalance of investments needs to address the existing gap between the excessively large pools of capital – i.e. the holdings of pension funds, sovereign wealth funds, and asset management funds are estimated to exceed $100 trillion (Arezki et al. 2016); and the huge unmet needs in infrastructure, human capital, and green energy especially in low- and middle-income economies.

4.1. Investments in infrastructure

In order to support a future global population of 9 billion, approximately US$5 trillion per year need to be invested globally in a variety of infrastructure projects, which is roughly equivalent to US$100 trillion over the next two decades. In addition to this, all existing and future investment must be greened to avoid dangerous levels of climate change and adverse environmental impacts that could erode the benefits from new green developments (World Economic Forum 2013). It is expected that an additional US$697 million per year are required to adapt and make more resilient investments – under the less-than-2 Celsius scenario (See Figure 10).
As international institutions and individual governments embark on the adoption of Climate Change Action plans (CCAP) to meet their Paris COP21 pledges, a key focus should be placed on increasing resilient infrastructure. These efforts might include early warning systems, climate-smart social protection policies, and urban and coastal resilience programs (see for instance Executive Office of the President - The White House, 2013; World Bank, 2016a). Action plans should set investment targets in high-impact areas, including energy, transport, agriculture, and urban development; as well as in finding mechanism to mobilize the private sector to expand smart-climate investments.

Infrastructure development in most parts of the world has been seriously lagging over the past three decades – with the notable exception of major state-sponsored efforts in infrastructure development in China and other Asian countries. Nevertheless, the role of the large scale private sector in the delivery of infrastructure services in energy, water or transport is far from being widespread (Estache and Fay 2007). Delaying investments is a very expensive option since climate related damages can cause a myriad of damages and put the world’s critical infrastructure at risk. The 2010 floods in Pakistan, for instance, caused an estimated cost for relief, early recovery and reconstruction of approximately US$8.74 – 10.85 billion; with close to $2 billion in damages to physical infrastructure exclusively (World Bank 2010).

4.2. Human capital accumulation

In the world of the 21st century and in line with past experience in high- and middle-income countries, a rise in agricultural productivity in low-income countries would push millions of people
previously dependent on the agricultural sector to migrate to cities and find jobs either in low-tech manufacturing or service sectors. Despite the inherent challenge of raising agricultural productivity in lagging areas to the very high levels of productivity and mechanization observed in leading regions, the main challenge ahead is to make the rural-urban transition work in line with new demands from the global economy (World Bank and International Monetary Fund 2013).

The outlook for emerging technologies, including mechanization, robotics, and artificial intelligence is promising and they are expected to modify the future demand of labor. For instance, the number of industrial robots is growing fast not only in high-income countries, but also in traditional low-skill manufacturing countries like China (Figure 11). These disruptive technologies can improve welfare across the globe and economize on earth’s resources. However, raise in overall productivity comes with the challenge of labor displacement and concentration of economic gains in fewer hands. The speed at which these technologies are being implemented in manufacturing and service sectors alike raises some concerns because the speed at which jobs based on routine tasks are being destroyed, as a result of automation, is presently exceeding the rate of new job creation (Frey and Oborne 2013).

**Figure 11 Stock of multipurpose industrial robots at year-end, units**

![Stock of multipurpose industrial robots at year-end, units](image)

Source: International Federation of Robotics, 2015

These technologies – while raising overall productivity, are rapidly altering the current speed and scope of automation, leading to fiscal strains and social discontent (Autor 2014). The challenge is how best to manage and navigate the technological transition for the decades ahead. Some initiatives argue that a core medium- and long-term growth strategy must be to improve the distribution of human capital by building up the skills and health of low-income households. Directly targeted policies are needed that enhance productivity, especially in small-scale enterprises in developing countries, which are the mainstay of employment for large numbers of poor people (Kanbur 2014).
4.3. Green energy

Existing energy technologies are not capable of delivering on the most basic items of the SDG agenda without an environmentally catastrophic increase in greenhouse emissions. A green energy revolution, meaning that future technologies must provide clean and affordable energy, is indeed needed if poverty eradication and guaranteeing a minimum standard of living are to be set as universal development outcomes.

Investments in emerging greener energy sectors require decisive actions to avoid the so-called “environmental poverty traps”. The risk of weak investment is that if the new green sector does not grow fast enough to move through the phase of increasing returns, the sector face the risk of being in a low productivity level indefinitely or get driven back down to environmental degradation standards. If the green sector shows increasing returns, there may be a role for more active industrial policy to complement conventional measures of environmental externality pricing.

The IEA’s Energy Technology Perspectives 2012 has estimated that the investment costs in technologies for electricity supply and demand technologies in a low carbon or 2°C Scenario (2DS) will reach US$140 trillion between 2010 and 2050, US$36 trillion more than under a business as usual scenario (with 6°C Scenario, 6DS). Improving the resilience of the economy also involves investments to scale up new technologies that are less vulnerable to the effects of climate change. Building up early on the required capacity can be an effective hedging strategy against the possibility of serious future shocks. Expectations about the speed at which negative shocks degrades economies and the variability of those shocks stresses the need of investing in emerging green and resilient technologies urgently.
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Verisk Maplecroft. 2015. “Climate Change Vulnerability Index.”


Annex
Figure 12 Immunization, DPT (% of children ages 12-24 months old)

Source: World Bank, (2016b)

Figure 13 Contraceptive prevalence (% of women ages 15-49)

Source: World Bank, (2016b)
Figure 14 Physicians (per 1,000 people)

Source: World Bank, (2016b)

Figure 15 School enrollment in primary

Source: World Bank, (2016b)
Figure 16 Effective transition rate from primary to secondary school

Source: World Bank, (2016b)

Figure 17 Average years of schooling

Source: World Bank, (2016b)
Figure 18 Pupil-teacher ratio, secondary

Source: World Bank, (2016b)

Figure 19 Access to electricity (% of population)

Source: World Bank, (2016b)
Figure 20 Improved sanitation facilities (% of population with access)

Source: World Bank, (2016b)