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UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

# EQuIP

## Enhancing the Quality of Industrial Policies

# TOOL 9

## Industrial Capabilities Indicators

# EQuIP Tool 9:

# Industrial Capabilities Indicators

# Summary Sheet

| Enhancing the Quality of Industrial Policies (EQuIP) – Tool 9 | |
|---|---|
| **Name of the tool:** | Industrial capabilities indicators |
| **Objective:** | The aim of this tool is to capture a country's different types of industrial capabilities and to facilitate a better understanding of the role they play in industrial production, technological and structural change. It builds indicators for the factors that either determine or enable processes of industrial capabilities development and accumulation and links them to different types of industrial outputs, thereby explaining and measuring the role of industrial capabilities as main drivers and enablers of countries' industrial competitiveness and development. |
| **Key questions addressed:** | Where does a country stand with regard to the production capacity as well as the production and organisational capabilities owned by its firms? What can be said of its firms' technological capabilities and innovation capabilities?<br><br>What are the country's industrial capabilities related to physical and institutional infrastructures?<br><br>How do the country's industrial capabilities compare to peer or benchmark countries?<br><br>How have these different types of capabilities changed over a certain period of time in the past? Has the country's industrial sector seen fast or slow processes of industrial capabilities development and accumulation? How can the country's industrial capabilities be improved? |

| | |
|---|---|
| **Indicators used:** | Share of Manufacturing in Total Gross Fixed Capital Formation (GFCF)<br>Share of GFCF in GDP<br>Manufacturing Value Added (MVA) per Manufacturing Establishment<br>Electric Power Consumption (kWh per capita)<br>Share of Secondary and Tertiary Educated in Total Population<br>Share of Science and Engineering Students in Total Tertiary Graduates<br>Manufacturing Wages per Worker<br>Labour Force Participation Rate (LFPR)<br>Vocational Students in Secondary Education as a Share of Population<br>Share of Secondary and Tertiary School Enrollment in Population<br>Employment per Manufacturing Establishment<br>ISO 9001 Certificates per 1,000 People<br>Gross Expenditure on Research & Development (GERD) per capita<br>Share of R&D personnel per 1,000 Full-Time Employees<br>Business-Financed GERD in Total GERD<br>Government-Financed GERD in Total GERD<br>GERD on Applied Research in Total GERD<br>GERD on Experimental Development in Total GERD<br>Capital Goods Imports<br>FDI Inflows as a Share of GDP<br>Intellectual Property Rights Payments<br>Stock of Patents in Force<br>Scientific and Technical Journal Articles<br>Patents Granted to (Non-)Residents per Patent Application by (Non-)Residents<br>Growth Rate of Patent Applications by Residents<br>GERD in Basic Research<br>Share of Patent Applications by Non-Residents<br>Goods Transported by Roads<br>Goods Transported by Railway<br>Freight Transported by Air Transport<br>Telephone Lines per 100 people<br>Mobile Cellular Subscriptions per 100 people<br>Personal Computers per 100 people<br>Internet Users per 100 people<br>Domestic Credit to Private Sector by Banks as a Share of GDP Turnover Ratio<br>Cost of Business Start-up Procedures as a Percentage of GNI per capita |

# Contents

# 1. Introduction[1]

The debate around industrial policies is increasingly shifting from 'why' industrial policies to 'what', 'when' and 'how' these can be more effectively designed and implemented. Despite this shift, policymakers still lack an appropriate set of diagnostic tools to benchmark and monitor changes in the industrial capabilities of their economic systems. This tool addresses this gap by building on (and expanding) the *UNIDO Industrial Capabilities Scoreboard* introduced in the UNIDO Industrial Development Report 2002/3. The new set of indicators developed in this tool is presented within a structured analytical framework whereby each indicator can be linked to different types of industrial capabilities. Moreover, the different roles that various types of industrial capabilities (proxied by different sets of indicators) play in manufacturing production and learning processes in manufacturing firms are revealed.



The following definition of industrial capabilities will be used in the development of the tool:

***Countries' industrial capabilities are various types of firms' competencies (associated with production and its organisation, technological change and innovations) as well as firms' production capacity (determined by investments in machines, equipment and other capital goods). Countries' industrial capabilities also relate to the physical and institutional infrastructure supporting the overall productive economy. This is why countries' industrial capabilities are the main 'drivers' and 'enablers' of countries' industrial competitiveness.***

The concept of countries' industrial capabilities may be adopted at the macro-level, which is, by focusing on macro-aggregates such as total investments in fixed capital, total stock of skilled workers or total R&D efforts. This tool mainly focuses on industrial capabilities indicators at the country level for which international data are broadly available from the 1990s. Thus, this tool allows for benchmarking exercises *across countries* and for assessing individual countries' industrial capabilities development and accumulation *over time*.

At the macro level, a country's industrial capabilities include various types of competencies and capacities owned by productive firms as well as country's physical and institutional infrastructural endowment.

The concept of industrial capabilities can also be 'scaled-down' at the sectoral level or at the regional level, depending on the availability of data within countries (sectoral and regional data) and across countries (sectoral data). In this respect, the tool identifies those indicators that can be scaled down from the macro/country's level to the meso/sector's level. Finally, possible extensions that rely on the combination of input and output variables for the assessment of sector-specific industrial capabilities will be discussed.

## 1.1. Country-level industrial capabilities owned by productive firms

Firms' capabilities are personal and collective competencies, skills, productive knowledge and experiences needed for firms to perform different productive tasks as well as to adapt and undertake in-house improvements across different technological and organizational functions.

From a 'static efficiency' point of view, ***production and organisational capabilities*** are *competencies,*

1 This toolkit was prepared by Antonio Andreoni (SOAS Economics Department, University of London and IfM, University of Cambridge, leading author), Ming Leong Kuan (Centre of Development Studies, University of Cambridge) and Daniel Goya Leon (Faculty of Economics, University of Cambridge). The indicators were selected and constructed based on the analytical framework and industrial capabilities taxonomy developed in Andreoni (2011) 'Productive Capabilities Indicators for Industrial Policy Design', UNIDO Working paper 17/2011.

*skills, productive knowledge and experiences* whereby productive agents and organisations select, install and maintain capital goods; operate technical and organisational functions; perform and monitor the execution of a set of interdependent productive tasks given certain time and scale constraints.

In fact, performing a set of interdependent productive tasks does not only require capable agents and functioning organisations – that is, individual and collective agents endowed with productive knowledge and relevant skills; it does require the establishment of a certain ***production capacity*** as well, that is, of *a scale-appropriate assortment of equipment, machinery and other capital goods*.



From a 'dynamic efficiency' perspective, the *absorption, adaptation and improvement of given productive techniques*, as well as *innovations across different organisational and technological functions*, mainly depend on the availability of two specific subsets of industrial capabilities owned by firms and other technology/research focused actors. They are ***technological capabilities*** and ***innovation capabilities***. Capabilities needed to generate, absorb and manage technological and organizational change may differ substantially from those needed to operate existing production systems.

The types of industrial capabilities listed above are difficult to capture directly. Among others, there are two main reasons for this difficulty worth mentioning:

a. ***The availability (and quality) of each type of industrial capability is determined by a combination of different factors and their interactions.*** For example, the skills of the workforce depend on the overall level, quality and composition of countries' education offering but also on the workforce's health conditions and other interacting factors. Moreover, the workforce's production capabilities will be determined by a combination of factors that is different from the one underlying the technological or innovation capabilities of the workforce.

b. ***The availability (and quality) of each type of industrial capability continuously changes throughout their deployment in production by firms.*** Given a certain endowment of educated workforce and machines, the skills of the workforce and the production capacity of machines will develop and change in production. Workers continuously learn in production, that is, develop and accumulate relevant competencies, skills, experiences and productive knowledge. Machines' production performances also depend on the way in which workers use them and the different ways in which machines are integrated in the production process.

Thus, as a result of their complex, interacting and continuously evolving nature, industrial capabilities cannot be directly captured. The tool addresses these challenges by adopting the following strategy. Given that the actual capabilities are not measurable, the tool focuses on those determining factors – i.e. ***capability determinants*** – we can directly measure and links each of them to the different types of industrial capabilities listed above.

The reason why the tool maintains a distinction between a certain type of industrial capability (e.g. workforce production capabilities) and its measurable determining factors (e.g. secondary and tertiary education) is related to the fact that the actual capabilities are not measurable but also to the fact that policy makers may be tempted to equate the actual capabilities and their determinants, although they are fundamentally different issues. For example, increasing the production capabilities of the workforce is not simply a matter of investing more funding in secondary and tertiary education. In fact, it is a problem of investing in the combination of various determining factors associated with the workforce's production capabilities.

## 1.2. Country-level industrial capabilities related to physical and institutional infrastructures

The development and deployment of firms' production, organisational, technological and innovation capabilities depend on the existence of a number of ***infrastructure capabilities*** which enable firms' production processes by reducing learning and transactions costs in the economy. There are different types of countries' infrastructure capabilities. Among the many stock variables that can be used to capture them directly in each country, the tool relies only on data sources and indicators available for a broad set of countries and long time period (e.g. roads or information and communication technology (ICT) infrastructures).

Industrial capabilities indicators are extremely useful tools for the assessment and comparison of productive and technological structures of different countries, as well as for the analysis of industrial capabilities development and accumulation processes underlying technological change. By relying on time-series data they can be employed as diagnostics for identifying:

- the presence of industrial development precursors (that is, the 'starting point conditions' in terms of industrial capabilities shown by a given country at a certain stage of manufacturing development);
- the different trajectories of industrial capabilities development and accumulation;
- the different impact of various types of industrial capabilities on countries' industrial competitiveness performances and structural change dynamics.

The tool mainly focuses on a new set of country-level industrial capabilities indicators, the available data, variables, indicators and methodology that countries can adopt to perform a diagnosis of their industrial capabilities. Measuring the available stock of industrial capabilities and tracking its change over time are critical functions in the industrial policy design and M&E processes. A number of examples and analyses are provided in order to show the explanatory power as well as the limitations of the available indicators. These analyses are used to suggest further potential developments of the tool, especially in terms of including sectoral-level industrial capabilities indicators.

To recap the tool proposes the following industrial capabilities taxonomy:

**Table 1: Industrial capabilities taxonomy**

| Industrial capabilities taxonomy | |
|---|---|
| COUNTRY-LEVEL INDUSTRIAL CAPABILITIES OWNED BY FIRMS (AND OTHER TECH/RESEARCH FOCUSED ACTORS) | |
| Production capacity | Scale-appropriate assortment of equipment, machinery and other capital goods |
| Production capabilities | |
| - *Individual capabilities* | Skills, experiences and productive knowledge that workers/individuals require to choose, install and maintain capital goods, and to operate various technical functions |
| - *Organisational capabilities* | Skills, experiences and productive knowledge that organisations require to operate technical and organizational functions; perform and monitor the execution of a set of interdependent productive tasks given certain time and scale constraints |
| Technological capabilities | Capabilities needed to generate, absorb and manage technological and organisational change |
| Innovation capabilities | Capabilities needed to innovate across different organisational and technological functions |
| COUNTRY-LEVEL INDUSTRIAL CAPABILITIES RELATED TO PHYSICAL AND INSTITUTIONAL INFRASTRUCTURE | |
| Infrastructure capabilities | Different types of physical and institutional infrastructure reducing learning and transaction costs for the overall economy |

# 2. Analytical Framework and Methodology

The approach to and construction of industrial capabilities indicators result from the analytical distinction of different types of industrial capabilities and from understanding the role they play in industrial production, technological and structural change (Andreoni, 2011). The usual approach to production based on input-output models (e.g.) does not contribute to opening the black box of industrial capabilities development and, thus, to explaining and measuring their role as main drivers and enablers of countries' industrial competitiveness (Andreoni, 2014).

This tool proposes to move beyond such an input-output black-box approach by:

- building indicators for the factors determining processes of industrial capabilities development and accumulation;
- defining different types of industrial capabilities according to their different production, organisational, technological and innovation functions;
- linking and clustering the indicators to these various types of industrial capabilities;
- distinguishing factors determining processes of industrial capabilities development and accumulation from those factors which simply enable these processes by reducing learning and transaction costs in the economy
- linking –theoretically– the selected industrial capabilities dimensions (and related indicators) to different types of industrial outputs.

The strategy adopted here is summarised in the following Table 2.

**Table 2: Beyond the input-output black-box approach**

| **Beyond inputs:** | **Beyond the black-box:** | **Beyond outputs:** |
|---|---|---|
| **<u>Industrial drivers *as*</u>** | **<u>Production *as*</u>** | **<u>Industrial Output *as*</u>** |
| - **different types of industrial capabilities deployed in production** | - **a process for transforming material and immaterial inputs in outputs enabled by infrastructure capabilities** | - **different types of sectoral products for the internal and export markets** |
| - **different types of factors 'determining' the industrial capabilities endowment** | - **a learning process through which different types of industrial capabilities develop and accumulate** | - **different socio and environmental outcomes** |
| | | - **different technological innovations** |

For capability indicators to be meaningful, the assumptions made for their construction as well as their informative limits need to be known. Actually, the more synthetic indicators are grounded in a thorough analytical framework, the more informative and testable they are. Building indicators without an analytical framework has various shortcomings. For example, variables tend to be selected more on the basis of data availability rather than their informative content. Secondly, overly composite indicators are generated under the assumption that more ingredients will provide the cake with a better taste. Thirdly, indicators tend to be adopted by practitioners and policymakers in an uncritical way – i.e. list diseases without realizing that these measures are mainly proxies of extremely complex and multi-layered processes (Lall, 2001; UNIDO, 2002; Andreoni, 2011; UNIDO 2013).

Although it is practically impossible to quantify all the complex and multi-layered learning processes through which the industrial capabilities of a given country (and productive firms as its components) develop and accumulate over time, a second best strategy would be to identify, distinguish and group the most important factors that *enter, interact with* and *exit from* firms' production and learning processes (provided data availability).

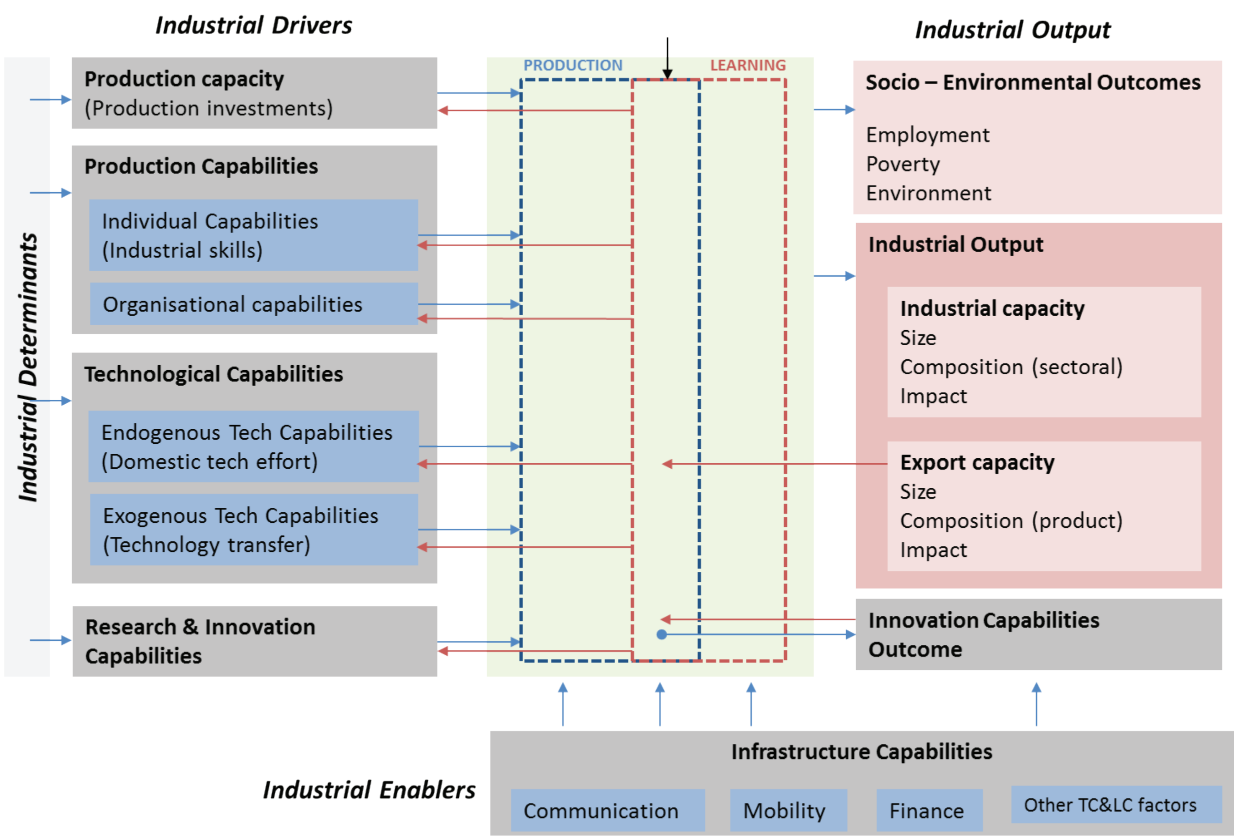
Building on the definition and industrial capabilities taxonomy developed above, the new set of industrial capabilities indicators proposed here focuses on two dimensions:

- **INDUSTRIAL DRIVERS**: different types of industrial capabilities *driving* industrial competitiveness (and respective factors determining their endowment in the country);

- **INDUSTRIAL ENABLERS**: different types of industrial capabilities *enabling* industrial competitiveness;

The following Table 3 stylises the way in which these two dimensions and the various types of industrial capabilities (as identified in the industrial capabilities taxonomy, see Table 2) are related.

**Table 3: The Industrial Capabilities Analytical Framework**




Let us look at these two dimensions and the underlying industrial capabilities dynamics in more depth.

- **Industrial drivers: Country's industrial capabilities owned by firms and their determining factors**

A set of 'determining factors', such as technical education and R&D spending, works as knowledge ingredients in firms' production and learning processes. These knowledge ingredients are mainly human capital and investments in the acquisition of codified knowledge (e.g. design and engineering specifications for machineries). These knowledge ingredients have to be processed, transformed and adapted by the actors that undertake production in firms. This is the process whereby production, organisational and technological capabilities develop in firms. In doing that, these actors are complemented by a broad assortment of machines, equipment, firm infrastructures, all elements that define the production capacity of a given firm. Thus, the set of factors entering learning processes in production must be proxied by a series of variables capturing these determining factors, both the overall investment in knowledge ingredients and production capacity at the country level.

According to the amount and quality of capabilities determinants available in a certain country, and given the ability of its entrepreneurs to identify and capture productive opportunities, productive firms will undertake production processes in a certain combination of sectors and industries. They will also experience cumulative processes of learning and productive capabilities building triggered by 'internal compulsions' in production (Andreoni, 2014). As a result of the dynamics discussed above, a certain amount of industrial capabilities develop and accumulate, while others are simply transformed or even lost. In turn, the new developed and accumulated industrial capabilities are continuously re-inserted into production and affect the same learning processes from which they have been originated – i.e. there are feedback mechanisms. Some industrial capabilities outcomes such as new products, new machineries and blueprints can be directly measured. The reason is that these kinds of industrial capabilities outcomes tend to be codified and, when possible, patented. Thus, there are a set of directly measurable industrial capability outcomes re-entering the learning in production process as new capability determinants that we can directly measure. We will call these innovation capabilities outcomes.

- **Industrial enablers: Countries' infrastructure capabilities**

The firm-level process of industrial capabilities development and accumulation, its speed, effectiveness and multi-directionality, are affected by the presence (or absence) of a series of 'mediating/facilitating factors' which are country-specific. These mediating factors, mainly infrastructures such as roads, railways, port, network systems, public research infrastructures and ICTs, rather than directly entering in the firm-level process of capabilities development and accumulation work as mediating/facilitating factors. In other words, by reducing *transaction costs* (e.g. transportation costs of machinery or technicians exchange as well as output export) and *learning costs* (e.g. increasing absorption capacities with ICTs, faster diffusion of productive best practices) these factors enable firm-level processes of capabilities building and accumulation.

