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Improving the Performance of Ethiopian Universities in Science and Technology

A Policy Note

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Abbreviations and Acronyms

ACE Africa	Higher Education Centers of Excellence Project
ACEWM	Africa Higher Education Center of Excellence for Water Management
CTE	College of Teacher Education
EQA	External Quality Assurance
ESDP V	Education Sector Development Program V
GDP	Gross Domestic Product
GII	Global Innovation Index
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoE	Government of Ethiopia
GTP II	Growth and Transformation Plan II
HEIs	Higher Education Institutions
HEMIS	Higher Education Management Information System
HEP	Higher Education Project
HERQA	Higher Education Relevance and Quality Agency
HR	Human Resources
IBE	Institute for Scholarship
ICS	Intellectual Capital Statements
ICT	Information and Communication Technology
IDF	Institutional Development Fund
IQA	Internal Quality Assurance
LFS	Labor Force Survey
MIS	Management Information System
MSI	Millennium Science Initiative
MOUs	Memoranda of Understanding
NGOs	Nongovernmental Organizations
NMMU	Nelson Mandela Metropolitan University
NRF	National Research Fund
PASET	Partnership for Skills in Applied Sciences, Engineering and Technology
QA	Quality Assurance
QIF	Quality Enhancement and Innovation Fund
R&D	Research and Development
RSIF	Regional Scholarship and Innovation Fund
S&T	Science and Technology
SDGs	Sustainable Development Goals
SIDA	Swedish International Development and Cooperation Agency
SMEs	Small and Medium Enterprises
STI	National Science, Technology, and Innovation Policy
TVET	Technical and Vocational Education and Training
UNESCO	United Nations Educational, Scientific and Cultural Organization
WIPO	World Intellectual Property Organization

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Executive Summary

Introduction and Objective

The Government of Ethiopia (GoE) has demonstrated commitment to expand higher education science and technology (S&T) programs to spur and support its growth and transformation agenda. Ethiopia has made a tremendous advance in access to higher education over the past decade. This rapid expansion, however, has raised concerns about quality. Many students are entering universities with a low level of academic preparation and a weak mastery of English. Qualified faculty are in short supply, especially in science and technology. The Higher Education Relevance and Quality Agency (HERQA) was established in 2003 to implement a quality assurance system for higher education, but it lacks the resources to carry out its mission.

The purpose of this report is to identify the main challenges facing the sector and propose a policy agenda to address them. Our analysis is based on information from the Ministries of Education and of Science and Technology of Ethiopia, a review of relevant literature from Ethiopia and elsewhere, and an analysis of data and information collected from stakeholders at public and private universities through semi-structured interviews.

The report contains five chapters. Chapter 1 presents background information and the study's methodology. Chapter 2 provides broader analysis of demand for skills, graduate employability, feedback from employers on skill supply and the relationship with the economy at large. The next Chapter analyzes the recent developments in S&T higher education. Chapter 4 assesses the research performance of Ethiopian universities. Concluding Chapter 5 summarizes the key reform options and policy measures to improve the performance of the higher education S&T system.

Context

Ethiopia has achieved strong and inclusive economic growth. It has been one of the world's fastest growing economies, with gross domestic product (GDP) growth averaging 10.9 percent per year since 2004. In recent years, the country has also demonstrated an impressive track record of poverty reduction. Since 2000, when Ethiopia had one of the highest poverty rates in the world of 55 percent, extreme poverty fell to 33 percent in 2011. The medium-term growth outlook remains overall positive.

The GoE's aspiration is that the country would achieve middle-income status by 2025. This requires, in turn, a significant increase in productivity in agriculture; the gradual transformation of the Ethiopian economy from agriculture to industry and services; and heavy investment in backbone infrastructures such as roads, railways, energy, and telecommunications. The Government also aims to build a climate-resilient green economy, develop renewable energy projects and leapfrog to energy-efficient technologies in transport, industry, and construction, as identified in the Growth and Transformation Plan II (GTP II). The mining, chemical, petro-chemical, and pharmaceutical, construction, transport, information and communication technology (ICT), and agro-processing industries are all to be developed. Development of the national quality infrastructure is another important endeavor, including for standardization practice, conformity assessment services, metrology, and accreditation, to support expansion of

products and services into the new export markets. The Government is building new industrial parks and is increasing capacity in power generation along with the completion of transmission lines to neighboring countries (Sudan and Kenya) which is expected to improve export performance and stimulate growth in the short to medium term.

Increasing urbanization and huge infrastructure deficits catalyze the demand for engineering, technology and applied science solutions to areas such as water and sanitation, power generation and supply, environmental management, transportation and communications. There is also increasing demand for middle- and high-skilled occupations and education system needs to produce relevant skills for changing demands. These developments call for effective contribution of higher education, through high-quality graduates, especially in S&T, relevant research, and close links between the universities and the productive sectors.

The GTP II underlines the importance of "enhancing the national research and technology capacity of the country." The five-year plan recognizes the crucial role of higher education as a driver of competitiveness and growth and envisages special support for S&T programs and the establishment of several Centers of Excellence. The Government has also approved the Education Sector Development Program V for 2015/16–2019/20 (ESDP V) and the National Science, Technology, and Innovation (STI) Policy, strengthening regulatory framework for the sector. The policy documents set ambitious targets for the expansion and promotion of equity in the subsector.

Advances and Challenges in Science and Technology Higher Education

The Government has significantly expanded access. In 2004/05–2014/15, the number of public higher education institutions (HEIs) increased from 8 to 36. The number of private HEIs has also increased, reaching over 100 institutions. Overall enrollment multiplied fivefold since 2005, and now stands at 762,000, with more than 85 percent of students in public HEIs. Ethiopia has reached the Sub-Saharan African average with a gross enrollment ratio of about 10 percent; though further progress will be needed to reach the ESDP V target of 15 percent by 2019/20. Ethiopia has implemented a 70:30 technology and science to social sciences and humanities student admission ratio, which, despite dropouts, was close to that goal for undergraduates in 2014 (63:37 overall).

In light of the rapid expansion, the system is under pressure on multiple fronts and must employ more staff, increase the number of PhD holders and focus on their career development, provide more books, build more laboratories and so on. The main challenges in the higher education system concern the qualifications of academic staff, the quality and relevance of science and technology programs, and the research capacity of universities.

Faculty Qualifications and Training

The rapid expansion of higher education in Ethiopia has increased the demand for qualified academic staff. Between 2010 and 2015, the number of academics increased by 58 percent to more than 27,000 members, of which about 1,000 are expatriates. The Government has moved to address staffing needs by (a) expanding master's and PhD programs in the first-generation universities, (b) training Ethiopian students abroad, (c) attracting qualified expatriates (by providing better remuneration packages compared to their Ethiopian colleagues), and (d) covering staff gaps through the contracting of academic staff on a part-time basis in other HEIs, in addition to their

work in the primary employing institution. In the last decade, the Government has accelerated the production of postgraduate degree holders, who are the natural candidates for faculty recruitment. Enrolment in PhD programs has increased from a low base of only 258 in 2007/08 to around 800 in 2010/11 and over 3,150 since 2012/13.

Still, many faculty members are underqualified. Currently, 29 percent of faculty members have only an undergraduate degree. The situation is of particular concern in the engineering and technology fields, with 56 percent of faculty holding a bachelor's degree. Also, only about 15 percent of staff hold PhDs. The statistics clearly shows that Ethiopia needs to ramp up the production of graduates with a doctoral degree. Ghana and Vietnam presently produce 5 times more PhDs per million inhabitants than Ethiopia every year and Senegal 22 times.

Existing performance assessment systems do not work well in practice. Regular high-quality performance assessments can motivate staff to continue improving. But current performance assessment falls short of this goal. This is partly because the assessments are similar for all academic staff, regardless of their discipline, but also because they are often not shared with faculty. Universities also do not have flexibility in determining performance-based remuneration packages.

Few universities offer professional development programs for young staff or established faculty. There is also no evaluation of delivered programs to improve their quality and relevance. Each university should have staff development units with experts capable of organizing and delivering professional staff development programs. Inter-university cooperation is also vital for this purpose, particularly for countries like Ethiopia, which have great need for strong professional development but little experience in the field. The Africa Centers of Excellence Project II is a good example of such cooperation designed to address critical human resource gaps in higher education.

Women are also poorly represented on university faculties. Women currently comprise just 10 percent of academic staff. Only 33 percent of undergraduate students are women, with much lower numbers in science and technology programs. The Government, recognizing that it needs to make progress in harnessing the full human capital of its people, has plans to increase the undergraduate enrollment of women to 45 percent and raise their share in PhD programs to 20 percent.

Links Between Science and Technology Programs and Industry

Most current and planned industrial parks are built near the top ten public universities which train 63 percent of all undergraduate students in public engineering and technology programs. These top ten HEIs, together with the recently established Addis Ababa Science and Technology University (2011), could help Ethiopia overcome the disadvantages of being a latecomer in technological catching-up and support the national industrialization and growth agenda.

