



Technical and statistical report

Statistical Guidelines for Measuring Productive Capacities



United
Nations



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**United
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Geneva, 2025

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United Nations publication issued by the United Nations Conference on Trade and Development

UNCTAD/ALDC/2025/4

ISBN: 978-92-1-159793-6
eISBN: 978-92-1-154606-4
Sales No. E.25.II.D.49

Acknowledgements

This report, *Statistical Guidelines for Measuring Productive Capacities*, was prepared, under the overall guidance of Paul Akiwumi, Director, Division for Africa, Least Developed Countries and Special Programmes of UNCTAD, by a team led by Mussie Delelegn Arega and including Rachid Bouhia. Stefanie Garry and Lisa Borgatti contributed valuable comments and suggestions. Anu Peltola, Director, and Benny Salo and Petra Kynclova of the of the Statistics Service of UNCTAD provided valuable comments and suggestions.

UNCTAD gratefully acknowledges the contributions of Emmanuel Milet.

UNCTAD further extends Appreciation is also extended to the members of the UNCTAD statistical and technical advisory group, who provided peer review of the guidelines at the group's second meeting on 15 January 2025, and to the anonymous reviewers from the national statistical offices of Benin and France.

Cover design and desktop publishing were undertaken by the UNCTAD Communication and External Relations Section.



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Abbreviations

LDC	Least-Developed countries
LLDC	Landlocked Developing countries
SIDS	Small Island Developing States
NSO	National Statistical Office
PCI	Productive Capacities Index
PCA	Principal Component Analysis
NPCGA	National Productive Capacities Gap Assessment
HPCDP	Holistic Productive Capacities Development Programme
UN	United Nations
UNSC	United Nations Statistical Commission
UNCTAD	United Nations Conference on Trade and Development
SNA	System of National Accounts
SDG	Sustainable Development Goals
IMF	International Monetary Fund
ODC	Other Developing Countries



I. Executive Summary

These Statistical Guidelines for Measuring Productive Capacities are intended to support statisticians, economists, practitioners, policy experts, and other stakeholders in using the Productive Capacities Index (PCI) for policy analysis and compiling nationally or regionally adjusted measures of productive capacities. These guidelines introduce the latest statistical concepts, methods, and tools to harmonize the measurement of productive capacities, while also laying the groundwork for their further consolidation and development. At its 56th session, the United Nations Statistical Commission (UNSC) was informed by UNCTAD about these guidelines, and the Bureau of the UNSC was invited to consider how to further address this topic in the Commission's discussions.¹

Since the 1950s, structuralist economics has highlighted the limitations faced by developing economies, emphasizing the necessity of structural transformation (chapter II). Today, this concept is a cornerstone of development economics and is integral to modern frameworks, including the Sustainable Development Goals (SDGs). However, a consistent and coherent method to measure productive capacities has been lacking.

In response to this gap, UNCTAD developed a comprehensive conceptual framework defining productive capacities as «the productive resources, entrepreneurial capabilities, and production linkages that collectively determine a country's ability to produce goods and services essential for its growth and development» (chapter III). The PCI was subsequently developed as an official metric to measure and benchmark productive capacities, following requests from member States through the Nairobi Maafikiano (TD/519/Add.2, para. 76(k)) and ECOSOC (E/RES/2017/29, para. 6) resolutions.

The second-generation PCI, which was launched in 2023 covers 194 countries and economies from 2000 to 2022. It builds on the first generation which was finalized and launched in 2018. The set of productive capacities and their combinations are mapped across 42 indicators under the following eight categories: human capital, natural capital, energy, transport, information and communication technologies (ICTs), institutions, the private sector and structural change (chapter IV). The PCI compilation follows a standard statistical process, from data collection to validation, aggregation, analysis, and result release. Chapter V outlines the six steps specific to the PCI, from data reading to composite index calculation. Given the significant data gaps affecting some categories and countries, enhancing statistical capacity is crucial. UNCTAD is dedicated to fostering partnerships to support member States in addressing these gaps and ensuring the availability of key statistics for inclusion in the index.

This guide provides an overview of the statistical methodology used to construct the PCI, without delving into excessive technical detail. For in-depth discussions on alternative techniques and the robustness of the second generation of index, please refer to the statistical manual published by UNCTAD (2023).

¹ See paragraph C/56/103/(f) of United Nations Statistical Commission Report on the 56th session (4-7 March 2025), available at https://unstats.un.org/UNSDWebsite/statcom/session_56/documents/2025-37-Report-E.pdf.



UNCTAD established a Statistical and Technical Advisory Group (STAG) to ensure the index's methodological rigour and integrity with the evolving statistical methods, quality and standards. STAG consists of notable academics in the field, national statisticians, and statisticians and econometricians from international organisations such as OECD, IMF, ECA, ESCAP, ECLAC, ILO, WHO, UNDP, UNDESA, etc. These guidelines were peer reviewed by the members of the STAG in its meeting of 15 January 2025. The PCI is also supported by a High-Level Advisory Board (HLAB) that guides UNCTAD's Secretary-General on related research and policy matters.

The PCI is also subject to peer reviews from other statisticians and academics, including during its initial development when it was reviewed by affiliates from the University of Sydney, Hong Kong Polytechnic University, Australian National University, the University of Doha, and research institutes from Kenya, Botswana, and Namibia, the Centre for the Study of the Economies of Africa (CSEA) and various UN entities, like UNDP, UNDESA Committee for Development Policy and UN Regional Economic Commissions.

Requests for productive capacity reviews and statistical capacity building are quickly increasing (chapter VI). When the PCI was introduced to Chief Statisticians at a side event of the 55th UN Statistical Commission, many expressed their interest in collaborating with UNCTAD to address data gaps and enhance statistical capacity. To date, capacity-building events have been held with statistical authorities of Angola, Botswana, Ethiopia, Kenya, Lao PDR, Malawi, Nigeria, Mozambique, Rwanda, Zambia and Zimbabwe, and are planned for Honduras and Mongolia to be followed by several small island developing States (SIDS), like Antigua and Barbuda, Dominican Republic, Jamaica and Trinidad and Tobago. More than 40 developing countries requested similar supports from UNCTAD.

Discussions on incorporating new key dimensions into PCI have also been held under the guidance of the HLAB and STAG (chapter VI). These deliberations have highlighted three central themes: environmental resilience, gender equality and financial vulnerability.

The PCI provides a valuable tool for policymakers, bringing official statistics to a framework that informs national policies and also draws attention to investments needed in statistical capacity (chapter VII). In addition to national uses, the PCI has been utilized in over 50 academic papers by organizations, such as the OECD, IMF, UNDP and World Bank to analyse growth and development, inequalities and environmental capacities.

The PCI holds particular relevance for developing economies, offering an opportunity for statistical offices to inform its structured framework with official statistics' data to help governments develop evidence-based policies to enhance productive capacities and address structural vulnerabilities.





II.

Introduction and background



1. What are productive capacities and why do they matter?

a. Definition

Although the term “productive capacities” is increasingly used in national and international development discourses, mandates and roadmaps, there has been no universally accepted definition of what they are. The lack of an agreed definition of productive capacities mostly emanates from the complexity of the processes and the diversity of factors driving the fostering of such capacities and capabilities (Deleegn Arega, 2023). It is, for instance, not obvious to what extent productive capacities should refer to existing or potential capabilities. Should fertile, yet uncultivated land, be considered a productive capacity or not? Can untapped natural resources be considered as productive capacities? Can a large population with abundant yet unemployed labour be considered as part of the productive capacities of nations irrespective of income, knowledge, skills, or educational levels? Similarly, institutional conceptualization of the notion is also heterogenous, each institution providing functional definitions within its areas of expertise. Moreover, different schools of thought variously view productive capacities from technological, innovation, and learning systems as key to boosting sectoral or economy-wide productivity, employment, and growth.

UNCTAD defines productive capacities as «*the productive resources, entrepreneurial capabilities and production linkages that together determine a country's ability to produce goods and services that will help it grow and develop*». This definition aims to capture the broadness of the term and diversity of factors influencing it. Building these capacities is vital for developing countries to achieve inclusive and sustainable economic development, including the SDGs.

Strengthening productive capacities also helps address economic vulnerabilities, overcome income traps, and foster the creation of value-added, technology-driven goods and services, allowing countries to participate more effectively in global trade.

The UNCTAD definition stresses three distinct but interrelated dimensions – productive resources, entrepreneurial capabilities, and production linkages – that make up fundamental elements or pillars of productive capacities. In a nutshell, the first pillar, productive resources, is the factors of production and consists of natural and human capital, financial capital, and physical capital, which are key in the production and supply of goods and services. The second pillar, entrepreneurial capabilities, concerns core competencies and the technological capabilities of firms and households that maximize business and production possibilities and produce ranges of goods and services efficiently and competitively. The third pillar, production linkages, sometimes referred to as productive linkages, relates to (production, processing, business, information, and marketing linkages) which all together form interactions among enterprises through trade, production, investment, and technology flows.

UNCTAD's concept of productive capacities draws eclectically on a range of analytical traditions in development economics. It builds, first, on the foundational insights of the first generation of development economists in the 1950s and 1960s, particularly the Lewis model of economic growth with unlimited supplies of labour (Lewis, 1954) and Hirschman's theory of linkages (Hirschman, 1958). Ros (2001) provides a valuable formalization of these ideas, integrating them with selected elements of neoclassical and endogenous growth theories.

UNCTAD defines productive capacities as



the productive resources, entrepreneurial capabilities and production linkages that together determine a country's ability to produce goods and services that will help it grow and develop



UNCTAD's concept of productive capacities draws eclectically on a range of analytical traditions in development economics

Second, it incorporates the contributions of Kalecki (1969) and Kaldor (1967, 1981), who emphasized the roles of aggregate demand and intersectoral dynamics in shaping economic growth. Post-Keynesian models also play a role, especially those that highlight the balance-of-payments constraint as a structural limit on growth differentials between countries (McCombie and Thirlwall, 2004).

Third, it draws on structuralist analyses of growth and structural change, such as the empirical work of Chenery, Robinson and Syrquin (1986) on recurring development patterns, and the Latin American structuralist tradition. The latter includes early critiques of how integration into the global economy affects national development, as well as the neo-structuralist contributions of the 1990s that revisited these ideas in light of the debt crises of the 1980s and the mixed outcomes of subsequent economic reforms (Sunkel, 1993; Ocampo, 2005).

b. The historical role of productive capacities and the resurgence of the concept

Since the 1970s, UNCTAD research has shown that one of the keys to addressing risks, uncertainties, and vulnerabilities to shocks is the development of economy-wide productive capacities and structural economic transformation.² Additionally, building national productive capacities would enable countries to take the lead in, and ownership of, their national development by playing a greater role in the global economy.

Developing productive capacities has played a central role in initiating the long-term process of structural economic transformation in developed and newly industrializing economies, which served

as the backbone in building their socioeconomic resilience to shocks and facilitating progress towards inclusive growth and sustainable development. No nation has ever achieved development without nurturing productive capacities and kick-starting the process of structural economic transformation.

However, between the 1980s and the mid 2000's, scant attention was paid by policy makers and development partners to productive capacities per se, with the prevailing belief that their development would unfold automatically through the liberalization of trade, finance and through accelerated GDP growth. Yet, for most developing regions, this expectation never came to fruition. The process of structural transformation has stalled, or in some cases, reversed, leaving a large number of developing countries in "low" or "middle"-income traps. In others, economic growth was fuelled by sectors which are not intensive in labour and did not translate into creation of jobs, let alone into higher productivity growth. The end result was a failure to reduce poverty or income inequalities (UNCTAD, 2016).

Compounding this challenge, many economies find themselves highly vulnerable to an array of increasingly recurrent internal and external shocks, as seen lately with the COVID-19 pandemic, regional conflicts, financial crises, commodity price shocks and climate disasters. The lack of economic diversification, resulting in insufficient capacity to generate investible resources and to produce technology-intensive goods and services, often makes it difficult to cope with the adverse effects of "hyperglobalization" and climate change.

² See resolution 93 (IV) of UNCTAD IV, adopted in Nairobi in 1976: "With a view to improving the terms of trade of developing countries and in order to eliminate the economic imbalance between developed and developing countries, concerted efforts should be made in favor of the developing countries towards expanding and diversifying their trade, improving and diversifying their productive capacity, improving their productivity, and increasing their export earnings, with a view to counteracting the adverse effects of inflation, thereby sustaining real incomes." (UNCTAD, 1976).

In the face of these challenges, there has been a global resurgence of interest in fostering productive capacities and understanding their underlying concepts, theories and related operational programmes, with the aim of repositioning such capacities at the core of the development narrative and achieving sustainable and inclusive growth (Juhász, Lane and Rodrik, 2024). The development of the PCI, thus, follows at least two decades of discussion, both within and beyond UNCTAD, about the importance of productive capacities in policy making. For instance, in its 2005 report about economic growth in the 1990s, the World Bank argued that “the policy focus of the 1990s enabled better use of productive capacity but did not provide sufficient incentives for expanding capacity” (World Bank, 2005a). The 2020 report on Least Developed Countries (LDCs) by UNCTAD was almost entirely dedicated to the question of building productive capacities in least-developed countries (UNCTAD, 2020a). A recent IMF publication highlights the important role played by productive capacities in mitigating the effect of negative shocks on economic growth (Yaya, 2024).

Fostering productive capacities has recently been debated in major international conferences under the auspices of the United Nations. Ministerial declarations, along with the Vienna Programme of Action for Landlocked Developing Countries (LLDCs) for the decade 2014-2024, the Doha Programme of Action (DPoA) for the Least Developed Countries of the fifth UN-Conference on LDCs, the Nairobi Azimio, and Nairobi Maafikiano of the 14th quadrennial Conference of UNCTAD (UNCTAD XIV), the Bridgetown Covenant adopted at UNCTAD XV, as well as the Antigua and Barbuda Action

Agenda for Small Islands Developing States, have consistently emphasized that fostering productive capacities is crucial for achieving sustainable development.

The importance of developing productive capacities has also been demonstrated in the successful experience of catching-up by some developing countries in achieving sustained poverty reduction over the past 30 years (Birdsall, 1993; Krugman, 1994; Ranis, 1995). While so-called “pro-poor” growth policies have always been the hallmark of development policies and policy recommendations,³ how to achieve this remained elusive and for the most part unanswered. Focusing on productive capacities can help provide answers and offer tools and guidance on how to promote pro-poor growth policies (Ravallion and Chen, 2003; Ravallion, 2004; World Bank, 2005b; Loayza and Raddatz, 2010). Poverty reduction is not only a consequence of economic growth, but a driver of it. The relationship between income growth and poverty reduction depends on how productive capacities expand, develop, and are used.

Building the economic resilience of developing countries remains a daunting challenge. It requires a shift from the current fragmented, micro-level and project-based interventions towards coherent, economy-wide and programme-based approaches to removing binding constraints on development (Deaton, 2010). As countries do not operate in a vacuum but are linked to one another (through trade, investment, migrations, etc.), actions and interventions at the domestic level need to be supported and complemented by additional robust international support measures anchored on mutually beneficial global partnerships.

There has been a global resurgence of interest in fostering productive capacities

³ Ravallion (2004) reviews the two main definitions of pro-poor policies found in the literature: First, growth is pro-poor if income inequalities decline to the benefit of the poor. Second, growth is pro-poor if poverty declines in the process of economic growth. Ravallion notes that the first definition is problematic as it implies that recessions can be pro-poor if the income of the richest falls more than that of the poor.



2. Why and how was PCI developed?

a. Measuring and benchmarking productive capacities

Building on the definition, UNCTAD developed the PCI to measure, monitor, and benchmark productive capacities, in response to requests from member States through various UN fora. At UNCTAD XIV held in Nairobi, Kenya in 2016, member States called on UNCTAD to identify indicators and develop an index to measure productive capacities (UNCTAD, 2016). This call has further been further amplified by the ECOSOC resolution (E/RES/2017/29), encouraging UNCTAD “to pursue its methodological work to measure progress in and identify obstacles to the development of productive capacities in developing countries (ECOSOC, 2017).

The PCI draws on extensive research and policy analysis work, as well as lessons learned from UNCTAD’s technical support to the most vulnerable countries such as LDCs, LLDCs and SIDS in developing key aspects of their trade and productive structures. Eight main categories for the PCI were thus identified. These are grounded in the theoretical framework further developed in Chapter III and informed by consultations with pilot countries, which helped pinpoint areas where policy action was both feasible and impactful.⁴ This structure allows to measure, monitor, and benchmark productive capacities across eight key policy areas, while also aggregating them into a single composite index for an overall picture. Naturally, alternative categorizations are possible, including out of the same theoretical foundations and depending on the intended final and policy use of the index.

The index is the first comprehensive attempt to measure productive capacities in all economies and construct a multidimensional index that can provide country-specific insights and diagnostics of productive capacity development. The overall objective is to formulate and implement data-driven and evidence-based development policies and strategies. The PCI was designed for two purposes, which reflect its current structure: to provide a synthesis score for an overall assessment, and to offer individual scores for each dimension. The latter addresses UNCTAD’s need to support countries in producing national productive capacity gap assessments, where a sectoral approach is required.

The first version of the index is described in UNCTAD (2020b) and was officially launched in February 2021. An updated version was released in June 2023 and the index now covers 194 economies over the period 2000-2022. This updated version of PCI underwent extensive testing and consultation. The statistical methodology is presented in chapter V.

b. Desired attributes for the PCI and methodological challenges

As mentioned previously, the development of the PCI stems from requests made by countries during UNCTAD conferences and in ECOSOC resolutions. These mandates come with specific requirements: the index must be policy-relevant, easy to use and interpret by policymakers, and operational, meaning it should help map out actionable areas for policy intervention. It must also be as universal as possible, covering a wide range of countries, and enabling meaningful cross-country comparisons, despite the inherent differences in how «productive capacities» may manifest across regions and development levels. These design imperatives were fundamental in shaping the structure of the PCI.

UNCTAD developed the PCI to measure, monitor, and benchmark productive capacities, in response to requests from member States

⁴ See, for instance, outcomes of the UN Development Account on “Indices for benchmarking productive capacities for evidence-based policymaking in landlocked developing countries”.



Composite indices are valuable for setting policy priorities, as they simplify the interpretation of numerous indicators into a single measure (Saisana and Saltelli, 2011). However, they should be viewed as starting points for deeper analysis of their individual components (Kynčlová, Upadhyaya and Nice, 2020).

Beyond its policy-oriented design, the measurement of productive capacities entails several methodological and practical challenges. These include the latent nature of key dimensions, difficulties in selecting appropriate indicators due to endogeneity, data availability and quality across countries, and methodological trade-offs in constructing a composite index. These limitations highlight the importance of interpreting the PCI as a guiding tool rather than a definitive measure. Bouhia and Delelegn Arega (forthcoming) examine in further detail the challenges of translating the conceptual definition of productive capacities into operational statistical measures, along with the proposed methodological and institutional solutions to overcome these challenges.

3. Added value of the PCI as a tool for statisticians and policy makers

PCI aims at providing policymakers with a practical tool to assess productive capacities of an economy, and their evolution over time. The index can help identify competitive advantages or areas where countries may be falling behind, spotlighting where policies are working and where corrective efforts are needed. It suggests a roadmap for future policy actions and interventions under each of its eight components: human capital, natural capital, energy, information and communications technology, structural change, transport, institutions, and the private sector.

As emphasized in (UNCTAD, 2006), focusing on productive capacities can help promote economic growth and provides a better understanding of its link with poverty reduction.

In the context of stagnant economic development, increased income inequalities and greater vulnerability to shocks, PCI fits into the new global strategies to measure differently social and economic progress. As pointed out early by Kuznet (1962), *“goals for “more” growth should specify more growth of what and for what.”* Measuring economic and social performances has undergone a revival since the 2008 financial crisis and several attempts have been made to move beyond GDP as a measure of economic and social progress.⁵ SDG 17.19 specifically addresses this idea of how to measure progress.⁶

PCI is a tool to guide policy intervention to address gaps in productive capacities. It also helps in comparing performances across economies and tracking progress towards defined national and international goals (e.g. SDGs) by indicating necessary inputs, drivers and policy interventions. PCI strong focus on the development of productive capacities complements other existing national and international statistics aiming at monitoring progress in the areas of economic development.

PCI measures economic and social phenomena aligned with but going beyond existing statistical frameworks such as the System of National Accounts (SNA), which is critical to the development of a nation. While the main approach in developing official statistics has been to make “inventories” of stocks and flows across economic sectors, prominent development economists, including Hirschman (1958) and Kaldor (1967), have shown that what matters perhaps equally is how sectors interact with each other along what we call “linkages”.

The measurement of productive capacities entails several methodological and practical challenges

⁵ See for instance the reports by the 2008 Stiglitz-Sen-Fitoussi commission. An updated version of their work is available in Stiglitz et al. (2018). Several books have also been published on the topic of moving beyond GDP (Fioramonti, 2013; Coyle, 2014; Philipsen, 2015).

⁶ A review of the literature on how to measure economic and social progress is available on UNCTAD's page dedicated to SDGs ([link](#) – accessed November 2024).

They have also highlighted that some sectors or economic activities are more important than others to foster these linkages. The PCI, not only by its conceptual framework but also the statistical methods it employs, aims to quantitatively capture these “linkages”. PCI is an important step towards using statistical measures to help devise development policies.

The System of National Accounts focused on economic activity, leaves many issues of human and social development (education, health, demographics, poverty, inequality...) to other official statistics or satellite accounts extensions. The SNA which is the cornerstone of official economic statistics is also designed to serve the purpose of calculating GDP and key macroeconomic aggregates with the view of comparing economic performance across countries. The PCI does not focus on economic performance but rather reveals how well-endowed countries are with a view of maximizing their progress towards sustainable development. It is also important to bear in mind that the SNA was built on the model of already industrialized nations, thereby potentially overlooking relevant aspects of the developmental journey.