# 3. Industrial Capabilities Indicators (ICI)

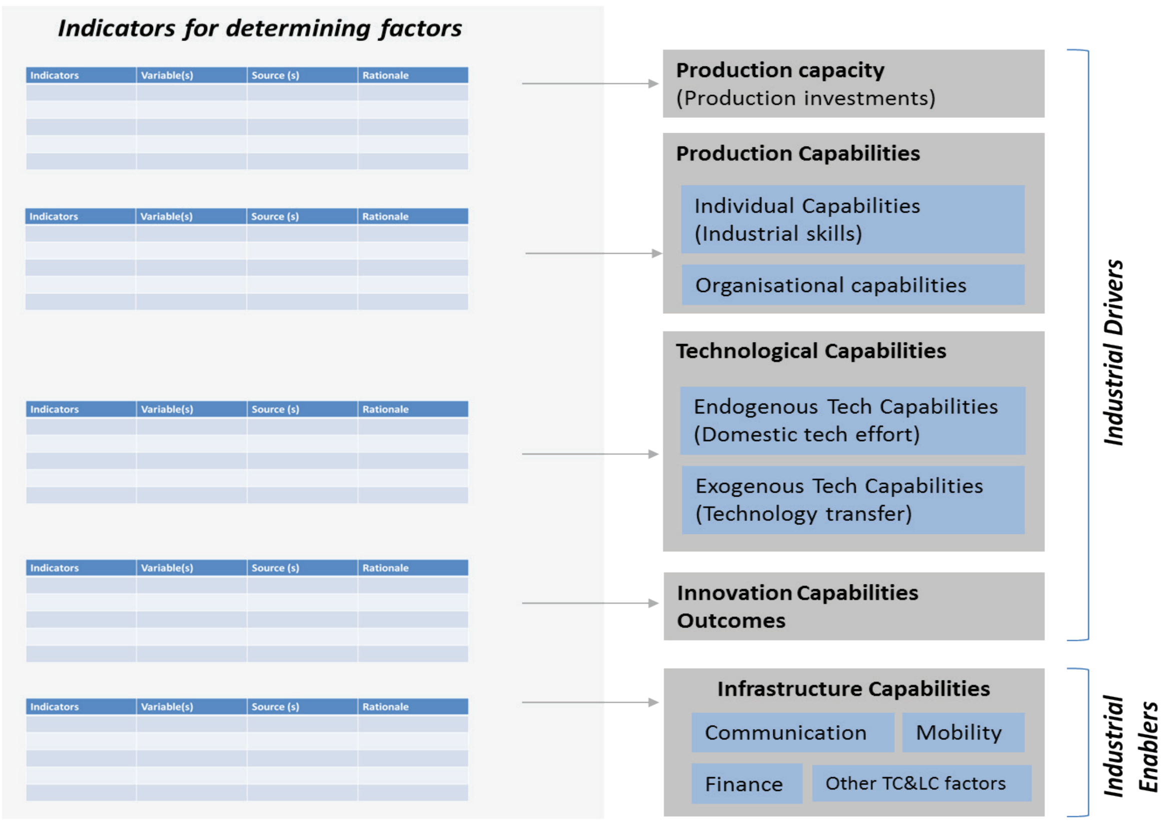
The new methodology suggested for this tool focuses on the abovetwo sets of industrial capabilities indicators:

- INDUSTRIAL CAPABILITY DRIVERS
- INDUSTRIAL CAPABILITY ENABLERS



Table 4 provides a schematic representation of the strategy adopted in the construction of industrial capabilities indicators.

**Table 4: Methodology for the development of industrial capabilities indicators**




The main reason for distinguishing these groups of factors resides in the fact that they play different roles in industrial capabilities development and accumulation. Another rationale is that ***these factors are linked by a relationship of complementarity more than one of substitutability***. For example, by developing indicators for investments in production capacity on the one side and indicators for knowledge ingredients (mainly investments in human capital) on the other side, it is also possible to analyse the relationships of complementarity existing among different sub-groups of factors. Clearly, at the country level, investments in production capacity and investments aimed at increasing the amount of knowledge ingredients available to firms (typically, human capital) call for different forms of policy intervention.

The selected variables and data sources which would enter in the construction of each set of indicators are discussed and synthesized in the following sub-sections.

## 3.1. Production capacity

As discussed in section 2, industrial capabilities include firms' production capacity. This is determined by investments in machines, equipment and other capital goods. The following four indicators can be used to measure investments in new production capacity as well as to account for the productive capacity of firms in the economy. Two of these indicators focus exclusively on the manufacturing sector because of its importance as an economic engine of growth (see Rowthorn & Wells, 1987; Andreoni and Gregory, 2013).

**Table 5: Production Capacity Indicators**

| Indicators | Variables | Source |
|---|---|---|
| Share of Manufacturing in Total Gross Fixed Capital Formation (GFCF) | Manufacturing GFCF | UNIDO |
| | Total GFCF | World Bank |
| Share of Private GFCF in Gross Domestic Product (GDP) | Private GFCF | World Bank |
| | GDP | |
| Manufacturing Value Added (MVA) per Manufacturing Establishment | MVA | UNIDO |
| | Manufacturing Establishments | UNIDO |
| Electric Power Consumption (kWh per capita) | Electric Power Consumption | World Bank |
| | Population | |

- The share of manufacturing in total Gross Fixed Capital Formation (GFCF) provides an indicator that tracks investments targeted to raise manufacturing production capacity (e.g. plant, machinery, equipment, etc.). While the total GFCF can be used as a separate indicator of the overall accumulation of production capacity across sectors and overall investments in land, infrastructure and durable goods, the share of manufacturing in total GFCF captures those specific investments in capital goods through which intermediate and final products are continuously produced for the overall economy.

- The share of private GFCF in Gross Domestic Product (GDP) highlights the role of the private sector in raising production capacity. While at initial stages of manufacturing development the public sector tends to account for a relatively larger share of GFCF, the indicator captures the increasingly larger contribution of private sector investments and the sustainability of industrialisation.

- MVA per manufacturing establishment illustrates the size of manufacturing firms in the economy. Larger firms tend to benefit from scale economies that favour the development of the manufacturing sector, reduce costs of intermediate goods for other sectors and create opportunities for small and medium size companies.

- Electric power consumption serves as a proxy of the availability of energy required to power industries (which are major consumers of energy). A high level of electric power consumption reflects the ability of countries to access domestic and foreign sources of energy for its use. However, it can be also used to proxy the extents to which firms in the country are substituting industrial machines for labour, the latter being sourced by electricity.

## 3.2. Production capabilities

Production capabilities are skills, experiences and productive knowledge that agents and organisations require to choose, install and maintain capital goods; operate technical and organisational functions; perform and monitor the execution of a set of interdependent productive tasks. Production capabilities are affected by the size and quality of the workforce, as well as the organisational capabilities of firms. Indicators related to the size and quality of the workforce can be also split into two groups (present and future) depending on (i) whether they reflect existing production capabilities or (ii) whether they influence future production capabilities.

**Table 6: Individual Capabilities Indicators (Present)**

| Indicators | Variables | Source |
|---|---|---|
| Manufacturing Employment | Manufacturing Employment | UNIDO |
| Share of Secondary and Tertiary Educated (Maximum Educational Attainment) in Total Population | Secondary and Tertiary Educated (Maximum Educational Attainment) | Barro & Lee |
| | Total Population[2] | |
| Share of Science and Engineering Students[3] in Total Tertiary Graduates | Science and Engineering Students | UNESCO |
| | Total Tertiary Graduates | |
| Manufacturing Wages per Worker | Total Manufacturing Wages | UNIDO |
| | Manufacturing Employment | UNIDO |
| Life Expectancy at Birth | Life Expectancy at Birth | World Bank |

- Manufacturing employment captures the size of the workforce engaged in the manufacturing sector.
- Reflecting the educational attainment of the population, the share of secondary or tertiary educated in the population measures the quality of the current stock of human resources.
- Among tertiary education graduates entering the workforce, the composition matters for a country's production capabilities. Science and engineering students generally have a higher propensity to join the manufacturing workforce and are equipped with more specific production and technology related knowledge.
- Average manufacturing wages reflect the quality (i.e. productivity) of the manufacturing workforce. Increases in manufacturing wages are associated with higher level skills in productive firms, changes in production equipment and machines (more skilled people are required to control complex operations) and the overall structural change of the economy.
- Life expectancy at birth can be considered both a quantity and a quality indicator. Higher life expectancy is associated with a population that can work for a longer duration of time. As a quality measure, it proxies for the general health and wellbeing of the labour force, which tends to translate to higher productivity.

2 The population refers to individuals who are aged 15 and above.
3 Includes graduates from science programmes and engineering, manufacturing and construction programmes.

**Table 6b: Individual Capabilities Indicators (Future)**

| Indicators | Variables | Source |
|---|---|---|
| Labour Force Participation Rate (LFPR) | LFPR | World Bank |
| Vocational Students in Secondary Education as a Share of Population | Vocational Students in Secondary Education | World Bank |
| | Total Population | World Bank |
| Share of Secondary and Tertiary School Enrollment in Population (of Appropriate Age)[4] | Secondary and Tertiary School Enrolment | UNESCO |
| | Population (of Appropriate Age) | |

- The labour force participation rate (LFPR) indicates the potential to increase the workforce size. A lower LFPR today suggests that there is more scope to encourage the population to join the labour force (and workforce) in the future.
- The number of vocational students in secondary education, normalised by the population size, proxies for the emphasis on vocational and technical education in a country. A larger number suggests that the future workforce will have more skills that are geared towards the manufacturing sector.
- In a similar vein as Harbison and Myers (1964), the third indicator emphasises the importance of secondary and tertiary school enrolment in raising the skills and education profile of the future workforce.

**Table 7: Organisational Capabilities Indicators**

| Indicators | Variables | Source |
|---|---|---|
| Employment per Manufacturing Establishment | Manufacturing Employment | UNIDO |
| | Manufacturing Establishments | UNIDO |
| ISO 9001 Certificates per 1,000 People | ISO 9001 certificates | ISO |
| | Population | |

- Employment per manufacturing establishment reflects the size of a firm. Larger firms tend to develop more and higher-level organisational capabilities as they need to organise (and synchronise the work of) a larger base of employees, and manage more complex production systems and operations.
- The ISO 9001 is a certification of the firm's 'quality management system'. Only firm with good organisational capabilities are able to obtain it. The certification acts as a signalling device that can help firms access international customers with high quality requirements. One limitation of this indicator is that it does not say anything about the firms which do not get certified: for example, there can be many ISO 9001 firms per thousand people, but at the same time, a much larger number of small, inefficient, informal firms. It is an indicator of whether the countries' best firms achieve international-level standards in organisational capabilities or not.

4 This indicator is calculated by the average of the country's share of secondary and tertiary school enrolment in the age-appropriate population groups.

## 3.3. Technological capabilities

Countries and their firms can endeavour to raise their technological capabilities through two channels: (i) domestic technological effort and (ii) technological transfers from other countries.

**Table 8: Domestic Technological Effort Indicators**

| Indicators | Variables | Source |
|---|---|---|
| Gross Expenditure on Research and Development (GERD) per capita[5] | GERD | UNESCO |
| | Total Population | |
| Share of R&D personnel per Thousand of Total Full-Time Employment | R&D Personnel | UNESCO |
| | Total Employment | |
| Business-Financed GERD in Total GERD | Business-Financed GERD | UNESCO |
| | Total GERD | |
| Government-Financed GERD in Total GERD | Business-Financed GERD | UNESCO |
| | Total GERD | |
| GERD on Applied Research in Total GERD | GERD on Applied Research | UNESCO |
| | Total GERD | |
| GERD on Experimental Development in Total GERD | GERD on Experimental Development | UNESCO |
| | Total GERD | |

Within the group of domestic technological effort indicators, two indicators measure the extent to which a country is enhancing its internal technological capabilities:

First, gross expenditure on research and development (GERD) per capita measures the level of investments in R&D in the country.

- Second, the share of R&D personnel in total employment indicates the proportion of workers who are devoted to raising the country's domestic technological capabilities.

The other indicators deal with the composition of GERD in the economy[6].

- To determine the sustainability of R&D activity in a country, the funding source of GERD matters. In this regard, business-financed GERD and government-financed GERD are included as indicators. In the early stages of a country's development, GERD tends to be publicly financed as the government invests in the technological capabilities of the country. Over time, there should be a larger participation of the private sector in the country's domestic technological effort. Tracking both indicators also allows a comparison of the relationship between business- and government-financed GERD.

- The different types of R&D activities in an economy have different impacts on technological capabilities. Applied research and experimental development deal more with the practical application of science and the systematic development of new products, processes and systems that are more directly linked to industrial capabilities (vis-à-vis basic research).

5 GERD is expressed in US dollars at constant prices (2005 base year) and adjusted for purchasing power parity.
6 These indicators are not available for as broad a number of countries as the rest of the indicators used in this tool.

**Table 9: Technological Transfer Indicators**

| Indicators | Variables | Source |
|---|---|---|
| Capital Goods Imports | Capital Goods Imports | OECD |
| | GDP per capita | World Bank |
| FDI Inflows as a Share of GDP | FDI Inflows | World Bank |
| | GDP | |
| Intellectual Property Rights Payments | Intellectual Property Rights Payments | World Bank |
| | GDP per capita | World Bank |

- Imported capital goods have embodied technology. For comparability across countries with different levels of economic development, the indicator is divided by GDP per capita. When used as a proxy for technology transfer, there are two important caveats. First, it is impossible to know whether the imported capital goods have frontier technology embodied in them, or relatively outdated technology. Second, not all firms attempt to exploit the learning possibilities associated to imported capital goods. They may simply install the machine as a black box in part of a production process, or at the other extreme, disassemble and reverse engineer it. Whether this is possible depends on how distant the technology embodied in the capital goods is from the firm's knowledge base.

- Foreign investment can be a way to obtain more advanced technologies used in the investor countries. It has several limitations however. First, some FDI flows are simply M&As and do not necessarily bring any new technology or even production capacity. When there is effectively investment in new capacity, it might bring any new technologies which might trigger any endogenous learning process. Finally, those foreign investment flows that do bring in new technologies may or may not diffuse the associated knowledge across the recipient countries' knowledge networks. This depends on the kind of interaction that these firms have with domestic firms, as well as whether governments impose technology-transfer related conditions to foreign investment inflows. Historical experiences show that while some countries have effectively used FDI as a key part of their technological upgrading strategies, it has played a marginal role for other countries.

- If firms are paying to use advanced, foreign-developed technologies in their processes, they likely need to make technology adaption efforts that will improve their own technological capabilities. Charges for the use of intellectual property payments are adjusted by GDP per capita to allow for comparisons across countries with different degrees of economic development. But just as with the import of capital goods, this use of foreign-developed technology may or may not be associated with a domestic technology absorption effort. In some cases close collaboration between the user and the developer of the technology is needed, but this is not always the case.

## 3.4. Innovation capabilities

A country's innovation capabilities can be proxied by indicators that track the successful creation of new knowledge (classified here as 'realised' indicators). At the same time, indicators can also shed light on the 'potential' that a country's innovation capabilities can be further enhanced.

**Table 10a: Innovation Capabilities Indicators (Realised)**

| Indicators | Variables | Source |
|---|---|---|
| Stock of Patents in Force | Stock of Patents in Force | WIPO |
| Scientific and Technical Journal Articles | Scientific and Technical Journal Articles | WIPO |
| Patents Granted to Residents per Patent Application by Residents | Patents Granted to Residents | WIPO |
| | Patents Applied by Residents | WIPO |
| Patents Granted to Non-Residents per Patent Application by Non-Residents | Patents Granted to Non-Residents | WIPO |
| | Patents Applied by Non-Residents | WIPO |

- The stock of patents in force is the most commonly used indicator to proxy the amount of 'codifiable knowledge' countries own and adopt to develop products' components, but also to adopt patented production technologies and operate complex production processes. Patents have been widely used to capture innovation capabilities, however they have to be used bearing in mind that they are 'sector biased'. This means that in certain sectors (e.g. electronics) there is more scope for patentable innovations given the architectures of products, their modularity and related production technologies. As a result, according to countries' sectoral composition at different stages of manufacturing development, there is higher or lower scope for increasing patents, independently from the innovation capabilities of firms.

- The scientific and technical journal articles represent the realised innovation capabilities of a certain country. In particular, it captures the development of its research infrastructure, its quality, productivity and capacity of producing scientific knowledge recognised by the international scientific and technical community.

- The number of patents granted to residents reflects the increasing innovation capabilities of domestic firms and research/innovation focused actors. By considering the ratio between the number of patents granted to residents and the number of patent applications by residents, the indicator captures the increasing capacity and professionalisation of companies in translating innovative solutions into codified pieces of knowledge that can be then redeployed by other firms. It must be kept in mind that this is not the share of applications that were granted, as the approval process usually begins in one year and finishes in other. This variable is a proxy for the success rate of patent applications.

- The number of patent applications by non-residents reflects the increasing interest by foreign companies and other actors in penetrating the domestic market. Non-residents applications, and in particular those successful, are sometimes the results of processes of reverse engineering as well as re-engineering of products for specific markets[7]. The same product architecture can be used for developing a 'new product' with reduced or simplified functionalities at lower costs. Patenting these new products and underlying technology solutions reflect the increasing innovation activities in the countries and the fact that they have been targeted by foreign actors for market development.

7 Firms also tend to register their original inventions in the patent offices of different countries, also developing countries.

**Table 10b: Innovation Capabilities Indicators (Potential)**

| Indicators | Variables | Source |
|---|---|---|
| Growth Rate of Patent Applications by Residents | Patents Applied by Residents | WIPO |
| GERD in Basic Research[8] | GERD in Basic Research | UNESCO |
| Share of Patent Applications by Non-Residents | Patents Applied by Non-Residents | WIPO |
| | Total Patents Applied | WIPO |

While countries' innovation capabilities at each point in time can be captured by stock variables (see above), in order to understand the potential innovation capabilities outcome we can expect given certain innovation activities, we consider the three following indicators:

- The growth rate of patent application by residents signals the increasing interest by domestic firms and other actors to patent their innovative products and solutions. It also reflects the fact that companies are moving from a 'follower' attitude towards a more 'upgrading/innovative' approach to technological change.
- GERD in basic research is the most traditional indicator to capture and track countries' investments in basic scientific research. Although basic research does not translate immediately into new products, materials or technologies, they constitute the most fundamental basis of countries' innovation capabilities.
- The share of patent applications by non-residents indicates the extent to which countries are relying on internal or external innovation capabilities and the potential future prospects of innovation activities.

## 3.5. Infrastructure capabilities

As discussed above, a country's physical and institutional infrastructures support the development of a manufacturing sector and industrial capabilities by reducing transaction costs and learning costs. Infrastructure can be classified into (i) physical infrastructure, (ii) ICTs and (iii) financial institutions.

**Table 11: Infrastructure Capabilities Indicators (Physical)**

| Indicators | Variables | Source |
|---|---|---|
| Goods Transported by Roads | Goods Transported by Roads | World Bank |
| Goods Transported by Railway | Goods Transported by Railway | World Bank |
| Freight Transported by Air Transport | Freight Transported by Air Transport | World Bank |

- The volume of goods transported by roads, railways and air transport reflects the extensiveness and usage of transport networks in countries. Higher levels of these indicators are associated with more developed physical infrastructural networks.

8 GERD is expressed in US dollars at constant prices (2005 base year) and adjusted for purchasing power parity.

**Table 12: Infrastructure Capabilities Indicators (ICTs)**

| Indicators | Variables | Source |
|---|---|---|
| Telephone Lines per 100 people | Telephone Lines | World Bank |
| | Population | |
| Mobile Cellular Subscriptions per 100 people | Mobile Cellular Subscriptions | World Bank |
| | Population | |
| Personal Computers per 100 people | Personal Computers | ITU[9] |
| | Population | |
| Internet Users per 100 people | Internet Users | World Bank |
| | Population | |

Advancements in ICTs enhance the scope for countries to leverage on the benefits of globalisation. Good telecommunications infrastructure provides a conducive environment for countries to deepen industrial capabilities and support industrialisation (see Isaksson, 2009).

- 'Telephone lines per 100 people' is a traditional indicator used to reflect the level of telecommunications in a country. To account for the changing patterns of demand in certain countries, 'mobile cellular subscriptions per 100 people' is included as a complementary indicator.
- The indicator 'personal computers per 100 people' highlights the degree to which technology has penetrated the population. Similar to mobile phone penetration rates, the indicator 'internet users per 100 people' reflects a higher degree of telecommunications capital intensity in the country.

**Table 13: Infrastructure Capabilities Indicators (Financial Institutions)**

| Indicators | Variables | Source |
|---|---|---|
| Domestic Credit to Private Sector by Banks as a Share of GDP | Domestic Credit to Private Sector by Banks | World Bank |
| | GDP | |
| Turnover Ratio | Value of Shares Traded | World Bank |
| | Average Market Capitalization | |

- The private sector needs to be able to borrow money to expand production capacities and capabilities. A well-functioning banking sector, which provides financing to real economy activities, is fundamental for expanding manufacturing. Although most of these lending flows may not be directly associated to improvements in capabilities, this indicator still acts as a proxy for whether firms have access to the credit they need.
- A more developed financial sector help finance the emergence of new firms, their survival and growth, by providing not only credits, but other instruments such as factoring and leasing. The stock market is used here as a proxy for general financial deepening in the economy, which in turn determines the availability of useful financial instruments for firms. One shortcoming of this measure is that it may have strong cyclical fluctuations which are not necessarily correlated to changes in available financial instruments.

9 The indicator 'personal computers per 100 people' was previously in the World Bank's World Development Indicators (WDI), but the data was excluded from the online database when this paper was being prepared. An older data series from a previous WDI was used for the analysis in Section 4. More recent data can be purchased from the International Telecommunications Union (ITU).

To proxy the transaction and learning costs of the economy, the cost of business start-up procedures was included to measure the transaction costs faced by start-up companies.

**Table 14: Example of a Transaction Cost Indicator**

<table>
<tr><th>Indicators</th><th>Variables</th><th>Source</th></tr>
<tr><td rowspan="2">Cost of Business Start-up Procedures as a Percentage of GNI per capita</td><td>Cost of Business Start-up Procedures</td><td rowspan="2">World Bank</td></tr>
<tr><td>GNI per capita</td></tr>
</table>

# 4. Interpretation of Findings and Conclusions

The present tool proposes forty different indicators for the analysis of countries' industrial capabilities. In section 3 each indicator has been presented with reference to its constituting variables, its data sources and rationale. Indicators are proxies of complex 'driving' and 'enabling' factors, thus a number of limitations and caveats have been discussed. Indicators have also been clustered according to the specific type of industrial capability they capture, based on the structured analytical framework developed in section 2. Taken all together these indicators form an *Industrial Capabilities Scoreboard (ICS)*.

The Industrial Capabilities Scoreboard maintains a modular character. Although it would be possible to create a number of composite indexes capturing the different industrial capabilities types in a single measure, we have adopted a modular format which allows performing a broader set of analyses (according to the specific research questions) as well as avoiding a number of methodological problems. In particular, indicators remain 'transparent', that is, they are not conflated in overly-composite indexes and compensability problems related to aggregation are avoided. Moreover, for each industrial capability type identified in the framework (e.g. production capabilities), we can study the relationships among its various types of capability determinants (as for example different education levels reached by the workforce).