However, universities are not sufficiently engaged with industry, including in designing their science and technology programs. Although skills gaps are not the most pressing constraint firms face at the moment, skills concerns are on the rise. An increasing number of firms in dynamic and growing industries report that skills gaps limit their productivity and ability to grow. These are manufacturing firms (in particular textile, garments and food producers), export businesses, and large firms with foreign ownership. Collaboration with employers would promote innovations in

the curriculum and pedagogical practices to target the skills needed in the workplace. Further, universities do not have good information about what happens to their students when they enter the job market or what employers think about the skill base of the students they hire. The lack of modern management and information systems means that Ethiopian universities do not have the information they need to make improvements in their programs and operations.

Career counselling, with input from industry, is in short supply. Universities recognize that they need to do more to offer students opportunities for work placements and paid internships, as well as opportunities to hear alumni and guest speakers. Graduate tracer studies and employers' surveys are needed to get better information about the distribution of skills among new hires, as well as the demands for those skills from different economic sectors.

Another challenge is the high degree of similarity and duplication in program offerings and disciplines across the sector. Despite the stated objectives of differentiation and excellence, the higher education system is expanding without much differentiation in academic program offerings, leading to duplication of resources and lower quality.

Quality assurance systems are limited. The HERQA was established in 2003 and is responsible for promoting external quality assurance processes. In 2011 it has put a number of private institutions on probation, and closed 5 private HEIs for quality reasons. However, this study exposed widespread concerns about the agency's efficacy, which are linked to its limited resources: its small staff, difficulty in attracting accomplished experts and a focus on private institutions. Also, because it lacks independence from the ministry, there are potential conflicts of interest.

Research Output

There is a serious lack of research capacity in Ethiopian universities. The bulk of the research output in Ethiopia is produced by academics at the major universities, including Addis Ababa University, Haramaya University, Jimma University, and Mekelle University, and several research institutes which contribute to the overall scientific production in agriculture, medical and health research. At the same time, engineering research between 2005 and 2009 was still at the nascent state, with only 2 percent research output of the total. Although Ethiopia has recently made considerable progress in research output relative to the country's population, it is starting from a much lower base than most other countries. The output and impact of the research produced by Ethiopian universities are still very low.

Research funding is targeted to a handful of universities. Ethiopia's total research funding (0.6 percent of GDP) is on a par with leading African countries, but universities receive very little of that funding, and what they do receive is heavily concentrated in just a few institutions. Out of Ethiopia's 34 public universities, three of them (Addis Ababa University, Mekelle University and Addis Ababa Science and Technology University) capture the lion's share of the competitive research funding provided by the Ministry of Science and Technology.

The Government should consider innovative funding mechanisms for research, develop a clear science and technology development strategy, and establish a more flexible governance framework for research-intensive universities. Universities should be encouraged to forge partnerships with leading institutions in other countries for capacity building and joint research purposes and to

develop close linkages with the productive sectors, particularly in the key priority areas of economic growth identified in the Government's strategy.

Scientific infrastructure necessary to conduct research is often lacking. Very few universities have sufficient number of researchers and the scientific infrastructure necessary to conduct research in a meaningful manner, even among the nine oldest universities in the country. Despite significant efforts to invest in new laboratory facilities, many departments lack the up-to-date scientific equipment needed for advanced research, even in the two new Science and Technology Universities. Access to broadband is also unequal across the universities.

The lack of information on research funding and activities is a paramount problem at both national and institutional levels. Neither the Ministry of Education nor the Ministry of Science and Technology have the overall picture of research expenditures and research output in Ethiopia. This is the direct result of the universities' lack of capacity to track the publications and other research products of their academic staff.

Because of the rapid growth in enrollments, academic staff have heavy teaching loads and cannot make much time for research. In addition, the low salaries drive many of them to also teach in private universities or take on consulting assignments to make ends meet. This is an important impediment to the development of the research capacity of Ethiopian universities.

Recommendations

Overall, the ongoing expansion of S&T higher education as well as research production should be managed carefully and should be driven by country's economic and social needs and priorities.

Priority Area 1. Strengthen the quality of academic staff

1. Create incentives for current faculty members to pursue advanced degree programs.

2. Support institutional and system-wide faculty development including through twinning with S&T HEIs and regional initiatives such Partnership for Skills in Applied Sciences, Engineering and Technology (PASET) and Africa Higher Education Centers of Excellence Project (ACE).

3. Ensure the availability of accurate and reliable data for staff management in S&T programs (staff qualifications, research outputs, disciplinary orientation, inbreeding and so on; benchmarking within the PASET initiative, specialized studies on motivation and job satisfaction of faculty members, and so on).

Priority Area 2. Improve quality of S&T higher education programs and their relevance to growth and transformation goals

1. Strengthen the external quality assurance (EQA) system and its capacity to implement its mandate (through implementation of the HERQA's 2016 review recommendations)

2. Improve the internal quality assurance (IQA) system within each university, with close involvement of academic staff and students

3. Promote innovations in curricular and pedagogical practices to improve the relevance of S&T programs through their redesign and implementation in collaboration with employers

4. Ensure regular tracer studies to determine the employability of students and the relevance of programs to support their alignment with the needs of the economy

5. Create a system for collection, analysis, and dissemination of information on labor market outcomes of university graduates, vacancies and skills needs of employers

6. Develop student support services in S&T programs, including career counseling

Priority Area 3. Build up the capacity of universities to produce research and technology products responsive to economic needs and priorities

1. Provide competitive capacity- building grants to support those universities aspiring to become research- intensive institutions (master's and PhD training, labs, and equipment for advanced scientific infrastructure).

2. Provide competitive research grants in S&T domains aligned with the country's competitiveness priorities (funding for specific research projects, partnerships with industry, and partnerships with foreign universities).

3. Establish an appropriate governance and funding framework for the development of applied S&T university research.

Table 1. Key Policy Measures Suggested in the Study

Policy Objective	Issue	Recommendations	Expected impact
Enhanced quality	• Underdeveloped quality enhancement mechanism	• Provide support to HERQA to fully implement its mandate; • Strengthen the EQA system (through implementation of HERQA's 2016 review recommendations); • Improve, on a continuous basis, the IQA system within each university, with close involvement of academic staff and students; • Develop student support services in S&T programs, including career counseling.	• Conditions established for enhancing the quality and relevance of S&T programs, consonant with the social, economic, and employment priorities of the country (GTP II goals)
	• Shortage of qualified academic staff in the system	• Create incentives for current faculty members to pursue advanced degree programs; • Support institutional and system-wide faculty development (including through twinning with S&T HEIs and regional initiatives such as PASET and ACE) • Ensure the availability of accurate and reliable data for staff-related decision-making in S&T programs (staff qualifications, research outputs, disciplinary orientation, inbreeding, and so on; benchmarking within the PASET initiative, specialized studies on motivation and job satisfaction of faculty members, and so on).	• Better quality academic staff to ensure quality instruction in S&T programs • Improved quality of education programs
Improved relevance	• Weak links with the industries • Rising skills concerns • Lack of information about system and universities' performance	• Ensure regular tracer studies in S&T programs to determine the employability of students and the relevance of programs to support their alignment with the needs of the economy; • Create a system for collection, analysis and dissemination of information on labor market outcomes of university graduates and vacancies and skills needs of employers • Promote innovations in curricular and pedagogical practices to ensure the relevance of S&T programs through their redesign and implementation in collaboration with employers	• Improved relevance of education programs to economic needs and priorities • Evidence-based decision making • Improved accountability through provision of relevant information on the quality and relevance of S&T HEIs programs (graduation rates and salaries by occupations and sector of employment, job satisfaction). This would serve to make universities more transparent and accountable for government investments, while also leading to better career and educational choices among the population

Policy Objective	Issue	Recommendations	Expected impact
Research output	• Limited research and innovation • Lack of adequate laboratory equipment and connectivity	• Provide competitive capacity-building grants to support those universities aspiring to become research intensive institutions (Master's and PhD training, labs and equipment for advanced scientific infrastructure) • Provide competitive research grants in S&T domains aligned with the country's competitiveness priorities (funding for specific research projects, partnerships with industry, and partnerships with foreign universities) • Establish an appropriate governance and funding framework for the development of applied S&T university research	• Improved quantity and quality of research output • Research output responsive to the national growth and transformation agenda and local agenda

Chapter 1. Introduction

1.1. Background

The innovative application of knowledge has become a fundamental driver of social progress and economic development. Advanced knowledge and modern technologies are also influencing the pace of competition and transforming the nature of labor market needs through substantial shifts in the configuration and content of jobs. In this context, higher education systems play a critical role in supporting knowledge-driven economic growth strategies and the construction of democratic, socially cohesive societies (World Bank 2002). Higher education is indispensable for the effective and efficient creation, dissemination, and application of knowledge and for building institutional, professional, and technological capacity.

Furthermore, a strong higher education system is essential for any developing country—notably low-income nations—keen on achieving the United Nations Sustainable Development Goals (SDGs). Besides the specific goals for the education sector (SDG 4), evidence from Asia points to the essential contribution that higher education can make to the goals of sustainable economic growth (SDG 8) and poverty reduction (SDG 1) (World Bank 2012b). Moreover, advances on all the other dimensions, from developing a vibrant agricultural sector through higher productivity and innovation to building up a resilient infrastructure to mitigating the devastating effects of climate change and preserving the environment cannot happen without the participation of scientists, technicians, and well-trained professionals and the application of leading-edge research for finding appropriate solutions to the big challenges faced by mankind. Achieving the SDGs also requires strong institutions for policy design and implementation and well-prepared citizens who care about inclusion and sustainability (Salmi 2016).