Academic researchers will also find the index useful as it does not focus on output but rather on the resources and overall economic environment and possibilities, which eventually lead to GDP.

4. Governance and review mechanisms

The PCI High-Level Advisory Board (HLAB) oversees the policy implications and application of the index. The HLAB was established to enhance the policy relevance of the index and support UNCTAD in developing its work programme on productive capacities. Serving in their personal capacity for two-year terms, HLAB

members advise UNCTAD on its research and policy agenda related to productive capacities. The board champions the use of the index by national, regional, and international entities, as well as academia and research institutions, proposes ways to improve the index and its policy relevance, and identifies key aspects of productive capacities to guide the development of Holistic Productive Capacities Development Programmes (HPCDPs) based on country-specific National Productive Capacities Gap Assessments (NPCGAs).

While the HLAB reviews and discusses policy orientations, as well as the scope of the PCI in terms of thematic areas, the Statistical and Technical Advisory Group (STAG) serves as a peer review mechanism to ensure the methodological and statistical consistency of the PCI, maximizing its use and application. Comprised of statistical experts and academics with expertise in developing indices, the STAG meets at least once a year, both virtually and in person, to support the efforts of the HLAB and UNCTAD. The STAG plays a key role in advancing the technical work on productive capacities, including periodically updating and refining the PCI. Its responsibilities include guiding the inclusion of new dimensions and data sources, enhancing the index's scope, integrating relevant development concepts (as recommended by the HLAB), and refining the PCI's methodology for international standards.

As part of its development, UNCTAD subjected the index to an extensive peer review process, including academic, statistical, and technical evaluations by experts. Involved Member States tested and validated the index through a series of national workshops, policy-oriented discussions and technical exchanges with national staff from relevant Ministries and NSOs.

UNCTAD subjected the index to an extensive peer review process, including academic, statistical, and technical evaluations





III.

Conceptual framework for productive capacities



As presented in the previous chapter, productive capacities are the productive resources, entrepreneurial capabilities and production linkages which determine an economy's capacity to grow and develop (see figure III.1 for a visual representation of the three "pillars" of productive capacities). At any given point in time, they set a ceiling on how much a country can produce. They can, however, be created and transformed over time to push this ceiling further out and create economic development. In a way, "for policymakers, what productive capacities are matters less than what they can become" (UNCTAD, 2006).

The core processes through which productive capacities develop are capital accumulation, technological progress, and structural change. A virtuous cycle then arises in which the development of productive capacities and the growth of demand mutually reinforce each other. These linkages between companies and with consumers operate under a common institutional framework which also contributes to the development of productive capacities. Finally, countries do not evolve in a vacuum but are integrated (albeit at various degrees) into the world economy through trade, financial flows, migration, international agreements. Their integration into the global economy strongly influences the development of productive capacities as well.

The three pillars of productive capacities interact with one another and their impact on productive capacities is amplified or diminished in the way they influence each other. For instance, the use of productive resources (e.g. natural resources) is more optimal when entrepreneurial capabilities

are improved, and production linkages are strengthened. Moreover, the attributes of these three constituents determine the types of goods and services produced in the country. Productive capacities can exhibit characteristics which are specific to certain activities and therefore create constraints on others. This is similar to the Heckscher-Ohlin theorem in international trade which states that countries specialize in producing goods that use their abundant factor intensively. For instance, if a country undertakes significant investments in the textile and clothing sector, the resulting skills and physical capital from these investments cannot be utilized in other sectors with different activities.

Productive capacities are thus understood as an important tool that takes into account a wide range of factors that contribute to economic development. Beyond the expected effect on poverty reduction and output growth, developing productive capacities can help relieve supply-side constraints and reduce unemployment. Similarly, the building of productive capacities is integral to efforts to support diversification and structural transformation, factors that are viewed as fundamental for inclusive growth and long-term development and to develop resilience in the face of climate change and increasing geopolitical tensions.

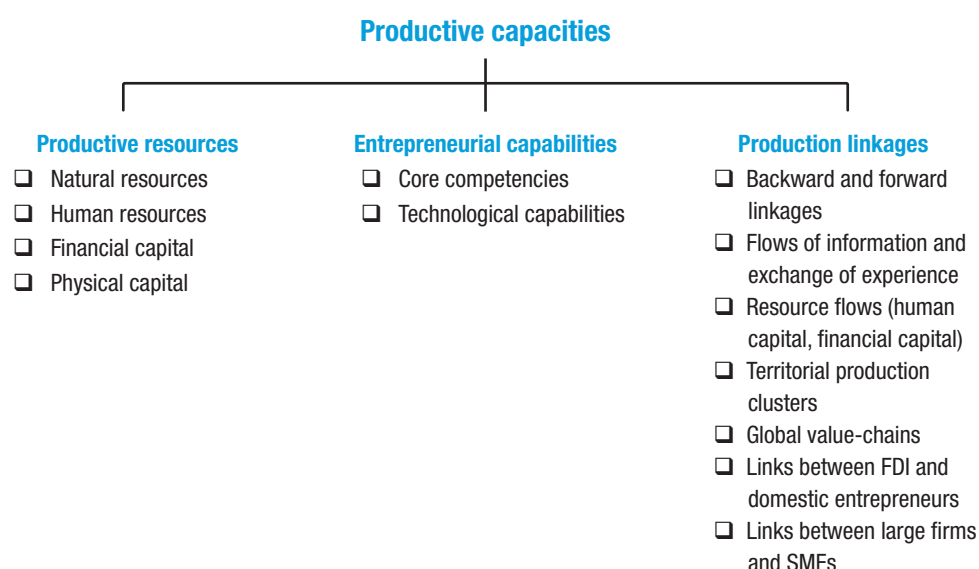
The following provides the theoretical grounding for the three pillars of productive capacities, and how capital accumulation, technological progress and structural change contribute to their development. How productive capacities are measured in practice through the PCI is presented in chapter IV.

The core processes through which productive capacities develop are capital accumulation, technological progress, and structural change





Figure III.1
The three-pillar structure of productive capacities



1. Productive resources

Productive resources are factors of production and include human, natural, financial capital and physical capital resources. Human resources relate to the quantity and quality of labour and therefore involve issues related to education, health and skills. Natural resources encompass agricultural land, water, forest and energy resources, among others. Financial capital resources refer to the availability and cost of financial capital to finance production, investment and innovation. Physical capital resources are capital stock and physical infrastructure such as transport, energy and telecommunications infrastructure.

A country's stock of capital increases through investment. Investment in physical capital such as new equipment and machinery is made possible by the existence of profits (which are reinvested) and a banking system able to channel domestic savings towards firms who want to invest.⁷ Hence, accumulation of physical capital is rendered possible by the availability of financial capital, and by the institutional framework that allows it.

Governments have a role in the creation of physical capital through their corporate tax policy which affect decisions to invest as well as the size of their investment made by firms (Abramovsky, Klemm and Phillips, 2014). They also provide the regulatory framework under which banks operate to make loans to businesses (Anginer, 2019). Foreign investors may also be providing the necessary funds for domestic investment, or be the one doing the investment directly through FDI.

Capital has not always flown from developed to developing countries, despite its relative scarcity there (Lucas, 1990). Explanations for this include weak institutional framework and inadequate human capital in the destination countries. The waves of capital account liberalization in the 1990s, based on the assumption that free movement of capital would lead to an efficient allocation of capital across countries, did not lead to massive investments into developing countries (Stiglitz, 2002), and since the 2000s net capital flows show a movement out of developing countries (UNCTAD, 2020c).

⁷ Academic literature on capital accumulation and economic growth underwent a revival during the 1990s. Important contributions include (Mankiw, Romer and Weil, 1992; Barro, Mankiw and Sala-i-Martin, 1995; Young, 1995).



Investment in human capital occurs through knowledge acquisition in schools, through experience, and on-the-job training. Physical and mental health are crucial components of human capital, and public health expenditures are the primary tool available to governments for promoting them (Bloom, Canning and Sevilla, 2001; Bloom et al., 2024). Human capital determines worker's wages but is also a crucial prerequisite for innovation in the workplace, and adoption of new technologies (see next section). On-the-job training in particular can promote technology adoption, as shown by a recent study by the Asian Development Bank (2020) which finds that firms providing *“even minimal formal training to employees are 7.5 and 7.7 percentage points more likely to introduce a new product and implement a new process”*.

Greater skill acquisition contributes to the mobility of workers across jobs and firms which allows firms in demand for labour to grow. It may, however, also lead to international migration, which, in the case of developing countries constitutes a relatively large loss in human capital. This *“brain drain”* phenomenon leads to a decline in the stock of human capital available in the country (Docquier and Rapoport, 2012). The prospect of international migration may also lead some individuals to acquire more education than they would otherwise in hope of migrating to a high-wage country in the future. Since not all workers successfully migrate, the end result can be a *“brain gain”* for the country (Beine, Docquier and Rapoport, 2010).⁸ Hence, an increase in human capital through schooling (by government intervention for instance) can generate two conflicting effects: a brain drain scenario under which the investment in education disappears

abroad, and a brain gain scenario under which the investment leads to an increase in the human capital of the country.

The accumulation of productive resources alters what the economy can produce. In an international context, it also changes a country's comparative advantage and its export patterns. This has significant implications for productive capacities. It means the economy is shifting its production patterns: new linkages are formed across firms and sectors, while others diminish; some firms and sectors decline, while others expand. Capital accumulation and the uneven growth of sectors go hand-in-hand with structural transformation of the economy.⁹ Two factors are crucial for this transformation to happen. First, businesses must be allowed to grow, expand, but also to shrink and close down in order to release productive resources (workers, physical capital) to the expanding ones. Regulations about business creation and bankruptcy have a direct effect on this dynamic process. The financial system also needs to facilitate the expansion of new business by channelling effectively savings towards businesses in needs of funds to investment. The second factor relates to the mobility of factors of production. For firms and sectors to grow, they must be able to attract productive resources. Workers need to be mobile across occupations, firms, but also regions. Workers need obtain information about jobs opening, to be able to transfer their skills and to physically move to where jobs are. This is strongly correlated to the third pillar of productive capacities which emphasizes the role of production linkages. Information linkages about job opportunities are an important element of worker's mobility.¹⁰

⁸ Artuc et al. (2015) showed that movement of workers between developing countries are important too, and highlighted lower estimates of brain drain.

⁹ Structural transformation is indeed characterized by the relative decline of some sectors to the benefit of others. This implies significant transitory periods where mismatch in the labour market are likely to occur for instance (McGuinness, Pouliakas and Redmond, 2018).

¹⁰ Estimates of mobility costs of workers across sectors or regions can amount to several times the average annual wage (Artuç, Lederman and Porto, 2015; Cruz et al., 2024).



The accumulation of one productive resource is likely to hit diminishing returns if other factors or resources are not accumulated simultaneously, or if technological progress is not happening (see the next section). This means it is important to consider the various productive resources together, rather than separately. For instance, workers can increase their stock of human capital through formal training and become more productive, but they can also become (or become more) productive by using better equipment, machinery or computers. The accumulation of a productive resource is also likely to divert investment towards the sector which uses intensively this resource. This is known as the Rybczynski effect (Rybczynski, 1955) in international trade and can influence structural change and production linkages in the rest of the economy. While both of these effects generate economic growth (either at a slower pace, or by being biased towards one sector), they also affect negatively some sectors or groups of the population. Such by-products are bound to happen as the growth process is unlikely to be equal and balanced across all sectors.

As we just discussed, production capacities typically increase at a diminishing rate if they solely rely on the accumulations of productive resources. There are two ways of escaping the law of diminishing returns. One way is to increase all factors simultaneously, but this is not always feasible. The other way is to raise the productivity of those factors. In a 2000 report on economic growth in East Asia, the World Bank wrote that “future growth hinges less on increasing physical capital accumulation and more on raising the productivity growth of all factors” (World Bank, 2000). Easterly and Levine (2001) also argue that economic growth in developing countries has been largely driven by increased productivity, a topic addressed in the following section.

Entrepreneurs are more likely to adopt different technologies when they can rely on high quality infrastructure

2. Entrepreneurial capabilities

Entrepreneurial capabilities are the abilities of firms and households to produce goods and services. A distinction is made between core competencies and technological capabilities, as follows: core competencies refer to applying current skills, knowledge and information to existing productive resources, to transform inputs into outputs; and technological capabilities refer to dynamic abilities to advance core competencies and thereby increase productivity, competitiveness and profitability and, as such, are the basis for the creativity, flexibility and dynamism of an economy. Technological capabilities, in turn, are comprised of the following five types of skills: expanding physical facilities (investment capabilities); upgrading products and processes (incremental innovation capabilities); developing new markets (strategic marketing capabilities); benefiting from the transfer of technology (linkage capabilities); and creating new technology (radical innovation capabilities).

The distinction between core competencies and technological capabilities matters for the development of production capacities. While core competencies do not lead to new products or new production linkages created with other companies, they can still benefit firms whenever other binding constraints limit the adoption of new technologies. In a recent contribution, Cirera et al. (2022) analyse survey data from entrepreneurs in 11 developing countries. Their results shed light on an interesting aspect of technology adoption. They find that the entrepreneurs interviewed work in firms that are quite far from the international technology frontier (meaning they have significant room for improvement in their own technology or in adopting new ones) but also lack that knowledge (they do not know how far they are). Their study shows that entrepreneurs are more likely to adopt different technologies when they can rely on high quality infrastructure (stable



source of electricity, transportation, and communication technologies), and that this is an important binding constraint in their decision to innovate. The key policy message from this study is the need for a paradigm shift, moving away from simply providing access to new (often imported) technologies, towards enabling firms to effectively adopt these technologies. For example, if the supply of electricity is unstable, firms may refrain from adopting technologies that are highly sensitive to power fluctuations, even if they are aware of such technologies. The authors emphasize that programs supporting technology adoption must take this into account. In other words, entrepreneurs and firms need to be empowered to adopt technologies by eliminating binding constraints that are beyond their control.

Developing entrepreneurial capabilities can be done via government-sponsored trainings, in the same vein as those sometimes proposed to workers (see the previous section). Cruz et al. (2018) document how a program offering coaching and consulting on management and production practices helped firms in Brazil reorganize, increase productivity, and become more likely to engage in exports. This program significantly enhanced the entrepreneurial capabilities of these companies. By becoming exporters, they also established production linkages with other international firms

It is difficult to measure entrepreneurial or managerial quality. The previous studies rely on small samples of firms following specific programs in a specific country. While very valuable, the methodology is likely to differ across studies and the content of the programmes evaluated too. An indirect measure of entrepreneurial capabilities can be derived from total factor productivity (TFP). TFP captures lots of unobserved components of technological improvements which cannot be accounted

for by accumulation of factors.¹¹ Productivity improvement matters because they translate into increased standards of living through higher real wages and goes a long way into explaining long-lasting differences in income across countries (Easterly and Levine, 2001).

The literature has long established that the most productive firms dominate both domestic and international production (Mayer and Ottaviano, 2008; Bernard et al., 2018). They are also more likely to be part of dense networks of firms and to have multiple linkages with both domestic and international companies (Bernard, Moxnes and Saito, 2019). This literature has highlighted the role of international trade in providing firms with the opportunity to access foreign technology. There are essentially three ways in which this can be achieved. First, firms can import high-tech inputs which better suits their need than what they can find domestically. This creates production linkages with a foreign supplier, and the importing firm can reduce its production costs. Second, evidence suggests that importing higher-quality inputs can lead to higher-quality output from the firm as well (Verhoogen, 2008; Kugler and Verhoogen, 2009). Third, firms can learn about foreign technologies embedded in the goods they import (Ferreira and Rossi, 2003; Amiti and Konings, 2007; Topalova and Khandelwal, 2011; Zaclicever and Pellandra, 2018). These studies highlight the crucial role trade policy can play in facilitating the import of intermediate products. Imports can promote quality upgrading and technology transfer domestically. Acquiring new technologies through trade is a cost-effective way to develop productive capacities.¹²

As with capital accumulation discussed in the previous section, the development of entrepreneurial capabilities is likely to have distributional effects. Technologies are typically adopted because they allow firms to reduce the use of certain factors of production. Since the post-World War II era,

¹¹ The measurement of productivity remains a subject of ongoing discussion and debate among economists and statisticians (Bartelsman and Doms, 2000; Syverson, 2011).

¹² See also Verhoogen (2021) for the role of global value chains in technology transfer.



Linkages and flows between enterprises have long been suggested as important elements for the productivity and competitiveness of countries

this factor has often been labour, particularly unskilled and middle-skilled labour. This trend was evident with the introduction of computers and, more recently, with the adoption of new information and communication technologies (Autor, Katz and Krueger, 1998; Autor and Dorn, 2013). In contrast, high-skilled workers and capital owners have generally benefited from these technologies (Moll, Rachel and Restrepo, 2022). As a result, wage inequalities have increased in the U.S. and other developed economies, contributing to the phenomenon known as the «great decoupling,» where median wages stagnated while GDP per capita continued to rise (Schwellnus, Kappeler and Pionnier, 2017). Additionally, the rise of multinational companies and global value chains has increased their market power and made it more difficult for successful entrepreneurs to compete in global markets (UNCTAD, 2017, 2018).

3. Production linkages

Production linkages are the interactions between economic sectors and among enterprises through trade, investment and technology flows and among firms and farms. These linkages include domestic and foreign-owned firms, as well as firms located in other countries, through international trade or the participation in global value chains. The presence of forward linkages (between a firm and its buyers) and backward linkages (between a firm and its suppliers) and the shift of productive resources from traditional sectors to modern ones are considered as signs of structural transformation. Similarly, linkages and flows between enterprises have long been suggested as important elements for the productivity and competitiveness of countries, with studies drawing attention to, among others, backward and forward linkages (Hirschman, 1958), global value chains (Humphrey and Schmitz, 2002; Gereffi, Humphrey

and Sturgeon, 2005; Gereffi, 2019; Tian, Dietzenbacher and Jong-A-Pin, 2022), and production clusters (Porter, 1990). Production linkages therefore encompass different types of interactions that affect sectors and all types of enterprises such as, small and medium-sized enterprises, large firms, household businesses, domestically owned enterprises and foreign-owned enterprises. Note that deeper links between firms and sectors creates both resilience but also more exposure to shocks. The failure or success of a particular firm can be significantly influence by what happens in other parts of the network. Industrial policies need to carefully consider the structure of the production linkages when designing new interventions (Porter, 1990; Juhász, Lane and Rodrik, 2024).

Historically, the network structure of the economy has been approached through the lens of large sectors: agriculture, manufacturing, services, and an “infrastructure” sector which many structuralists economist deemed as important in facilitating the spread of information, or knowledge across other sectors (Hirschman, 1958; Aschauer, 1990).¹³ The manufacturing sector has always been seen as the engine for economic growth where productivity gains are possible and increasing returns can exist (Kaldor, 1967). The sector could absorb unskilled labour from the agricultural sector at a wage premium. Thus, economic development is associated with a shift away from agriculture and towards a more diversified economy primarily based on industrial production. The growth in the “leading” manufacturing sector is then communicated to other sectors (Hirschman, 1958).¹⁴ Imbs and Wacziarg (2003) showed convincingly that the emergence of new sectors and the ensuing diversification is supported by a wide range of data and has also happened within the manufacturing

¹³ The sector loosely includes production and distribution of energy, transportation, and information and communication networks.

¹⁴ Income linkages may also arise emerge from rising wage generated by the expansion in the leading sector. Income linkages also operate through supplementary government revenues (i.e., ‘fiscal linkages’), which may therefore expand public expenditure (Hirschman, 1986).



industry itself. This is also discussed by Rodrik (2013) who emphasizes the importance of strong linkages between manufacturing industries in order to create value chains and economic growth.

Over time, firms specialize in fewer activities and outsource others (either domestically or internationally). Mechanically this creates new links and densifies the overall network of production linkages (Chenery, Robinson and Syrquin, 1986; Hausmann and Hidalgo, 2011). Recent theoretical research has shown that production linkages can arise endogenously and that economies with denser networks (i.e. with more linkages between sectors) have higher real growth (Acemoglu and Azar, 2020). Empirical analysis of the benefits of denser networks can be found in the international trade literature (data availability is better for international trade than for national trade). Bernard et al. (2022) for instance show that Japanese firms benefit greatly from having a better access to more suppliers. Access to more suppliers leads to more linkages and to improved productivity.

Networks of production across firms and sectors also act as a catalyst for investment and further output growth. This is an important argument already exposed in Hirschman (1958) who describes how “induced investment”, that is investment which takes place in a sector because firms in other sectors are growing and complementarities between the two are driving the decision to invest. According to Hirschman, the result of this is that manufacturing sectors grow at various speed and diversification follows in a “seesaw” kind of way. The profitability of an investment is therefore correlated with the simultaneous investment in related activities (Juhász, Lane and Rodrik, 2024).¹⁵

In addition to investment, production linkages in network production also favour the diffusion of technologies and knowledge across firms and sectors. The presence of industrial clusters in many countries is a

good example of how knowledge diffusion can significantly boost productive capacities and economic growth. For example, export-oriented clusters in many East Asian countries (called Special Exporting Zones) have been at the centre of the export-led growth of these countries in the 1990s (Ranis, 1995). Interestingly, the success of special economic zones in several African countries have yield mixed results regarding knowledge diffusion or increases in productivity, and an important reason seems to be the lack of infrastructure to support the growth of firms and their internationalization (Farole, 2011). This result points towards the necessary complementarity between the various facets of productive capacities.