Given the broad variety of potential analyses that are possible to perform based on the ICS, this section is aimed at providing only some illustrative examples of the possible analyses for a selected number of countries. In this respect we can distinguish two broad classes of analyses:

**Assessment of a country's industrial capability development and accumulation trajectory**

For each country, we can analyse:

- The trajectory of each indicator followed over time;
- The trajectory of clusters of indicators related to the same industrial capability dimension followed over time (as single indicators or composite);
- The evolving relationship (and potential unbalances) among different indicators related to the same industrial capability dimension;
- The evolving relationship (and potential mismatches) among different indicators related to different industrial capability dimensions (as single indicators or composite);
- The relationship between an industrial capability indicator and output variables, such as the MVA per capita.

These analyses provide information on countries' industrial capabilities development but also point out the existence of potential mismatches between different capability drivers, thus different types of industrial capabilities, as well as between capability drivers and enablers. These indicators could also permit to evaluate if, for example, a country's industrial policies have been oriented mainly towards one group of industrial capabilities and allowed others to lag behind.

**Benchmarking countries industrial capability development and accumulation trajectories**

Across countries, we can compare:

- Countries' different industrial capability development and accumulation trajectories (of single indicators or composites) over time;
- Countries' industrial capability development and accumulation trajectory with

'regional benchmarks' over time;

- Countries' industrial capability endowments at the same stages of industrial development (proxied by MVA per capita);
- Countries' industrial capability development and accumulation trajectory along their industrialisation path (proxied by MVA per capita);



The set of possibilities listed above refers to both benchmarking countries and performing cross-countries comparisons at discrete moments in time and over time. In this latter case, time-series data are required in order to perform longitudinal analyses and cluster analyses[10].

The data analyses presented in the following subsections have been performed for a selection of industrialising countries from different regions and at different stages of industrial capabilities development. The countries were selected in view of covering leading catching up economies in each continent (BRICS) and different regions (horizontal axis). For each continent/region we also considered countries at three different stages of industrialisation (late industrialisers, 'middle income trap' countries, and fast industrialisers).

**Table 15: Industrial capabilities analysis: selected countries**

| Type / Region | Africa & Middle East | East Asia & South East Asia | Centre & Latin America |
|---|---|---|---|
| *Regional benchmarks* | South Africa | China | Brazil |
| | Turkey | India | Mexico |
| | | Russia | |
| *Middle - trap* | | Malaysia | Uruguay |
| | | Thailand | |
| | | Indonesia | |
| *Late industrialisers* | Tanzania | Vietnam | |
| | Kenya | Bangladesh | |

Overall countries' industrial capabilities assessments and comparisons have revealed a number of distinctive features of industrial capability development processes:

1. The development and accumulation of industrial capabilities take significant time. Time is required to transform an educated workforce in a skilled workforce, to deploy machines effectively, to absorb imported technologies and so on. Thus, the ICS tends to have a higher explanatory power in medium-long term analyses;
2. Higher levels of industrial capabilities seem to be associated with higher and faster industrialisation, although countries tend to show different combinations of industrial capabilities at each point in time and tend to follow different development and accumulation trajectories;
3. Certain countries might have 'learning-rich industrialisation paths' such as Korea (that is, increasing industrialisation output associated with increasing industrial capabilities

10 Cluster analysis is a statistical technique for identifying relatively homogenous groups of cases (e.g. countries) according to their quantitative features (e.g. a certain level of capability determinants)

development/accumulation) or 'learning-poor industrialisation paths' such as Mexico (vice versa). Countries where increasing industrialisation output is associated (or not) with the process of industrial capability development, will have a more (or less) sustainable development path (see for example UNIDO, 2013);

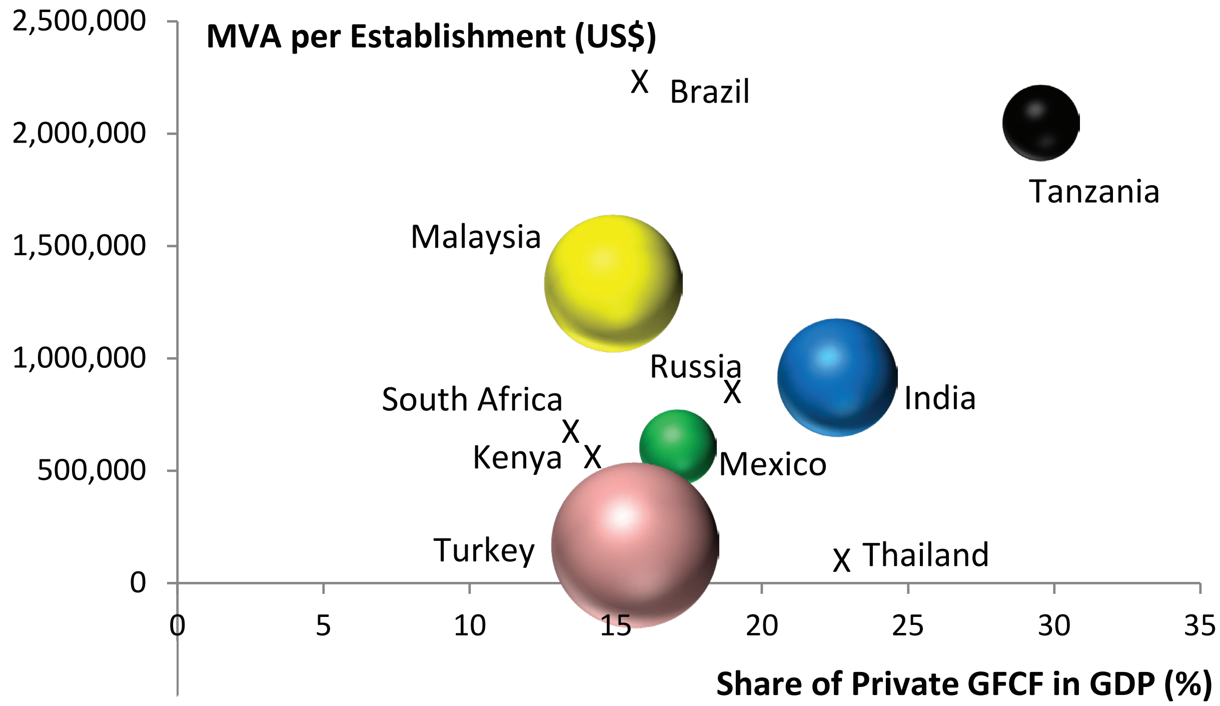
4. Countries characterised by a learning-poor trajectory do not simply have a lower level of investments in capability determinants. They also tend to experience more mismatches and unbalances, that is, the composition of their investments tend to be more skewed and remain static over time;

5. Countries may experience both accumulation and de-cumulation of different industrial capabilities.

## 4.1. Production capacity

Figure 1 presents a snapshot of the production capacity indicators for the latest-available year. Among the countries, Turkey stands out for devoting the largest share of domestic investments to the manufacturing sector, as shown by the bubble size. However, it fares poorly in the MVA per establishment indicator, suggesting that its small firms may not be adequately harnessing economies of scale. Brazil and Tanzania had larger firms which generated high levels of MVA for each establishment. Of the two countries, the private sector played a more significant role in Tanzania's domestic investments.

**Figure 1: Production Capacity Indicators, Latest-Available Year**



Notes:

(1) The size of bubbles is proportionate to the share of manufacturing GFCF in total GFCF. Ideally, the graph can display the share of manufacturing in total GFCF against the share of private GFCF in GDP, with the size of the bubbles proportionate to the MVA per establishment (firm size). This form was not used as many countries without recent data on the share of manufacturing GFCF in total GFCF would have dropped out.

(2) The full basket of countries could not be represented in the figure. Recent data was unavailable for China, Indonesia and Vietnam for the indicator 'Share of Private GFCF in GDP', while it was unavailable for Bangladesh and Uruguay for the indicator 'MVA per Manufacturing Establishment'.

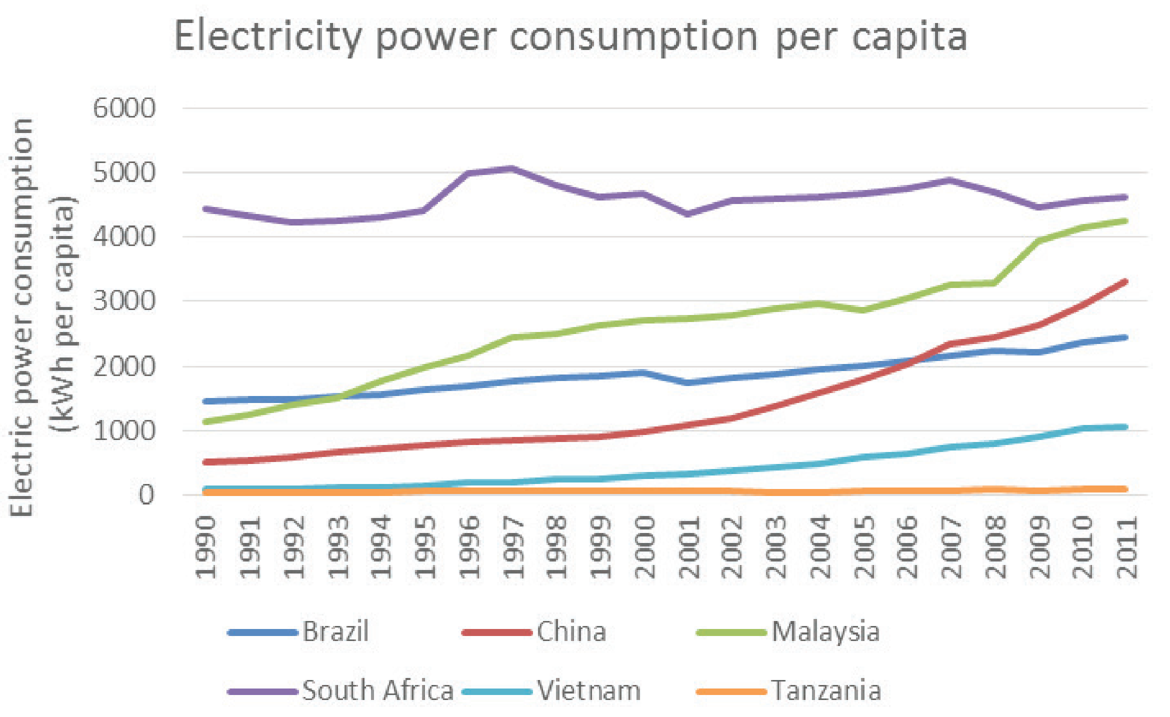
(3) The indicator 'Share of Private GFCF in GDP' was for 2012 or the latest-available year: 2009 (Kenya, South Africa), 2010 (Russia) and 2013 (Turkey, Tanzania).

(4) The indicator 'Share of Manufacturing GFCF in Total GFCF' was for 2010 or the latest-available year: 2009 for India and Turkey. Recent data was unavailable for Bangladesh, Brazil, China, Kenya, Russia, South Africa, Thailand and Vietnam. Their data points are marked with an "X" rather than bubbles.

(5) The indicator 'MVA per Manufacturing Establishment' was for 2010 or the latest-available year: 2006 (Thailand) and 2009 (India, Russia, Turkey).

The group of countries shows very different realities in terms of per capita electricity consumption (Figure 2). South Africa for instance, has high levels in all the periods, possibly associated to the need to supply energy to the mining industry. Tanzania on the other hand, uses marginal levels of electricity; energy might currently be a constraint for its industrialisation.

**Figure 2: Electric Power Consumption (kWh per capita), 1990-2011**

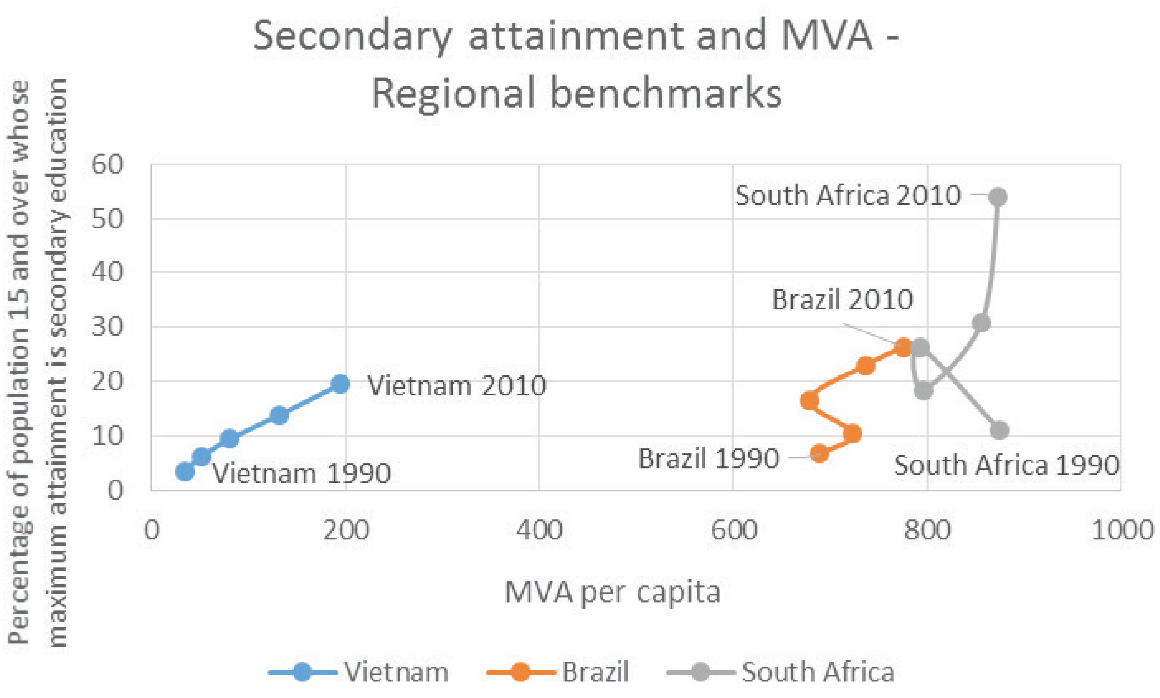


## 4.2. Production capabilities

Most of the time, a positive relationship between educational attainment and MVA exists (Figure 4). There are however cases like South Africa, where increases in education are not associated to improvements in value added, i.e. higher stages of manufacturing development. As shown in Figure 5A, the relationship between MVA and tertiary education is still positive, but not a carbon copy of what happens with secondary education. Different capabilities are needed at different levels of industrialisation, and skipping stages is usually not an option. There must be consistency between changes in educational levels and the employment requirements of particular output structures. As Kenya shows in Figure 5B, a huge increase in tertiary attainment does not mean a country will automatically leapfrog into innovation-driven industrial growth, as a series of other complementary resources and capabilities must be developed.

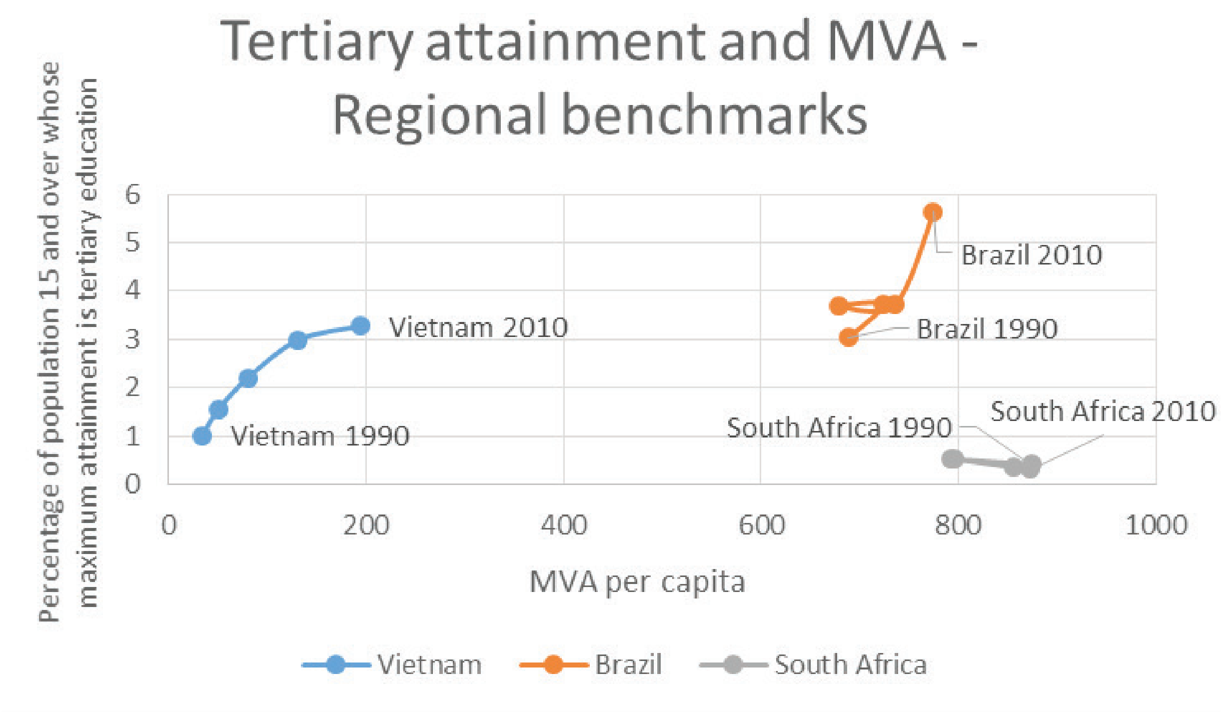
Comparing different countries, shows that when Brazil attained the same degree of industrialisation that South Africa had in 1995 (as proxied by MVA per capita), their shares of population who had attained at most secondary education were almost exactly the same. Vietnam, compared to the other two, has a low degree of industrialisation for its educational attainment. Looking at tertiary education, Brazil has always had in this period a much higher share of people who finished tertiary education than South Africa, even if they have roughly comparable degrees of industrialisation.

**Figure 4: Share of Population with Completed Secondary Education (Maximum Attainment) vs. MVA per capita, 1990-2010**



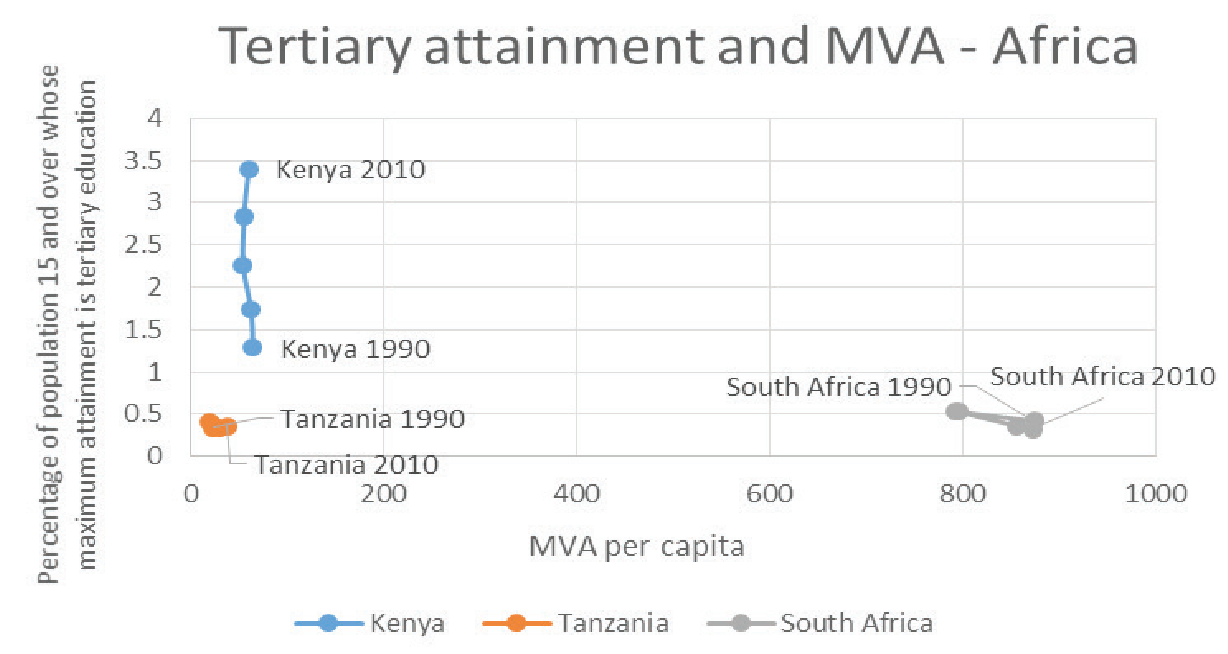

Note: The data points are for the years 1990, 1995, 2000, 2005 and 2010.

**Figure 5A: Share of Population with Completed Tertiary Education (Maximum Attainment) vs. MVA per capita (Regional Benchmarks), 1990-2010**




Note: The data points are for the years 1990, 1995, 2000, 2005 and 2010.