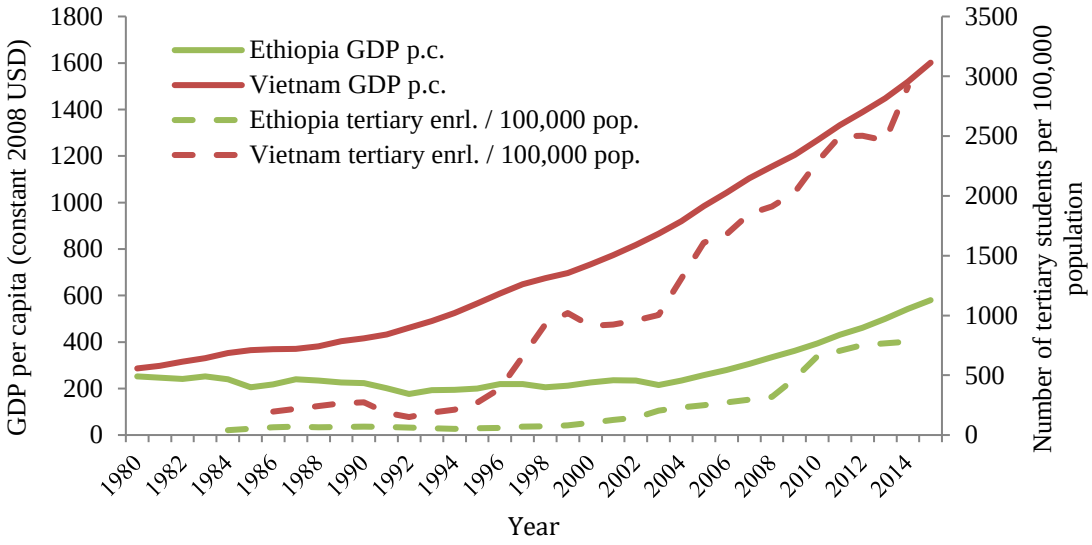
To illustrate the importance of higher education development in relation to economic growth, figure 1 compares the paths of Vietnam and Ethiopia, which share two significant experiences in their recent history. Both countries made the transition from socialism to market economy, and both nations suffered a costly war. There is clear correlation between economic growth and higher education expansion in both countries.[1] Countries with a more highly skilled workforce have seen faster economic growth[2] (figure 2).

Worldwide, the higher education ecosystem is evolving at an increasingly rapid pace, influenced by elements of uncertainty, complexity, and disruption such as changing demographics, global competition, political volatility, diminished public funding, greater private involvement, growing accountability demands, alternative delivery modes, and game-changing technologies (Salmi 2016). In this challenging context, developing countries can either become economically marginalized, incapable of using advanced technology and unable to compete on the global stage because their higher education systems are insufficiently developed and underperforming, or they

[1] The rapid expansion of higher education in Vietnam was made possible, in part, by increased cost sharing: today the Vietnamese public universities receive more than 30 percent of their resources from private sources (fees, contracts, and research grants).
[2] World Bank. 2012a..

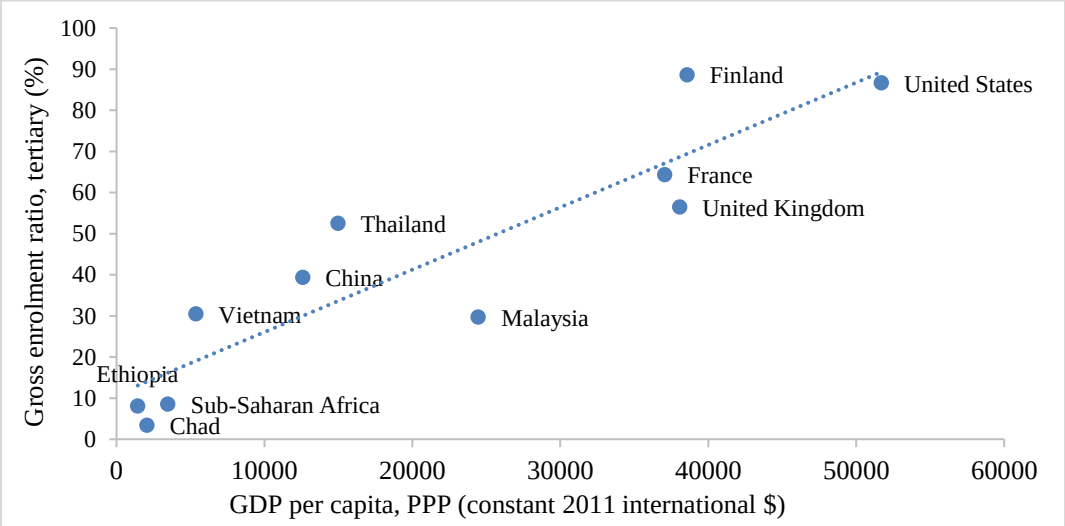
can strengthen their capacity to create and apply knowledge through well-trained graduates and relevant research produced by a diversified and increasingly international higher education system.

Figure 1. Economic Growth and Higher Education Expansion in Ethiopia and Vietnam (1980–2014)



Source: K. Macdonald for this report based on World Bank and United Nations Educational, Scientific and Cultural Organization (UNESCO) databases.

Figure 2. Tertiary Enrollments and Per Capita GDP, 2014



Source: World Bank data.
Note: PPP = Purchasing power parity; GDP = Gross Domestic Product.

Over the past decade, Ethiopia has achieved substantial progress in economic, social, and human development. The GoE's aspiration is that the country would achieve middle-income status by 2025. This requires, in turn, a significant increase in productivity in agriculture; structural transformation of the economy with bigger weight of industry and services; and heavy investment in backbone infrastructures such as roads, railways, energy, and telecommunications. This requires

effective contribution of high-quality graduates, especially in science and technology (S&T), relevant research, and close links between the universities and the productive sector.

1.2. Objectives and Conceptual Framework

Against this background, this Policy Note aims at providing objective elements of diagnosis and a range of policy options based on international experience to guide the GoE in defining the road map for the development and transformation of the higher education system with a focus on the S&T capacities that are critical for the country's development. The report is focused on the three priority areas of the university sector as identified by the Government:

- Strengthening the quality of academic staff, with a focus on S&T faculty
- Improving the quality and relevance of S&T academic programs delivered in Ethiopian universities
- Building up the research capacity of the universities

The Policy Note is based on the analysis of World Bank reports and other available documents, as well as on field visits by a World Bank team that was in Addis Ababa over a two-week span in February 2017. The team met with senior leadership in ministries, agencies, and universities. Interviews with academic staff and students were also conducted. The schedule of the field visits is in appendix 1.

After this contextual introduction, Chapter 2 discusses demand for skills, graduate employability, feedback from employers on skill supply and the relationship with the economy at large. Chapter 3 analyzes the recent developments in S&T higher education. Chapter 4 assesses the determinants of present research performance of Ethiopian universities. The last chapter summarizes the main reform options and policy measures outlined in the previous chapters.

The theory of change and capacity development that guides the organization of this report rests on the premise that, in complex higher education environments, better quality research and teaching outcomes cannot be obtained without the proper alignment of all the key factors contributing to these outcomes. It is not sufficient to focus on one aspect, for example, just injecting large amounts of additional financial resources or financing scholarships to train professors while neglecting the other drivers of performance of HEIs.[3]

Theories of change in basic education point to many factors affecting educational outcomes, such as the quality of teaching, time spent on tasks, the quality of educational facilities, the curriculum, or language of instruction. The complexity is likely to be even greater in the case of HEIs, considering their multiple missions of teaching, research, and service to the community and the local economy.

[3] This theory of change was developed by Jamil Salmi in the context of a recent evaluation of Norwegian Programme for Capacity Development in Higher Education and Research for Development (NORHED), the Norwegian Government's program in support of partnerships with developing countries universities (DPMG 2014).

Unlike what happens at the lower levels of education, the interaction between research and teaching adds a dimension of complication to the measurement of results in tertiary education. Besides inculcating appropriate values and attitudes in young people, the main purpose of primary and secondary education is to transmit existing knowledge. By contrast, a core mission of universities is to create new knowledge, in addition to teaching existing knowledge. The synergy between the production and dissemination of knowledge is one of the characteristics and strengths of universities (Boyer 1990).