The deindustrialization of developed economies since 1970 has been accompanied by a shift of manufacturing activities towards lower-income countries (Felipe and Mehta, 2016) and a corresponding industrialization of their economies. Not all developing countries managed to benefit from this transfer of manufacturing production, and many latecomers are experiencing a “premature deindustrialization” (Rodrik, 2016). Their share of manufacturing employment and value added peaked sooner than for other countries. This matters because new jobs are then absorbed by low-productivity service or agricultural activities. As summarized in Atoli et al. (2018), “for those economies, income per capita is thus relegated to a lower growth trajectory, which in some cases, has approached stagnation.” For them, structural change contributes less to the creation of production linkages, because structural change itself has stalled. Gaurav et al. (2021) refine this (rather pessimistic) view and argue that some service sectors share some of the important features of manufacturing industries (that is, important for growth, such as economies of scale, focus on innovation and orientation towards exports). However, they argue that not all services sectors will be able to provide simultaneously productivity growth

¹⁵ This departs from standard growth theories where investment in capital depends only on past levels of capital stock.



and jobs for unskilled workers the way manufacturing industries have done in the past. Some services sectors are deeply dependent on manufacturing production (e.g. transportation, logistics, wholesale and retail) while others much less.

Depending on the type of labour demanded by each of these sectors, structural transformation may be favouring high-skilled or low-skilled workers.





IV.

**From concept to
measurement:
Productive
capacity
categories and
input indicators**



The three pillars outlined in the previous chapter—productive resources, entrepreneurial capabilities, and production linkages—form the theoretical foundation for defining the categories and indicators used to measure productive capacities. It is important to point out that the three pillars of the conceptual framework together (not in isolation) determine the capacities of economies to produce and export a range of sophisticated goods and services.

The PCI consists of eight categories which are inherently interconnected and each representing different facets of productive capacities. The selection of these categories is driven by several factors. First, structuralist theories emphasize the significant role of major sectors in economic development, such as agriculture, manufacturing, services, as well as infrastructure and institutions. Some categories are specifically focused on these sectors. Second, the PCI was designed as a tool to support policymakers in the design and implementation of policies. Therefore, the categories were structured with consideration for how governments are typically organized into various ministries, departments, or agencies. This ensures the tool's ease of use and relevance for sector-specific policies. For example, there is a separate “transport” category and an “ICT” category, both of which could be seen as part of the broader “infrastructure” aspect of productive capacities. However, the government bodies responsible for each sector are often distinct from one another.

It is crucial to recognize the multifaceted nature of productive capacities and the deep interconnections among its components. Therefore, the eight categories presented here do not represent isolated aspects of productive capacities, as they are often interrelated. For instance, improvements in a country's transport network can enhance worker mobility, which, in turn, can influence the structural change and private sector categories. It is important to stress again that alternative categorizations

are possible out of the same theoretical foundations, depending on the intended final and policy use of the index.

Each category within the PCI is evaluated using several indicators, which together form the aggregate category score (see chapter V for details on the statistical methodology). The selection of indicators is guided by their relevance to the specific facet of productive capacity the category aims to measure, the availability of reliable data, and a statistical limit on the number of indicators that can be selected to avoid challenges associated with high dimensionality in Principal Component Analysis (PCA). Alternative indicators may be considered if data availability permits. Section VI.2 presents additional key indicators that statisticians can use to design their own indices or that UNCTAD may incorporate into future updates of the PCI, following consultations with the HLAB and STAG.

It is important to note that the three pillars of productive capacities discussed earlier are abstract concepts that are challenging to measure directly. What the PCI seeks to do is provide a statistically sound and theoretically grounded method for assessing productive capacities based on observable information. Some indicators directly capture productive capacities, while others are more closely correlated with latent (and unobservable) components. For example, a perfect measure of human capital would capture the exact knowledge, skills, and potential of all individuals in a country. However, such a measure is impossible to construct. Instead, years of schooling are used as a proxy, since they are strongly correlated with knowledge, even though they do not account for educational quality,¹⁶ knowledge gained outside formal schooling, or innate abilities. Years of schooling are a practical measure because data on this variable is available for all countries and years. The same limitations apply to government interventions.

The PCI consists of eight categories which are inherently interconnected and each representing different facets of productive capacities

It is important to stress again that alternative categorizations are possible out of the same theoretical foundations, depending on the intended final and policy use of the index

¹⁶ See chapter VI for a discussion of this topic



While PCI can measure the outcomes of government actions, such as promoting education, it does not directly measure the latent components, such as the effectiveness of educational policies. For example, a government may invest in education by hiring more teachers, building schools, or offering vocational training. The effects of such interventions are reflected in the years of schooling indicator, which, while not a perfect measure of educational quality, provides valuable insights into the outcomes of such policies.

The remainder of this chapter presents the eight categories, and the 42 input indicators used to construct the second generation of the PCI.

1. Category Human Capital

Human capital is one of the components of the Productive Resources pillar presented in the previous chapter. Broadly speaking, human capital encompasses the education, skills, and health of the population, all of which serve as direct inputs in the production of goods and services. As highlighted in the previous chapter, it is also a key component of innovation, entrepreneurial capabilities, and overall innovation (Asian Development Bank, 2020). Finally, certain aspects of human capital can be task-specific, which influences worker mobility across jobs (Gathmann and Schönberg, 2010). Policies aimed at developing human capital span a wide range, including education policies, active labour market policies that encourage on-the-job training (Bacchetta, Milet and Monteiro, 2019) and innovation policies.

Human capital is a latent concept that can only be imperfectly measured using official statistics. To address this, the PCI employs multiple indicators to capture the various dimensions described earlier.

Formal education acquired through schooling is measured by the expected years of schooling within the population.¹⁷ It also correlates with the ability of individuals to acquire other skills later while on the job (Becker, 1964), which is much more difficult to measure. It is important to note that knowledge gained through work experience can be highly specific to the job itself. This specific knowledge matters for the current wage (Abowd and Kramarz, 2005) but may also have limited market value outside of the context in which it was acquired (e.g. technical knowledge about drilling equipment in copper mines has limited use outside of the mining industry). While both types of knowledge contribute to wage determination, general knowledge plays a more significant role in enhancing worker mobility than specific knowledge (Acemoglu and Pischke, 1999; Gorry, Gorry and Trachter, 2019).

The role of human capital in innovation is captured by two separate indicators: the number of researchers, and the expenditures in research and development (R&D) as a share of GDP. The number of researchers correlates with firms' ability to innovate, introduce new products and production processes. Meanwhile, R&D expenditure as a share of GDP reflects the intensity of innovation, encompassing both public and private investment in R&D.¹⁸

Health conditions are a crucial component of human capital, as healthier workers tend to be more productive, experience less absenteeism, and report greater job satisfaction. Health is "both human capital itself and an input to producing other forms of human capital" (Bleakley, 2010). It is incorporated via both health adjusted life expectancy and health expenditures as a share of GDP.¹⁹ A positive correlation is expected, particularly in developing countries, where higher health expenditures typically result in broader healthcare coverage for the population.

¹⁷ See the discussion in chapter VI for other possible measure of formal education.

¹⁸ These indicators align with SDG 9.5. to "enhance research and upgrade industrial technologies".

¹⁹ Access to health care constitutes an important target in SDG 1 to end poverty, in particular with indicator 1.a.2: "Proportion of total government spending on essential services (education, health and social protection)"



Fertility rates, influenced by social norms and economic development, also play a significant role in human capital. A substantial body of literature has shown that higher income is negatively correlated with fertility rates, due to the quality-versus-quantity trade-off (fewer children but more investment in each child's education) and women's career choices (higher income for women increases the opportunity cost of having children). Lower fertility rates, a key

aspect of the demographic transition, are associated with greater female participation in the labour market and higher investments in children's education—both of which contribute positively to the development of productive capacities²⁰, provided that investment in social production is maintained (Braunstein, Bouhia and Seguino, 2020).

Table IV.1 summarizes the indicators used in the Human Capital category of the index and the source for their data.

Table IV.1
Indicators measuring Human Capital

Indicator	Data source	SDG target
Health expenditure, total (% of GDP)	World Health Organization. Global Health Expenditure database	1.A.2 ^a
Research and development expenditure (% of GDP)	UNESCO Institute for Statistics	9.5.1
Researchers in R&D (per million people)	UNESCO Institute for Statistics	9.5.2
Health adjusted life expectancy (years)	The Institute for Health Metrics and Evaluation	
Expected years of schooling	UNDP Human Development Reports	
Fertility rate, total (births per woman)	UN Population Division. <i>World Population Prospects: 2022</i> National statistical offices Eurostat UNSD. <i>Population and Vital Statistics Report</i> U.S. Census Bureau: <i>International Database</i> Secretariat of the Pacific Community*	

^a SDG also includes expenditures on education and social protection.

* Sourced via World Bank Open Data.

2. Category Natural Capital

Natural resources are fundamental components of productive capacities and are closely linked to the first pillar discussed in the previous chapter. However, many developing countries experience the 'resource curse,' also known as 'Dutch disease,' where the discovery of valuable natural resources, often oil, leads to over-specialization in this sector. This results in a diversion of investment, which can hinder the development of the manufacturing sector and limit the diversification of the economy.²¹ In contrast, the availability of

other natural resources, such as forests, minerals, and rivers, does not appear to have the same negative impact on economic growth. These resources play a crucial role in the production of commodities and can serve as inputs for energy production. They can also be processed into finished goods, which can be sold both domestically and internationally, or used as inputs for the production of more advanced products.

The Natural Capital category of the PCI measures the potential domestic production of natural resource-based goods and services.

²⁰ See for instance Becker et al., (1990), Klemp and Weisdorf (2019), Black et al. (2005), Hanushek (1992) and Doepke et al. (2022) for a recent review of the literature.

²¹ See for instance Mien and Goujon (2022) for a recent survey.

The potential for agricultural production (for human or animal consumption) is assessed by the percentage of agricultural land relative to total land in the country. The potential for producing wood products or wood-based goods is measured by the percentage of forested area in the country's total land area.²² The importance of other extracted natural resources for productive capacities is captured by two complementary indicators: one is the value of resource extraction as a percentage of GDP, and the other is the resource rents associated with this extraction as a share of GDP. It

is important to note that these indicators reflect the amount of resources extracted each year, rather than their availability.

The dependence on commodities is measured by the ratio of total domestic extraction of raw materials to industry value-added. This ratio is negatively correlated with the natural capital score (see chapter V) and reflects the potential «resource curse» that countries may face.

Table IV.2 summarizes the indicators used to measure Natural Capital and the data sources.



Table IV.2
Indicators measuring Natural Capital

Indicator	Data source	SDG target
Agricultural land (% of land area)	Food and Agriculture Organization*	
Extraction flows (% of GDP)	United Nations Environment Programme, International Resource Panel. Global Material Flows Database	
Forest area (% of land area)	Food and Agriculture Organization*	
Total natural resources rents (% of GDP)	World Bank staff estimates based on sources and methods described in the World Bank's The Changing Wealth of Nations*	15.1.1
Material intensity	c / d	
c: Total domestic extraction of raw materials (t)	United Nations Environment Programme, International Resource Panel. Global Material Flows Database	
d: Industry (including construction), value added (constant 2015 US\$)	World Bank and OECD national accounts data*	

* Sourced via World Bank Open Data.

3. Category Energy

Countries able to secure their own source of energy are less exposed to international shocks, whether geopolitical or financial

Energy is a fundamental input in all human activities and can be considered a key, cross-cutting characteristic of productive capacities. It is an important element of a broader «infrastructure» sector whose importance for productive capacities has already been highlighted in the previous chapter. Energy affects economic production in a very direct way through the use of electric equipment, but also indirectly through its effect on the possibility to innovate (part of the innovation process is more productive when helped by a computer for instance), and on the potential to create links between companies as

a result of such innovation. In addition, countries able to secure their own source of energy are less exposed to international shocks, whether geopolitical or financial.

Providing a sufficient and stable source of energy to economic actors lifts a serious binding constraint to economic production. Depending on the intensity of energy use in various economic activity, a stable and continuous supply of energy can be a critical input. Power blackouts can have significant consequences on a wide range of activities: it prevents hospitals from functioning adequately and can also prevent the emergence of energy-intensive activities (e.g. metal smelting), or the development of

²² See chapter VI for a discussion on how to include environmental concerns into PCI, in particular related to forest management and preservation of biodiversity in forested areas.



new energy-intensive products too. Hence, it has consequences on the production linkages that can be created (or not) in an economy. Measuring the potential for energy production is difficult, mostly because of data limitation. The indicators used in the construction of this category reflect only partly the potential in energy production. They tend to measure the result of such potential in the form of energy consumption and efficiency in production and use.²³

How much energy is produced is measured by the total primary energy supply as a share of population. This is a broad measure used in energy statistics which measures the potential for energy supply in a country.²⁴

The consumption of renewable energy is measured by its share in total energy consumption. This enters negatively in the computation of the index as the analysis shows that countries with high share of renewable energy tend to have low energy capacities overall.

For energy to be used to its full potential, the distribution and production network needs to limit as much as possible the loss in power from the place of production

to its final destination. This is measured by the amount of electric power lost in transmission and distribution. The efficiency in the consumption of electricity is measured by how much output (measured by GDP) is generated per unit of energy consumed. This measures the productive use, or lack of waste, in the utilization of energy.

Finally, the availability of energy to the overall population is measured by two indicators: first is the share of population with access to electricity. It correlates with productive capacities and with other components of it in many ways: households with access to electricity can have safer conditions to preserve food, use electric lights at night instead of burning wood, use electric devices to communicate, etc.²⁵ The second indicator is the consumption of energy per capita. This last indicator is interpreted as the (measurable) result of energy production. It complements the previous one on energy efficient use which focuses on the link between energy consumption and production.

Table IV.3 summarizes the indicators used in the Energy category, along with the data sources.

Table IV.3
Indicators measuring Energy

Indicator	Data source	SDG target
Access to electricity (% of population)	IEA, IRENA, UNSD, World Bank, WHO (2023) <i>Tracking SDG 7: The Energy Progress Report*</i>	7.1.1
GDP per total energy supply (thousand 2015 USD PPP per toe)	IEA World Energy Statistics and Balances. <i>World Indicators.</i>	
Renewable energy consumption (% of total final energy consumption)	IEA, IRENA, UNSD, World Bank, WHO (2023) <i>Tracking SDG 7: The Energy Progress Report.*</i>	7.2.1
Total primary energy supply per capita	IEA. <i>World Indicators.</i>	
Total energy consumption (per capita)	IEA. <i>World Energy Balances.</i>	
Electric power transmission and distribution losses (% of output)	$a/b * 100$	
a: Losses of electricity output (ktoe)	IEA. <i>World Energy Balances.</i>	
b: Electricity output (ktoe)	IEA. <i>World Energy Balances.</i>	

* Sourced via World Bank Open Data.

²³ Chapter VI offers a discussion on how to incorporate other measures potential for production of renewable energies.

²⁴ Primary energy is then transformed into “usable energy”. For example, fossil oil (primary energy) needs to be refined in order to become fuel oil or electricity (which are called an energy carrier).

²⁵ The share of population with access to electricity also falls into SDG 7.1 “Universal access to modern energy”.

4. Category Transport

Transport is another element of the “infrastructure” sector that is so critical to economic activity. Better transport networks facilitate the movement of people within a country (an important component of the production linkages), the movement of goods and services (from suppliers to buyers, to ports, and to consumers). They also facilitate the diffusion of knowledge and ideas and foster productive capacities by spreading technologies across the country. As mentioned in the previous chapter, reduction in transportation between regions of a same country contributes to unifying and increasing the size of the market, which is beneficial to both firms through higher demand and to consumers in the form of lower prices.²⁶ The unbundling of production and consumption location allows for some degree of geographic specialization (Baldwin, 2016) which in turn requires goods and services to physically go where final consumers are.

Measuring transport capacity is done through several indicators, focusing on three main modes of transportation: road, rail, and air. For each mode of transportation, indicators measure either the potential for transportation (which is a more direct measure of transport capacity), or the correlated output of such potential.

For air transport, three key indicators have been selected: the amount of freight carried by aircraft, the total number of passengers (per capita) each year, and the number of registered carrier departures worldwide. The latter indicator also serves to measure the international position of a country, reflecting its direct air connections with other nations. This illustrates how the international mobility of workers, as well as the flow of knowledge and technology, contribute to fostering productive capacities.

The rationale for incorporating these three air transport variables is rooted in development economics and its focus on productive capacities. Compared to road and rail transport, air traffic requires higher technological intensity and is more likely to generate both backward and forward linkages. A country with extensive air connectivity is more likely to have developed expertise in building various transportation infrastructures, including roads, rails, and maritime routes that interconnect airports, train stations, bus terminals, and ports. The air transport industry plays a crucial role in global socio-economic growth, creating both direct and indirect employment, supporting tourism and local businesses, and stimulating foreign investment and international trade.

Although the three air transport variables are related, they measure different stages of development. «Registered carrier departures worldwide» capture both domestic and international departures of air carriers registered in the country, highlighting the extent to which domestic value is generated from air traffic. A country with high air traffic but no domestic airlines may not fully benefit from the structural transformation associated with air transport.

The road and railroad networks are more closely measuring the potential for transportation. The indicators reflect the presence and density of such network rather than their use. The road network is measured by the kilometres of roads per 100km, and the railroad network is measured by the kilometer or rail lines per capita.

Table IV.4 summarizes the indicators used to measure the Transport category.²⁷

²⁶ See papers by Gachassin (2013) and Gachassin et al. (2015) on the effect of better road networks on economic activity and internal migration in African countries, and Donaldson (2018) on how reduced transportation cost contributed to integrate regions in India during the British Raj.

²⁷ Developing transportation capabilities is also part of SDG 9.1: “Develop sustainable, resilient and inclusive infrastructures”.





Table IV.4
Indicators measuring Transport

Indicator	Data source	SDG target
Air transport, freight (million ton-km per capita)	International Civil Aviation Organization (ICAO), Civil Aviation Statistics of the World and ICAO staff estimates.*	9.1.2
Air passengers (per capita)	ICAO, Civil Aviation Statistics of the World and ICAO estimates*	9.1.2
Air transport, registered carrier departures worldwide (per capita)	ICAO, Civil Aviation Statistics of the World and ICAO estimates*	9.1.2
Km of roads (per 100km ² land)	ICAO, Civil Aviation Statistics of the World and ICAO estimates*	
Km of rail lines (per capita)	International Road Federation International Union of Railways (UIC)*	

* Sourced via World Bank Open Data.

5. Category Information and Communication Technology (ICT)

The ICT category also relates to the “infrastructure” sector. While the transport category had a strong focus on the capacity to move goods around, ICT is about moving ideas and information around. The ICT revolution in the late 1990s has had tremendous impact on developed and emerging economies (Niebel, 2018). Very quickly, the cost of moving ideas and technologies declined, paving the way for the modern global value chains and a profound change in the way industrial production was conceived (Baldwin, 2019). The massive flow of technology towards emerging economies was made possible by the development and adoption of information and communication technologies in these countries. This matters greatly for productive capacities as it correlated strongly with technology adoption, innovation and the introduction of new goods, services, and production processes. It also fosters the emergence of new sectors and thus creates new links between companies and sectors.

The indicators selected capture the various forms that ICT takes. Some indicators measure the potential for communication while others (again, due to data limitation) measure the outcome of such potential.

One indicator is closely related to the potential for communication: the number of fixed telephone subscriptions (per 100 people). While subscription can be made through private companies, the state is very often the ultimate owner of the network of landlines on which fixed telephones rest. Developing such network can be done directly by government intervention. In certain regions where alternative internet infrastructures are less developed, fixed telephone lines are still an important method of access to the internet.

Regarding mobile phones, the network consists of antennas spread across the countries. Because of data limitation, the number of antennas is not available, but the number of mobile cellular subscriptions is closely associated with it.

Regarding the use of the Internet, three indicators correlate with the potential for internet availability in the country. The first is the number of fixed broadband subscriptions. The second is the share of population using the internet, and the last is the number of secure servers (public or private) present in the country. This last indicator aims to measure the capacity for the development of economic activities which rely heavily on the use of data and the management of confidential information.

Table IV.5 summarizes the indicators and data sources used to construct the ICT category.





Table IV.5
Indicators measuring ICT

Indicator	Data source	SDG target
Fixed broadband subscriptions (per 100 people)	ITU <i>World Telecommunication/ICT Indicators</i>	17.6.1
Fixed telephone subscriptions (per 100 people)	ITU <i>World Telecommunication/ICT Indicators</i>	
Individuals using the Internet (% of population)	ITU <i>World Telecommunication/ICT Indicators*</i>	
Mobile cellular subscriptions (per 100 people)	ITU <i>World Telecommunication/ICT Indicators</i>	17.8.1
Secure Internet servers (per 1 million people)	<i>Database*</i>	
	Netcraft (netcraft.com) and World Bank	5.B.1 ^a

^a SDG also includes expenditures on education and social protection.

* Sourced via World Bank Open Data.

6. Category Institutions

Institutions shape the environment in which economic decisions are made and are thus a cornerstone of long-term development

Institutions shape the environment in which economic decisions are made and are thus a cornerstone of long-term development, justifying their inclusion in the PCI. They can be seen as a form of “institutional infrastructure” — the legal and regulatory foundations that underpin markets, protect property rights, and manage industries driving economic transformation. This aligns with the concept of the “Developmental State” (Woo-Cumings, 1999), in which the state actively shapes institutional frameworks to guide economic development. Structuralist thinkers have long emphasized the need for state-led planning and institutional mechanisms to support industrial policy, coordinate investment, and manage external shocks. Post-Keynesians highlight the institutional determinants of income distribution, labour markets, and investment dynamics, while the evolutionary tradition sees institutions as part of the national innovation system, shaping learning processes. Effective institutions reduce uncertainty, support entrepreneurship, and foster inclusive governance, creating the stability and predictability needed for long-term development goals.