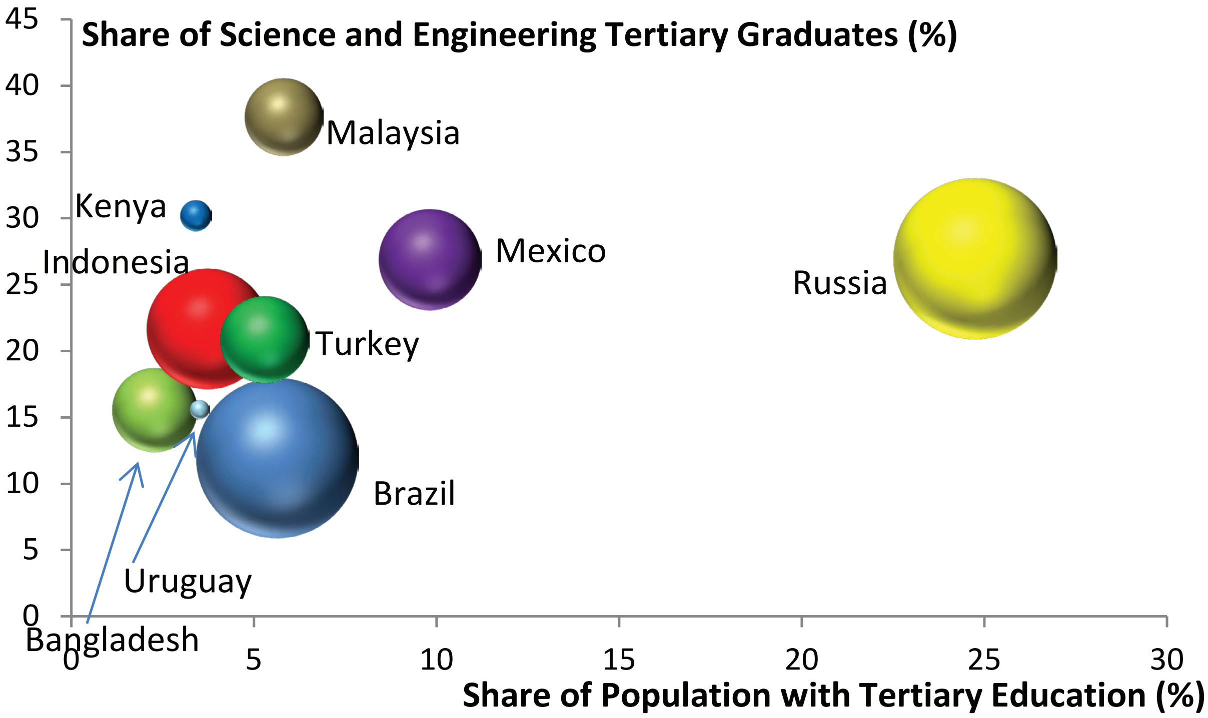
**Figure 5B: Share of Population with Completed Tertiary Education (Maximum Attainement) vs. MVA per capita (Africa), 1990-2010**




Note: The data points are for the years 1990, 1995, 2000, 2005 and 2010.

Russia's production capabilities benefited from having both a higher share of the population with tertiary education and a higher share of tertiary graduates taking science and engineering programmes (Figure 6). Among the countries selected, Malaysia (37.7%) and Kenya (30.2%) had the largest share of tertiary graduates pursuing science and engineering programmes. Nonetheless, the size of employment in Kenya's manufacturing sector was constrained by the small percentage of tertiary graduates in the population (3.4%).

**Figure 6: Share of Science and Engineering Tertiary Graduates vs. Share of Population with Tertiary Education, Latest-Available Year.**




Notes:

(1)The size of bubbles is proportionate to manufacturing employment in the countries;

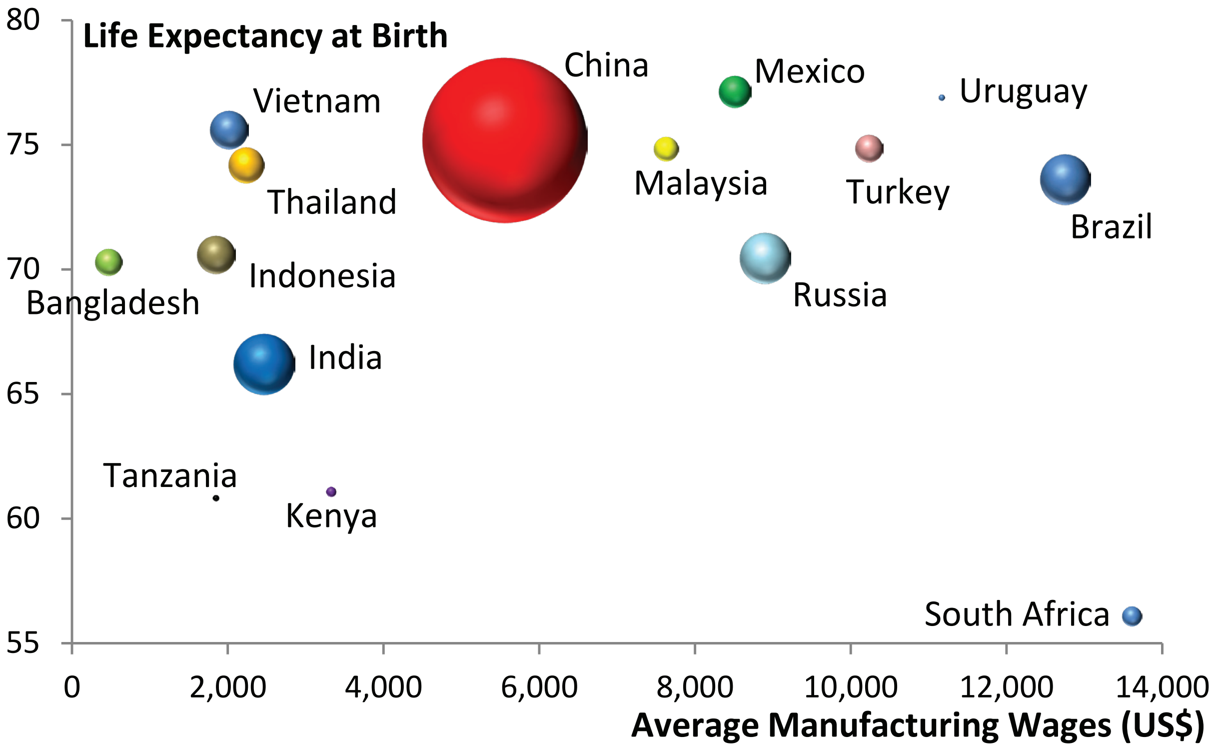
(2) The share of the population with tertiary education was for 2010;

(3) The share of tertiary graduates in science and engineering programmes was for 2012, or the latest available year: 2001 (Kenya), 2009 (Indonesia), 2010 (Uruguay) and 2011 (Bangladesh, Malaysia, Russia). Data was unavailable for China, India, South Africa, Thailand, Tanzania and Vietnam.

Figure 7 shows the production capabilities indicators that reflect the quality of the present manufacturing workforce. Poorer developing countries like Tanzania and Kenya have both low average manufacturing wages and poor health, as proxied by life expectancy. At the other end of the spectrum, Brazil and Uruguay enjoy high average manufacturing wages and life expectancy. South Africa raises an interesting case whereby it has high average manufacturing wages but low life expectancy.



**Figure 7: Life Expectancy at Birth vs. Average Manufacturing Wages, Latest-Available Year**




Notes:

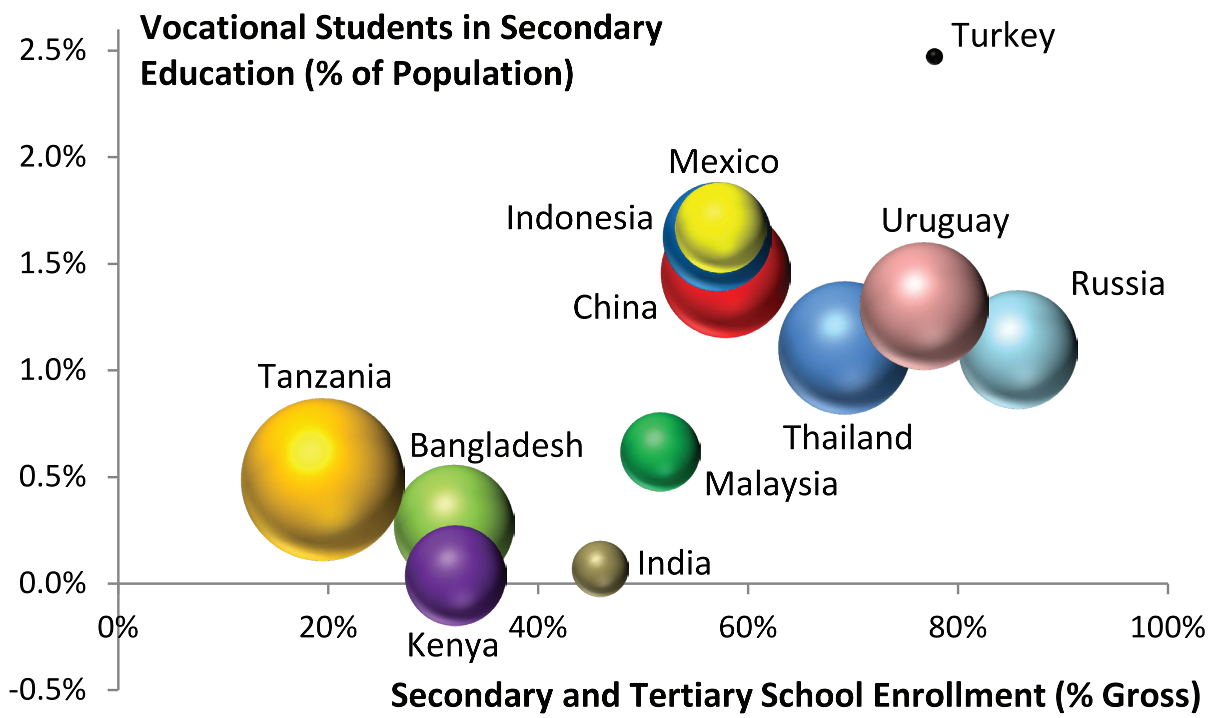
(1) The size of bubbles is proportionate to manufacturing employment in the countries.

(2) Life expectancy was for 2012. Average manufacturing wages were calculated for 2010 or the latest-available year: 1998 (Bangladesh), 2006 (Thailand), 2008 (Uruguay), 2009 (India, Indonesia, South Africa, Turkey) and 2011 (Russia).

Figure 8 provides a snapshot of the human resource indicators (which is an indicator for future production capabilities) in 2012 (or the latest-available year). Among the basket of countries, Turkey showed the most potential to raise future production capabilities. It had the highest share of the population in vocational secondary education and the lowest LFPR Life Expectancy at Birth (denoted by the small bubble size). On the other hand, countries in Africa (Tanzania and Kenya) and South Asia (Bangladesh and India) ranked poorly on these indicators. Notably, the high LFPR of Tanzania (90.6%) constrains its ability to further increase the size of its workforce.



**Figure 8: Production capabilities Indicators (Future), 2012**




Notes:

(1) The size of bubbles reflects the different LFPRs of the countries. As LFPRs tend to fall within a narrow range, they were normalised to a scale from 1 to 100 in order to accentuate the differences in the bubble sizes.

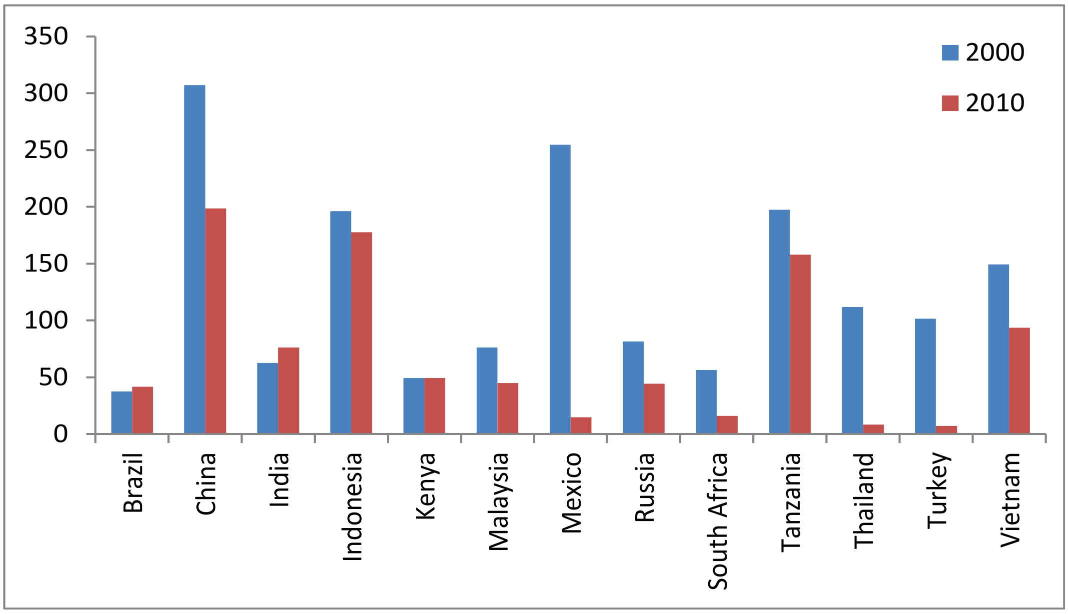
(2) The latest-available data was used when 2012 data was unavailable. For secondary and tertiary school enrollment, this applied to Bangladesh (2011), India (2011), Kenya (2009), Malaysia (2011) and Uruguay (2010). For vocational students in secondary education, this applied to India (2008), Kenya (2009), Malaysia (2011) and Uruguay (2010).

(3) Brazil, Vietnam and South Africa were excluded as recent data was unavailable, particularly for the 'secondary and tertiary school enrollment' indicator.

Among the countries selected, China had the largest manufacturing employment per manufacturing establishment in 2000 and 2010 (Figure 9). In general, most countries saw declines in this indicator as more establishments were recorded. Notably, Mexico, Thailand and Turkey experienced the largest falls in the average employment per manufacturing establishment. By contrast, others such as Brazil and India had marginal increases. Among the developing countries, Indonesia and Tanzania stood out for continuing to have relatively large manufacturing enterprises in terms of employment.



**Figure 9: Manufacturing Employment per Manufacturing Establishment, 2000 and 2010**



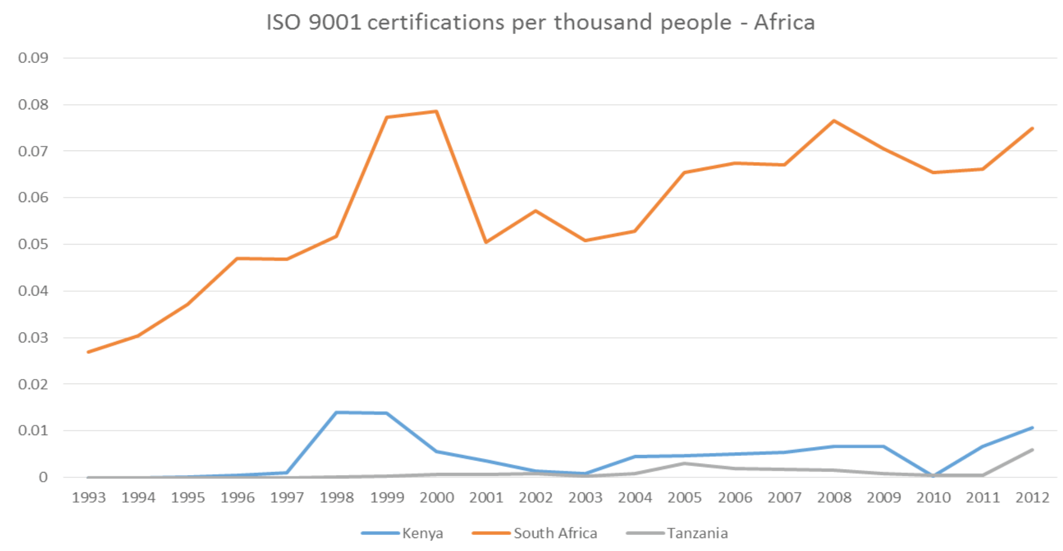

Notes:

(1) Data were for 2010 and 2000 or the latest-available year before these two years: Bangladesh (1998), India (2009), Indonesia (2009), Russia (2009), South Africa (1996, 2009), Tanzania (1999), Thailand (2006) and Turkey (2009).

(2) Uruguay was excluded as it only had a data point for 1988. Bangladesh was excluded as data was unavailable from 2001.

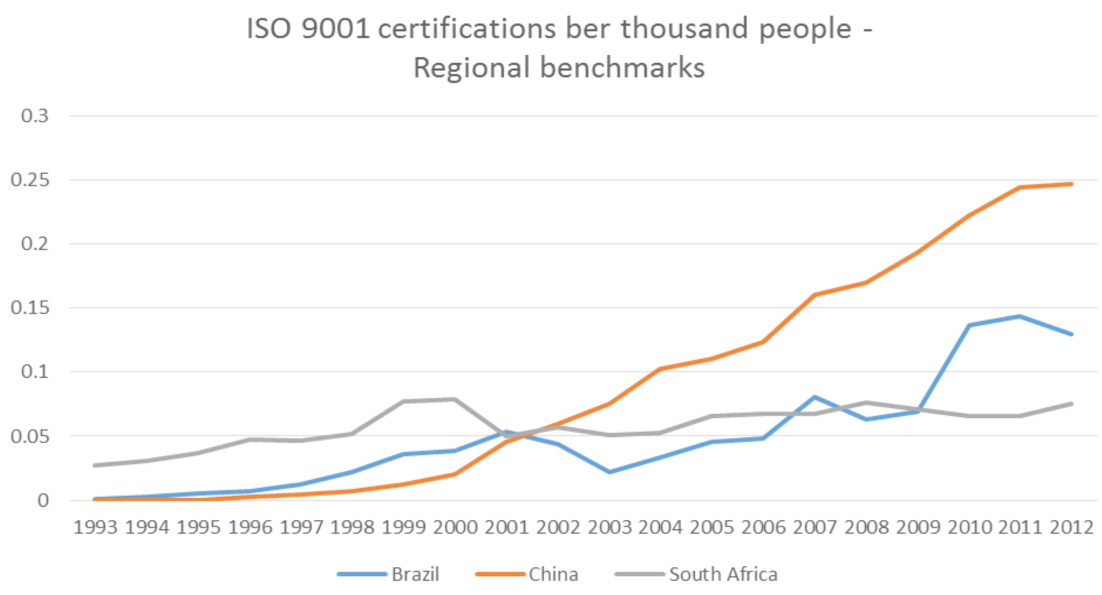
A strong upwards trend in ISO 9001 certifications per thousand people can be seen in South Africa, in contrast to other countries in the region (Figure 10A). The country also starts from a much higher level of certifications.

**Figure 10A: ISO 9001 Certifications per Thousand People (Africa), 1993-2012**




When compared to the other regional benchmarks however, its performance is not remarkable (Figure 10B): Brazil and China started at lower levels and have surpassed the density of South African certifications. The increase in Chinese certifications is consistent with the need of its firms to demonstrate their reliability if they further want to insert themselves into the value chains of higher-value products.

**Figure 10B: ISO 9001 Certifications per 1,000 People (Regional Benchmarks), 1993-2012**

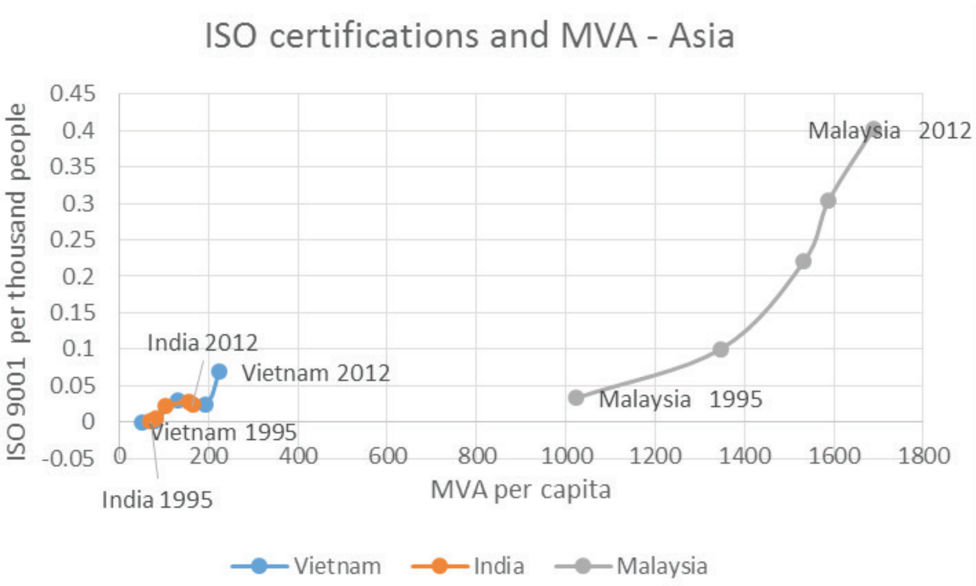


Looking at ISO 9001 certificates attainment at different stages of manufacturing development proxied by MVA per capita, there tends to be a positive relationship between the two, but not in all cases (Figures 11A and 11B). Brazil has had a huge increase in certification density, but its value added has not increased by much in the last fifteen years (Figure 11B). Increases in ISO certifications seem to be lumped in certain periods, possibly associated to economic cycles.

The low performers in the Asian graph have very similar levels of industrialisation – as proxied by MVA per capita – and similar intensities and trends of ISO 9001 certification too. At a much higher degree of industrialisation, the comparables South Africa and Brazil show very different trends in this indicator.