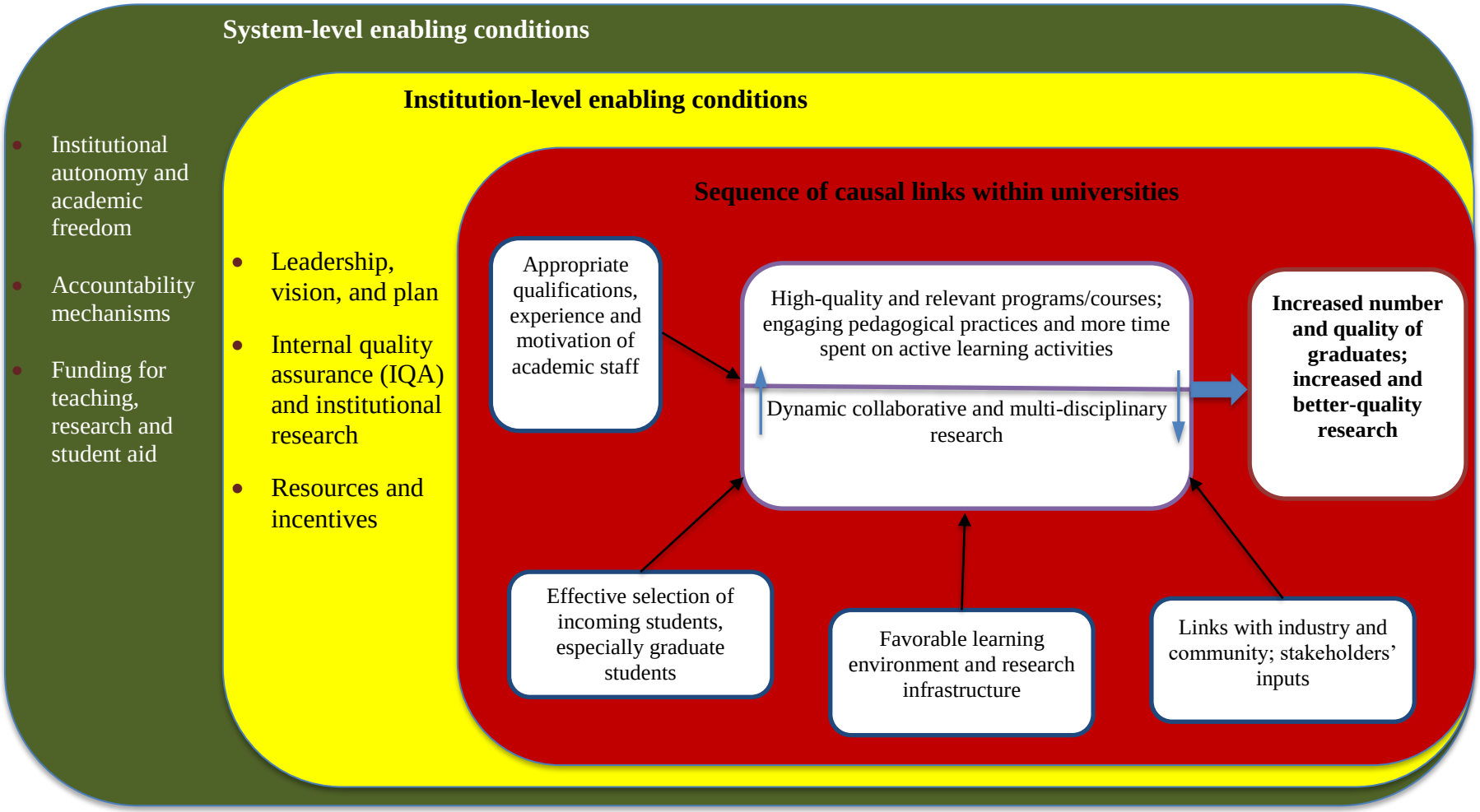
The joint production of education and research makes the separation of results between research output and graduates somehow artificial. The quality of research influences, to a large extent, the quality of teaching and learning. Some studies argue that teaching can also positively influence the direction and quality of research (Becker and Kennedy 2005). This feature of academic life needs to be taken into consideration when examining the determinants of the quality of graduates. For these reasons, the proposed theory of change looks at the causal chain leading to improved research and graduates within a single framework.

Furthermore, the range of monetary and prestige incentives that countries and HEIs used to reward good research and teaching directly affects the behavior of faculty and the likelihood of a strong link between the two activities. For example, under the influence of the global rankings, a growing number of universities are offering special monetary incentives for publications in prestigious international journals, which can result in excessive recognition of research contributions compared to teaching.

Figure 3 represents the general theory of change for increasing the supply and quality of graduates and improving the production and quality of research by strengthening the capacities that affect these two outcomes. After identifying two sets of contextual factors—system-level and institutional-level dimensions—that affect the performance of HEIs by directly influencing their mode of operation, the figure shows a sequence of inputs and intermediary results that, according to the literature, lead to better graduates and research. In this context, staff qualifications and motivation, examined in Chapter 3, are an essential ingredient in the causal chain explaining the results of universities. The elements of quality assurance (QA) analyzed in this chapter of the report are the most important pillar of accountability as part of the system-level and institutional-level conditions and should also be viewed as tools to enhance quality. Chapter 4, focusing on research capacity building, looks at the production of knowledge.

The main implication of this analytical framework is that government programs and donor projects must consider all these dimensions of complexity in the design of interventions in support of higher education development.

Figure 3. General Theory of Change for Producing More/Better-qualified Graduates and More/Higher-quality Research



Chapter 2. Science, Technology, and Development

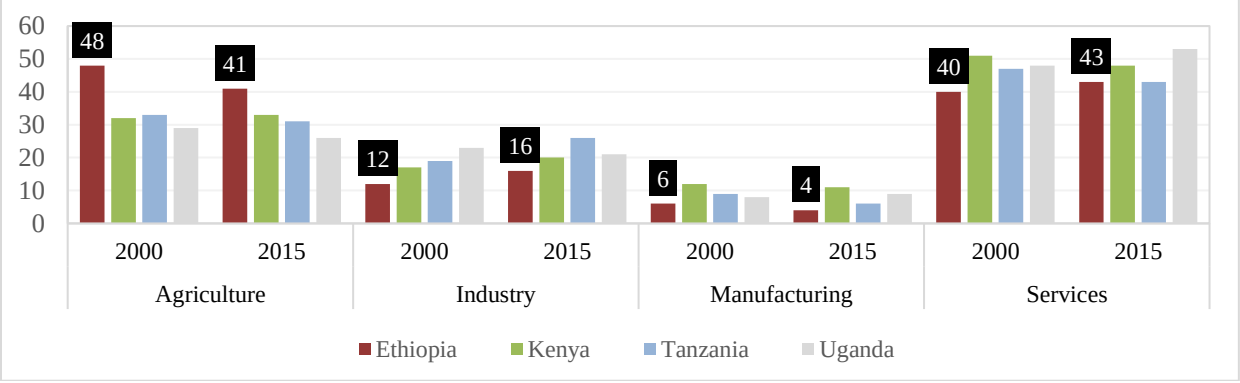
2.1. National Priorities and Demand for Skills

Ethiopia is a large, landlocked, and diverse country with more than 90 ethnic and linguistic groups and a population of over 99 million. With an annual growth rate of 2.5 percent, Ethiopia's population is expected to reach 130 million by 2025. The country has experienced fast economic growth over the past decade. According to official data, real GDP growth averaged 10.9 percent annually (8 percent per capita) in 2004–14. The recent El Niño drought slowed growth in 2015/16. The GDP growth was estimated at 8.5 percent, a rate that still places Ethiopia among the fastest-growing economies in the world. Nonetheless, Ethiopia remains the 13th poorest country in the world. More than 80 percent of the population lives in rural areas, although urbanization is increasing as workers move from agriculture toward more proactive manufacturing and services jobs.

The contributions of different sectors to registered economic growth of 10.3 percent in 2011–14 was as follows: agriculture 2.3 percent, industry 2.7 percent, and service 5.3 percent. In subsectors, the respective contributions were 2.3 percent for wholesale and retail trade, 2.2 percent for construction, 1.9 percent for crops, 1.0 percent for hotels and restaurants, and 0.5 percent for large- and medium-scale manufacturing. The service sector started to produce a larger share of output than agriculture, although the share of the latter continues to be large compared to the neighboring countries (figure 4).

Structural transformation, industrialization, and urbanization have been promoted in line with the country's aspirations to achieve middle-income status by 2025. Massive public infrastructure investment has been at the center of the country's economic strategy to address existing infrastructure deficits and provide conditions needed for subsequent private sector growth. The country has been able to achieve a substantial expansion of energy, road, railway, and telecommunication infrastructure. Roads have been completed to connect Ethiopia with Sudan, Kenya, Somalia, and Djibouti. The big interstate projects include the Modjo-Hawassa-Kenya expressway, which is part of the Cairo-Cape Town Highway project. In addition, Ethiopia and Djibouti recently inaugurated an electrified railway line. Also, with the support of foreign investors, the Government has been actively promoting industrial parks.