Institutions can be defined as the set of constraints (formal or informal) devised to create order and to reduce uncertainty in exchange (North, 1991). A vast literature has established important links between institutions and economic growth for

instance (Acemoglu, Johnson and Robinson, 2005; Ogilvie and Carus, 2014). Strong institutional frameworks—accepted and enforced codes of conduct—encourage investment by safeguarding returns, support entrepreneurship by providing clear rules on bankruptcy, and lower the cost of doing business by limiting corruption and ensuring the effectiveness of government agencies. Over the past two decades, development economists have increasingly emphasized strengthening such institutions as key to designing and implementing effective industrial strategies, with industrial policy itself experiencing a strong revival as a tool to help countries escape low- and middle-income traps and overcome structural constraints within the global trade and financial system (Chang and Andreoni, 2020).

Measuring institutions with a focus on their role for the development of productive capacities is no easy task. The notion of “institutions” itself is multifaceted and several indicators are therefore necessary. Six indicators are used to measure this latent concept of institutions. They are commonly used in the literature. They include the control of corruption; government effectiveness; political stability and the absence of violence and terrorism; regulatory quality; respect of the rule of law; and a measure of voice and accountability. All indicators are sourced from the Worldwide Governance Indicators database and are presented in table IV.6.





Table IV.6
Indicators measuring Institutions

Indicator	Data source	SDG target
Control of corruption	Worldwide Governance Indicators	16.1.3 ^a
Government effectiveness	Worldwide Governance Indicators	
Political stability and absence of violence/ terrorism	Worldwide Governance Indicators	
Regulatory quality	Worldwide Governance Indicators	
Rule of law	Worldwide Governance Indicators	
Voice and accountability	Worldwide Governance Indicators	

^a Proportion of population subjected to (a) physical violence, (b) psychological violence and (c) sexual violence in the previous 12 months

7. Category Private sector

The private sector is central to economic activity and plays a pivotal role in developing productive capacities. A dynamic and diversified private sector generates employment, income, innovation, and opportunities, while fostering entrepreneurial capabilities and linkages between sectors and firms. Its inclusion in the PCI is justified by its contribution to capital accumulation and enterprise development. Development economics theories highlight this role: in Lewis's framework, the "capitalist sector" drives growth by reinvesting profits and absorbing labour from the subsistence sector; Hirschman emphasized the catalytic role of pioneering entrepreneurs in creating linkages and stimulating investment; post-Keynesian models, notably Kalecki's, link private investment decisions to profitability expectations that shape the business cycle; and Schumpeter saw the private entrepreneur as the agent of innovation and structural change. Capturing the dynamism of the private sector is therefore essential to understanding and fostering productive capacities, employment, and sustainable economic transformation.

Two indicators measure the growth potential of the sector. The first is the cost of borrowing in the domestic market.

Lower costs of borrowing mean more investment by firms as well as more firms investing. This indicator aims to measure whether access to fund is an important constraint to businesses.²⁸ The second is the size of such borrowing and is measured by domestic credit to the private sector as a share of GDP. This second indicator is correlated to the first and measures the outcome of investment decisions.

The private sector's ability to innovate is indirectly measured by the output of its innovations, using two indicators: the number of patent applications and trademark applications, both expressed as a share of the population. These two indicators are measures of the outcome of such innovation. We assume these are correlated with the necessary conditions under which innovation is more likely to occur in firms (e.g. the presence of property rights which favours innovation), which are closer measures of innovation capabilities.

Finally, the private sector's overall logistical efficiency, which includes the movement of goods and services both domestically and internationally, is measured by the Logistics Performance Index.²⁹ This index evaluates key factors such as the quality of trade and transport infrastructure, the efficiency of customs procedures, the reliability of shipping services, the ability to track and

²⁸ Other elements, besides the cost of credit, matter for borrowing, such as the necessity for collaterals, the possibility to renegotiate terms of the contract, or how interest rates adjust. Data on these other elements are however strongly limited, while information on interest rate charged to businesses is more readily available.

²⁹ In the first-generation PCI, the private sector's overall logistical efficiency through indicators of the World Bank's Doing Business project. These indicators have been, however, discontinued, with the World Bank discouraging the further use of the indicators.



trace shipments, and the timeliness of deliveries, providing a comprehensive view of a country's logistics capabilities.

Table IV.7 summarizes the indicators used in constructing the Private Sector category, along with the data sources.



Table IV.7
Indicators measuring Private Sector

Indicator	Data source
Domestic credit to private sector (% of GDP)	IMF, International Financial Statistics and data files, World Bank and OECD GDP estimates.*
Patent applications (per capita)	WIPO statistics database
Trademark applications (per capita)	WIPO statistics database
Lending interest rate (%)	IMF, International Financial Statistics and data files.*
Logistics performance index: Overall	World Bank: <i>Logistics Performance Index</i> *

* Sourced via World Bank Open Data.

8. Category Structural change

Structural change is both an outcome and a driver of productive capacity development: it is a continuous process whereby transformation in sectoral composition generates further transformation

The structural change category aims to capture whether the right sectoral dynamics are in place to support the fostering of productive capacities. Structural change is both an outcome and a driver of productive capacity development: it is a continuous process whereby transformation in sectoral composition generates further transformation, creating what Kaldor described as a 'virtuous circle of productivity.' In this cumulative causation process, output growth fosters productivity growth, which in turn enhances external competitiveness and stimulates further output expansion. Lewis's dual-economy model highlights structural change as a self-reinforcing reallocation of labour from low-productivity to high-productivity sectors. Post-Keynesian approaches also stress the key role demand-led dynamics and cumulative causation, while evolutionary economics interprets structural change as the outcome of innovation and creative destruction. Taken together, these perspectives underscore that tracking structural change as a driver is essential for understanding and measuring the development of productive capacities.

Following this literature, the structural change category uses four indicators measuring the relative size of the main sectors of the economy: namely the production of the agriculture, forestry, and fishing sectors; the production of the service sector, and the industrial sector (including the construction sector). The industrial ratio (the share of industry and services over value added) aims to measure the shift away from an agriculture-based economy and towards a more sophisticated production of manufacturing goods and services. This sophistication is further measured by an indicator on economic complexity and is seen as an outcome of the linkages between firms and sectors in the economy.

The dynamism of the economy is measured by the gross fixed capital formation which is a common indicator to measure the creation of new physical capital.

Finally, all countries being engaged in international trade, the extent to which their economy is diversified is measured by the export concentration index. This indicator is an additional measure for the dependence of the economy on the production of few products. While production-level data is rarely available at the product level, international trade data are widely available and have such feature.



This indicator serves an approximation for the concentration of domestic production,

which itself reflects the extent (or lack thereof) of diversification of the economy.



Table IV.8
Indicators measuring Structural Change

Indicator	Data source
Export concentration index	UNCTADstat
Economic complexity index	UNCTAD secretariat calculations based on UN COMTRADE
Industrial ratio (Industry and Services VA over total GDP)	$(d + e) / (d + e + f) * 100$
d: Industry (including construction), value added (constant 2015 US\$)	World Bank and OECD national accounts data*
e: Services, value added (constant 2015 US\$)	World Bank and OECD national accounts data*
f: Agriculture, forestry, and fishing, value added (constant 2015 US\$)	World Bank and OECD national accounts data*
Gross fixed capital formation (% of GDP)	UNSD. National Accounts Main Aggregates Database

* Sourced via World Bank Open Data.





V.

Statistical methodology and compilation process



This chapter presents the methodology of the PCI as of November 2024, which may be subject to amendments in future updates, at the request of the STAG. The aim of this chapter is to present the methodology used to construct the second generation of the PCI without being too technical. As mentioned earlier, further details on the methodology, statistical techniques and discussions on the robustness of the index can be found in (UNCTAD, 2023) .

This chapter adopts the following terminology:

- “*Raw data*” refers to the untreated, uncleaned data that is collected for all indicators from various sources in various formats.
- “*Indicator*” denotes a measurable economic indicator, for which data for all countries and all years are available or imputed.
- “*Category*” refers to one of the eight productive capacities that make up the PCI.
- “*Component*” refers to the variables extracted from a Principal Components Analysis for a given category. Each category may

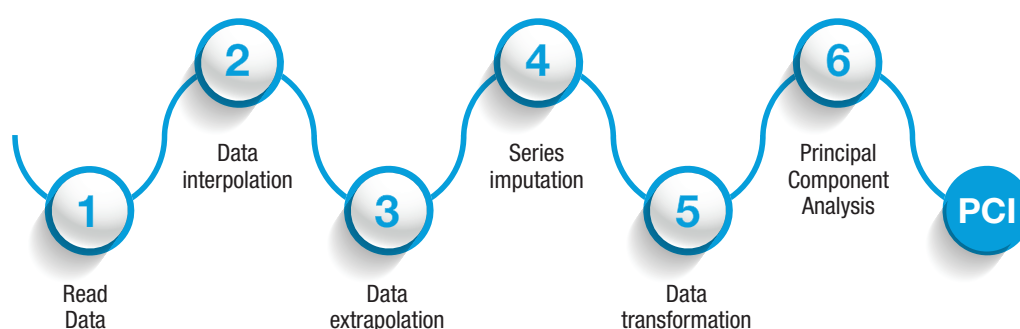
have one or two components.

- “*Principal Component Analysis*” (PCA) is a dimension reduction technique that transforms a set of input variables into a smaller set of components.

The compilation of the PCI follows a typical statistical production process, from data collection to data editing and validation followed by aggregation, analysis and release of results. This description focuses on steps specific for the PCI from data reading to composite index calculation. The process of transforming the multiple “input indicators”, selected for their relevance to productive capacities and collected from international sources (as listed Chapter IV), into a single measure is completed in six steps. Step 1 consists of reading the data to ensure their compatibility. Steps 2 through 4 focus on data manipulation to address missing values and Step 5 handles scaling and extreme values. For each one of the 8 categories defined in Chapter 4, a score is computed in Step 6 using Principal Component Analysis (PCA). Finally, the PCI is calculated by taking a geometric average of the 8 category scores. Figure V.1 summarizes this 6-step process.

The compilation of the PCI follows a typical statistical production process, from data collection to data editing and validation followed by aggregation, analysis and release of results

Figure V.1
Statistical pipeline for the PCI



1. Step 1: Reading Data

This initial step consists in reading the original raw data sources on 45 indicators, in addition to the auxiliary variables of population and gross domestic product (so a total of 47). Some indicators are later combined to construct more appropriate measures (e.g. material intensity is the ratio of total domestic extraction of raw materials and industry value added). In the end, 42 final indicators are used to compute the 8 categories of the index.

2. Steps 2-4: Dealing with missing data

Missing data is a major issue everywhere, but more particularly in low- and middle-income developing countries. The PCI is available for 194 economies over the period 2000-2022 and requires information on 47 economic and social variables. In the 2023 version, about 22% of available data is found to be missing in international sources.

Several factors contribute to this issue: some data are simply not collected at the national level (or not yet collected/processed for the latest years); others may be collected but lack harmonization to meet international standards; some data may not be reported internationally; and in some cases, data that were previously collected and reported internationally may have been disrupted due to various reasons, such as conflicts or economic crises.

The prevalence of missing data is generally negatively correlated with the level of development of a country. Table V.1 shows the extent of missing data for each category of the PCI by level of development. Overall,

more missing data is found for LDCs than other developing economies or developed economies. The transport and private sector categories are particularly affected.

This documented prevalence of missing data for key indicators of economic and social development underscores the need for enhanced statistical capacity-building assistance to developing economies, particularly in LDCs, SIDS and LLDCs. This assistance is essential for improving data collection, processing, and dissemination, thereby enhancing the quality and relevance of the PCI and other key international indices. UNCTAD is committed to seeking partnerships to support member States in filling data gaps of key statistics included in the index.

For the implementation of the PCA, the time series of the input indicators must not include missing data, necessitating the filling of any gaps. Two methods can be used, depending on how severe the issue is. If there are only a few missing values for a particular indicator in a given country, then available (i.e. non-missing) data points can be utilized, and the gaps can be filled using interpolation (Step 3) or extrapolation (Step 4). Conversely, if the entire series is missing or if there are insufficient available observations, multivariate techniques (Step 5) are applied to extract insights from information available in other related time series. available observations and impute the complete series.

To ensure transparency, UNCTAD provides metadata on the prevalence of missing data in the input indicators for each category alongside the dissemination of the PCI scores at the country level.³⁰

Missing data is a major issue everywhere, but more particularly in low- and middle-income developing countries

³⁰ <https://unctadstat.unctad.org/datacentre/dataviewer/US.PCI>





Table V.1
Share of missing value by category and group of country

PCI Component	Development status		
	Least Developed Countries	Other developing economies	Developed economies
Energy	41.0	22.5	13.3
Human Capital	36.3	29.9	14.7
ICT	22.2	18.7	16.2
Institutions	14.0	11.3	14.3
Natural Capital	11.1	10.9	9.6
Private Sector	54.6	42.0	35.3
Structural Change	12.7	10.5	8.1
Transport	60.2	40.2	23.2

Note: The regional grouping refers to the UNCTAD classification, as specified in the UNCTAD classification, 2023 revision (UNCTAD, 2023).

a. Step 2: Data interpolation

Interpolation means, in this case, replacing missing value with a linear approximation. It is a technique used to address short

gaps in the middle of a time series by assuming a linear trend between the available values at either end of the gap. Table V.2 provides an example of such data.



Table V.2
Data configuration suited for linear interpolation

Year	Var	Var imputed
2010	15.5	15.5
2011	NA	14.4
2012	NA	13.3
2013	NA	12.3
2014	11.2	11.2

Note: The missing years 2011, 2012 and 2013 are imputed with linear interpolation.

This method is applied to indicators that have at least 8 non-missing observations for a given country (i.e. data has been collected in at least 8 years between 2000 and 2022) and no more than 5 consecutive missing years. Series with fewer than 8 non-missing observations or containing gaps of at least 5 consecutive years are

treated with reference to the process detailed in Step 4. In practice, existing data points are used to establish a linear time trend which represents the average linear progression of the indicator over time.³¹ Missing values are then replaced by the corresponding trend value for that year.³²

³¹ Given two data points: (t_1, y_1) and (t_2, y_2) , where $t_1 < t_2$, we can estimate the value y at any point x between t_1 and t_2 by: $y = y_1 + (t - x_1) \times \frac{y_2 - y_1}{t_2 - t_1}$; Where: y is the estimated value at t , the year for which we want to estimate the value.

³² For example: an indicator takes the value 10 in 2005, is missing in 2006, and 12 in 2007. A linear interpolation will produce a value of 11 for 2006.



Linear interpolation is a simple and efficient method for imputing missing data within a time series. However, since real data does not always follow a linear trend, this assumption can introduce some inaccuracies. However, any adverse effects are expected to be minimal given the very limited range of imputations and most importantly the use of PCA as the aggregation technique to come up with the category scores.

b. Step 3: Extrapolation

If data is missing for the most recent years of an indicator, then an extrapolation (or forecasting) technique is used. This refers to the prediction of the “future” values of a series in the light of observed patterns from past data. Table V.3 presents an example of such data.



Table V.3
Data configuration suited for extrapolation

iso3	Year	Var1	Var2	Var3
HTI	2012	78.64	47.96	11097.77
HTI	2013	79.92	48.86	11621.11
HTI	2014	81.32	48.83	12986.08
HTI	2015	82.56	48.79	11077.36
HTI	2016	83.64	46.41	12283.94
HTI	2017	85.52	48.84	11320.29
HTI	2018	87.00	46.23	12990.80
HTI	2019	88.43	48.87	11653.42
HTI	2020	NA	46.85	12655.43
HTI	2021	NA	NA	NA
HTI	2022	NA	NA	NA

Note: The red area signals missing data points suited for extrapolation.

Extrapolation is performed using a double-smoothing exponential function. It consists in fitting a non-linear function over all existing non-missing data points (some of which may have been interpolated in the previous step) in order to predict future values (cf. Box V.1: Double exponential smoothing). Double-exponential smoothing has the advantage of being easy to implement and requiring fewer parameters to estimate compared to ARIMA models. It has been documented to perform well across a wide range of forecasting exercises, particularly for time

series with relatively few observations (Gardner, 2006; Hyndman, 2008).³³

Extrapolation has been used in the 2023 version of PCI to replace missing data observed during the Covid-19 years. The method differs slightly from the one presented above and is only a temporary measure to avoid a simple extrapolation which may prove to be misleading.³⁴ Box V.2 describes how extrapolation was conducted.

³³ Double exponential smoothing is an extension of simple exponential smoothing (Holt, 1957).

³⁴ The method is a linear regression analysis where the dependent variable is the indicator with missing values for the last years, and the explanatory variable is GDP.



**Box V.1****Double Exponential Smoothing (DES)**

DES involves a forecast equation and two smoothing equations:

- Forecast equation: $\hat{y}_{t+h/t} = l_t + h * b_t$
- Level equation: $l_t = \alpha y_t + (1 - \alpha)(l_{t-1} + b_{t-1}) \quad 0 \leq \alpha \leq 1$
- Trend equation: $b_t = \beta(l_t - l_{t-1}) + (1 - \beta)b_{t-1} \quad 0 \leq \beta \leq 1,$

where: l_t is an estimate of the level of the series at time t , b_t is an estimate of the trend (slope) of the series, α is the “smoothing” parameter for the level, and β is the smoothing parameter for the trend. In other words, l_t is a weighted average of observation y_t and the one-step-ahead training forecast for time b_t , here given by $(l_{t-1} + b_{t-1})$. b_t is a weighted average of the estimated trend at time t based on $l_t - l_{t-1}$ and b_{t-1} .

The smoothing constants in forecasting models control how sensitive the forecasts are to recent changes in demand. Higher values make forecasts more responsive to recent data, while lower values dampen this responsiveness. There is no systematic method to determine the best values for these parameters; instead, they are typically chosen by optimizing a specific metric, such as Mean Absolute Deviation (MAD), Mean Squared Error (MSE), or Mean Absolute Percent Error (MAPE). Statistical software often handles this optimization, starting with initial values provided by the user.

**Box V.2****Accounting for external shocks in the PCI: the example of the COVID-19 pandemic**

Extrapolation uses available information to predict future values in a way that follows the underlying existing trend in the data. In other words, it predicts values based on a “business-as-usual” scenario and cannot anticipate major shocks such as that of the Covid-19 pandemic. Some indicators have been significantly affected by the pandemic, and for those, GDP was used as a predictor (see chapter IV for the list of indicators where extrapolation, if applicable, uses GDP as an auxiliary variable). Note this should not be considered as an alternative method to extrapolation, but as temporary replacement for it, due to the unique nature and size of the shock.

Shocks are reflected in different ways in the computation of PCI. A random shock affecting negatively an indicator will lead to a decline in the value of PCI. If this shock is temporary, PCI is expecting to revert to its pre-shock values after a few years (depending on the size of the shock). Shocks which affect the linkages across various dimensions of productive capacities are likely to have long-term effects on PCI too. For instance, a shock which profoundly limits the ability of the manufacturing sector to support exports may have such an effect. Part of this is due to the aggregation (or “loading”) method used, where each indicator is given a fixed weight in the computation of the category index.



c. Step 4: Data imputation

Series which have too many missing values need to be imputed. The methods used are considered very robust and are commonly used in the creation of composite indices. To guarantee full transparency, imputed data are clearly labelled as such in the dataset. The threshold for imputation (as opposed to interpolation and extrapolation) is set to gaps of 5 or more observations. This of course includes cases where series have no observation at all. For such big gaps of missing values, instead of guessing the values of the series based on trend of previously observed values (in the cases where they exist), the missing values of the series, say, indicator for country, are imputed based on the values of the other indicators of the same country, as well as on the relationship between the indicator and the other indicators in countries which have sufficient data on indicator.

Two methods were considered for those imputations:

1. *missForest*: A non-parametric method using random forests³⁵ to make iteratively better predictions (see Box V.3: *missForest*).
2. *missPCA*: An Expectation-Maximization (EM) approach based on iteratively predicting the missing values and computing the loadings of a PCA until convergence is reached.

In both cases, the imputations use information from all other original indicators used for the PCI, for the same country. Empirical results show a better performance of *missForest*, in particular due to its ability to represent non-linear relationships (UNCTAD, 2023), leading to its selection over *missPCA* for the computation of the PCI disseminated by UNCTAD.



Box V.3 *missForest*

missForest is a nonparametric imputation method that can accommodate almost any kind of data, and is provided in the software R package of the same name. It can cope with mixed-type variables, nonlinear relations, complex interactions and high dimensionality. It only requires the observations (i.e. the rows of the data frame supplied to the function) to be pairwise independent. The algorithm is based on random forests (Breiman, 2001), which are powerful predictive models which, for the sake of brevity, can be compared to very flexible nonlinear regression models.

Let the series X_j for indicator j be decomposed into an observed and missing part, which can be written as $X_j = (X_{j,obs}, X_{j,mis})$. Likewise, denote by $X_{-j} = (X_{-j,obs}, X_{-j,mis})$ the observed and missing part of all the indicators except for indicator j . At every iteration of *missForest* and for each indicator j with missing values, *missForest* performs the following two steps:

Fits a random forest on the observed part $X_{j,obs} \sim X_{-j,obs}$

Applies the trained random forest on $X_{-j,mis}$ to predict the missing part $X_{j,mis}$

Put simply: for each variable, *missForest* fits a random forest on the observed part and then predicts the missing part. The algorithm continues to repeat these two steps until a stopping criterion is met or the user specified maximum of iterations is reached.

³⁵ A random forest is, put it simply, a group of decision trees generated using bootstrapped samples and considering only a subset of variables at each step.



3. Step 5: Data transformation

As required by the PCA, the yearly distribution of indicators across countries should approximate a normal distribution. This prevents a few countries with abnormally low (or high) values from having a disproportionately large impact in computing the factor.