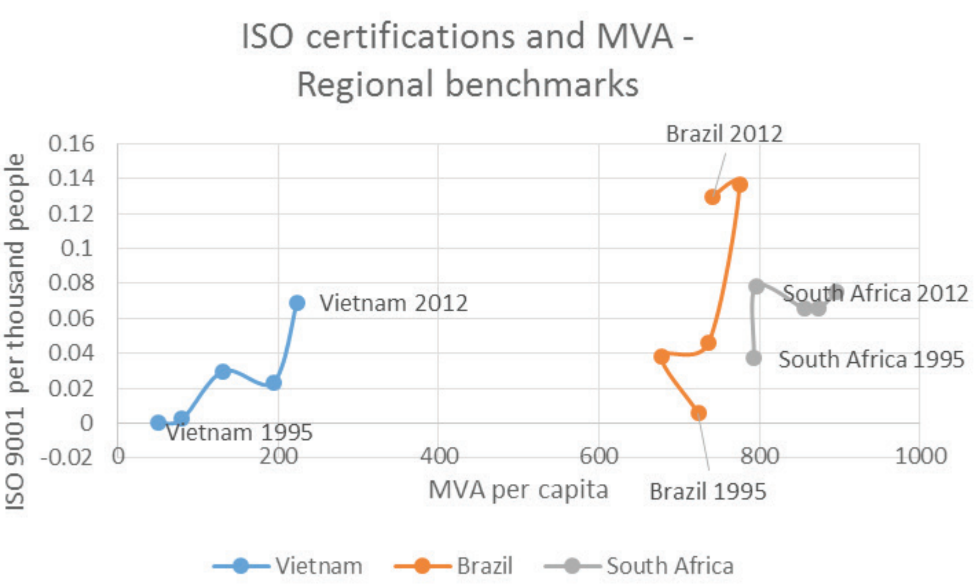


**Figure 11A: ISO 9001 Certifications vs. MVA per capita (Asia), 1993-2012**




Note: The data points are for the years 1995, 2000, 2005, 2010 and 2012.

**Figure 11B: ISO 9001 Certifications vs. MVA per capita (Regional Benchmarks), 1993-2012**



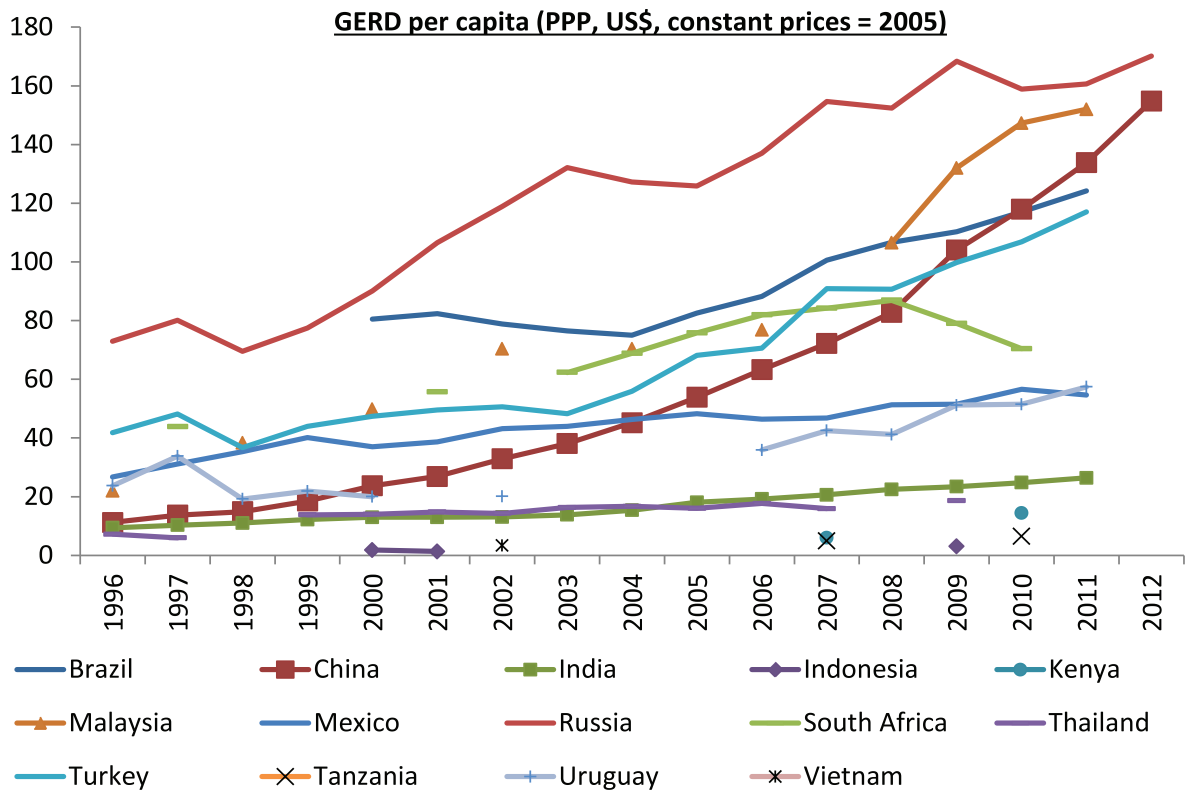

Note: The data points are for the years 1995, 2000, 2005, 2010 and 2012.

## 4.3. Technological capabilities

Among the selected countries, Russia maintained its position of having the highest GERD per capita between 1996 and 2012 (Figure 12). However, China is rapidly catching up to Russia. Although China (US$11.20) and India (US$9.40) had a similar GERD per capita in 1996, China's phenomenal growth led to a level that was five times that of India by 2011.



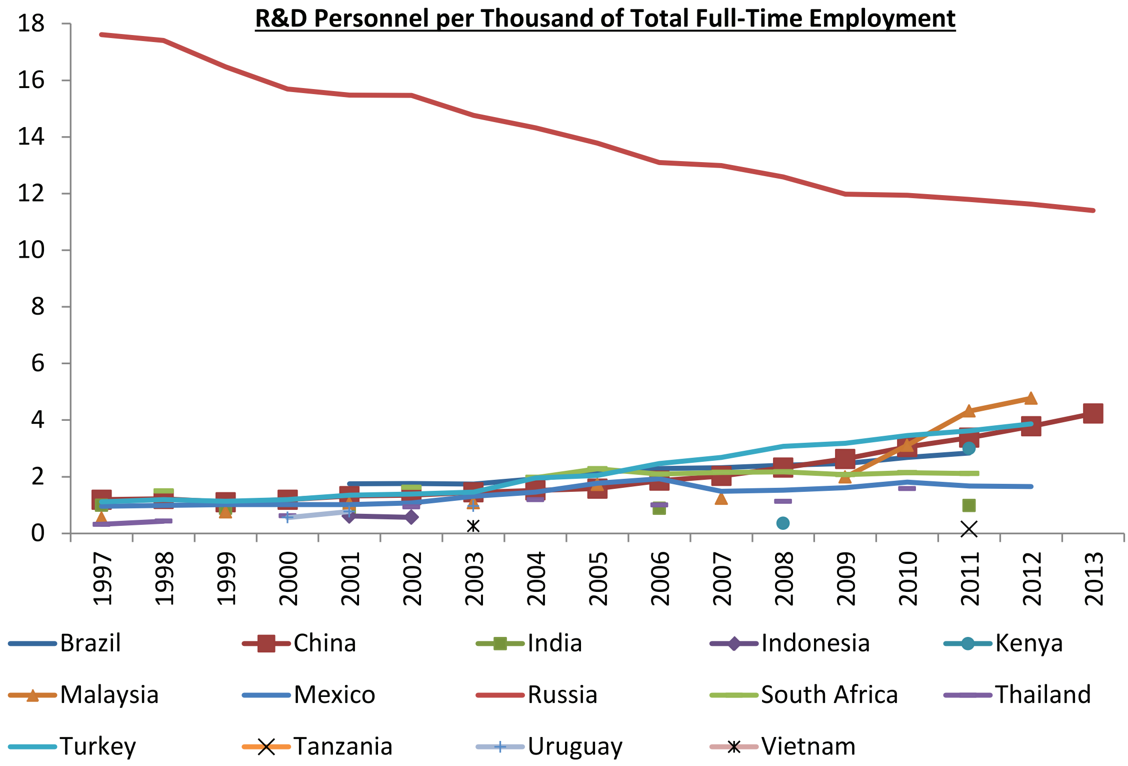
**Figure 12: GERD per capita, 1996-2012**




Note: Data for Bangladesh was unavailable for GERD per capita.

Russia also holds a leading position in the share of workers who are engaged in R&D activities, although the share has declined over time (Figure 13). Similar to the upward trend seen for GERD per capita, China experienced strong increases in the share of R&D personnel in its workforce. Between 1996 and 2012, the share of R&D personnel in its workforce grew by 3.6 times. By contrast, developing countries such as Tanzania, Kenya and Indonesia remained weak in both indicators.

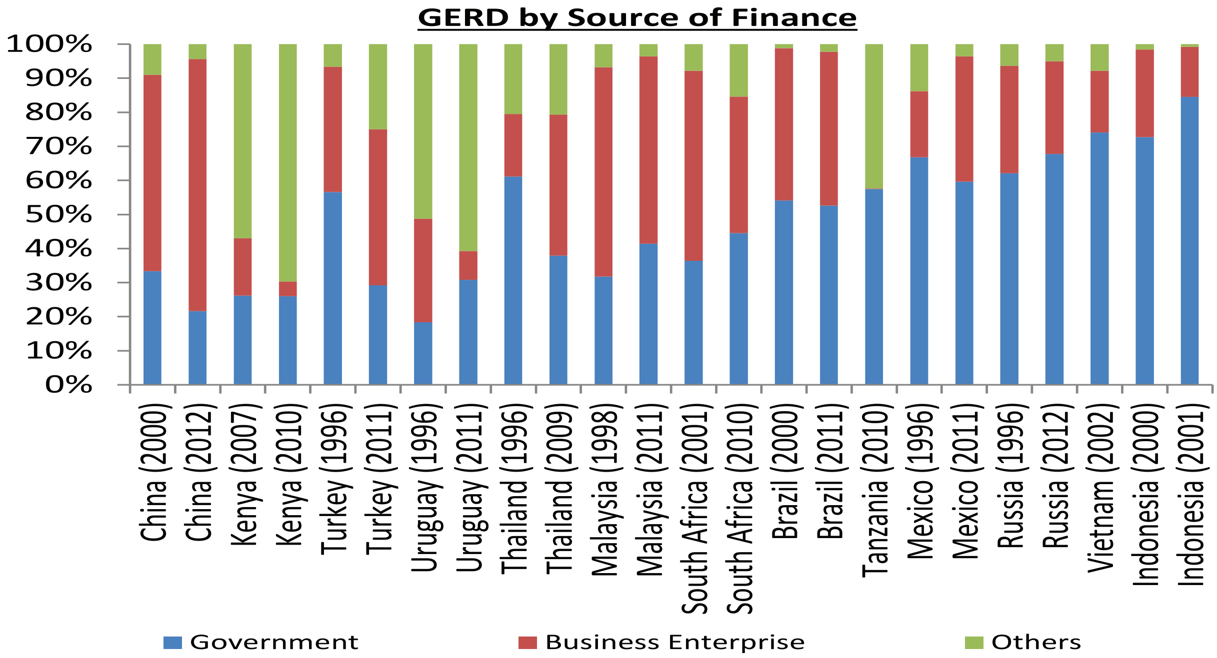
**Figure 13: R&D Personnel per Thousand of Total Full-Time Employment, 1996-2012**




Note: Data for Bangladesh was unavailable for R&D personnel per thousand of total full-time employment.

The private sector was a key source of finance for GERD in countries such as China and Malaysia that attracted significant FDI inflows. By contrast, the private sector was virtually non-existent in African countries such as Tanzania (0.1% in 2010) and Kenya (4.3% in 2010). In Russia, Vietnam and Indonesia, the government was the primary source of finance for R&D (more than 60% contribution to GERD) (see Figure 14).

**Figure 14: GERD by Source of Finance, Various Years**



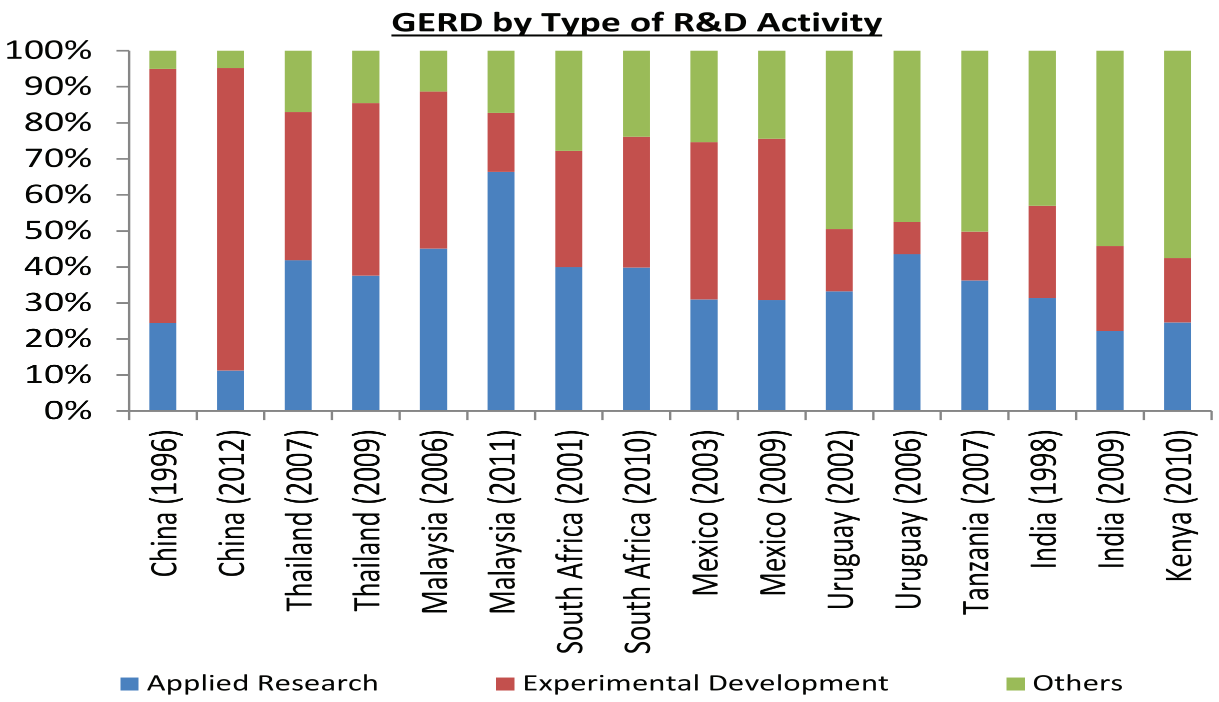

Notes:

(1) The ‘Others’ category includes higher education institutions, private non-profit organisations, foreign and unknown sources.

(2) The countries’ data were presented for the earliest- and latest-available years between 1996 and 2012. Countries were ordered in ascending order based on the contribution by the countries’ governments to GERD in the latest-available year. For the period of analysis, data for Bangladesh and India was unavailable, while Tanzania and Vietnam only had one data point each.

In terms of the type of R&D activity, the more successful industrialising countries such as China, Thailand and Malaysia devoted a significant proportion of their GERD to applied research and experimental development (Figure 15). By contrast, poorer economies such as Tanzania, India and Kenya continued to focus heavily on basic research (more than 50% of GERD).

**Figure 15: GERD by Type of R&D Activity, Various Years**




Notes:

(1) The 'Others' category includes basic research and unspecific activities.

(2) The countries' data were presented for the earliest- and latest-available years between 1996 and 2012. Countries were ordered in ascending order based on the combined share of applied and experimental development in the latest-available year. For the period of analysis, data for Bangladesh, Brazil, Indonesia, Russia, Turkey and Vietnam was unavailable, while Kenya and Tanzania only had one data point each.

In terms of capital goods imports, some Sub-Saharan African countries, such as Kenya and Tanzania, have levels comparable to those of South Africa, which tends to dominate most indicators in the region (Figure 16). The problem is that these imports are only being translated into higher MVA per capita in South Africa (Figure 17A). Kenya and Tanzania might not have the capabilities required to understand the technology embodied in capital imports –thus cannot translate these imports into domestic technological capabilities– or might be importing capital goods which are used in the production of low value added products.



**Figure 16: Capital Goods Imports over GDP per capita (Africa), 1991-2010**

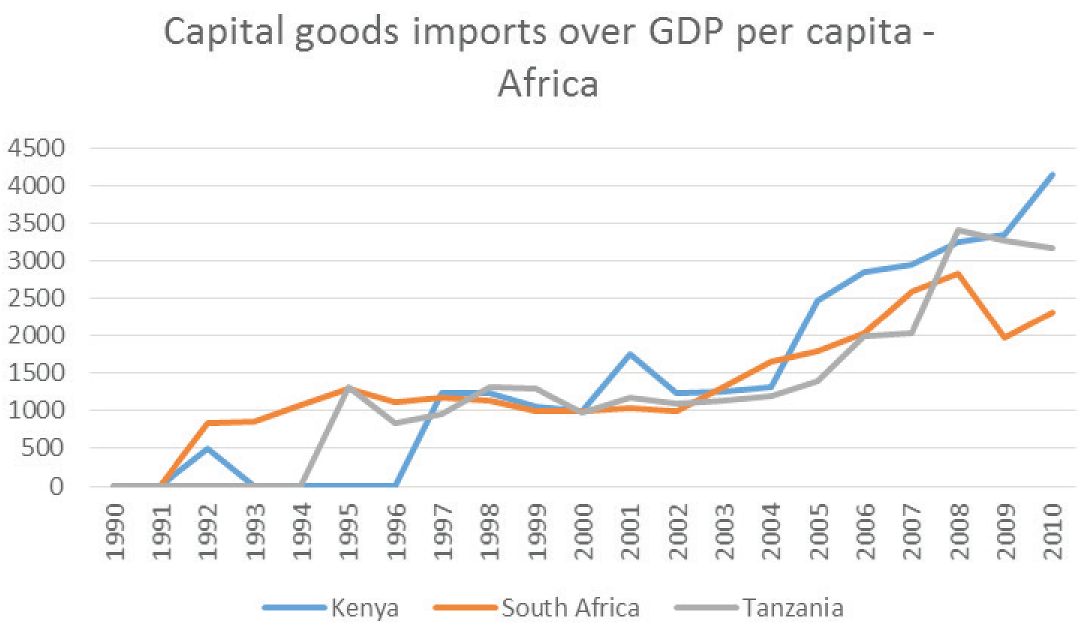
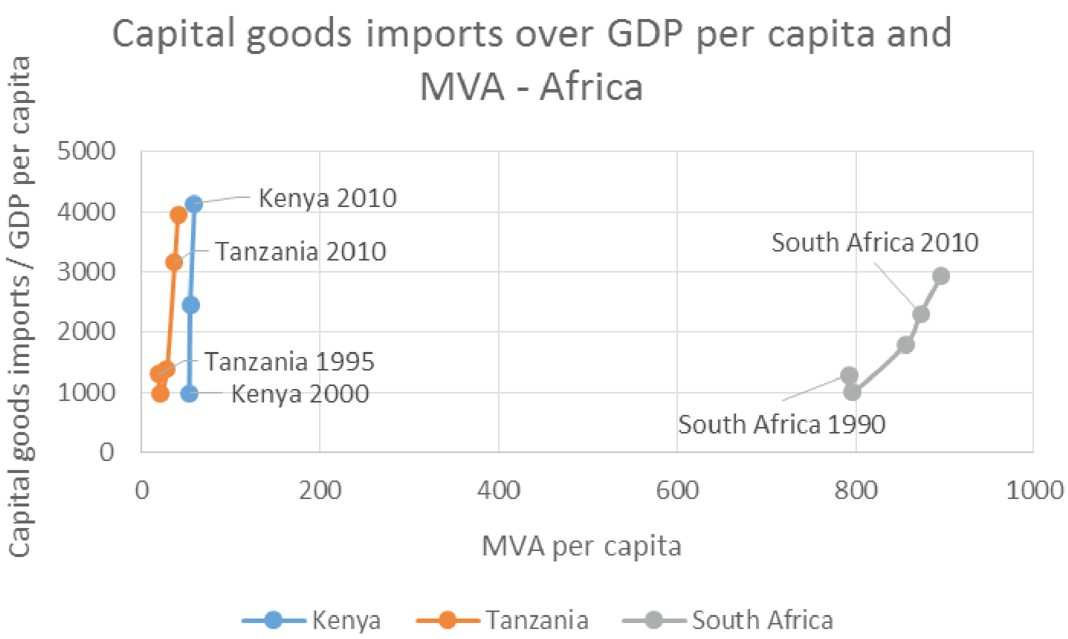



**Figure 17A: Capital Goods Imports over GDP per capita vs. MVA per capita (Africa), 1995-2010**

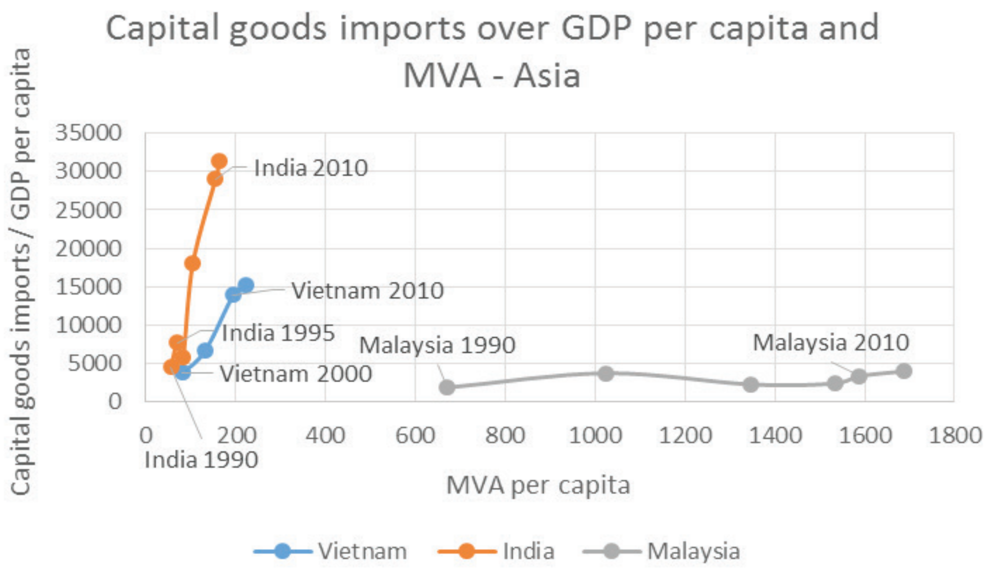



Note: The data points are for the years 1990, 1995, 2000, 2005 and 2010, except for Kenya, which has only data for 2000, 2005 and 2010.