Figure 4. Structure of Output (percent)

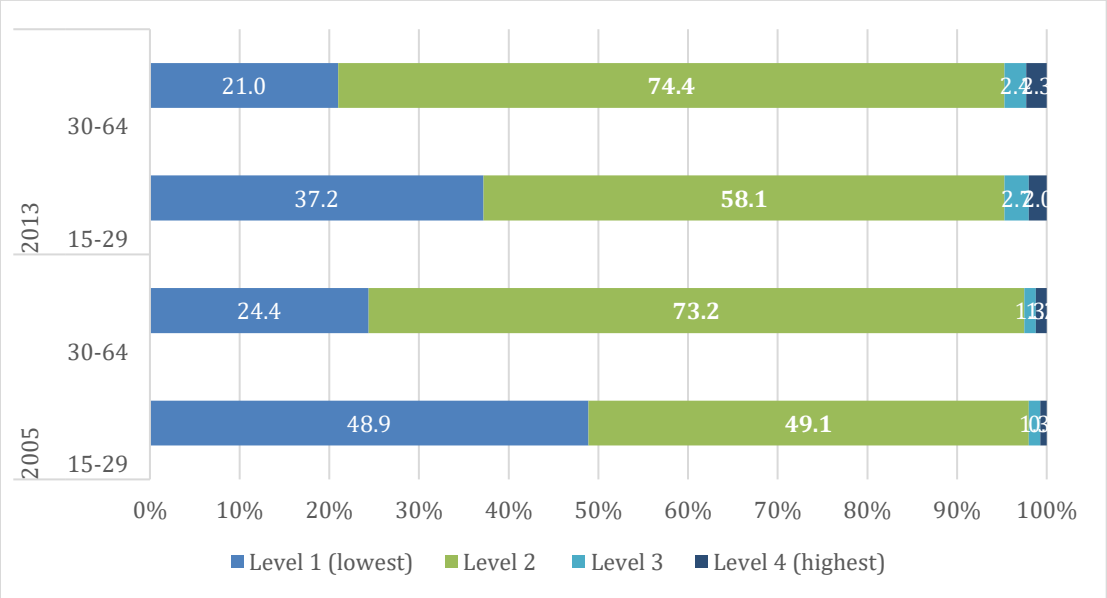


Source: World Development Indicators.

The labor market situation has generally improved over the past ten years. Unemployment decreased from 8 percent in 1999 to 5 percent in 2005 and 4.5 percent in 2013, with a sharper decrease in urban areas (from 26 percent in 1999 to 17 percent in 2013)[4]. Farm employment increased by half in relation to 122 percent increase in the nonfarm sector. Still, in absolute terms agriculture has added 8 million new workers since 1999, compared to 5.5 million for the nonfarm sector. Wage employment in the formal private sector has doubled since 1999 but remains exceptionally low at a mere 2 percent of total employment. The share of wage employment remains small overall, accounting for 12 percent of employment in 2013 compared to 9 percent in 1999.

While the sectoral composition of employment changed only marginally, composition of the workforce has been changing toward middle- and high-skilled occupations (figure 5). Trade and foreign ownership have labor-augmenting effects in Ethiopia. In firms located close to the capital, foreign ownership tends to be associated with increased demand for skilled labor (Haile, Srour and Vivarelli 2013). In 2005–2013, the economy added around 750,000 new skilled jobs (figure 6).

Figure 5. Skills Composition of Employment, 2005–2013

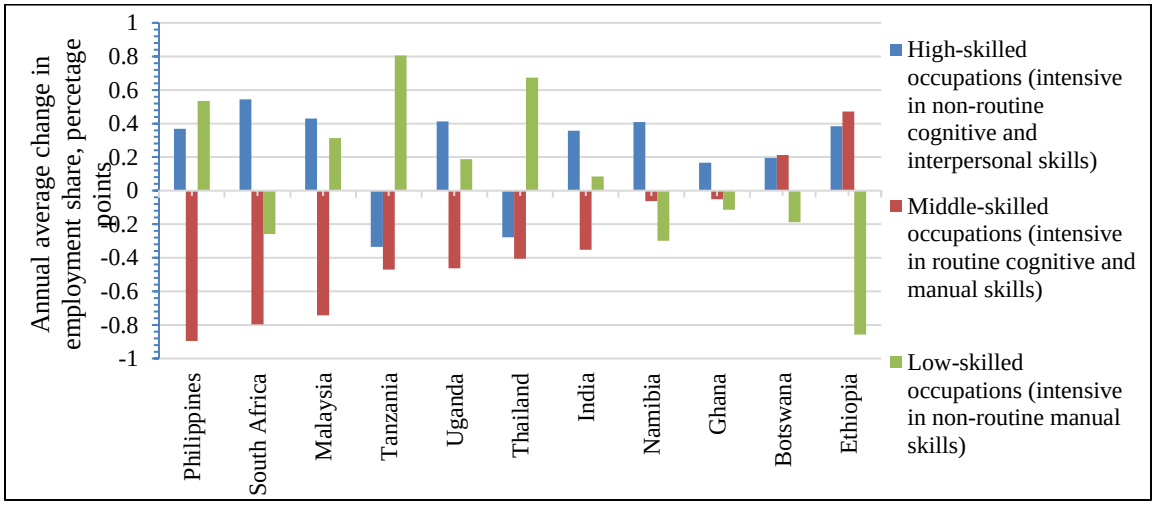


Source: Bundervoet et al. (forthcoming).

In advanced economies and increasingly also in many developing countries there is a decline in the routine middle-skills jobs (World Development Report 2016). Based on technological feasibility, 43.9 percent of all jobs in Ethiopia are estimated to be susceptible to automation, though the effects are currently moderated by the lower wages and time lag for adoption of technologies (figure 7). Lessons from the history of technological changes suggest that the winner-countries will be those with more responsive education and training systems, producing relevant skills for the changing world.

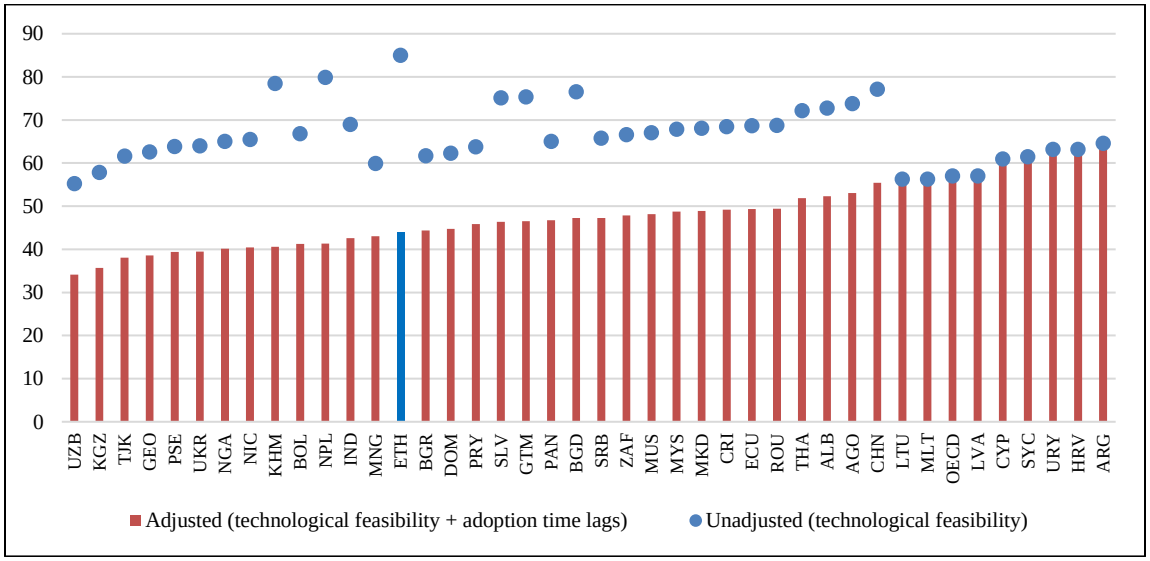
[4] Hill and Mejia-Mantilla 2016.

Figure 6. Changing Demand for Skills in Ethiopia and Comparator and Stretch Countries, Circa 1995–2012



Source: World Development Report 2016.
Note: High-skilled occupations include legislators, senior officials and managers, professionals, and technicians and associate professionals. Middle-skilled occupations comprise clerks, craft and related trades workers, plant and machine operators, and assemblers. Low-skilled occupations refer to service and sales workers and elementary occupations.

Figure 7. Estimated Share of Employment that is Susceptible to Automation



Source: World Development Report 2016.

Ethiopia's development needs and priorities increase the demand for applied S&T solutions (drawing on international knowledge and applying it for local development and growth). Increasing urbanization and huge infrastructure deficits catalyze the demand for engineering, technology, and applied science solutions to areas such as water and sanitation, power generation and supply, environmental management, transportation, and communications.[5] The Government

[5] Ethiopia's urban population is projected to nearly triple from 15.2 million in 2012 to 42.3 million in 2037, growing at 3.8 percent a year (World Bank Group's Ethiopia Urbanization Review 2015). However, in 2015 only 27.2 percent of urban population had access to sanitation facilities, well below 40.4 percent of Sub-Saharan Africa's

also aims to build climate-resilient green economy, develop renewable energy projects, and leapfrog to energy-efficient technologies in transport, industry, and construction, as identified in the GTP II. The mining sector; chemical, petrochemical, and pharmaceutical industries; the construction sector; transport; ICT and electronics; and biotechnology and agro-processing industries also require adequate engineering and applied S&T capacity. Development of the National Quality Infrastructure is another important endeavor which requires appropriate capacity, including for standardization practice, conformity assessment, metrology, and accreditation to support the expansion of products and services into the export markets.

None of these developments can take place without the effective contribution of high-quality graduates, especially in S&T, relevant research, and close links between the universities and the productive sectors. This is particularly important because the lowest scores in the Global Competitiveness Index for Ethiopia appear to be in the areas of technological readiness (132) and higher education and training (129).