Most of the indicators requiring transformation are either right skewed or are compositional data, i.e., they represent a share of some quantity. In the former case, a log transformation is often appropriate (and determined to be sufficient for the construction of the PCI); in the latter case, a logit transformation was considered, which is one of the standard options for compositional data (Aitchison, 1983). In two cases, neither of these transformation methods were judged to be sufficient and were thus treated with a Box-Cox transformation (Box and Cox, 1964). These standardizations also broadly align with the elasticities empirically documented in academic and policy literature.³⁶

Even after the above transformations, some outliers may remain in the data. To prevent such observations from having too much weight when computing PCI, all indicators are winsorized prior to performing PCA.³⁷ Data beyond the top and bottom 2.5% of data are moved to their nearest corresponding percentile (i.e. extreme data beyond the top 2.5 percentile are assigned the value corresponding to this percentile, and similarly for data below the 2.5 bottom percentile).

Finally, four initial indicators (*Electric power transmission and distribution losses*, *Fertility rate*, *Lending rates*, and *Export concentration index*) are factored in through their inversion, by taking the

max of the indicator and subtracting the initial indicators value. Thus, for example, a positive correlation between the Human Capital score and the indicator *Fertility rate* in the PCI statistical output should be seen as a positive correlation between human capital and a low fertility rate.

4. Step 6: Principal Component Analysis and compiling the PCI

For each category, indicators from all countries and years are used to perform a PCA.³⁸ This statistical technique reduces data dimensionality by identifying combinations of variables that capture the most variance, called “components” (Hotelling, 1933, 1936). Scores are hence calculated independently for each of the eight categories.

The number of components extracted equals the number of components with both eigenvalues over 1.0 and variance explained over 10%. If more than one component were extracted, these were rotated using *varimax* rotation. In the most recent edition of the PCI, a single component was extracted for four categories (Human Capital, ICT, Institutions and Transport) and two components were extracted in the remaining four (Energy, Natural Capital, Private Sector and Structural Change).

A raw category score is computed by first calculating scores for each extracted component. When only one component is extracted, the score on this component equals the raw category score. When two components are extracted the category score is the average of the two component scores weighted by the variance explained by each component.

PCA reduces data dimensionality by identifying combinations of variables that capture the most variance, called “components”

³⁶ For example, *Health expenditures* are expected to have diminishing marginal returns on productive capacities.

³⁷ This is primarily done in order to meet assumptions for the PCA. Outliers (even if representing correct data) can affect the final score of a country and significantly skew the results of the PCA.

³⁸ Further discussion and information regarding the choice of PCA over other aggregation methods can be found in Bouhia and Deleegn Arega (forthcoming), UNCTAD (2023) and in the reports of the STAG meetings (available upon requests).



Figure V.2 visually describes the steps from raw data to category score, and Figure V.3 shows the distribution of category scores across countries and years. Each box contains 50% of score

values, with the average represented by the bold horizontal line inside it. Vertical bars extend up to 1.5 times the interquartile distance (i.e. the height of the box). Dots represent values lying beyond this.

Figure V.2
From input indicator to category score

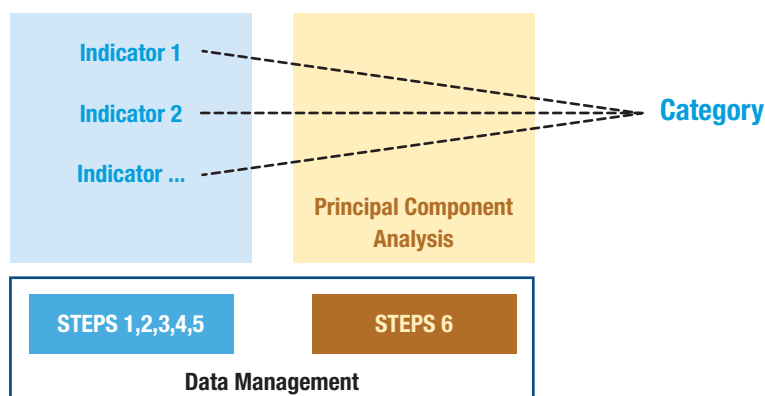


Figure V.3
Distribution of normalized scores.

Normalized score

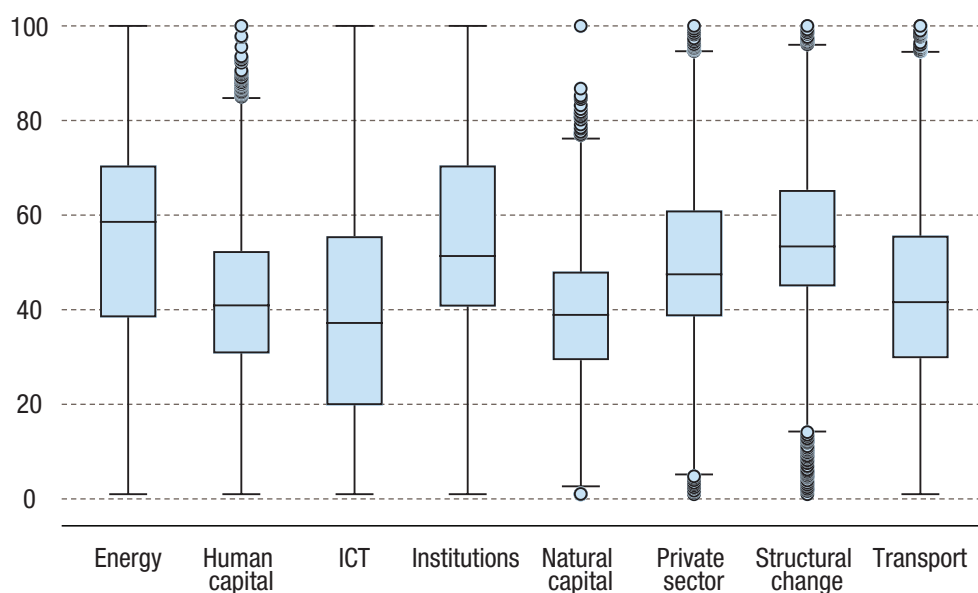
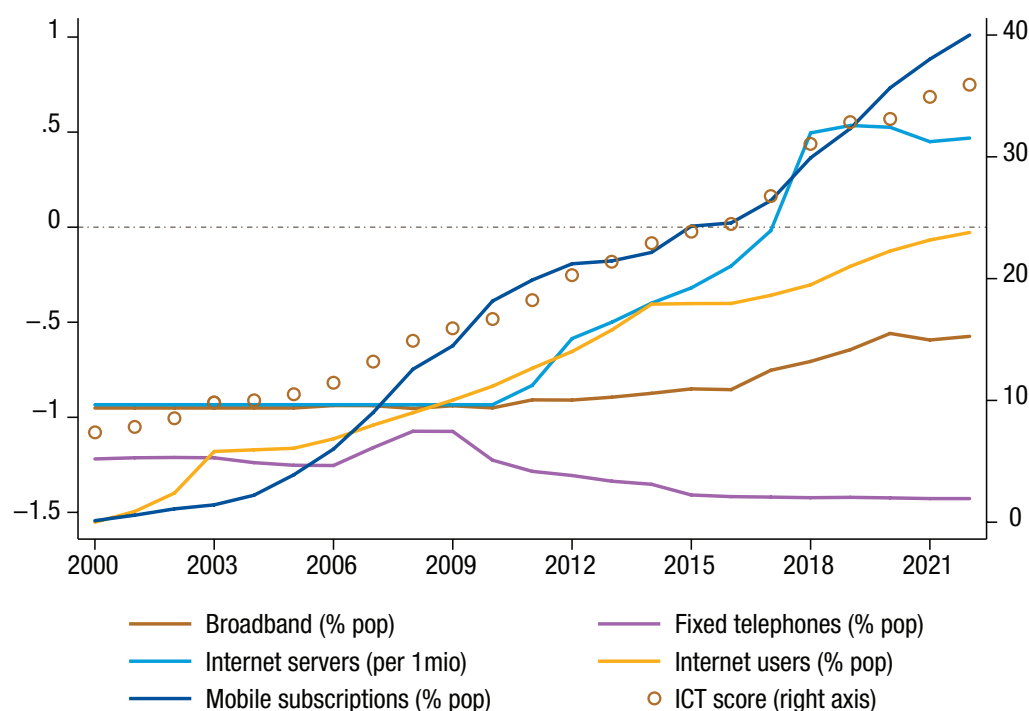


Figure V.4 gives an example of indicators in the ICT category for Kenya. Note that the transformed indicators data are standardized with mean 0 and standard deviation 1. A value of 0 means the indicator is at the sample average, and +1 means it is one standard deviation above the sample average (meaning this observation is in the top 15% of values across all countries and years). In the case of Kenya, most indicators are significantly below the average over all years and all countries, between 1 and 1.5 standard deviation below sample mean. The number of mobile subscriptions and internet

servers reaches the sample average around 2015-2017 and kept increasing in the following years. The number of internet users also shows significant improvement over the period, going from one of the lowest values in the sample in 2000 to reaching sample average by 2022. Only the number of fixed telephone lines does not show any significant improvement over the period and remains quite low in Kenya. The ICT score reflects the significant improvement of most of its underlying indicators, going from below 10 to 37 in 2022.

Figure V.4
ICT indicators and score for Kenya



Finally, each category score is scaled so that the highest score in the time series for each category is given the score 100, and the lowest the score 1. The final step produces the PCI overall score and consists of a geometric average of the eight categories scores. The formula is $PCI = \sqrt[8]{\prod_{i=1}^8 X_i^{PCA}}$ where X_i^{PCA} is the score of category i obtained with principal component analysis. Using a geometric rather than arithmetic average gives less weight to very high scores in computing the index. Other weightings could have

been implemented, but this choice has been justified by the theoretical framework underlying productive capacities, which emphasizes the need for a balanced mix of inputs to foster economic development.

Figure V.5 summarizes the final step from category score to the PCI, and figure V.6 shows the category scores for Kenya and its PCI. It shows a steady increase in PCI between 2000 and 2022, strongly driven by significant improvements in Human capital, ICT and Energy.

The PCI overall score consists of the geometric average of the eight categories scores

Figure V.5
Final step in compiling the PCI

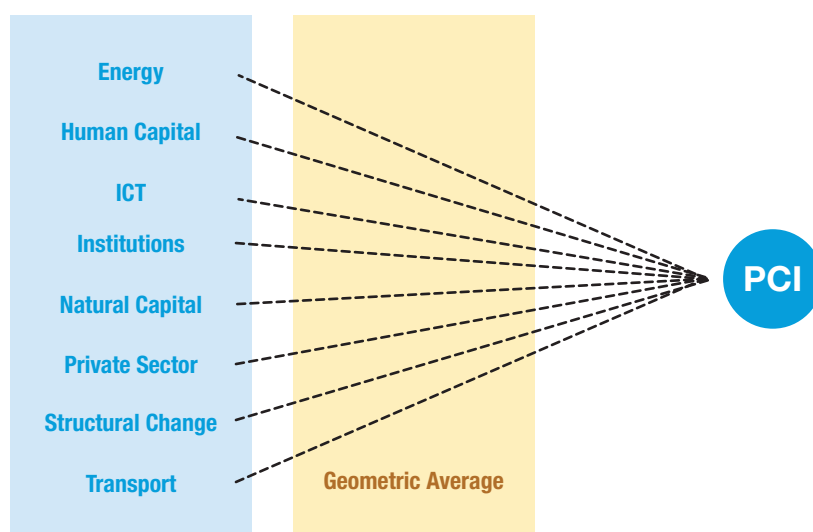
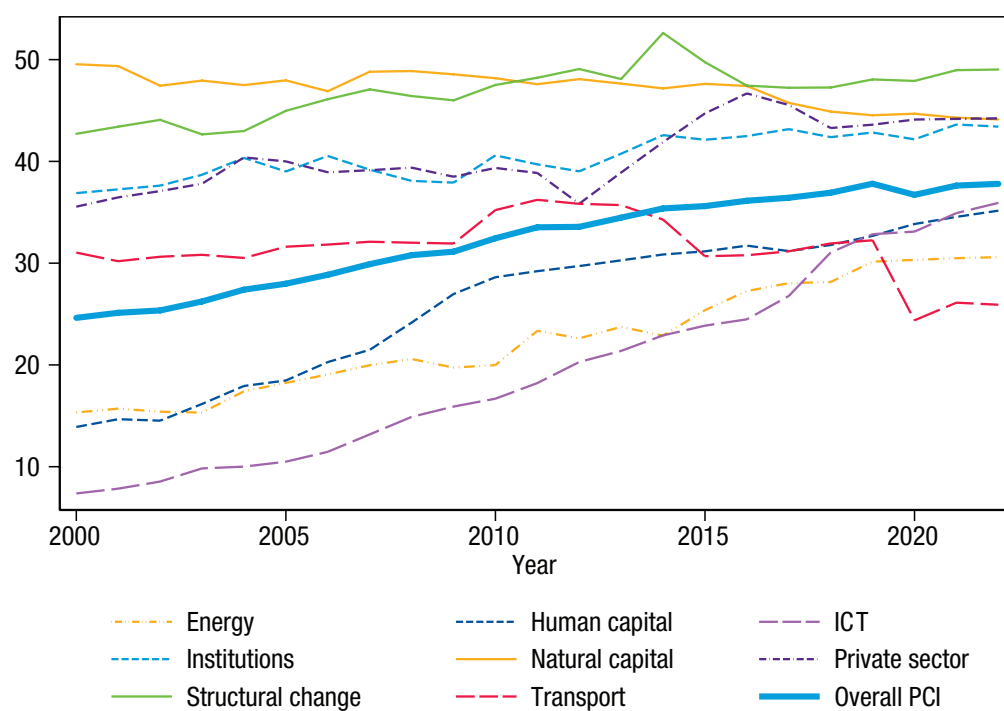


Figure V.6
PCI and categories' score for Kenya





VI.

International research agenda on the PCI



The PCI is subject to continuous improvement, also prompted by its review and governance mechanisms, the HLAB focusing on relevance and STAG with advice on statistical data and methodologies. The PCI is a reflection of available data and measurement possibilities. UNCTAD works in close collaboration with the statistical authorities of member States to enhance statistical capacities and fill data gaps for PCI, among other areas. As such, PCI can provide an advocacy tool for statistical authorities to draw policy attention to the need to enhance national statistical capacity to enable more evidence-based policies on productive capacities.

The PCI research agenda is currently focused on two main areas of improvement:

- Expanding the conceptual framework to measure productive capacities stemming from the environment, gender equality and finance;
- Supporting member States in conducting nationally or regionally expanded or adjusted PCIs for in-depth national studies, as well as studying the possibility to include additional input indicators to inform the eight categories of PCI as data availability improves; and

As mentioned in chapter II, UNCTAD's approach to productive capacities is established within the structuralist view of development economics, which highlights the very important roles of links between sectors, governments and firms, institutions, and the international context. In this view, incorporating new dimensions into the conceptual framework of the PCI also reflects the crucial role that these new dimensions can play by themselves, but also in conjunction with the existing categories. The first section motivates the inclusion of these new categories and stresses how they can be inputs into productive capacities.

The second set of recommendations follows the request by many developing countries of creating nationally or regionally

expanded or adjusted PCIs. In this regard, several propositions are made on possible extensions within the existing eight categories of PCI to consider country or region-specific factors affecting productive capacities. This could be elaborated further in a country to reflect its national context.

1. Expanding the PCI conceptual framework to environment, gender equality and finance

Discussions about incorporating “new dimensions” into the PCI have been conducted at HLAB in various meetings. Three main themes have emerged from the discussions: environment, gender and finance. While these dimensions are not entirely absent from the current PCI, they are only partially represented. Environmental considerations are reflected to some extent in the Natural Capital and Energy categories; gender-related factors appear within Human Capital and Energy³⁹; and certain financial aspects are embedded in the Private Sector category. These partial representations highlight the need to further develop and explicitly incorporate these dimensions into the PCI framework. The following section explains the relevance of each theme for productive capacities and explores potential avenues for identifying additional indicators.

a. Environment

Historical challenges in integrating environmental considerations into the concept of productive capacities

Since the launch of the PCI, capturing environmental and climate change dimensions in the index has been a recurring theme in discussions at various forums, including at the first meeting of STAG. From the policy perspective, further

While environment, gender and finance dimensions are not entirely absent from the current PCI, they are only partially represented

³⁹ Not only through fertility rates, but also through access to and investment in health, education, and infrastructure, widely recognized as key enablers of gender equality.



incorporating environmental and climate change considerations into the PCI is absolutely necessary. However, the paucity of data and statistical information and the absence of a robust conceptual framework that refines or reexamines the concept of productive capacities in that area, pose exorbitant challenges. The interplay between the environment and productive capacities is intricate and multifaceted, and the current efforts have resisted a simplistic and unidimensional interpretation.

The environment constitutes a full-fledged productive resource, which aligns with the first pillar of the definition by UNCTAD. In traditional development models, countries typically initiate their development through exportation of raw materials or agricultural products for which they have “comparative advantages” in terms of price and labour costs. They then gradually climb the value chain by specializing in products or services with higher added value. Having abundant natural resources and, more broadly, a thriving environment is an asset for initiating the process of structural transformation. This is roughly one of the ideas underpinning the Natural Capital component. However, as discussed earlier, this view of the environment as a productive resource is empirically challenged since many countries endowed with natural resources paradoxically suffer from the “Dutch Disease” or the “resources curse” and find themselves locked in “low-income” and “lower-middle income” traps.

Natural resources are inherently constrained by both temporal and spatial limitations, unlike other recognized resources such as technology, human capital, and knowledge. Consequently, the primary sector is often characterized by “diminishing marginal returns”. This understanding underscores that natural resources are genuine productive capacities only when they catalyse the emergence of other sectors with more sustainable gains in terms of employment, growth, and standards of living. Moreover, not all natural resources

are economically viable “resources”; the depletion or exploitation of natural resources such as water, soil quality, minerals and forests may yield short-term financial gains while jeopardizing the fundamental pillars essential for the proper functioning of society and long-term sustainable development.

More than the manner of exploiting natural resources, it is the overall modes of production that complicate the line between the environment and productive capacities. Historically, whether in Europe, North America, or more recently in East Asia, all industrialized countries have developed relying on fossil fuels, emitting considerable CO₂ emissions, and generating substantial waste and pollutants. However, this production approach has deleterious effects not only on the productive capacities of the producing countries but also on those of other nations. The transformation process as we know it today unfortunately involves negative externalities through the shift towards manufacturing and industry, or even certain energy-intensive services.

These spillovers affect all productive capacities, either by simply reducing them, such as human capital through health, transportation networks, or income-generating capabilities like certain sectors such as tourism, or by creating economic and social vulnerabilities that act as a looming threat to their long-term viability. This vulnerability is exemplified by a climate disaster that can wipe out decades of infrastructure and essential equipment development in a single instance. In fact, the PCI views productive capacities as assets, examining the accumulation of productive capacities but not truly considering the risks they face, including environmental risks. If we are to address climate change more deeply in the PCI, it would be necessary to broaden this underlying approach and open the possibility of accounting for liabilities. Additionally, the PCI should ideally be able to inform policymaking in devising decoupling and decarbonisation strategies.

Historically, whether in Europe, North America, or more recently in East Asia, all industrialized countries have developed relying on fossil fuels, emitting considerable CO₂ emissions



Proposals for environmental extensions based on HLAB recommendations

As per the outcomes of the HLAB meeting of 19th March 2024 (UNCTAD, 2024b), a category focusing on the environment is highly relevant for the measure of productive capacities. It ensures that economic growth is aligned with environmental sustainability goals, such as those expressed in the SDGs. It also helps reduce vulnerability to climate change by providing guidance for sustainable economic growth and attracting green investments.⁴⁰

Natural resources are already included in the PCI, but as an input into the production process. Viewing the environment as a productive resource is increasingly being challenged since many countries well-endowed with natural resources paradoxically suffer from the “resource curse”, or “Dutch disease” and find themselves stuck in low-income traps. The current environmental crisis calls for a shift in paradigm towards a better recognition of the services ecosystems and what they bring to human well-being, and how this needs to be incorporated into decision-making (Watson et al., 2022). Examples include for instance the protection of biodiversity within forests as it enhances their ability to store carbon and fight climate change (Mori et al., 2021); or the recent UNEP report “Becoming #Generation Restoration” which found that “*every dollar invested in restoration creates up to 30 dollars in economic benefits*” (UNEP, 2021a). The shift in paradigm correlates with adopting a long-term approach of economic development and towards a more resilient and sustainable notion of economic growth. Protecting existing productive capacities goes hand-in-hand with environmental protection.

The number of extreme climatic events has been increasing over the past 40 years due to climate change (IPCC, 2023). A direct consequence of such events can be the destruction or severe alteration, be they temporary or permanent, of productive capacities. Individuals may suffer physically and mentally from natural catastrophes affecting their daily life, forest wildfires can quickly eliminate or seriously damage the availability of wood as a natural resource for production (in addition to greatly affecting biodiversity); large scale floods and landslides can damage or destroy people’s homes, factories, and transport infrastructure. This is especially relevant for LDCs and SIDS which are at the forefront of natural disasters caused by climate change. They contribute the least to CO₂ emissions, and yet “69% of worldwide deaths caused by climate-related disasters [are] in LDCs.” (More, Swaby and Wangdi, 2019).

Developing sustainable production is crucial in successfully dealing with climate change and extreme weather events. Building resilience in this new environmental and economic landscape contributes to preserving existing productive capacities.⁴¹

Depending on data availability and quality across countries, and following further methodological and statistical assessment, the following indicators are proposed for potential inclusion in an environment category linked to productive capacities: GHG emissions, air quality, access to water, deforestation, land use change, exposure to extreme climatic events, biodiversity, and waste management.

1. Greenhouse Gas emissions

Lowering emissions is essential in the fight against climate change and is becoming an important component of sustainable growth and competitiveness.