For the evolution of capital imports over MVA in Asia and Latin America (Figures 17B and 17C), there existed two groups of countries: while in one group the increases in capital imports over GDP per capita are associated with increases in MVA, the other group showed improvements showed improvements without a change in capital goods imports. For Vietnam, India and especially Mexico, the increase happened together with increases in MVA. The second group, exemplified by Malaysia and Uruguay, presents important improvements in MVA, without a change in capital goods imports.



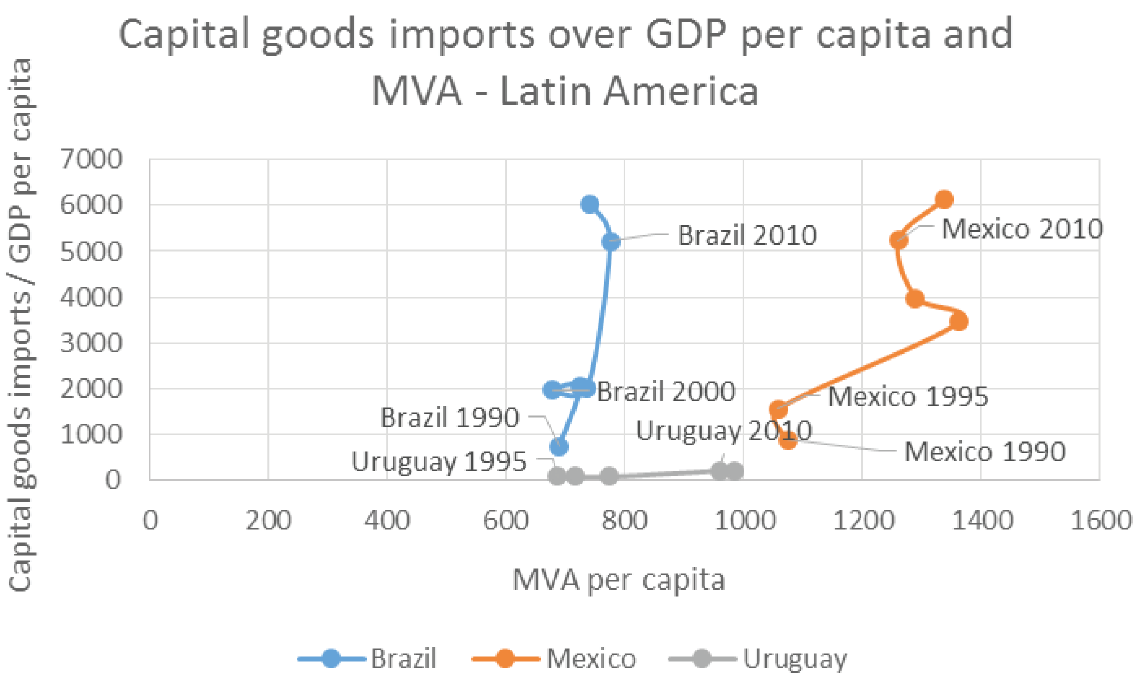
**Figure 17B: Capital Goods Imports over GDP per capita vs. MVA per capita (Asia), 1990-2010**




Note: The data points are for the years 1990, 1995, 2000, 2005, 2010 and 2012, except for Vietnam, which has no data before 2000.

The pairs of Asian and African countries with comparable levels of industrialisation both start from similar levels of capital goods imports, but they differ in their final levels. While Kenya and Tanzania move together, India left Vietnam behind in this indicator, even though they are still at comparable levels of industrialisation, according to their MVA per capita.

**Figure 17C: Capital Goods Imports over GDP per capita vs. MVA per capita (Latin America), 1990-2010**



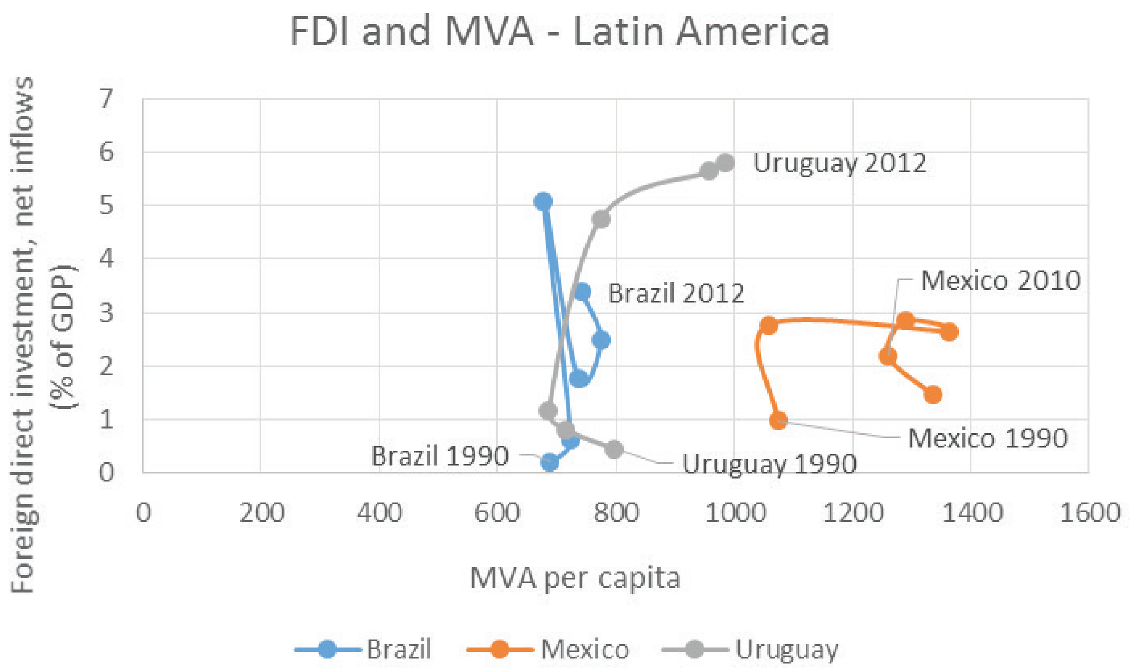

Note: The data points are for the years 1990, 1995, 2000, 2005, 2010 and 2012, except for Uruguay, which had no data for 1990.

In terms of FDI inflows and MVA, it can be seen that it is Uruguay and Tanzania that have had the most important increase in FDI inflows in this group of Latin American countries (Figure 18A & B). This highlights that the different ways to obtain foreign technology, such as capital imports, FDI and licensing, might be substitutes to a certain extent, and different countries might follow different strategies.

At least for the countries exemplified in Figures 18A and 18B, increased FDI appears to have been more effective in Latin American than in African countries. Mexico is interesting, as the increase in MVA appears to have been right after a period of increased foreign investment, but then both FDI and MVA receded. The continued increase in the intensity of capital goods imports does not seem to have been enough to continue improving MVA per capita.

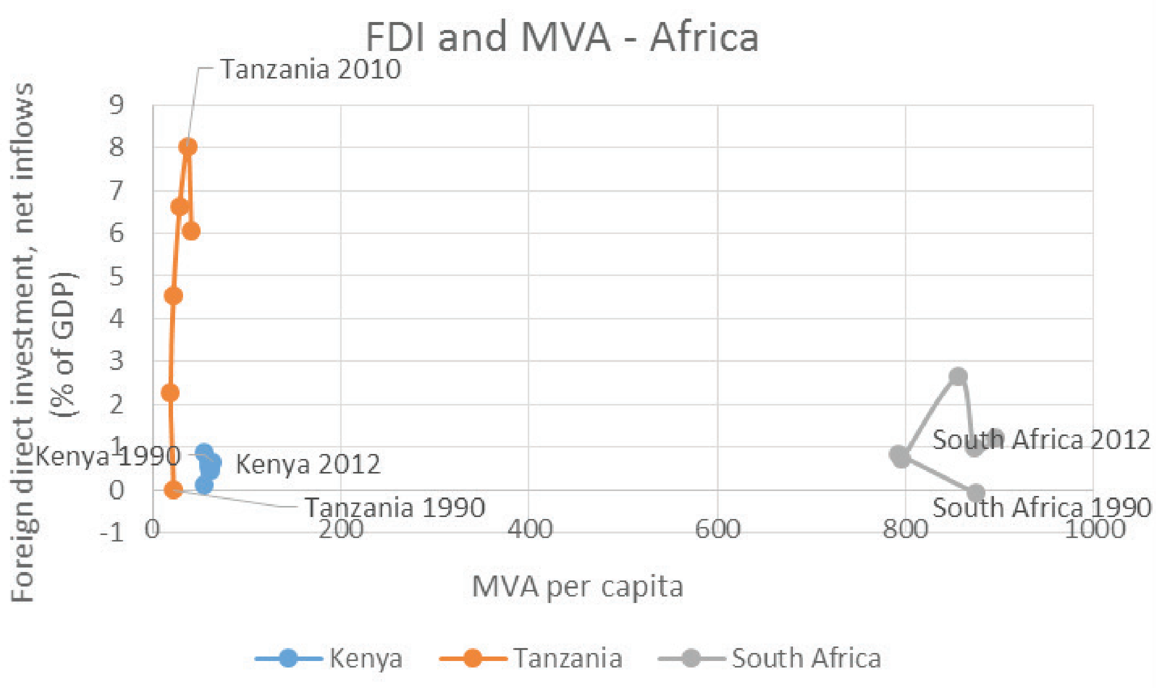
Kenya and Tanzania have similar levels of industrialisation, but very different trends in this indicator.

**Figure 18A: Net FDI Inflows vs. MVA per capita (Latin America), 1990-2012**




Note: The data points are for the years 1990, 1995, 2000, 2005, 2010 and 2012.

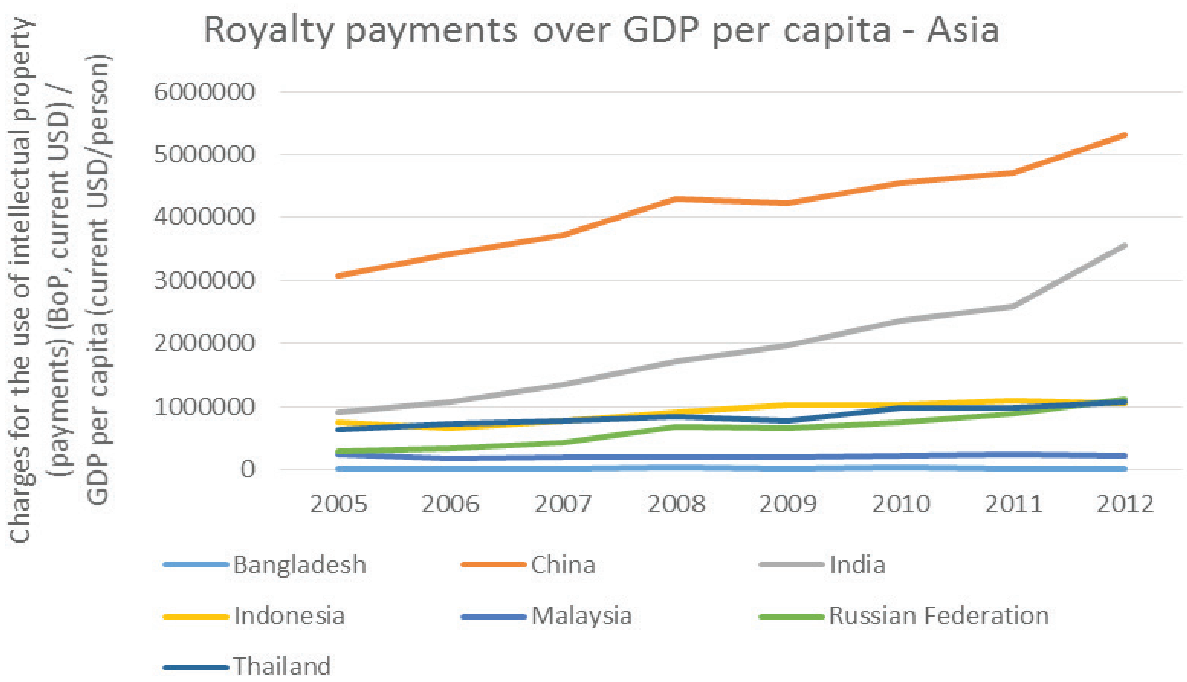
**Figure 18B: Net FDI Inflows vs. MVA per capita (Africa), 1990-2012**




Note: The data points are for the years 1990, 1995, 2000, 2005, 2010 and 2012.

In Asia, not all countries have increasing trends in this form of importing technology (Figure 19). The most interesting case is that of India, which started clustered together with all other countries in 2005, and is catching up with China's much higher levels.

**Figure 19: Royalty Payments over GDP per capita (Asia), 2005-2012**

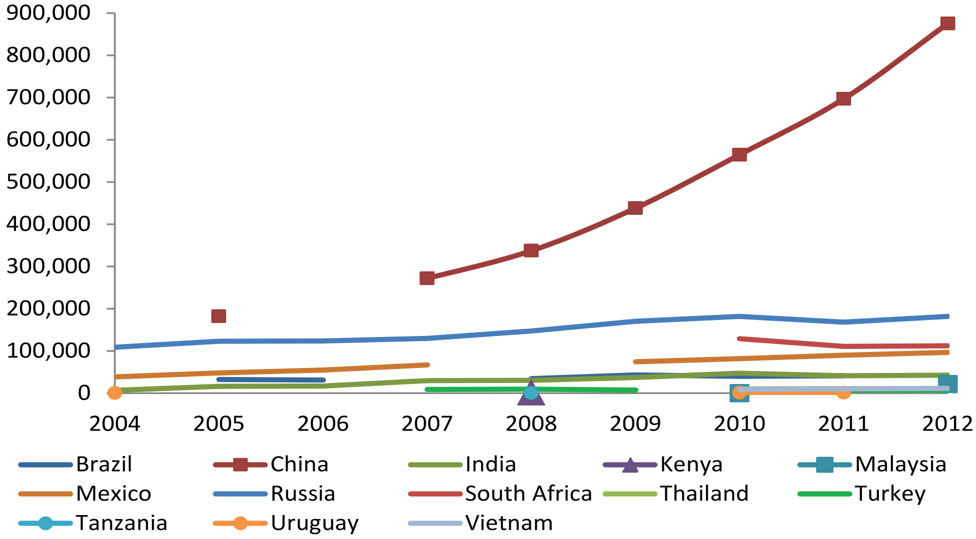



Tool 9 Interpretation of Findings and Conclusions

## 4.4 Innovation capabilities

The phenomenal rate of growth of China's stock of patents has led to a level that far surpassed the other selected countries (Figure 20). In 2005, China had 182,396 patents in force, 48% higher than the level in Russia (123,089). With a 25.1% annual growth in the stock of patents between 2005 and 2012, the differential between China and Russia widened to 382% by 2012. At the other end, Kenya, Uruguay and Tanzania had the fewest number of patents in force.

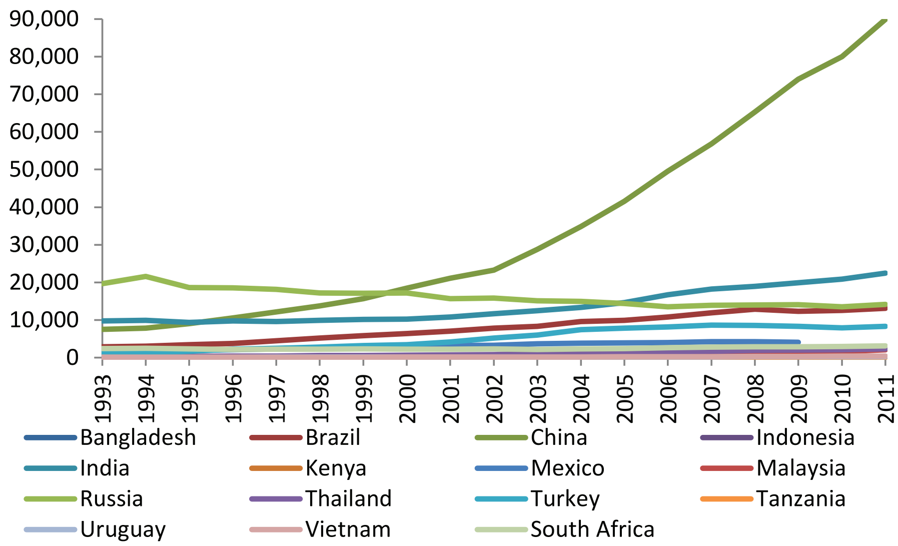
**Figure 20: Stock of Patents in Force, 2004-2012**




Note: Data for Bangladesh and Indonesia were unavailable.

A similar picture emerged for the number of scientific and technical journals in the basket of countries (Figure 21). China and Russia experienced contrasting fortunes since the mid-1990s. While China further augmented its dominance during 2000s, the number of scientific and technical journal articles published by Russia steadily declined. In 1994, Russia had 2.8 times China's number of published articles. However, by 2011, it barely had 16% of China's level.

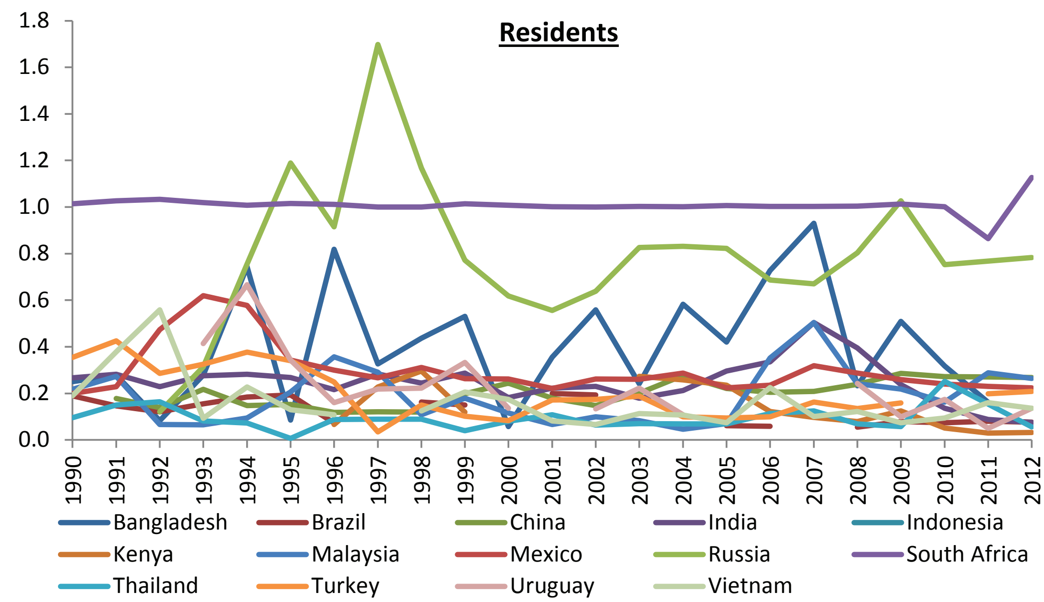
**Figure 21: Scientific and Technical Journal Articles, 1993-2011**



A comparison of patents granted per application for residents (Figure 22A) and non-residents (Figure 22B) yields several insights. First, virtually all patents filed by South Africa's residents were granted (i.e. it had a patent grant to application ratio of around 1 between 1990 and 2010). Second, in virtually all the countries, non-residents had a higher 'success rate' on average compared to residents for patents filed between 1990 and 2012. The only exceptions were Indonesia, Russia, South Africa and Uruguay. Third, Turkey appeared to have a significant lag time before patents applied by non-residents were granted. Between 2002 and 2009, its ratio of patent grants to applications exceeded 1 and surpassed 3 from 2003 to 2006.

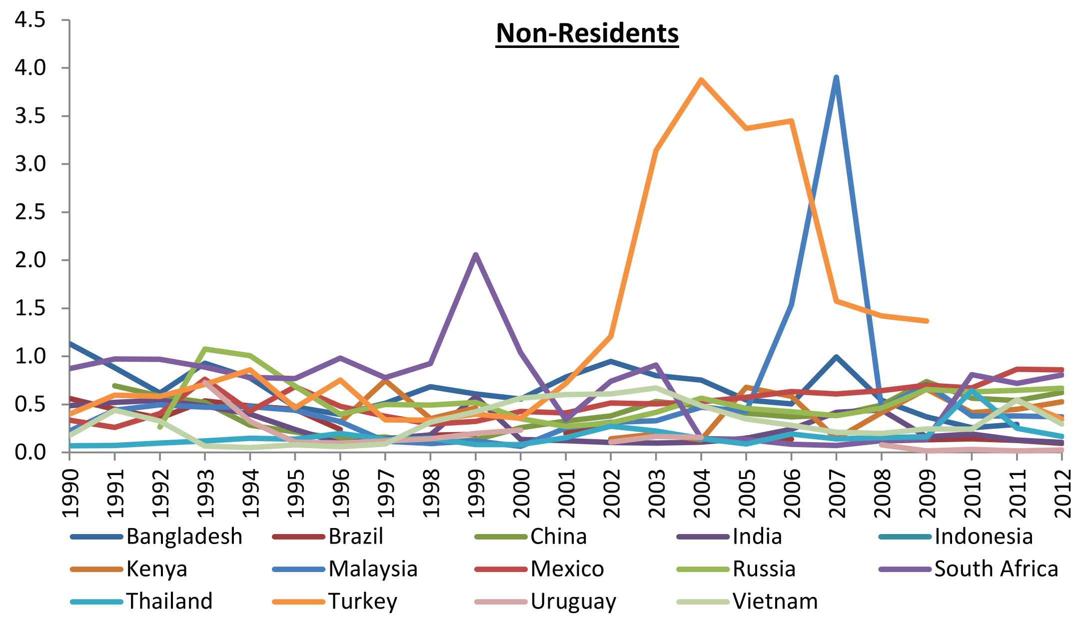


**Figure 22A: Patents Granted per Patent Application by Residents, 1990-2012**




Note: Data for Tanzania was unavailable.