GTP II underlines the importance of "enhancing the national research and technology capacity of the country in line with its level of development." In addition to access, equity, and quality targets for higher education, the target for admission by public universities was set at 70 percent of students to S&T programs. GTP II envisages special support for S&T programs and the establishment of several Centers of Excellence, such as high technology and human resources (HR) enrichment centers for mega projects that require a high level of construction technology. The Government has also approved the ESDP V for 2015/16–2019/20 and the National Science, Technology, and Innovation (STI) Policy, strengthening regulatory framework for the sector. The policy documents set ambitious targets for the expansion and promotion of equity in the subsector with the overarching aim of ensuring "quality and relevance [of education] in public and private higher education institutions."

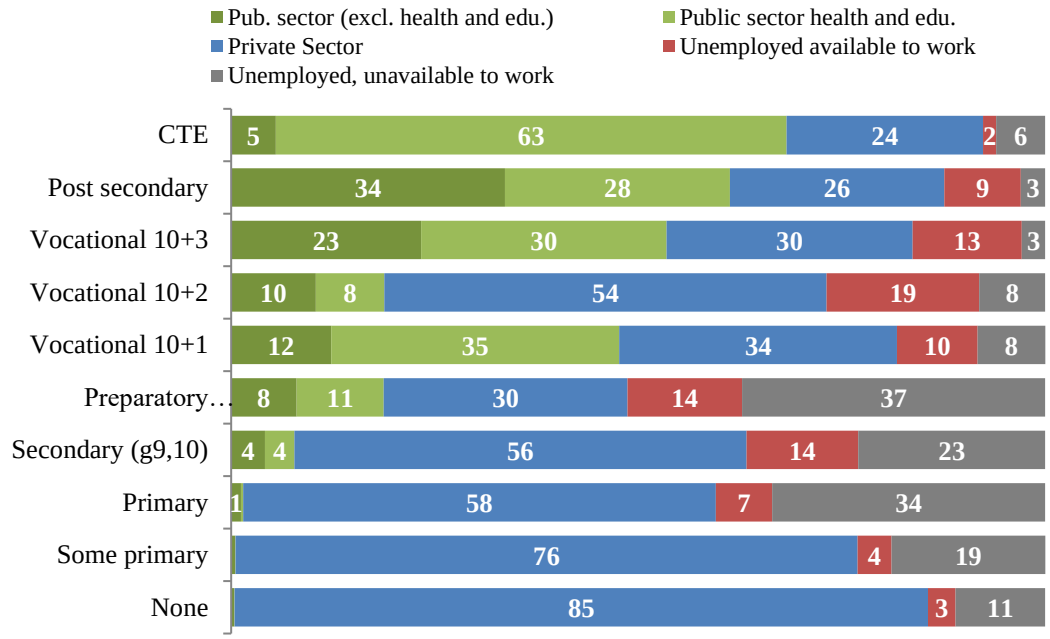
With regard to expansion of the sector, the ESDP V aims to increase the gross enrollment ratio in higher education from 9.4 percent in 2014/15 to 15 percent by 2019/20. The ESDP V recognizes that this step in the next five years "will move Ethiopia halfway towards a lower middle income average of GER for higher education, which currently stands at 22 percent." The Government has defined intermediary targets to achieve the long-term objectives of the plan. To increase the enrollments and improve access for underserved groups, 11 new universities are being established across the regions in Ethiopia. Postgraduate enrollments are expected to double and first-tier universities are expected to expand the number of PhD students enrolled by the sector. The plan is also to improve the relevance of research and strengthen the technology transfer capacity of universities through partnerships with industry and incubation centers.

The impact of tertiary education on employment tends to be positive. Share of persons with tertiary level of education among the unemployed is lower than the share of the labor force with the same educational level as shown in annex 2 suggesting that education protects from unemployment. An analysis of 2013 data is captured in figure 8, which show that the public sector absorbs a higher percentage of the labor force with higher education than the private sector.[6]

average. Municipal sewerage system is available only in Addis Ababa and serves a mere 10 percent of its population. Ethiopian cities also struggle to manage solid waste. Access to electricity and road density remain low.

[6] Kevin Macdonald for this report.

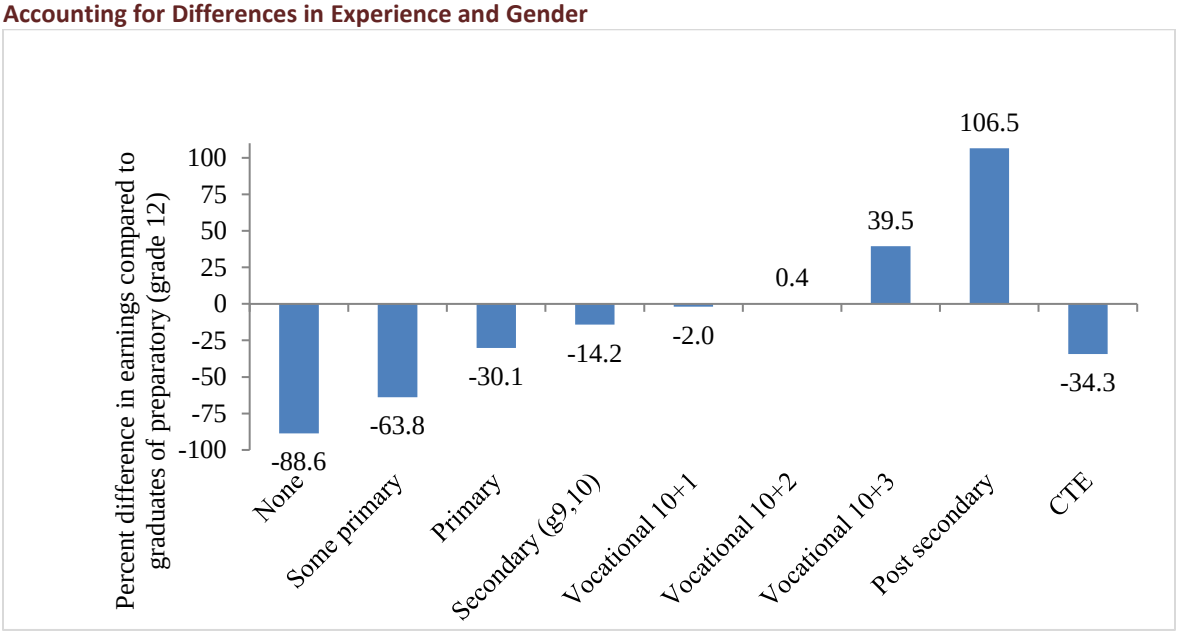
Figure 8. Labor Market Status by Highest Level of Education Completed - Ages 15 to 30



Source: Labor Force Survey (LFS) 2013.
Note: CTE is College of Teacher Education.

Furthermore, those with post-secondary education earn 106.5 percent (2.06 times) higher monthly earnings than those who have completed grade 12 (this is the preparatory level and is the base level in figure 9). However, there are rising concerns about the skill sets of the graduates produced by the education system.

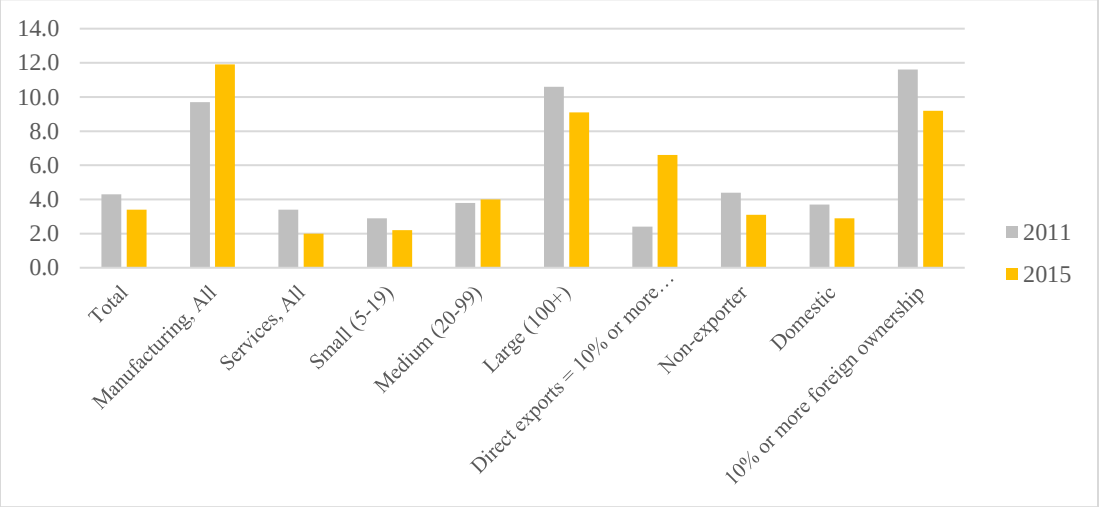
Figure 9. Labor Force with Higher Education Earns Over Twice As Much As Those with Secondary Education Accounting for Differences in Experience and Gender



Source: LFS 2013 (estimates of a Mincer earnings function).
Note: This figure is only about wage earners. The incomes of those working on own account or in subsistence farming are not included.