⁴⁰ Climate change is a global phenomenon and collective actions are required to mitigate its effect or reverse it, and a country’s efforts may be undermined by the inactions of others. However, it remains that each country can work on developing its own resilience to climate change.

⁴¹ The fight against climate change exhibits positive externalities and all countries benefit from the efforts of others. From the perspective of PCI, it remains however that country needs to build their own resilience to preserve as much as possible its own productive capacities.



The framework for the global action on Greenhouse Gas (GHG) emissions was set by the Paris Agreement (2015) aiming to maintain global temperature rise to well below 2°C, operationalized at the national level through Nationally Determined Contributions (NDCs) to reduce GHG. The Paris Agreement was followed by subsequent instruments aiming to pursue further efforts to limit the global temperature increase to 1.5°C.⁴² Measuring productive capacities to foster sustainable long-term growth therefore needs to take into account GHG emissions. They affect economic growth but also environmental and human health. Developed economies are also increasingly concerned with importing products made using clean or low-emitting emissions technologies. An example of this growing concern is the Carbon Border Adjustment (Cosbey et al., 2012; Bellora and Fontagné, 2023).

Data on GHG emissions for all countries since at least 2000 are available on ClimateWatch ([link](#)) (which can also be sourced through World Bank's WDI), on the Global Carbon Atlas ([link](#)), or on the UN Framework Convention on Climate Change (UNFCCC – [link](#)). It is possible to scale this variable by population or GDP to account for the size of the country. GHG emissions and CO₂ emissions are covered by SDG 13.2.2 and 9.4.1 respectively and are both classified as “Tier I” by the Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs).⁴³

2. Air quality

The quality of air is a direct input in the production process through its effect on human capital (UNEP, 2021b). People living in polluted places have lower life expectancy, lower productivity, and children in particular show lower cognitive and

physical development (Zivin and Neidell, 2013). A study by Fang et al. (2013) also shows that climate change has significantly worsened the quality of air, which resulted in 100'000 additional deaths each year since 2000. Khomenko et al. (2021) find that complying with WHO air pollution guidelines in European cities could save up to 200'000 lives each year. Air quality has therefore consequences on economic activities too and Dechezleprêtre et al. (2019) show that a 10% increase in PM_{2.5} concentration (a common measure of air quality) reduces GDP by about 0.8% in European countries.

Air pollution is typically measured by the concentration of fine particles (PM_{2.5} and PM₁₀) and azote dioxide (NO₂). The WHO has created the Ambient Air Quality Database ([link](#)) which is updated every 2 or 3 years. It provides data on air quality at the country level. It is used as a tool to monitor advances towards SDG Indicator 11.6.2, related to air quality in cities.⁴⁴ Murray et al. (2020) propose data between 1990 and 2019 on the number of death attributable to many factors, including air pollution.

3. Access to water

Access to water is an essential input in agriculture, industrial production, but also human capital development and well-being, and sustainable urbanization (Devoto et al., 2012). Access to clean water and sanitation is an SDG in itself,⁴⁵ which additionally helps alleviate poverty, increase human capital, enhances health condition of the population, etc. Climate change often leads to water scarcity and droughts, threatening food security and economic activities. Managing water resources efficiently supports economic stability and growth (Duflo and Pande, 2007). A possible way to measure access to water is by using a Water Stress Index.

⁴² COP27 Cover Decision (Sharm el-Sheikh Implementation Plan).

⁴³ Tier 1 means that the SDG indicator is conceptually clear, has an internationally established methodology and standards are available, and data are regularly produced by countries for at least 50 per cent of countries and of the population in every region where the indicator is relevant.

⁴⁴ SDG 11.6: Reduce the environmental impacts of cities. SDG indicator 11.6.2 is the annual mean levels of fine particulate matter (e.g. PM_{2.5} and PM₁₀) in cities (population weighted).

⁴⁵ SDG 6: Clean water and sanitation.



Such index is available on the World Bank WDI, through the Aqueduct Water Risk Atlas ([link](#)) from the World Resources Institute ([link](#)) and UNEP's Global Freshwater Quality Database ([link](#)).

4. Land use change

Understanding how land is used is vital for maintaining ecological balance and enhancing carbon capture. Deforesting in order to create agricultural land increases food production and can surely alleviate hunger and poverty.⁴⁶ Once land is used for agriculture, introducing sustainable practices which maintain soil health and prevent desertification is essential for sustainable development. This is particularly crucial for countries reliant on agriculture as a primary economic activity and for ensuring long-term food security.⁴⁷ The Global Forest Watch ([link](#)) provides real-time data on land use change using satellite imagery (in addition to data on deforestation and reforestation).

5. Exposure to extreme weather and climate events

Understanding and assessing climate risks allows countries to improve their adaptation and resilience capabilities. Reducing the vulnerability to climate change safeguards economic growth by maintaining productive capacities and secures the path towards long-term sustainable development. Climate change is a complex phenomenon and what matters for productive capacities is to measure the vulnerability of a population or a location to extreme climatic events (an exposure measure), and the ability to bounce back following such events (a resilience measure). Such efforts have been

conducted by the UN with the publication in 2024 of report on a Multidimensional Vulnerability Index (United Nations, 2024).⁴⁸

The University of Notre Dame has also developed an “adaptation index” ([link](#)). The Bündnis Entwicklung Hilft and the Institute for International Law of Peace and Armed Conflict (IFHV) at Ruhr University Bochum ([link](#)) released their 2024 World Risk Report with a special focus on climate change (Bündnis Entwicklung Hilft / IFHV, 2024). Their report features an index using a measure of exposure and of vulnerability to climate change. The INFORM Climate Change provides now information on the impacts of climate change on the future risk of humanitarian crisis and disasters ([link](#)). The World Bank Climate Change Knowledge Portal also provides assessment of climate risk and vulnerability analysis at the country level ([link](#)).

6. Biodiversity

Forests showing greater species diversity are better at capturing carbon. Healthy ecosystems provide essential services, from pollination, to water purification and climate regulations. Protecting biodiversity is also crucial for agriculture and tourism. Both contribute to the economy's productive capacities. Protecting biodiversity is a key component to SDG 15 on “life on land”.⁴⁹ To measure biodiversity, one can include the size of protected areas, the existence of conservation policies, or measures of biodiversity loss or gain. Several indicators can be found on the Biodiversity Indicators Partnership (BIP) ([link](#))

⁴⁶ It also reduces the ability of the land to contribute to the fight against climate change. This further reveals the multi-faceted aspect of productive capacities, whereby progresses towards reducing extreme poverty can conflict with environmental goals too (Pradhan *et al.*, 2017; Bennich *et al.*, 2023).

⁴⁷ Sustainable land use is linked to SDG 2 on “zero hunger” and target 2.4 “sustainable food production and resilient agricultural practices”, but also to SDG 11 on “sustainable cities and communities”.

⁴⁸ SDG 13.1 is strongly linked to this idea of building resilience: “Strengthen resilience and adaptive capacity to climate-related disasters”.

⁴⁹ In particular SDG 15.1 “Conserve and restore terrestrial and freshwater ecosystems” with target 15.1.2: “Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type”



7. Waste management

Waste management includes collection, treatment and recycling of used materials in order to be transformed into usable inputs. It is especially crucial in urban areas where their absence can lead to degradation of health conditions and to water pollution. Waste is no longer only viewed as an inevitable consequence of industrialization and economic development. It is also a resource which can bring major economic benefits. The European Union characterizes

a circular economy as one in which “Waste and resource use are minimised, and when a product reaches the end of its life, it is used again to create further value. This can bring major economic benefits, contributing to innovation, growth and job creation.” (link). Waste reduction and management figures prominently in SDG 11 on “sustainable cities and communities.”⁵⁰ UNEP proposes data on waste management with the Global Waste Management Outlook (link) and the World Bank “What a Waste Global Database” (link) proposes data since 2010.⁵¹



Table VI.1
List of indicators to measure the environmental dimension

Indicator	Data source	SDG
CO2 emissions	ClimateWatch, Global Carbon Atlas, UN Framework Convention on Climate Change	13.2.2
Air Quality	WTO Ambient Air Quality Database, Murray et al. (2020)	11.6.2
Access to water	«World Development Indicator (World Bank) Aqueduct Water Risk Atlas (World Resources Institute) Global Freshwater Quality Database (UNEP)»	6
Deforestation	The Global Land Analysis and Discovery, Global Forest Watch, Global Forest Resources Assessment	15.2.1
Land use Change	Global Forest Watch	2.4.1
Exposure to environmental extreme events	University of Notre Dame adaptation index, World Risk Report, INFORM Climate Change, World Bank Climate Change Knowledge portal	13.1
Biodiversity	Biodiversity Indicators Partnership	15.1.2
Waste management	«UNEP Global Waste Management Outlook World Bank» «What a Waste Global Database»	11.6.1

⁵⁰ In particular SDG 11.6: “Reduce the environmental impacts of cities”, with indicator 11.6.1: “Proportion of municipal solid waste collected and managed in controlled facilities out of total municipal waste generated, by cities”.

⁵¹ Academic research has also looked at international trade in waste. Such does not reflect domestic production of solid waste, but give nonetheless of fuller picture of what happens to domestic and industrial waste. A review of the literature can be found in Kellenberg (2015).



b. Gender gap

Background

In its current version, PCI tackles the gender issue through the Human Capital category and through access to and investment in infrastructures in Energy and other categories. Academic and policy research has long established a positive correlation between education achievement and health expenditures and improvements in women's living conditions. Following Sen (1999), development is a process of expanding freedoms, and gender equality is a goal in itself. Gender equality is a multifaceted concept, including (but not limited to), equality in the accumulation of endowments such as education, health, and physical assets; equality in economic opportunities such as access to jobs, and equality in agency meaning the ability to make choices affecting one's own welfare as well as that of the household (World Bank, 2012)

Jayachandran (2015) reviews the evidence on gender inequality and economic development and shows that a lack of economic development can be at the root of gender inequalities, and that cultural norms favouring males over females also play an important role. For instance, women can receive lower education because of a high probability of dying during childbearing. Goldin (2006) shows that the cost of education tends to rise with age more so for women than men, making schools somewhat inhospitable for women. Access to contraception also simultaneously reduces fertility rate while increasing education (Goldin and Katz, 2000). These facts suggest that external factors (different opportunity cost in education, differential life expectation at birth) can open up a gender gap without discrimination (Björkman-Nyqvist, 2018).

Gender equality enhances productive capacities in several ways. Gender equality leads to a fuller utilization of a country's labour force. The gender gap is reflected in the labour market in different ways: difference in labour market participation, wage differences, job opportunities.⁵² Low female participation in the labour market may create additional barriers. Access to information about jobs often occurs in gendered networks, making it difficult for women to enter male-dominated sectors. Women may end up in a "productivity gap", finding it more difficult to acquire productive inputs. For example, access to credit often requires a collateral and women have lower access to land ownership and tend to be disproportionately employed in service sectors where assets are usually intangible. As a result, in addition to access to education, better access to physical assets such as land ownership can help women move towards entrepreneurship (O'Sullivan, 2017; Gaddis, Lahoti and Li, 2018).

Second, with equal access to education and health, a country can use the full potential of its labour force and not limit itself to the male half of it. Klasen (2002) showed that gender inequality in education lowered the average level of human capital in developing countries, reducing economic growth.⁵³ The lack of education of girls and women is a "missed opportunity" which puts a drag on economic development (Wodon, 2018). Better access to healthcare by women is also closely associated with better health for children and lower infant mortality (World Bank, 2012). Closing the gender gap in education enlarges the skill base of the country, which leads to more talents emerging, increases in competitiveness and to more innovation (Elborgh-Woytek et al., 2013; Xie et al., 2020; Wu et al., 2021).

⁵² See Blau and Kahn (2017) and Olivetti and Petrongolo (2016) for their review on wage and employment gender gaps.

⁵³ The author finds that between 0.4 and 0.9 percentage points of differences in annual per capita growth rates between East Asia and Sub-Saharan Africa, South Asia, and the Middle East can be accounted for by differences in gender gaps in education between these regions.



Gender equality generates long-term and intergenerational benefits in the form of more sustainable and higher economic growth

Third, gender equality generates long-term and intergenerational benefits in the form of more sustainable and higher economic growth. Women's education benefits their own children and future generations. This leads to greater social cohesion and to a more resilient economy (Duflo, 2012). Alesina et al. (2013) for instance showed that ancient societies with initially greater gender equality have higher participation of women in the labour force, in politics, and in entrepreneurial activities.

Proposals for further gender inclusion in the PCI based on HLAB recommendations

Data available on gender inequalities do not measure inequality in job opportunities or in access to education. Instead, they measure the result of such inequalities in the form of lower participation of women in the labour force and lower educational achievement. Notwithstanding this issue, several indicators can be used in order to measure various dimensions of the gender gap, depending on data availability and quality across countries, and following further methodological and statistical assessment.

1. Access to education

Access to education can be indirectly measured by educational achievement of primary, secondary, or tertiary education. Better and indiscriminate access to education is included in several targets of SDG 4 related to education.⁵⁴ The World Bank WDI provides information on female enrolment in schooling and educational achievement. Other source include UNICEF ([link](#)) and UNESCO UIS data portal ([link](#)).

2. Reproductive health and rights

Reproductive rights are a crucial element of women's empowerment. It provides women with agency over their choice of childbearing and in their choice to invest in their own education and work career. This is therefore correlated with women's participation in the labour force and educational achievement but measures the capabilities of women to choose over these dimensions. Universal access to reproductive rights and health is one of the targets of SDG 5 on gender equality.⁵⁵ Information on reproductive health and rights can be found on the WHO Global Health Observatory ([link](#)), UNFPA Data ([link](#)), World Bank Health Data ([link](#)).

3. Gender participation and wage inequality in the labour market

The gender gap can be measured by the difference in participation rate in the labour market between men and women. Such measure informs on the access by women to labour market activities, which may differ from men for several reasons (e.g. cultural norms favouring women's presence at home in care activities, lack of knowledge about jobs in male-dominated sectors). Indiscriminate participation in the labour market is part of SDG 8 on decent work and economic growth. In addition to differences in participation in the labour market, wage inequalities also reflect unequal work opportunities.⁵⁶ The ILO ([link](#)) provides information about labour force participation rates for men and women since at least 2000 for most countries. Similar data are also available on the World Bank Gender data portal ([link](#)).

⁵⁴ Target 4.3: Equal access to affordable technical, vocational, and higher education; target 4.5: eliminate all discrimination in education.

⁵⁵ Target 5.6: Universal access to reproductive rights and health.

⁵⁶ Target 8.5: Full employment and decent work with equal pay.



4. Unpaid care and domestic work

In most countries, women spend a disproportionate amount of time in care (of children or elderly members of the family for instance) and household work compared to men. While such work is extremely valuable, such unequal distribution of tasks also limits women's ability to participate in the labour force. Reducing the unequal burden of such (usually unpaid) work enables them to dedicate time to engage in income-generating activities and contribute to raising the household income. Measuring unequal involvement in unpaid care and domestic work could be done by looking at the difference in time allocated to such activities between men and women. Reducing unpaid work is integrated in SDG 5 on gender equality.⁵⁷ Data can be found on the ILO portal ([link](#)) and on the World Bank Gender data Portal ([link](#)).

5. Gender-based violence and safety

In developed and developing countries alike, women are disproportionately subject to gender-based violence, both outside and within the household. Reducing gender-based violence is a goal in itself, and the focus of SDG 5.⁵⁸ Ouedraogo and Stenzel (2021) show that such violence constitutes a drag on economic development. The authors find that an increase in the share of women subject to violence (domestic or otherwise) by one percentage point reduces economic activity by up to 8%. In other words, more violence against women limits the capacity of the economy to successfully use its productive resources (here women labour and women human capital). Data on gender-based violence is provided by the UN Women Data Hub ([link](#)), the WHO Violence against Women portal ([link](#)).



Table VI.2

List of indicators to measure the gender dimension

Indicator	Data source	SDG
Access to education	World Bank WDI, UNICEF, UNESCO UIS	4.3, 4.5
Reproductive health and rights	WHO Global Health Observatory, UNFPA Data, World Bank Health Data	5.6
Gender labour gaps and wage inequality	ILO, World Bank Gender Data portal	8.5
Unpaid care and domestic work	ILO, World Bank Gender Data portal	5.4
Violence against women	UN Women Data Hub, WHO Violence against Women	5.2, 5.3

⁵⁷ Target 5.4: Value unpaid care and promote shared domestic responsibilities.

⁵⁸ Target 5.2: End all violence against and exploitation of women and girls, Target 5.3: Eliminate forced marriages and genital mutilation



c. Finance

Background

Firms borrow and invest for mainly two reasons: to build up inventories in order to produce, and to innovate. A costly access to funds limits the ability of firms to engage in these two activities, in particular for small and medium sized enterprises, which do not necessarily have the retained profits to do so. Hence, access to finance is crucial for innovation. The link between access to finance and productive capacities and economic development in general is well documented in academic and policy literature (Levine, 2005). The main channels through which finance benefits the real economy is by allocating capital to productive uses by mobilizing and pooling savings, by managing risk and producing information about investment opportunities, and by facilitating trading and the exchange of goods and services. It greases the wheel of market economies and acts as an enabler of very diverse activities: from financing education and public health services (hence building up human capital), to enabling firms to grow (hence developing the private sector), and allowing major public projects such as infrastructure projects to be financed. Access to finance also allows the economy to be more resilient to external shocks (e.g. major economic downturns, climate change) and allows for more sustainable economic growth and entrepreneurship (Guiso, Sapienza and Zingales, 2004), and even better education (Flug, Spilimbergo and Wachtenheim, 1998). Access to financial services is strongly linked to SDG 1 (poverty reduction) and SDG 8 (decent work and economic growth).⁵⁹

The development of financial institutions and financial markets are two important elements of financial development. Financial institutions include local and national banks as well as regulatory agencies whose goal

is to ensure that safe practices are adopted. Lack of regulations or weak supervision of major financial institutions contributes to the emergence of serious banking and financial crises, the latest major episode being the 2007-08 subprime crisis which then unfolded into the European debt crisis (Reinhart and Rogoff, 2011). Recent research shows that greater regulatory and supervisory independence is associated with improved financial stability (Fraccaroli, Sowerbutts and Whitworth, 2024), and that a too large financial sector can have a negative effect on economic growth (Arcand, Berkes and Panizza, 2015).

A well-developed and safe financial sector can promote sustainable and inclusive economic growth. Beck et al. (2007) for instance showed that “about 40% of the long-run impact of financial development on the income growth of the poorest quintile is the result of reductions in income inequality, while 60% is due to the impact of financial development on aggregate economic growth”. Raddatz et al. (2006) showed that in financially underdeveloped countries, sectors with the largest need for liquidity are more likely to experience greater volatility in production and experience deeper crisis than sectors less reliant on external finance.

Not all forms of financial markets matter equally for economic growth. While on average a bigger banking sector is correlated with higher GDP, this does not necessarily mean that all components of financial markets contribute to economic growth. Zingales (2015) argues for instance that “there is remarkably little evidence that the existence or size of an equity market matters for growth”. Currently, PCI has two indicators with a finance-oriented dimension: the gross fixed capital formation in the structural change category, which is a proxy for investment; and the lending interest rate and domestic credit in the private sector category, which aim at measuring access to finance by private enterprises.

⁵⁹ In particular, the indicators proposed are strongly linked to target 1.4: Equal rights to ownership, basic services, technology, and economic resources, and to target 8.10: Universal access to banking, insurance and financial services.



Proposals for further financial inclusion in the PCI based on HLAB recommendations

1. Access to credit by small and medium sized enterprises (SMEs)

SMEs face higher cost of credit (less collateral, greater reliance on external funds than large companies who can retain more profits to finance their own investment), especially when engaging in research and development (Hall and Lerner, 2010). SMEs are at the same time an important driver behind poverty reduction and economic growth (World Bank, 2018). Data source for access to credit by large and small enterprises include the World Bank Enterprise surveys⁶⁰ ([link](#)) and the IMF Financial Access Survey ([link](#)).

2. Mobile money

Access to financial services by households is also important in order to save, borrow, and manage risk. Access to financial services in the form of mobile money is extremely popular in Sub-Saharan African countries. Mobile money contributes to reducing household's volatility in consumption and generates higher tax revenues for governments. Recent study shows that countries with mobile money also have more entrepreneurs (Apeti, Combes and Edoh, 2023). Information on access to credit by large and small firms, and on money is available on the IMF Financial Access Survey ([link](#)).

3. Financial soundness

Financial institutions need to be regarded as safe by their users for finance to play its role in economic activities. Measuring independence of compliance with existing regulatory rules is challenging, however.

The IMF proposes indicators about financial soundness for many countries over a large period of time ([link](#)). Indicators are presented in their 2019 guide (IMF, 2019). Examples include a measure of sensitivity to market risk, several measures of capital adequacy (capital-to-asset ratios), asset quality, or measures of liquidity of financial institutions.

4. Public and private debt

Private and public debt is a great tool to promote investment and economic growth. The debate is still ongoing about whether high debt-to-GDP ratios constitute a boon or a drag on economic development. Debt for productive investment is of course a good thing, but borrowing is not always used to boost productive capacities (World Bank, 2019). Recent studies have reemphasized that the trajectory of the debt rather than its level is more relevant to assess whether it has a negative effect on economic growth (Chudik et al., 2017).⁶¹ Developing countries face much higher costs of borrowing than developed ones. A recent UNCTAD (2024a) publication highlights that some developing countries spend more on servicing their debt than on public education. Such high cost of borrowing and investing strongly limits their ability to invest in all types of productive capacities, from human capital (e.g. education, health) to more sustainable modes of production. This applies to governments and to households alike, and private debt can also be a limitation in private investment into productive capacities (Reinhart and Rogoff, 2011).