**Figure 22B: Patents Granted per Patent Application by Non-Residents, 1990-2012**

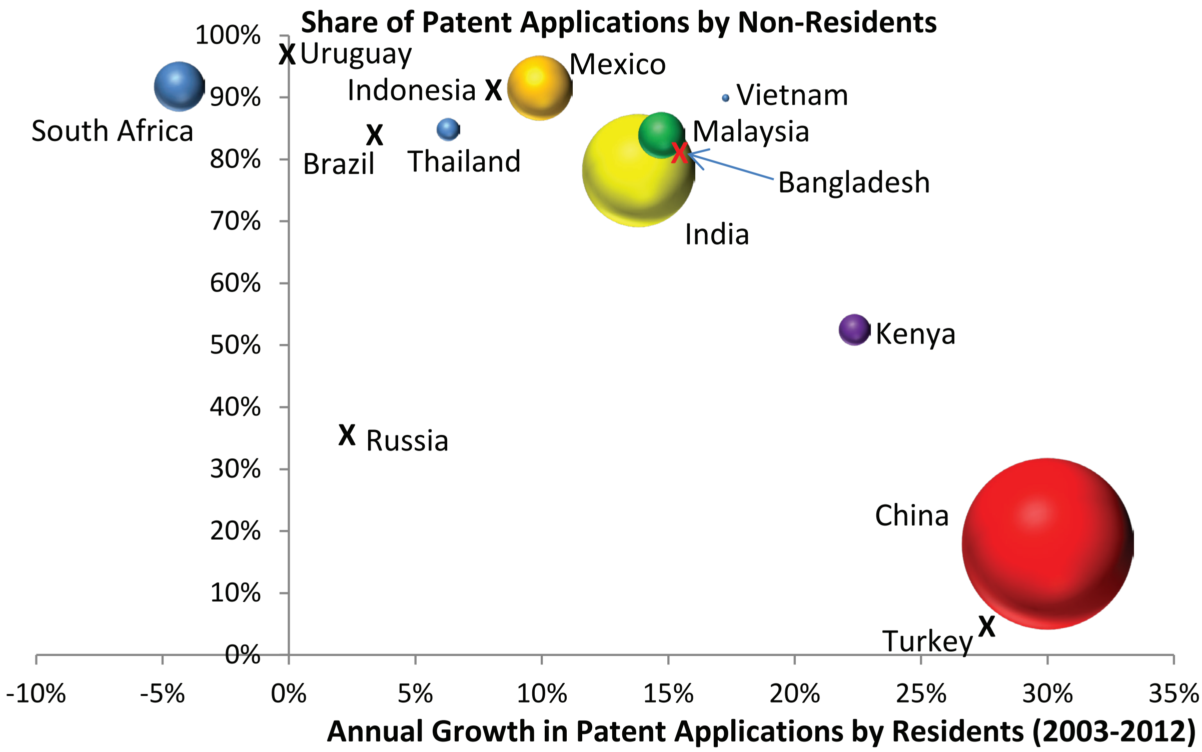



Note: Data for Tanzania was unavailable.

Figure 23 shows a negative relationship between the growth in patent applications by residents and the share of patent applications by non-residents. Stronger growth in patent applications by residents was associated with a smaller share of total patent applied by non-residents. Among the countries analysed, Russia saw the largest deviation from the general trend. Despite having slow growth in patent applications by residents, they still formed the bulk of patent applications (i.e. patent applications by non-residents experienced even slower growth). Partly reflecting their economic size, China and India devoted the most GERD in basic research among the basket of countries.



**Figure 23: Innovation Capabilities Indicators (Potential)**




Notes:

(1) The size of bubbles is proportionate to the GERD on basic research. Where recent data was unavailable (e.g. for Bangladesh, Brazil, Indonesia, Russia, Turkey and Vietnam), data points were marked with an “X” rather than bubbles in the figure.

(2) Tanzania was excluded from the figure because recent data on patents was unavailable.

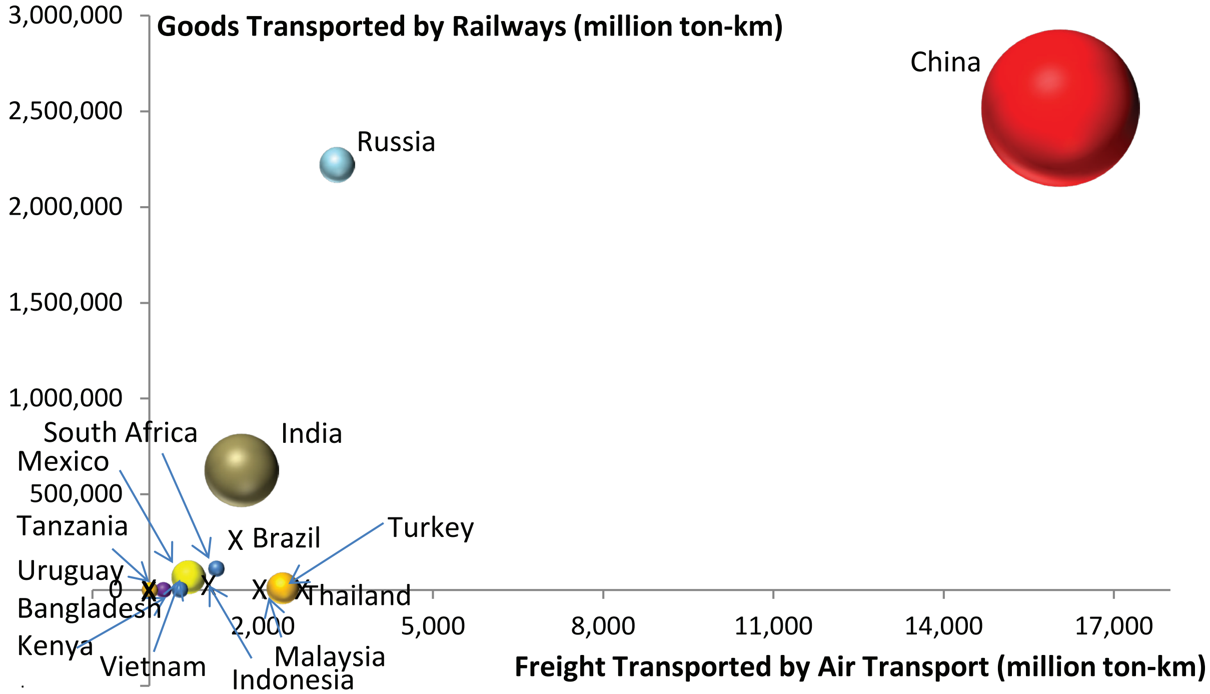
(3) The latest-available data was used when 2012 data was unavailable. For the share of non-resident patent applications, this applied to Indonesia (2011). For GERD on basic research, this applied to China and Malaysia (2011), Kenya and South Africa (2010), India, Mexico and Thailand (2009), and Uruguay (2006).

(4) The average annual growth rate of resident patent applications was calculated using a simple average of the annual growth rates over a 10-year period (2003-2012). Compounded annual growth rates were not suitable as there were data gaps for several countries in some years.

## 4.5. Infrastructure capabilities

Figure 24 shows the physical infrastructural capabilities indicators for the basket of countries. China has by far the strongest capabilities to transport goods and freight over roads, railways and the air. In contrast to China, the physical transport infrastructure still remained largely undeveloped in Uruguay, Bangladesh, Kenya and Tanzania.

**Figure 24: Infrastructure Capabilities Indicators (Physical), Latest-Available Year**




Notes:

(1) The size of bubbles is proportionate to the volume of goods transported by roads (in million ton-km).

(2) The indicator 'Goods Transported by Roads' was for 2011 or the latest-available year: 2000 (Kenya, South Africa), 2008 (Tanzania) and 2010 (India, Vietnam). Data was unavailable for Bangladesh, Brazil, Indonesia, Malaysia, Thailand and Uruguay. Their data points are marked with an "X" rather than bubbles.

(3) The indicator 'Freight Transported by Air Transport' was calculated for 2013 or the latest-available year: 2009 for Uruguay.

(4) The indicator 'Goods Transported by Railways' was calculated for 2012 or the latest-available year: 2006 (Kenya, Tanzania) and 2008 (Uruguay).

Of course, these figures are affected by the size of countries' economies, their participation in international trade and their specific geographical characteristics. This is why these indicators may be better used for the assessment of each country's improvement in infrastructures over time.

The density of fixed telephone lines has been traditionally used as an ICT infrastructure indicator. While in some countries with high levels of penetration, such as Turkey and Russia, this number has been falling – probably because of the growing use of mobile communications – (Figure 25), it is clear that this is still a relevant indicator. Brazil, China, and especially Indonesia show that fixed lines are still an important indicator of communication infrastructure in the twenty-first century.

**Figure 25: Fixed Telephone Lines per 100 people, 1990-2013**

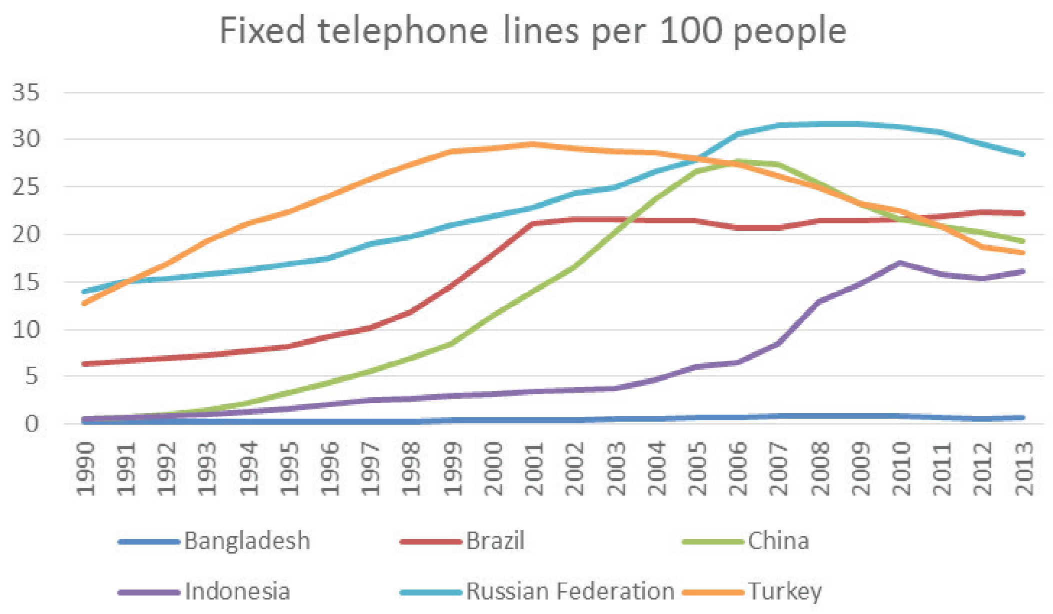



Figure 26 tells a very positive story. A graph with 15 countries would usually be messy and difficult to understand, but this one shows a very clear pattern: the revolution of mobile communications –which is fairly recent – has occurred in all developing countries. While as always, there are important differences in the current levels of penetration, this is probably the only indicator where all countries take off in such a reduced window of time (roughly 1999-2006), and attain levels of the same order of magnitude. The poorest countries in this sample should take advantage in innovative ways of the possibilities that a 60% mobile penetration rate gives them.

**Figure 26: Mobile Cellular Subscriptions per 100 people, 1990-2013**

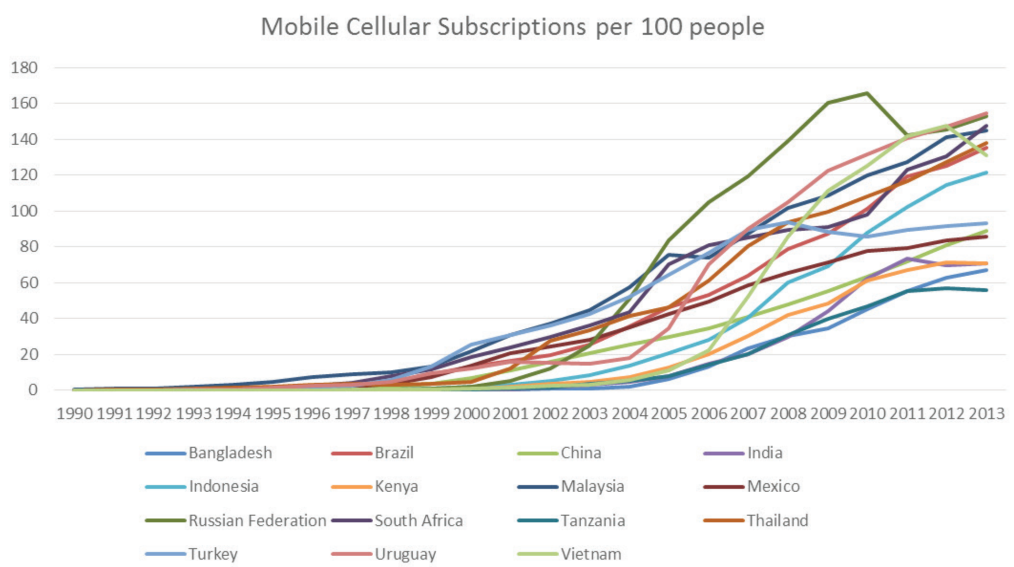


Figure 27 illustrates how countries have improved the access to personal computers at different points in time. Some countries however are still on very low levels. The interpretation must be cautious however, as India, with an important IT sector, seems lagging behind here. Dividing by population might not be enough to adjust for the differences in country sizes. Other possibilities, like dividing the number of computers by urban or educated population, could be explored in the future.

**Figure 27: Personal Computers per 100 people, 1990-2013**

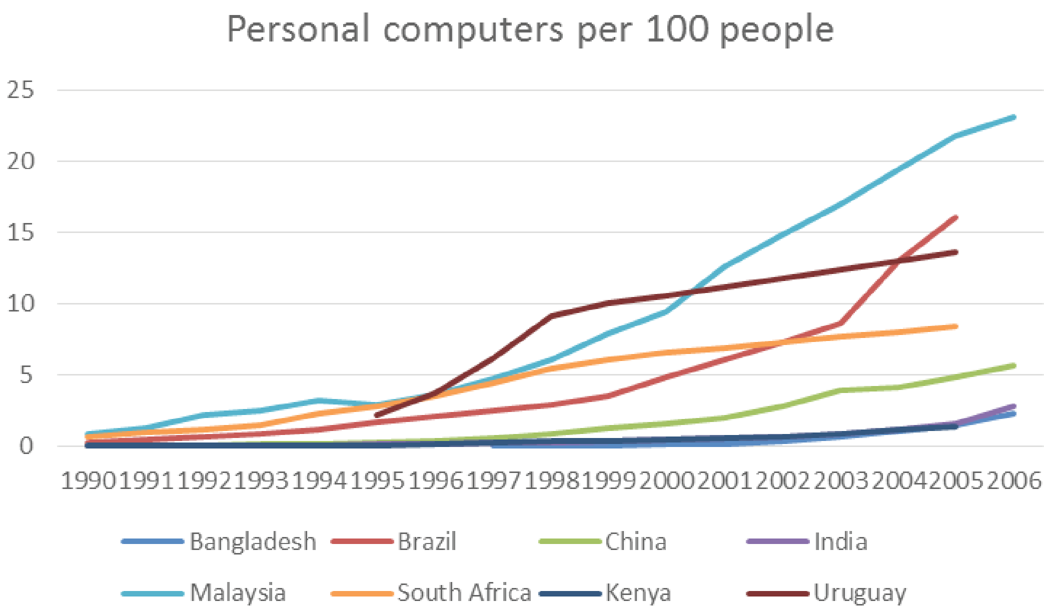
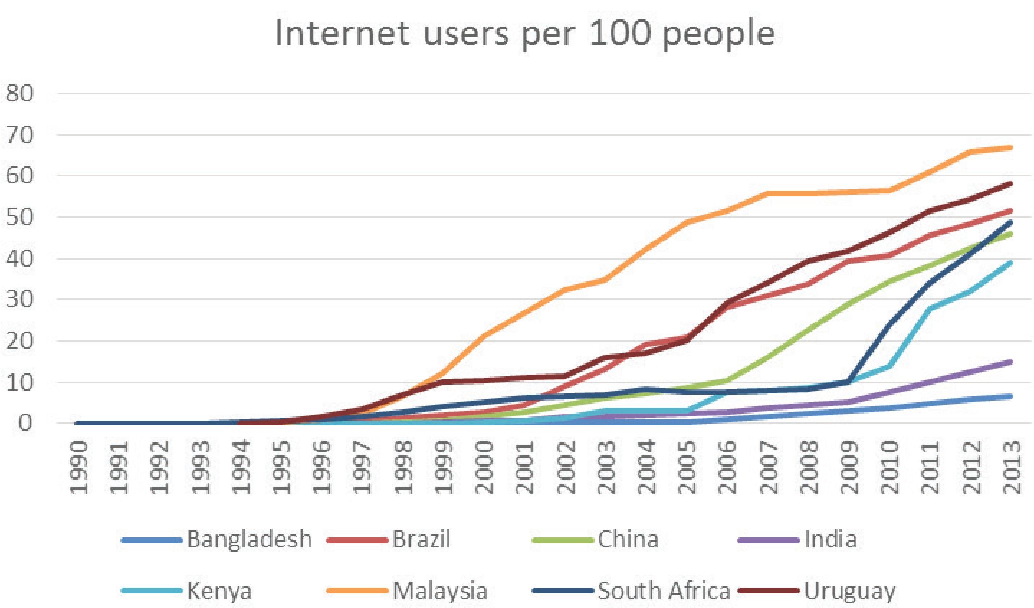



Figure 28 tells a similar story as Figure 27. Internet adoption has obviously started after the increase in personal computers. Some countries have had incredible surges, such as Malaysia, but others, like Bangladesh, are lagging behind. India shows, probably due to the low share of personal computers, also a low number of internet users per 100 people.

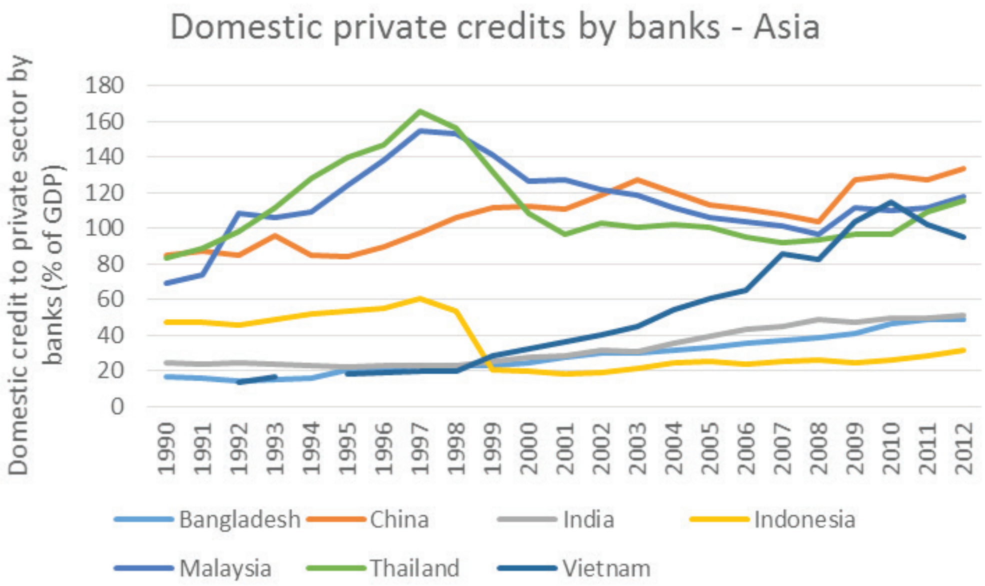
**Figure 28: Internet Users per 100 people, 1990-2013**



The impact of the 1997-98 Asian Crisis on domestic bank credit to the private sector is clearly visible for countries in Asia (Figure 29). In terms of industrial development, it is widely agreed that the fragility and volatility of the financial sector can easily translate into problems for the real economy. Lack of credit availability can mean bankruptcy for some firms and contraction for others. The longer credit constraints affect firms, the higher the risk of permanent losses of industrial capabilities.