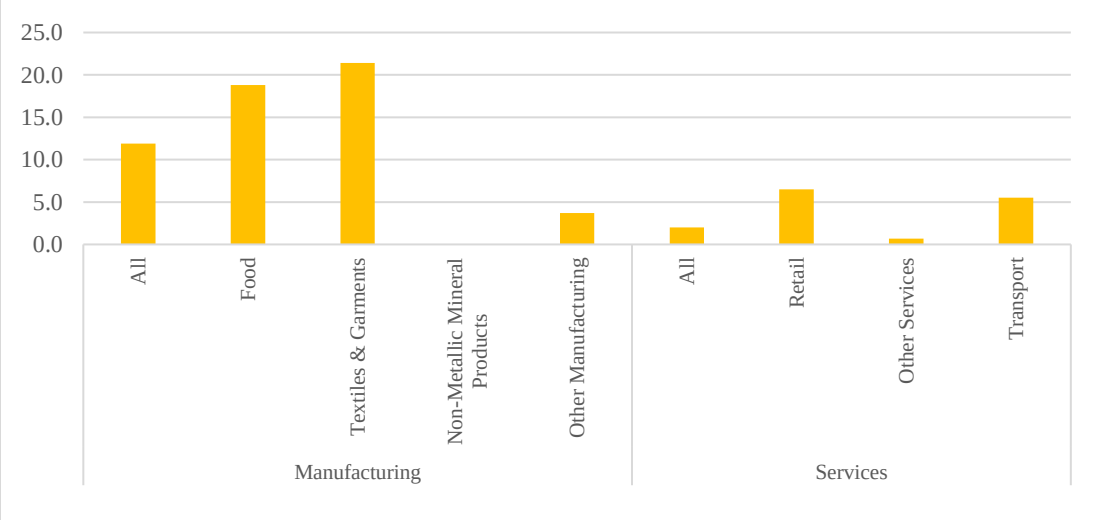
While the percentage of firms in Ethiopia identify an inadequately educated workforce as a major constraint to their operation and growth is quite low (3 compared to 19 for Sub-Saharan Africa), figures 10 and 11 show that skills concerns are on the rise for manufacturing firms (particularly in textile, garments, and food producers) and exporters. In addition, 9 percent of large firms and companies with foreign ownership view skills as one of the binding obstacles to their operation and growth.

Figure 10. Firms Rating Inadequately Educated Workforce As a Major Constraint (percent)



Source: World Bank Enterprise Surveys data.

Figure 11. Skills As a Major Constraint by Subsectors, 2015



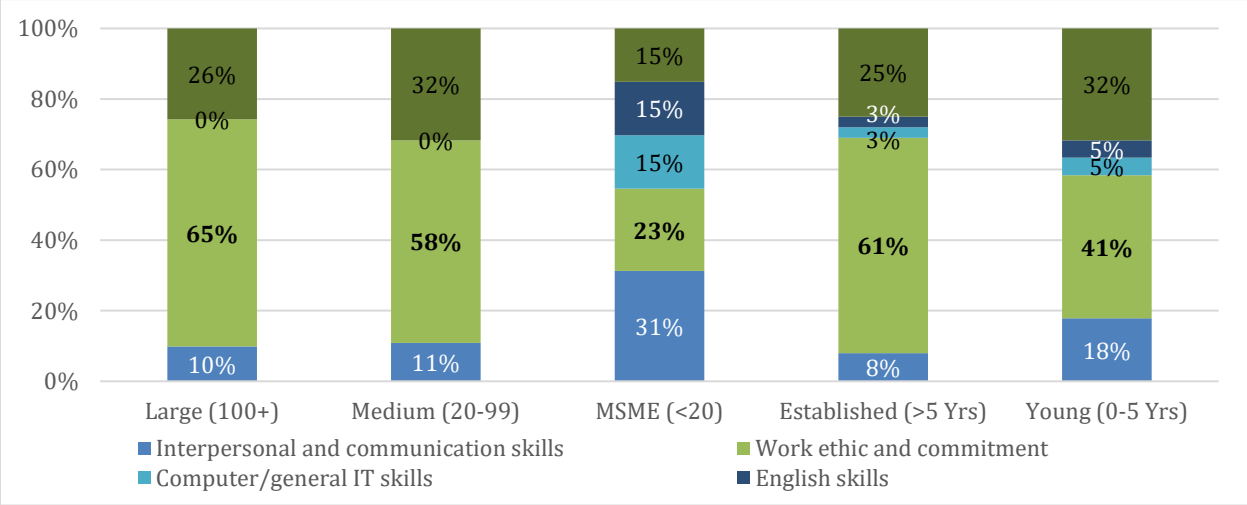
Source: World Bank Enterprise Surveys data.

For example, a small sample survey of Chinese investors, conducted by the World Bank, showed that 93 percent of all professional positions and 67 percent of skilled production workers' positions in these firms are held by Chinese employees. Relatively few of the skilled and professional

positions are held by Ethiopians.[7] In addition, more than 50 percent of Chinese firms indicated that an inadequately educated workforce is a major or severe constraint to their operations (compared to 4 percent result for domestic), particularly in the manufacturing and construction sectors. Also, a significantly greater proportion of Chinese firms invest in training of workers compared to domestic firms (75 versus 27 percent). Furthermore, a greater percentage of Ethiopian workers benefit from training, compared to Chinese workers (69 versus 40 percent). Given Ethiopia's relatively small manufacturing basis, the GoE's investments in higher education are sufficient for the manufacturing sector. However, these investments may not be providing the kind of quality that is required for foreign firms that are competing globally.

Furthermore, according to a 2013 employers' survey, manufacturing firms in Ethiopia struggle to recruit candidates with both appropriate technical competencies and socioemotional skills and behaviors, in particular work ethic and commitment (figure 12).

Figure 12. Skills Sought in New Hires, 2013 (percent of firms)



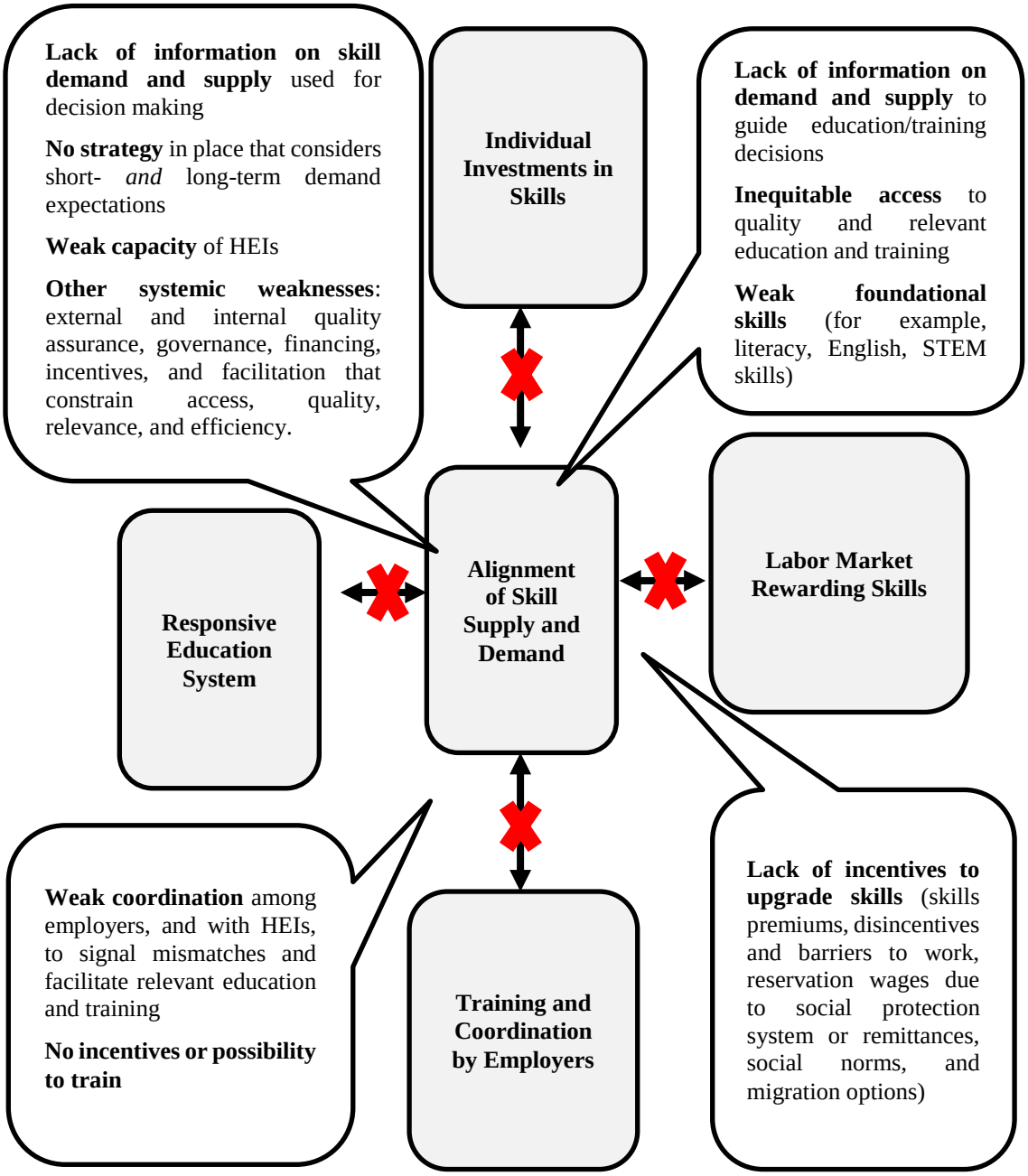
Source: Geiger and Moller. 2015.