Information on public debt-to-GDP ratio is available directly through the world development indicator. Levels of household debt-to-GDP ratio is available in the IMF guide on financial soundness presented above (IMF, 2019).

Recent studies have reemphasized that the trajectory of the debt rather than its level is more relevant to assess whether it has a negative effect on economic growth

⁶⁰ The coverage in terms of sectors, countries and years of the World Bank Enterprise Survey may not be sufficient to successfully measure access to credit. However, it provides, among other things, relevant information about how firms approach access to finance.

⁶¹ The authors argue that "Provided that public debt is on a downward trajectory, a country with a high level of debt can grow just as fast as its peers in the long run".



**Table VI.3****List of indicators to measure the financial dimension**

Indicator	Data source	SDG
Access to credit by SMEs	World Bank Enterprise Survey, IMF FAS and MFS	1.4, 8.10
Mobile money	IMF FAS and MFS	1.4, 8.10
Financial soundness	IMF FSI	
Public and private debt	"World Development Indicators IMF FSI"	

2. Development of nationally or regionally expanded PCIs

The PCI, as it is collected and compiled currently, is a powerful tool developed to assess national productive capacities. It can inform countries of challenges and opportunities with productive capacities to design appropriate policy interventions, and it can also help draw the attention of the government to the need to enhance statistical capacities to address data gaps and provide more complete information for national productive capacities analysis.

Countries may also adopt the PCI methodology at the national level to evaluate their productive capacities and review available data sources. UNCTAD's PCI dataset can be used for comparability across countries which would be lost from nationally or regionally expanded or tailored PCI. The creation of a "National PCI" must emanate from the countries themselves if the index is to reflect their specific needs, and be developed in collaboration with the national statistical office, government agencies and other relevant parties. The programme proposed by UNCTAD (with the NPCGA and HPCDP – see chapter VII.3) can be used as a roadmap on how to produce an index tailored to the need of each country. Building a national PCI can prove important for several reasons.

First, a national (regional) version of the PCI can foster fruitful discussions among key stakeholders, including government agencies, civil society, and NGOs about the state of productive capacities and the steps needed for progress which is further tailored to the national context, and can use all relevant information available in the country. UNCTAD's PCI has to balance data availability across countries, and therefore, cannot make use of all available evidence in each country. A nationally adapted PCI enables zooming further into each country's (or region's) unique needs and potential.

Second, countries may wish to include dimensions which are particularly relevant to them and are not currently included in the PCI. For instance, island states may consider adding indicators on maritime infrastructure within the transport category – something landlocked countries do not necessarily need.⁶² The following of the section offers suggestions on additional indicators which may prove useful to some countries.

Third, countries can use their own domestic data, which can be more detailed than the one used in the construction of the PCI, and/or less affected by missing values. The input data used in the construction of the PCI comes from international sources, and has, to a certain extent, been harmonized to ensure comparability across countries.

Countries may also adopt the PCI methodology at the national level to evaluate their productive capacities and review available data sources

⁶² Except if there is a focus on inland waterway transport



By using domestic input data, countries can gain deeper insights into the elements that are most significant for productive capacities. Additionally, national data enables the calculation of regional PCI measures (e.g., one for large cities and another for rural areas, where economic activities may vary significantly). A national PCI could also apply different weights to the categories; currently, each of the eight categories is weighted equally, but countries might choose a different weighting scheme to reflect specific policy priorities.

Finally, the PCI is a valuable tool for devising industrial policies, and a national version can be an even greater asset. Industrial policies are experiencing a resurgence in both developed and developing countries, driven by several key factors. Global value chains are now a ubiquitous component of manufacturing production, and their sudden stop as experienced during the COVID-19 pandemic prompted many policy makers and economists to rethink their views on industrial policy. Moreover, climate change is adding pressure on policy makers to move towards greener production processes and diversify economies to build resilience against future environmental shocks. Rising geopolitical tensions also contribute to a perceived need for greater industrial capabilities and technological sovereignty (Evenett et al., 2024).

The eight categories of the PCI aim to cover a large variety of dimensions which all contribute to the development of productive capacities. The categories selected are consistent with theoretical and empirical evidence justifying socioeconomic transformation. Countries that have attained the highest growth and development with sustained transformation are those that have fully harnessed and recalibrated the selected dimensions in their development processes.

The indicators selected for each category satisfy at least three characteristics: (1) they represent an important component of productive capacities (not already captured by another indicator); (2) each indicator is relevant for all 194 countries for which PCI is computed; and (3) data is available in a harmonized way which makes comparisons across countries and over time meaningful. Proposing new indicators in the existing categories, or an entirely new category requires keeping these three characteristics in mind.

For each existing category of the PCI, we propose one or several additional indicators, motivated by its importance regarding productive capacities and its links towards achieving the SDGs. The role of this section is to stimulate the discussion on how to adapt PCI to a country or a region's characteristics and specific needs. Table VI.4 at the end of this section summarizes the proposals and data sources.

Energy

Domestic production of renewable energies can benefit an economy through lower dependence on energy imports and lower CO₂ emissions. Moving towards greater use of renewable energies is also explicit in SDG 7.1.⁶³ Nonetheless, there are differences in the potential and comparative advantages of countries for the production of renewable energy. Coastal countries are likely to have greater potential for wind power than landlocked ones, while countries closer to the equator may have greater potential for solar energy. The Global Wind Atlas and Global Solar Atlas provide detailed information on the potential of these two renewable energy sources through geolocation.⁶⁴

⁶³ SDG 7.1: By 2030, increase substantially the share of renewable energy in the global energy mix.

⁶⁴ Note that the data does not change over time but can be used to keep track of the percentage of solar and wind power generated each year as a share of the potential energy production. Tian et al. (2024) stress the fact that progress towards SDGs and the development of renewable energies may not be compatible all the time and identify goals which may be undermined by greater production of renewable energies.



Human Capital

An important aspect of human capital creation (and accumulation) is the schooling system. The present indicators used in computing the human capital category do not include the quality of education. Years of schooling give an idea about the “quantity” of knowledge acquired, but education quality is at least as important. It is also strongly present in SDG4.⁶⁵ One important aspect of it is the motivation of teachers and their presence in the classroom. In the *Global Corruption Report on Education* by Transparency International, Patrinos (2013) shows that absenteeism of teachers in developing and emerging countries varies greatly, between 11% and 30%, and can account for a loss in primary education expenditures of between 10 and 24%.⁶⁶ Other measures of education quality could include the standardized PISA scores which are performed every three years since 2000. Note that not all countries are included (African countries, with the exception of Morocco, are not included for instance). Data is available on the OECD website ([link](#)).

ICT

While the number of fixed landlines may become less relevant as time passes, the use of mobile phones and accessing the internet through them has become ubiquitous in all countries. The International Telecommunication Union is the custodian of the ICT development index aiming at measuring “universal and meaningful connectivity” in order to “assess the extent to which a country’s connectivity is universal and meaningful” (ITU, 2024). The two main components of the index are “universal connectivity”, measured by the share of population with internet access or a mobile

phone subscription, and “meaningful connectivity” which includes information about the share of population covered by 3G or 4G networks, or the price of a fixed-broadband internet subscription. The index has been computed between 2009 and 2017, interrupted for a few years due to a data issue, and has been relaunched recently with data for 2021 (see [ICT Development Index’s page](#)). SDG 9 is related to industry, innovation and infrastructure and aims to “significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020” (target 9.C).

Fixed lines are as important and relevant today as they were in the past. This is for five important reasons: first, fixed lines are more secure and reliable than mobile networks as they are built on a separate infrastructure. Second, they are less vulnerable to natural disasters and less likely to be affected by poor reception or distorted quality. Second, fixed-line networks have better capacities to transmit digital communications, particularly in countries where cellular networks are weak and vulnerable to hacking, malware attacks, and cybersecurity threats. Third, fixed or landlines are powered by the local telephone exchange. Therefore, beyond excellent quality communications, they are also functional during power outages. Fourth, they also have locational advantages and qualities during emergencies by providing exact locations of operational needs during unforeseen circumstances and emergencies. Fifth, fixed lines are less environmentally polluting with little or no radiation emissions.

⁶⁵ SDG 4.1: “Free primary and secondary education”, with the mission of this target being: “By 2030, ensure that all girls and boys complete free, equitable, and quality primary and secondary education leading to a relevant and effective learning outcome”. SDG 4.2: “Equal access to quality pre-primary education”, with the mission of this target being: “By 2030, ensure that all girls and boys have access to quality early childhood development, care and preprimary education so that they are ready for primary education”.

⁶⁶ Bradley, Green and Leeves (2007) and Chaudhury et al. (2006) offer reviews of how teacher absenteeism affects education quality in developing countries. On general schooling quality, see the still very relevant review by Hanushek (1986).



Institutions

Judicial independence from political power is an essential element of the institutional environment. It ensures the fair and unbiased treatment of all parties in court cases and offers some degree of predictability in court decisions. This is an important element of the business environment in which individuals and firms operate and influences investment decisions for instance. The V-Dem institute ([link](#)) proposes a large variety of measures of various aspects of democracy for all countries and over a very long period of time. It proposes measures about independence of courts, political violence, or the exclusion of certain groups (based on gender, ethnicity, political affiliation) from government procurements.⁶⁷

Natural capital

Sustainability in the use of natural resources is an important element of sustainable economic growth. Forests are a critical natural resource in the fight against climate change. The way they are managed, however, can greatly influence their ability to capture carbon and maintain greater diversity which also contributes to carbon capture (Abhishek Chaudhary, 2016; Mori et al., 2021). Sustainable forest management is also an element of SDG 15.⁶⁸ The FAO provides information on forest management, including a [toolbox](#) on how to approach sustainable forest management (SFM). Additional data can be found in their Global Forest Resources Assessment ([link](#)).

Private sector

Informality is present in all sectors, particularly in developing countries. It is a multi-faceted phenomenon which demonstrates itself within firms (mostly in some form of tax avoidance, but also unregistered businesses) but also at the level of workers (absence of contracts or absence of declaration of individual business). Informality matters and extensive literature on the topic has shown that informal firms tend to be smaller, less productive and pay lower wages than formal ones. This has implications for economic growth, government revenues, and worker protection (Ulyssea, 2020). Entrepreneurs registering their firm at its founding grow faster and generate higher sales than those who remain informal (Assenova and Sorenson, 2017).⁶⁹ A study by De Mel et al. (2013) in Sri Lanka also finds that firms who formalized have higher average profits and express more trust in the state. In a recent publication, Elgin et al. (2021) propose an estimated measure of informality for 196 countries since 1990. The measure aims at capturing several of the dimensions discussed above, including self-employment and salaried work without formal contract.⁷⁰ The ILO also provides information about informality rates in many developing countries ([link](#)).⁷¹

⁶⁷ See also Linzer and Staton (2015) for another attempt at providing a global measure of judicial independence. The index they develop is however only available until 2012. Note that Staton is also part of the V-Dem project. The presence of independent institutions is linked to SDG 16, target 16.A: “Existence of independent national human rights institutions in compliance with the Paris Principles”.

⁶⁸ SDG indicator 15.2: “By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.”

⁶⁹ The study focuses on 18 sub-Saharan countries.

⁷⁰ Informality is linked to SDG 8.3 “Promote policies to support job creation and growing enterprises”, as measured by indicator 8.3.1: Proportion of informal employment in non-agriculture employment, by sex.

⁷¹ See also their statistical manuals on measuring informality (ILO, 2013a, 2013b).



Structural change

Structural change of an economy is not limited to the types of sectors or economic activities and certainly includes a geographic component. For example, an increase in agricultural productivity is often accompanied by migration of the workforce towards urban centres where industries tend to agglomerate (Michaels, Rauch and Redding, 2012; UN Habitat, 2016). Measuring urbanization can provide additional information on the current state of structural change. The UN's *World Urbanization Prospect* proposes data on urbanization for all countries in the world over the past 50 years at least (United Nations, 2019).⁷²

Transport

Measuring the quality of roads is challenging but at the same time critical to assess the sustainability of road networks. Recent study by Gertler et al. (2024) in Indonesia has shown that “better roads help manufacturers create new jobs, enabling worker transitions out of informal employment, and increasing labour income.” The World Bank BOOST database ([link](#)) provides information on road maintenance expenditures which can be used as a proxy for quality of existing network.⁷³



Table VI.4

Examples of country-specific or regional indicators for extended PCI compilation

Category	Indicator	Data source	SDG
Energy	Production of wind and solar energies	Global Wind Atlas, Global Solar Atlas	7.1
Human Capital	Quality of education	Global Corruption Report on Education	4.1, 4.2
ICT	"Share of populations covered by 3G or 4G network Price of a fixed-broadband internet connection"	ICT Development Index	9.C
Institutions	Judicial independence	V-Dem Institute	16.A
Natural Capital	Share of forest managed in a sustainable way	FAO, Global Forest Resources Assessment	15.2
Private Sector	Measures of informality	Elgin et al. (2021)	8.3
Structural Change	Share of population in urban centers	World Urbanization Prospect	11.3
Transport	Road maintenance expenditures	World Bank BOOST	9.1

⁷² SDG 11 on “sustainable cities and communities” includes target 11.3: “inclusive and sustainable urbanization”.

⁷³ See for instance Foster et al. (2022) for a recent use of the index present in the BOOST database.





VII.

Recommendations and resources for national statistical authorities and other government agencies

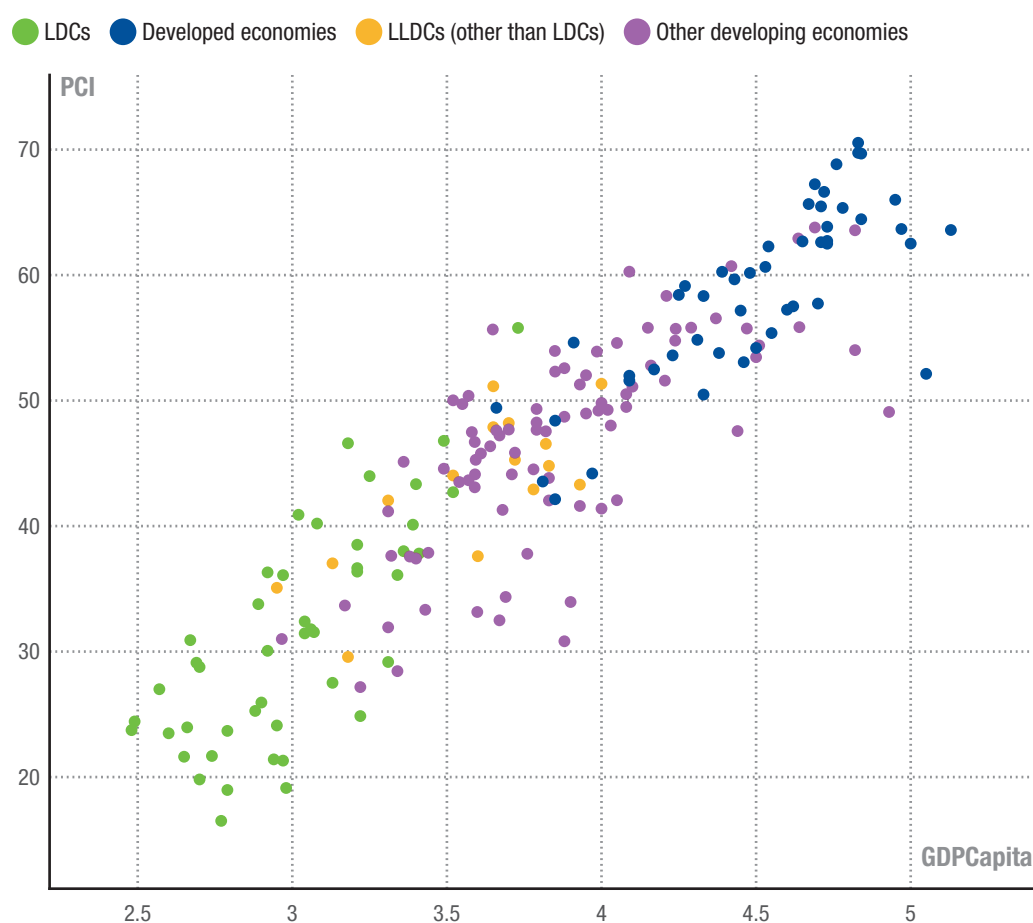


This chapter presents efforts made by UNCTAD to support international and regional organizations, governments, researchers in think-tanks and universities to analyse productive capacities and use the PCI. The first section presents the online portal which provides data and metadata on PCI. The following example of the use of PCI in Mozambique as part of its participation in UNCTAD's programme on developing productive capacities illustrates national uses of PCI. The content of the program is described in the third section, and UNCTAD invites interested countries to request support and participation in the programme. The last section reflects on how to enhance further dialogue with the UN Statistical Commission and the national statistical offices and other institutions responsible for data collection in developing countries.

1. Access to PCI data, analysis and metadata

UNCTAD encourages national statistical offices authorities and other government agencies to explore the PCI data provided by UNCTAD, assess its quality and relevance, and incorporate it into their economic analyses alongside other national and international sources. National and regional institutions are also invited to coordinate with UNCTAD for support on these tasks and to share any insights from their statistical analyses that may help enhance the long-term quality and relevance of PCI and its source data.

Figure VII.1
PCI and log GDP per capita



Source: UNCTAD from UNCTADstat, 2023.

LDC = Least developed countries, LLDCs = Landlocked developing countries.

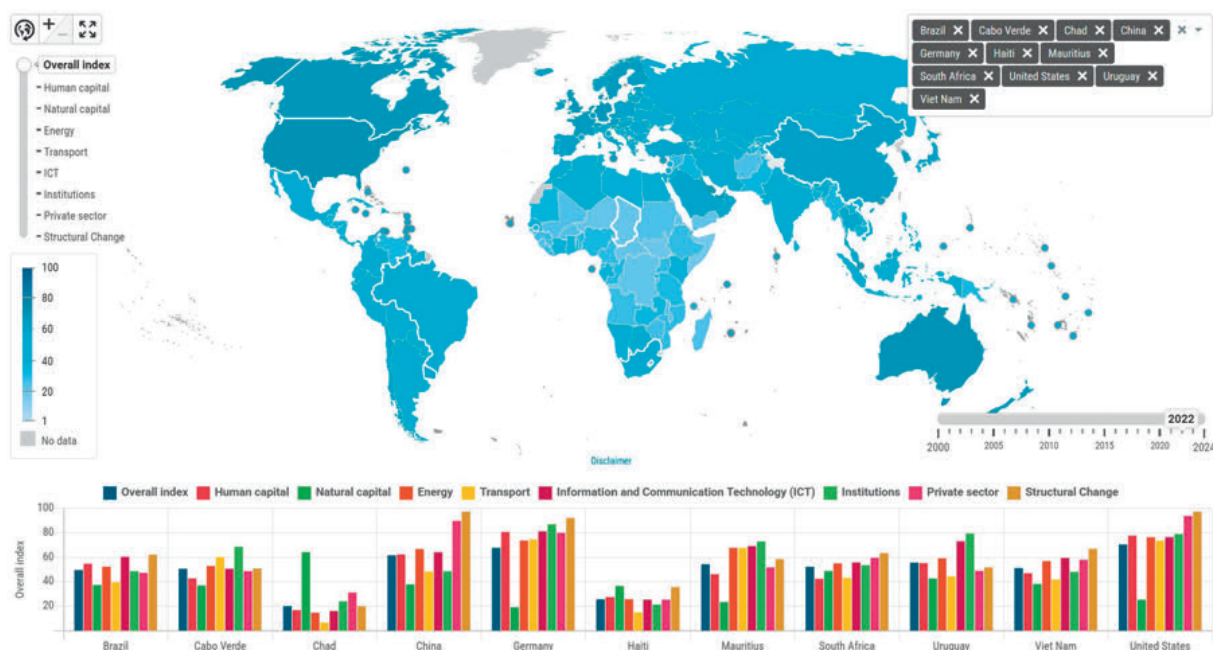
To support this purpose, concept notes, guides, policy briefs and other news related to the PCI can be easily found on the UNCTAD Website. A dedicated portal ([link](#)) provides the main resources where users can find: the history and rationale behind PCI; a description of the eight categories defining the index; a graphical visualization of the index showing for instance the cross-country correlation between GDP per capita and PCI (see figure VII.1 below), or between export concentration and PCI; UNCTAD publications related to PCI (technical notes, policy briefs, various reports); the list of forthcoming events of the PCI-UNCTAD team (capacity building in various countries, meetings of PCI teams, etc); and the latest news regarding PCI (e.g. new updates).

Data can be explored in the UNCTAD Data Hub ([link](#)) which features Data Insights and

data exploration tools including several world maps highlighting countries for which PCI is calculated (figure VII.2), the value of their PCI as well as for each of the eight categories over time. Groups of countries can also be selected (developing countries, LDCs, and LLDCs) on the map to make meaningful comparisons.

Finally, the UNCTAD data centre ([link](#)) is where comprehensive datasets can be found and downloaded. The user-friendly interface allows for the selection of a country or pre-defined groups of countries, a particular category, and years of interest. Layout can be easily modified, and data is downloadable in CSV format. Information about how data have been handled (see chapter V) and made compatible to be included in the index is also included.

Figure VII.2
Visualization of PCI on a map with category values for a selected group of countries



Note: graph access in October 2024, please consult the webpage for up-to-date information

2. How to use the PCI for evidence-based policy making

a. Using PCI for economic analysis: an example from Mozambique's National Productive Gap Assessment

The PCI supports a range of economic analyses at both country and regional levels, with one key application being the development of National Productive Capacity Gap Assessments (NPCGAs). An NPCGA provides a sectoral evaluation of a country's economic status and offers policymakers a roadmap to identify capacity gaps and formulate suitable policies. Each PCI category, along with its indicators, is examined, and comparisons can be made with regional PCI values or with countries of similar income levels to establish relevant benchmarks. This section includes an example of such analysis, featuring selected insights from Mozambique's NPCGA.