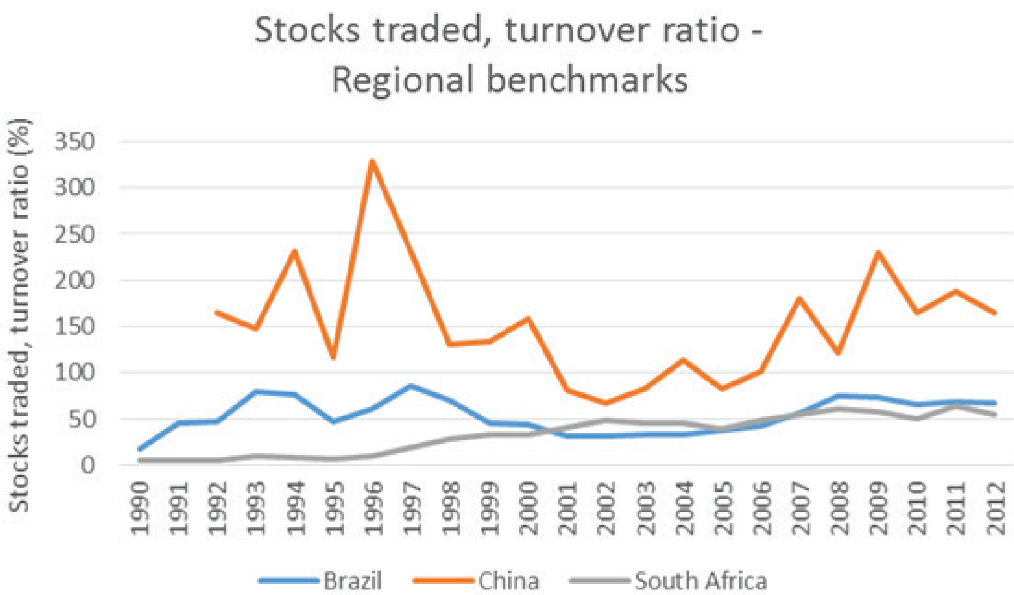


**Figure 29: Domestic Credit to Private Sector by Banks (Asia), 1990-2012**




The turnover ratio of stocks traded, in the Brazil, China and South Africa (Figure 30) tend to have significant swings. If it is used as a proxy for financial deepening, the long term trends should be considered rather than the yearly values. A deep and functioning financial system is required to finance industrial growth. This requires not only domestic policies to promote its development (as otherwise it can stagnate), but also policies to protect the manufacturing sector from the harmful exogenous swings in finance.

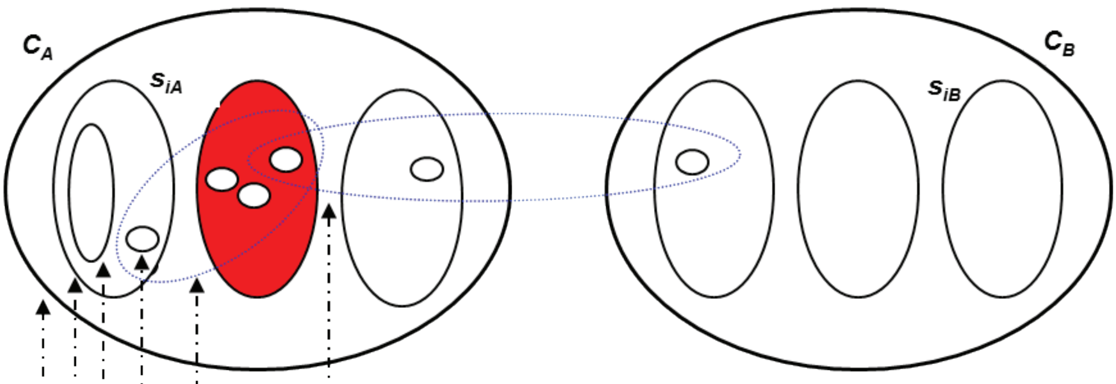
**Figure 30: Stocks Traded, Turnover Ratio (Brazil, China and South Africa), 1990-2012**



# 5. Possible Extensions

The Industrial Capabilities Scoreboard (ICS) is a new tool for the assessment and benchmarking of countries various types of industrial capabilities. The ICS has been developed focusing on industrial capabilities indicators at the country level for which international data are broadly available from the 1990s. Although country-level analyses are necessary to track changes in macro- drivers and enablers of industrial development, country-level indicators hide countries' sectoral specificities and differences as well as regional variations within countries. The possibility of extending the ICS tool by adopting different levels of analysis – country, sectoral, sub-sectoral, firm and regional – is summarised in the following Figure 31.

**Figure 31: Industrial capabilities indicators in a 3 sector, 2 country model: Levels of analysis**




| | Industrial capabilities indicators: possible levels of analysis |
|---|---|
| | **Country level**<br>➔ Countries' longitudinal studies<br>➔ Cross-countries comparisons |
| | **Sectoral level (2 digit)**<br>➔ Countries' longitudinal studies of sectors<br>➔ Sectoral comparisons across countries: the same sector across different countries |
| | **Sectoral level (3 digit)**<br>➔ Countries' longitudinal studies of sub-sectors<br>➔ Sub-sectoral comparisons across countries: the same sector across different countries |
| | **Firm level**<br>➔ Longitudinal studies |
| | **Regional level**<br>➔ Longitudinal studies of regions<br>➔ Longitudinal studies of regional industrial clusters<br>➔ Sectoral analysis of regions |
| | **Global production networks** |

**Source: Andreoni, 2011**

In section 4 we distinguished two main broad classes of analyses at the country level, that is:

1. Assessment of a country's industrial capability development and accumulation trajectory
2. Benchmarking countries' industrial capability development and accumulation trajectories

As shown in figure 31, when we scale down our indicators at the sectoral and sub-sectoral level we can perform the following three types of analyses:



1. Assessment of the industrial capabilities development and accumulation trajectory of a certain sector (or sub-sector) in a given country;
2. Comparative analysis of industrial capabilities of two (or more) sectors (or sub-sectors) in a given country;
3. Benchmarking the industrial capabilities of the same sector (or sub-sector) across countries

The possibility of 'scaling-down' the ICS indicators at the sectoral and sub-sectoral levels is constrained by the availability of sectoral and sub-sectoral data. For example, if we consider the forty indicators included in the country-level ICS, only six indicators can be scaled down.

1. **Share of Manufacturing in Total GFCF (Production Capacity)**
2. **MVA per Manufacturing Establishment (Production Capacity)**
3. **Manufacturing Employment (Individual Capabilities)**
4. **Manufacturing Wages per Worker (Individual Capabilities)**
5. **Employment per Manufacturing Establishment (Organisational Capabilities)**
6. **Capital Goods Imports (Technological Transfer)**

Data of manufacturing sub-sectors for the first five indicators, from the UNIDO INDSTAT2/INDSTAT4 Database, are available for a broad range of countries over time. Data for capital goods imports, from the OECD STAN Database, cover non-manufacturing sectors such as agriculture, mining and services. However, the existing database mainly centers on advanced OECD countries.

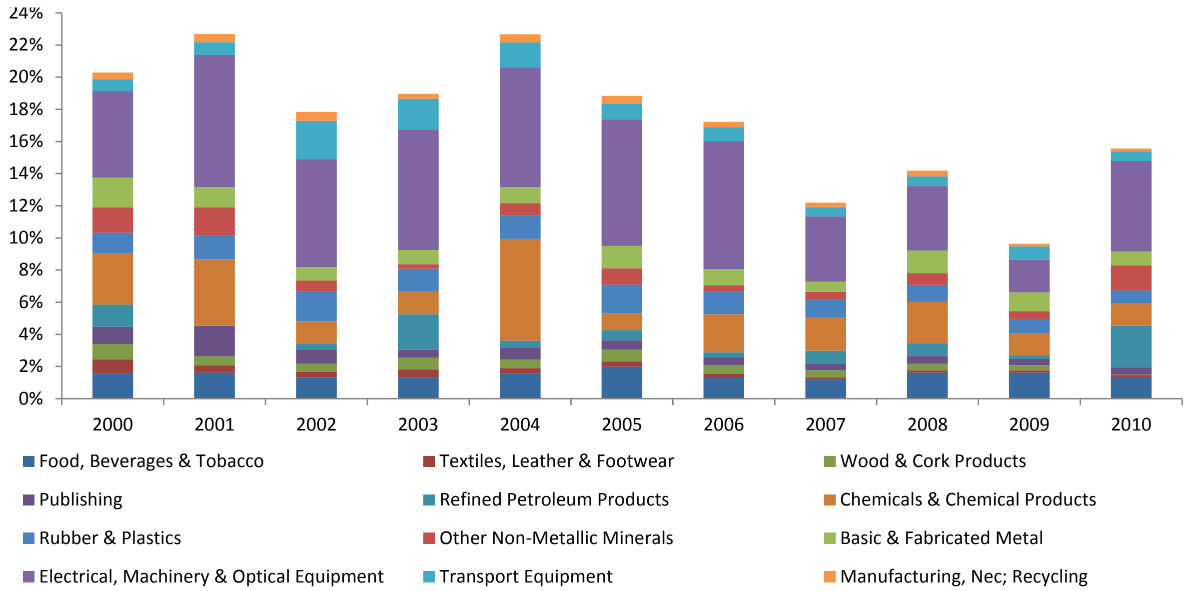
As in the ICS (see Section 3), these indicators shed insight on production capacity, the quantity and quality of the manufacturing workforce, firm size and the extent of technological transfers, with the added dimension that they can be narrowed to specific sub-sectors for analysis.

As an illustration of how these indicators can be used at the sub-sectoral level, we present several examples for three South-East Asian economies (Malaysia, Vietnam and Indonesia). Similar analyses can be applied for other countries and time periods of interest.

Figure A highlights the evolution of investments in Malaysia's manufacturing industries over time. Between 2000 and 2010, manufacturing has generally comprised between 10-23% of total GFCF. During this period, the electronics industry was a major recipient in domestic GFCF. The chemicals industry also received a significant share of total GFCF, although its investments tended to be lumpier in specific years. In 2010, the electronics (5.6%), petroleum refinery (2.6%) and non-metallic mineral (1.5%) industries experienced the largest investments in Malaysia's manufacturing sector. By contrast, low-tech industries such as wood and cork product; textiles, leather and footwear; and publishing had significantly fewer investments.



**Figure A: Share of Manufacturing Sub-Sectors in Total GFCF in Malaysia, 2000-2010**

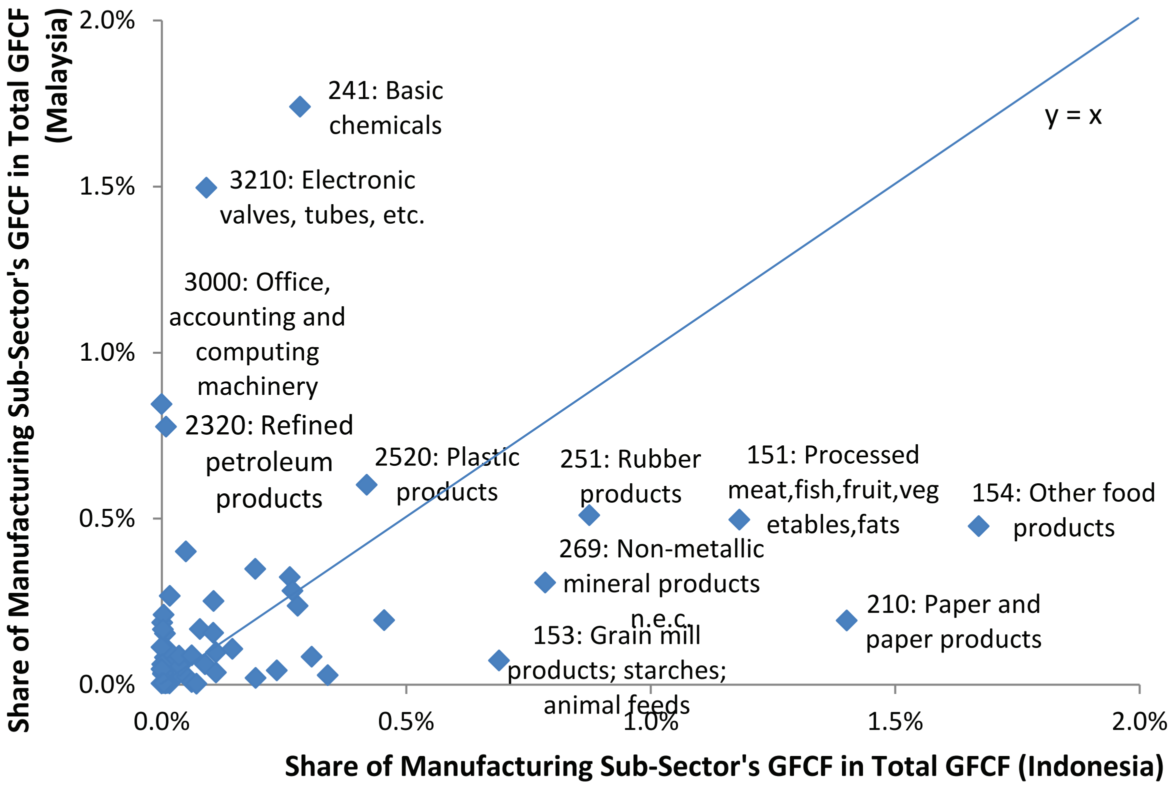



Compared to Malaysia, Indonesia has a more sizeable level of domestic investments. In 2007, the level of GFCF in Indonesia was US$107.8 billion, almost 2.5 times the level in Malaysia (US$43.4 billion). Nonetheless, in terms of the share of manufacturing in total GFCF, Malaysia held a slight edge (12.2%) over Indonesia (11.3%).

Figure B presents a scatter plot of the share of manufacturing sub-sectors' GFCF in total GFCF in Malaysia and Indonesia. If both countries exhibited the same pattern of investment across all sectors, the scatter plot would follow a 45 degree ray from the origin. Deviation from the 45 degree line reveals which industries Malaysia invests relatively more or less in compared to Indonesia.

Both Malaysia and Indonesia differ in the technological intensity of industries that their manufacturing investments focus on. Indonesia invested relatively more in natural resource related (e.g., rubber products) and low-tech industries such as food (e.g., processed meat, fish, fruit, vegetables; grain mill products) and publishing. By contrast, high-tech industries targeted by manufacturing investments in Malaysia included petroleum and chemicals (e.g., refined petroleum products, basic chemicals, and plastic products) and electronics (e.g., electronic valves, office, accounting and computing machinery).

**Figure B: Share of Manufacturing Sub-Sectors in Total GFCF, Malaysia vs. Indonesia, 2007**



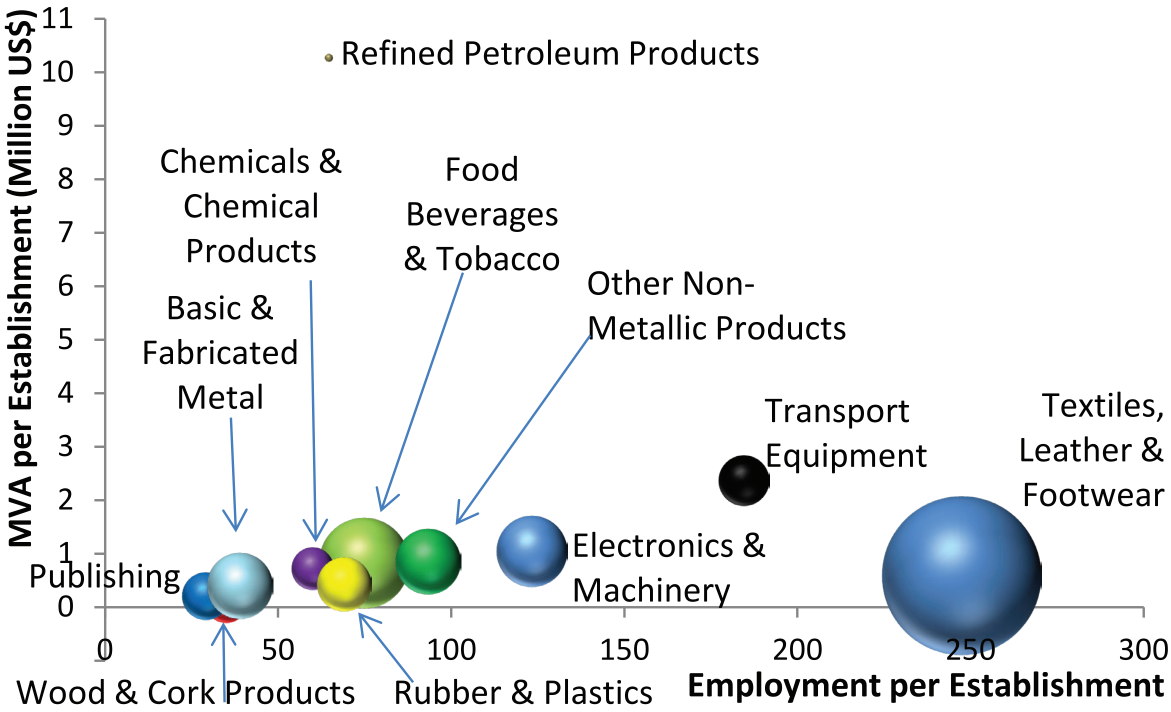

Note: The latest-available year for GFCF data for Indonesia was for 2007.

Figure C show indicators that reflect the average firm and employment size for manufacturing sub-sectors in Vietnam. Reflecting its production capacity, the petroleum refinery industry had the largest MVA per establishment in 2010. Nonetheless, the industry scored less well on individual capabilities indicators with its tiny employment base (indicated by the size of the bubble). Apart from the transport equipment industry (US$2.3 million), the other industries' MVA per establishment hovered between US$100,000 and US$1 million.

In terms of employment per establishment, the textiles, leather and footwear industry fared the best, followed by the transport equipment industry. Each firm in the former industry was more than twice the size of a firm in the electronics and machinery industry, suggesting better organisational capabilities (see Section 3). The textiles, leather and footwear industry also employed the most workers in Vietnam's manufacturing sector. By contrast, the publishing, wood and cork, and basic and fabricated metal industries tended to be more fragmented with smaller firms that employed fewer workers on average.



**Figure C: Firm and Employment Size by Manufacturing Sub-Sectors in Vietnam, 2010**




The approach to narrow the ICS indicators at the sectoral level is limited by data availability, and as such does not capture the full range of industrial capabilities identified in the ICS. For example, we do not have information about production capabilities in different sectors – i.e. skills profiles – or investments in R&D activities in different sectors.

Given the lack of input data at the sectoral level for the construction of industrial capabilities indicators, the above approach can be complemented by other output-based proxies. For example, trade-based indicators have been widely used to proxy the industrial capabilities of countries and might be 'scaled down' to the sectoral or product-related sectors levels.

These analyses have been mainly developed as substitutes for direct measures of country-level capabilities (for a detailed discussion of the following diagnostics see Andreoni, 2011). The three most common methodologies/indexes are:

- the 'Sophistication index' introduced by Lall and associates (Lall et al. 2005; see also

UNIDO 2009),

- the 'PRODY index' and 'EXPY index'
- the 'Method of Reflections' developed by the Harvard Research Group on Economic Complexity. The most important innovation of this latter group has been the 'method of reflections' which has been proposed as a way of solving a fundamental problem of 'circularity', that is, "rich countries export rich-countries products" (Hidalgo and Hausmann, 2009).



In a nutshell, trade-based indicators infer country-level industrial capabilities on the basis of the degree of complexity/sophistication shown by the products exported by countries in global trade (see Andreoni, 2011 for a review). Trade-based indicators aim to classify exports and thus rank countries according to their export-basket. The different methodologies proposed share the following analytical premises:

- The complexity/sophistication of a product is a function of the production capabilities it requires for its manufacture
- Exported goods are more sophisticated the higher the average income of the exporter (assumption)
- By looking at countries' export basket we can infer the degree of complexity/sophistication of a country's technological and production structure (assumption)

These methodologies build on a richer and more granular database for the assessment of countries' industrial capabilities and, thus, they might be adapted for analysing industrial capabilities at the sectoral or product-related sectors levels. However, they also present problems and limitation (Andreoni, 2011). Among them, the most immediate limitations are:

1. the degree of complexity/sophistication of a given product is extrapolated from an '*income content*' measure, rather than from an 'engineering content' measure;
2. the fact that industrial capabilities are proxied only by export data introduces an *export bias* in the analysis: independently from the capabilities required for producing a certain good or components for the internal or external market, export-oriented countries will be automatically considered having more industrial capabilities;
3. as industrial capabilities need time to develop, these analyses will have a *time lag problem*: this means that they reveal more what kind of industrial capabilities countries have been accumulating in the past, rather than what industrial capabilities countries are currently developing.

These problems could be addressed in a dedicated tool for the analysis of sectoral or product-related sector levels industrial capabilities.

# 6. Link to Other Areas

The analytical framework behind the industrial capabilities scoreboard (ICS) links explicitly the different types of industrial capabilities to a number of output variables considered in other tools (All Tools capturing Industrial Output performances). As discussed in sections 1 and 2, countries' industrial capabilities are the main 'drivers' and 'enablers' of countries' industrial competitiveness. Therefore, factor component analysis and other econometric analyses could be performed in order to better understand the explanatory power of the industrial capabilities drivers and enablers. As discussed in section 3 and shown in section 4, another way to link industrial capabilities indicators to the other tools is to compare countries experiences at the same stage of manufacturing development, as proxied by MVA per capita. Finally, the analysis has shown how the same indicator (e.g. wages) may be used to proxy different aspects (e.g. increasing productivity and better working conditions).

# 7. Possible Data Sources

The indicators in the paper were obtained from the following sources. A complete database for computing the indicators included in the Industrial Capability Scoreboard (ICS) is attached to the tool in electronic format. This database constitutes an integral part of the tool.

| Source | Database | Availability |
| --- | --- | --- |
| Barro-Lee | Barro-Lee Educational Attainment Dataset | http://www.barrolee.com/ |
| International Organization for Standardization (ISO) | ISO Survey | http://www.iso.org/iso/iso-survey |
| International Telecommunication Union (ITU) | ITU World Telecommunications Indicators Database | http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx |
| Organisation for Economic Co-Operation and Development (OECD) | STAN Bilateral Trade in Goods by Industry and End-use Database | http://stats.oecd.org/Index.aspx?DataSetCode=BTDIXE_I4 |
| United Nations Educational, Scientific and Cultural Organization (UNESCO) Institute for Statistics | UIS.Stat | http://data.uis.unesco.org/ |
| United Nations Industrial Development Organization (UNIDO) | INDSTAT2/INDSTAT4 | CD-ROM or http://stat.unido.org/ |
| World Bank | World Development Indicators | http://data.worldbank.org/data-catalog/world-development-indicators |
| World Intellectual Property Organization (WIPO) | WIPO IP Statistics Data Center | http://ipstats.wipo.int/ipstatv2/ |

# 8. References And Further Readings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