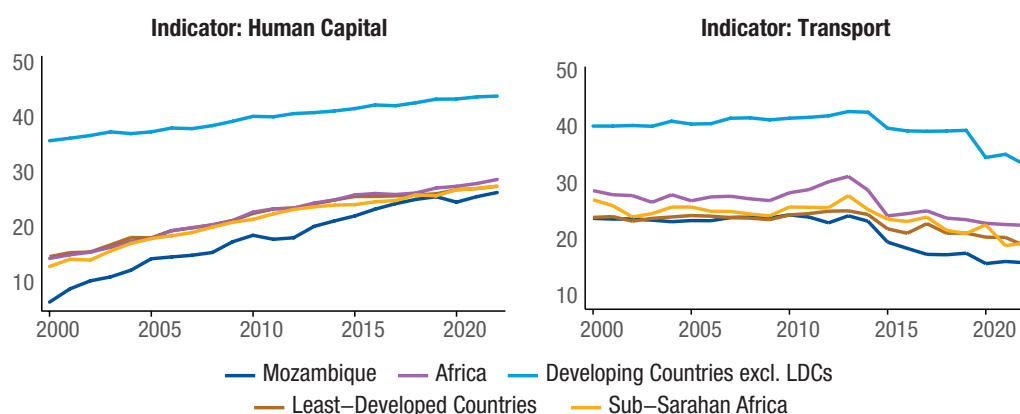
Figure VII.3 shows the evolution of the Human Capital and Transport category scores for Mozambique between 2000 and 2022, along with LDCs, the African continent, Sub-Saharan Africa, and Non-LDCs Developing countries. In the case of Mozambique, the score on Human Capital started from an initially low level compared

to other LDCs in 2000 but has shown significant improvement and has caught up to the average of LDCs in 2022. This is due to improvements in all indicators of this category. For instance, health adjusted life expectancy increased from 45 years in 2000 to 53 years in 2022, fertility rates improved from 5.8 to 4.5 children over the period, health expenditures as a share of GDP grew markedly (from 2.2% to 7.8%), and years of schooling increased from 6 to 10 years. The transport score shows little evolution in the first decade of the 2000s, and a decline after 2013 in Mozambique, but also in the entire continent and in other developing countries. The comparison with other LDCs and Sub-Saharan Africa shows that the lower performance is shared by other countries but appears more pronounced for Mozambique. The decline of Mozambique's scores is primarily due to a collapse of air transport and an erosion of the road density. The scores across the board collapsed, though Mozambique was hit the hardest among structural and comparative peers. While LDCs and SSA managed to retain scores around the value of 20 towards the early 2020s, Mozambique's performance hovers below that – without any signs that would indicate a sustainable change of this trend. The performance of ODCs equally suffered greatly after 2013, and particularly the COVID-19 shock accelerated the decline in recent years.

An NPCGA provides a sectoral evaluation of a country's economic status and offers policymakers a roadmap to identify capacity gaps and formulate suitable policies

Figure VII.3

Evolution of Human Capital and Transport scores in Mozambique and in selected groups of countries



b. Using PCI for academic and policy research

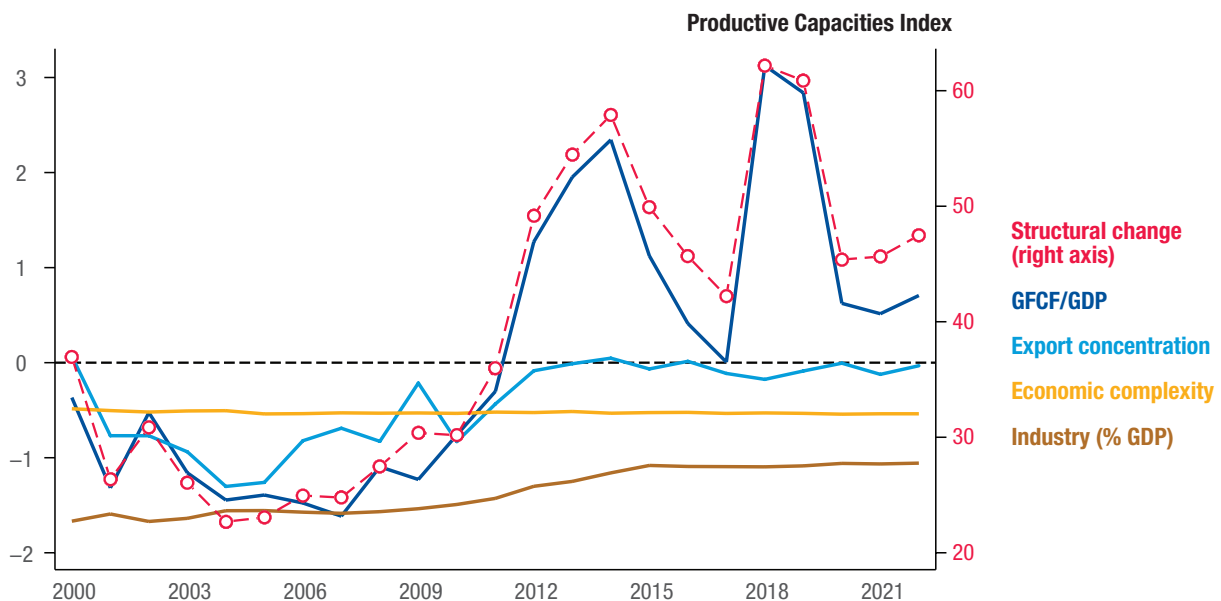
A strength of PCI for academic and policy research is its broad scope: it provides (non-missing) information about 194 developing economies over a period of 23 years (as of November 2024). The panel dimension of PCI enables researchers to go beyond cross-country analysis which suffer from numerous well-known statistical issues (Islam, 1995; Sala-i-Martin, 1997). This allows for analysis of how changes in productive capacities in a given country are correlated with other economic outcomes such as economic growth or poverty reduction for instance. The disaggregated nature of PCI also allows for the possibility to focus on certain aspects of productive capacities, depending on the research question. The transparent and rigorous statistical construction of the index, and the choice of categories and indicators backed by economic theory makes PCI a very useful tool for econometric and policy analysis. Between 2022 and 2024, the PCI has been used in at least 45 academic papers.⁷⁴

Between 2022 and 2024, the PCI has been used in at least 45 academic papers

Figure VII.4 shows the evolution of the indicators in the Structural Change category between 2000 and 2022. The category score increased from 37 to 47 over the period (right axis). This overall improvement is entirely driven by the increase in capital formation (as a share of GDP), as other indicators remained constant over the period. Larger investment did not lead to greater export diversification, nor to greater economic complexity or to a relative expansion of the industrial sector. The good performance of the index comes from the increase in investment into megaprojects in extractive industries which created little local employment. This absence of production linkages with other sectors of the economy likely hampered the creation of spillover effects. This highlights how the three different levels of PCI analysis (overall, by category, and by input indicator) are important and provide complementary value when understanding country performance.



Figure VII.4
Indicators on structural change in Mozambique



⁷⁴ Between 2022 and 2024, UNCTAD identified at least 45 academic or research papers referencing the PCI, authored by individuals affiliated with academic institutions, national bodies, and international organizations — including entities outside the United Nations system such as the IMF, OECD, the African Union...

Recent use of PCI is in an IMF working paper by Yaya (2024) who studies how macroeconomic shocks (e.g. Covid-19, armed conflicts, climate change) make economic growth more volatile in Sub-Saharan African countries. The author finds that indeed, countries facing more macroeconomic shock also have higher volatility in output, but this effect is mitigated by strong productive capacities, as measured by PCI. The author argues that *“Countries with high productive capacities have greater opportunities to mitigate the effect of economic vulnerability on growth volatility. Some specific dimensions of productive capacities (Institutions, ICT) seem to matter more than others”*. Tchagnao (2024) focuses on 37 sub-Saharan economies and finds that higher PCI is correlated with also have higher tax revenues. An increase by 1 point in a country's PCI is correlated with an average increase by 0,16% in tax revenue over GDP.

3. UNCTAD's support via its Programme on Productive Capacities

To help government agencies utilize the PCI for economic analysis and develop evidence-based policies that promote productive capacities and structural transformation, UNCTAD has created a comprehensive programme specifically tailored for developing economies. The objective of the programme is to equip beneficiary countries with policy tools as well as human and institutional capacities to formulate and implement sound policies and strategies, enhance inclusive and sustainable economic development, reduce poverty and accelerate the process of fostering productive capacities and structural economic transformation. The programmes are aligned with the beneficiary countries' National Development Plan and other key strategic development documents.

The programme has also a strong statistical component and seeks to aid countries in sharing feedback on PCI usage, receiving statistical support to improve the data quality of input indicators, and enhancing data reporting to international sources (see issues on missing data in Chapter V). It also supports interested countries in developing their own nationally and/or regionally adjusted PCIs. To participate in the programme, countries simply need to submit a request to UNCTAD, which will initiate consultations with the relevant national organizations.

The programme consists of four main activities co-led by UNCTAD and the relevant ministries in the country:

1. Strengthen countries' statistical capacity for improving data collection on and measurement of productive capacities and related vulnerabilities.

This activity aims to familiarize NSOs and other statistical institutions, including statistical services in the Ministries, on the compilation, data sources and use of the PCI. For instance, in May 2024, UNCTAD launched the programme in Mozambique and Zimbabwe with a statistical training and a policy workshop in each country.⁷⁵ The former trained around 45 statisticians from a wide range of organizations, such as NSOs, ministries, and academia, enabling compilation and interpretation of PCI scores and facilitating knowledge-sharing on statistical, methodological, and process aspects of PCI. The primary objective of the policy workshop was to set the ground for the National Productive Capacities Gap Assessments. Access to reliable data is extremely important for the NPCGA to accurately determine gaps and limitations in order to formulate relevant policy recommendations. In 2022-2023, UNCTAD delivered five training sessions to national statisticians, reaching 140 national statisticians from 74 different institutions and civil society (UNCTAD, 2024c).

⁷⁵ For further information on the training in Mozambique please see: <https://unctad.org/meeting/national-capacity-building-training-statistical-methodological-and-computational-aspects-0> and on Zimbabwe: <https://unctad.org/meeting/national-capacity-building-training-statistical-methodological-and-computational-aspects-1>



2. Formulation of the National Productive Capacities Gap Assessments (NPCGAs) by applying PCI to identify gaps, limitations, and challenges to foster productive capacities, structural transformation, and economic diversification.

NPCGAs are multidimensional diagnostics analysis that aim to respond to the question of how developing countries can best address the gaps and limitations to their productive capacities. They help in the identification of comparative advantages and binding constraints to build national productive capacities, as well as mapping intervention strategies.

Their novelty lies in their consistent application of the eight categories of PCI. With the help of PCI, the focus areas can be identified, and a coherent intervention built on an evidence-based platform. NPCGAs provide an in-depth assessment of socioeconomic performances together with opportunities, prospects, and challenges for further growth. At national level, they analyse key binding constraints to (i) building productive capacities; (ii) progressing in structural transformation; and (iii) achieve inclusive and sustainable growth. The NPCGA also makes use of additional external measure of economic performances (e.g. the Global Competitiveness Index developed by the World Economic Forum, the United Nations Human Development Index or the Human Assets Index for name a few) to provide a fuller picture.

NPCGAs are based on undertaking policy-oriented scoping studies and a closer examination of domestic policy and strategy documents, as well as interviews with relevant Ministries, public sector entities, and private sector institutions. They aim to reorient domestic policies from the current practice of isolated, project-based and short-term interventions towards programme-based, coordinated and economy-wide interventions. They also identify needs for future technical assistance and international support to build the capacity of policymakers in.

Once assessment has been carried out, a validation workshop is organized where results are presented, and its conclusions are discussed. The aim of this workshop is to ensure national ownership of the program and to help design holistic, comprehensive, and long-term interventions.

3. Formulation of the Holistic Productive Capacities Development Programmes (HPCDPs), which are holistic, economy-wide, and long-term roadmaps to address the gaps and facilitate the development of critical economic sectors based on comparative advantages.

HPCDPs have been created in response to the growing interest from member States. They are designed in close collaboration with the governments of the countries concerned. They consist in economy-wide, multi-year and multidimensional programmes of policy interventions to build productive capacities. The policy recommendations formulated in HPCDPs directly come from the NPCGAs which helped identify key binding constraints in the fostering of productive capacities. HPCDPs are the translation into policy recommendations of the analytical findings of the NPCGAs, and are designed together with governments and other stakeholders and aim at supporting domestic policies. Many countries are engaged in multi-years plan of economic development (e.g. *Vision 2030* in Kenya, *Malawi Vision 2063*). An HPCDP aligns with these programs and provides additional support and insights on important bindings areas identified via the NPCGAs. The alignment of HPCDP and country's other strategies enables the programme to become an integral and strategic instrument in the implementation of the State's developmental vision.

Once the HPCDP is launched, a Programme Coordination Unit is set up at UNCTAD and is supported through a country presence in the form of a National Programme Coordinator. Coordination ensures that the implementation of planned activities is consistent with the agreed objectives, terms



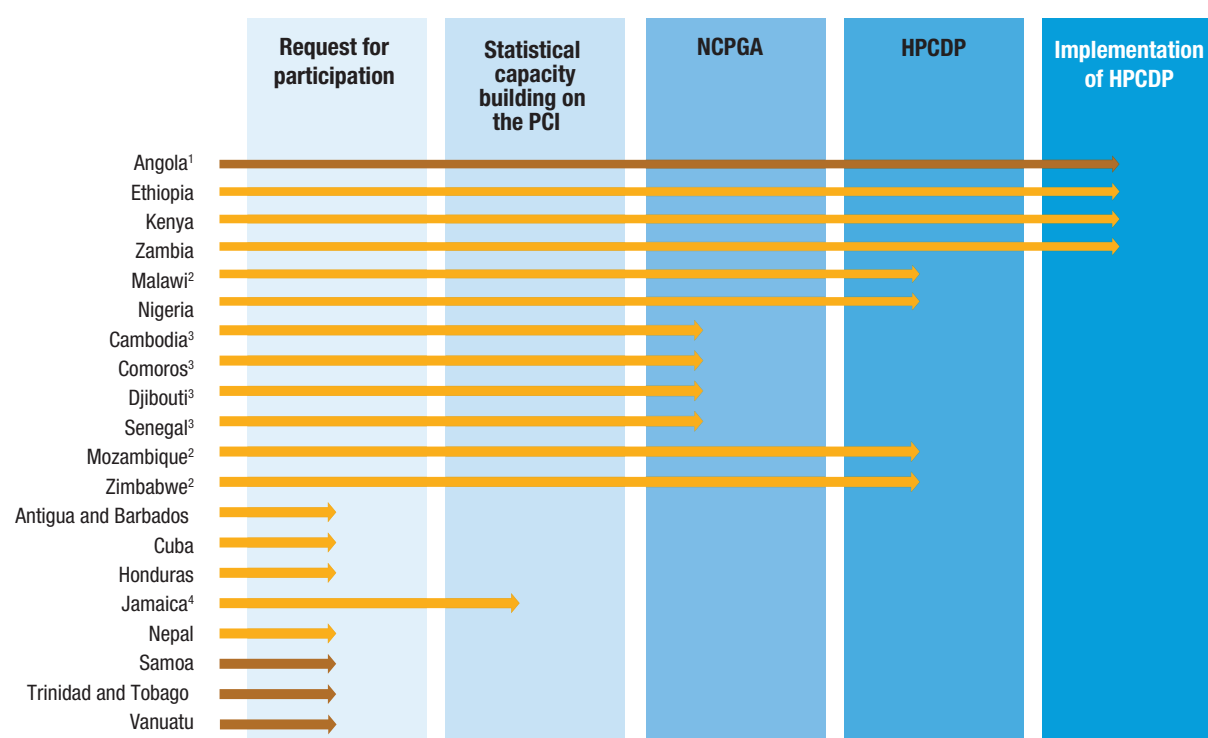
and conditions of the programme. Finally, evaluations of the program are planned and carried out by independent consultants. This ensures an objective analysis of the results of the programme and contributes to the improvement of the design and implementation of future programmes.

As of November 2024, 24 countries have been considered so far in the programme and are engaged at various stages, as illustrated in figure VII.5. Angola is the first country to have completed the full program. Launched in 2017, the program has achieved significant milestones by focusing on skill development within Angola's workforce and enhancing productive capacities across key industrial sectors. Efforts include training entrepreneurs in green sectors and providing targeted support to the national trade facilitation

committee, strengthening human capital for critical trade-related initiatives. The programme has trained over 3,300 Angolans, more than a third of whom are women. Additionally, UNCTAD's support in establishing public-private partnerships (PPPs) in transport and logistics infrastructure enabled the launch of tenders for major components of the Lobito corridor, representing a \$3.2 billion investment by the government. This corridor will facilitate market access for farmers from remote provinces, allowing them to distribute their green products more effectively. Macroeconomic indicators reveal a positive trend in economic diversification. Since 2016, Angola's non-oil exports have grown by over 5.7 percent, underscoring the program's impact on reducing economic dependence on oil.⁷⁶

24 countries have been considered so far in the programme and are engaged at various stages

Figure VII.5
Countries receiving assistance on productive capacities



Note: 1: Angola has successfully completed the initial phase of the program and has now extended it into a second phase. 2: NCPGA and HPCDP are still being finalized as of November 2024. 3: The NCPGAs for Cambodia, Comoros, Djibouti, and Senegal, considered for graduation, were prepared as part of UNCTAD's vulnerability profiles for the 2024 triennial review by the Committee for Development Policy (CDP). 4: Statistical capacity building is still ongoing as of November 2024.

⁷⁶ For details on achievements and impact of the programmes, please refer to the independent coverage by UN Africa Renewal (2024).

4. Train policymakers, national technical experts, private sector entities, academia, and civil society stakeholders in addressing gaps in productive capacities and facilitating structural transformation and economic diversification.

Follow-up trainings are proposed by UNCTAD teams in order to continue supporting countries in their efforts to develop their productive capacities. New challenges may arise due to changes in economic environment (either domestic or international) which may call for adaptation of current policies and the need for new assessment tools.

4. Conclusion

The PCI and its methodology were showcased to a wide audience of Chief Statisticians during the side event «Measuring Productive Capacities with the PCI: Background, Achievements, and the Way Forward» at the 55th session of the UN Statistical Commission in 2023.⁷⁷ Many Chief Statisticians expressed interest in collaborating further with UNCTAD on the PCI, particularly to enhance source statistics to underpin PCI for more comprehensive information for policy and analytical purposes or to develop nationally adjusted PCIs and to participate in UNCTAD's statistical capacity-building initiatives. One year later, at its 56th session, the United Nations Statistical Commission (UNSC) was informed by UNCTAD about these guidelines, and the Bureau of the UNSC was invited to consider how to further address this topic in the Commission's discussions.

The PCI was developed in a consultative process with national and international statisticians and economists at the

request of ECOSOC (2017), and following member states' calls at the UNCTAD XIV Conference. The process included significant collaboration with NSOs, especially from Botswana, the Lao People's Democratic Republic, Namibia, and Rwanda. The PCI underwent extensive peer reviews from statisticians and academics, including the University of Sydney, Hong Kong Polytechnic University, Australian National University, the University of Doha, and research institutes from Kenya, Botswana, and Namibia, the Centre for the Study of the Economies of Africa (CSEA) and various UN entities, like UNDP, UNDESA Committee for Development Policy and UN Regional Commissions.

However, with the growing interest from countries and international organizations, there is an urgent need to address productive capacity measurement gaps and needs on a larger scale and ensure harmonized approaches. The UN Statistical Commission as the highest United Nations body coordinating international statistical activities and promoting the development of national statistics and the improvement of their comparability, plays a key role in facilitating the harmonization of international, regional, and national initiatives, aligning them with existing statistical frameworks, such as the SDGs, the SNA and many others.

These guidelines encapsulate the knowledge on productive capacities by UNCTAD and its partners, serving as a foundational reference for member States, as well as upcoming sessions of the UN Statistical Commission, to advance the measurement of productive capacities with internationally comparable approaches that can be adjusted to national and regional needs.

⁷⁷ See <https://unctad.org/meeting/unsc55-side-event-productive-capacities-index-pci>



UNCTAD is experiencing a surge in direct requests from countries for statistical capacity building on productive capacities. To address this, there is a need to pool resources and create synergies with other international and national agencies working on the multidimensional areas related to productive capacities to provide effective assistance. Many challenges actually relate to data availability, reporting, and quality across different themes in official statistics, which require mainstreaming.

Lastly, these guidelines are intended to enhance the involvement of NSOs and other institutions in charge of official statistics in measuring productive capacities and disseminating data to support evidence-based policymaking, responding to a request from Chief Statisticians made during the side event at the 55th UN Statistical Commission, where the importance of NSO engagement in these areas was highlighted. By following these guidelines, it is hoped that NSOs will play a stronger role in both the assessment and communication of productive capacities, ultimately contributing to more informed and effective policy decisions.



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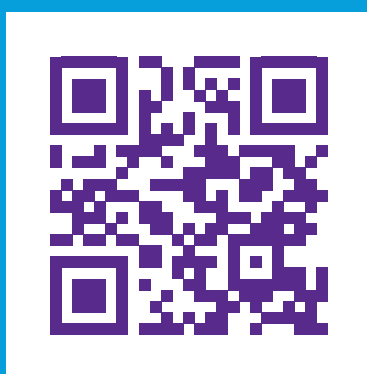


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Printed at United Nations, Geneva
2518613 (E) – November 2025 – 160

UNCTAD/ALDC/2025/4

United Nations publication
Sales No. E.25.II.D.49

ISBN 978-92-1-159793-6