The question of students' employability has become an issue of particular concern to many governments around the world who are aware that the shift to a knowledge economy requires the students to be equipped with relevant technical, behavioral, and analytical skills to contribute to economic development. This usually translates into questions about student success, graduate destination, the fitness between education and jobs, the soft skills that students have acquired, particularly those related to entrepreneurship, critical thinking, teamwork, and so on.

Skills are at the core of improving employment outcomes and increasing productivity and growth. Education and training systems, however, may not always provide the skills needed to succeed in the labor market. Chapter 3 examines issues related to the performance of higher education in Ethiopia (S&T programs). Figure 13 shows the key building blocks required for the alignment of the supply and demand of skills, which include a number of elements beyond the education system.

[7] Chinese firms are significant employers in Ethiopia. They accounted for 18,368 full-time jobs equivalent to 6.5 percent of the total full-time permanent jobs (282,306) in the formal nonagricultural sector in Ethiopia. Median wages in Chinese firms are higher than in domestic firms. Source: Bashir. 2011

Figure 13. Aligning Skill Supply and Demand: Critical Elements and Possible Disconnects



Source: Adapted from Hoftijzer (2015).
Note: STEM = Science, Technology, Engineering, and Math.

2.2. Science, Technology, and Innovation Performance

Science, innovation, and technological changes are important contributors to economic development. The Global Innovation Index (GII) produced by Cornell University, European Institute of Business Administration (*Institut Européen d'Administration des Affaires*, INSEAD), and the World Intellectual Property Organization (WIPO) allows comparing Ethiopia's innovation and higher education performance with relevant countries in Sub-Saharan countries and a few East Asian countries. South Africa, Malaysia, and the Republic of Korea represent stretch targets. Vietnam is a useful example of a low-income country that has been progressing rapidly in the past decade.

The GII ratings show that Ethiopia is lagging behind the comparator countries. As far as the GII is concerned, Nigeria is the only comparator country placed behind Ethiopia (table 2). Kenya and Rwanda score significantly higher, reflecting progress in research and development (R&D) in the first case and in higher education in the second place. The higher education ranking is a composite indicator measuring the enrollment rate, the proportion of graduates in science and engineering, and the inbound mobility of students. The Research and Development indicator is based on the number of researchers relative to the total population and on the level of expenditures on research calculated as a proportion of GDP.

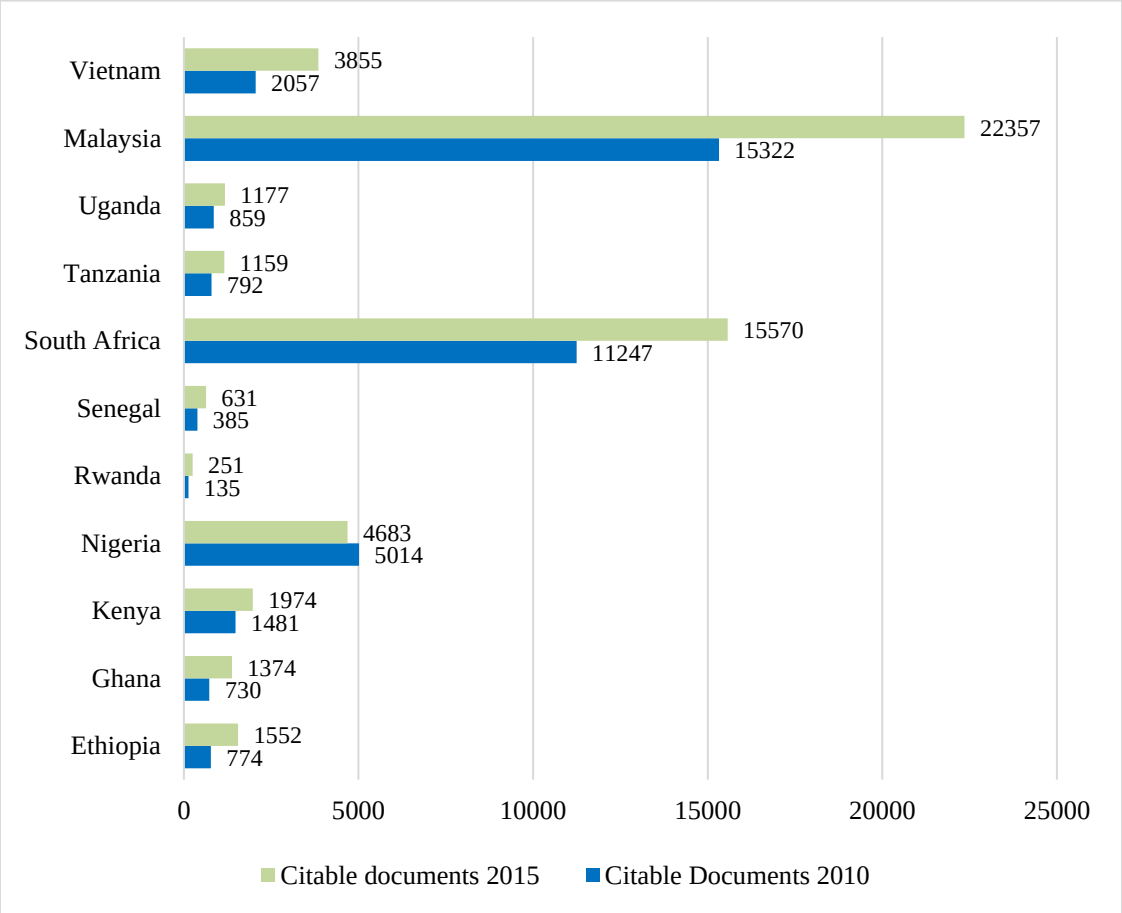
Table 2. GII and Higher Education Ranking (2016)

Country	GII	Higher Education Ranking	Research and Development Ranking
Ethiopia	**110**	**110**	**82**
Ghana	102	93	86
Kenya	80	122	73
Nigeria	114	n.a.	103
Rwanda	83	98	115
Senegal	106	120	77
South Africa	54	89	40
Tanzania	105	124	81
Uganda	99	82	87
Malaysia	35	27	35
Korea	11	12	1
Vietnam	59	84	99

Source: GII. 2016. https://www.globalinnovationindex.org/.
Note: GII provides an annual ranking of countries by their capacity for, and success in, innovation.

The research capacity improved over the last years but the scientific output of Ethiopian universities is still quite low at present. Altogether, the Ethiopian universities produce around 1,500 publications every year. However, the research output of Ethiopia has doubled over the past five years, considering all publications (universities and non-university research institutes). Figure 14 shows the evolution of the total number of scientific publications between 2010 and 2015 (citable documents).

Figure 14. Research Output of Ethiopia and Selected Comparator Countries in Absolute Volume (2010 and 2015)



Source: SCImago. SJR - SCImago Journal and Country Rank.

The bulk of the research output in Ethiopia between 2005 and 2009 was produced by academics at the major universities, including Addis Ababa University, Haramaya University, Jimma University, and Mekelle University (AU–NEPAD 2010). A number of research institutes contribute to the overall scientific production in agriculture and medical and health research. For example, the Ethiopian Institute for Agricultural Research has been pursuing applied research with a view to raise crop yield, quality, and disease resistance and minimize farm-to-market losses.[8] Ethiopia's traditional strengths in livestock research and studies in fauna and flora are reflected in the substantial contribution made by the agricultural, biological, veterinary, and environmental sciences (42 percent). Studies in medicine and health services made up 28 percent and there were significant contributions by the natural sciences (18 percent). At the same time, engineering research between 2005 and 2009 was still at the nascent state, with only 2 percent research output (table 3).

[8] There are activities under way to improve soil fertility management; improve rain-fed agronomic methods; increase the access to irrigation (the potential, according to Mellor is immense); and conserve natural resources. Mellor. 2014. http://ethioagp.org/aese-and-demar-ethio-afric-plc-host-seminar-on-cereal-production-growth-rates/; Yusuf. 2014.

Table 3. Scientific Publication by Disciplinary Area (percent), 2005–2009

Area	Burkina Faso (%)	Ethiopia (%)	Ghana (%)	Kenya (%)	Malawi (%)	Mozambique (%)	Senegal (%)	Tanzania (%)
Natural sciences	3	18	1	12	7	8	35	11
Engineering, energy, and technology	2	**2**	4	2	2	2	5	3
Medical and health sciences	68	28	38	34	63	49	47	47
Agricultural, biological, veterinary, and environmental sciences	10	**42**	30	36	18	15	6	30
Sub-total	*83*	*90*	*84*	*84*	*90*	*74*	*93*	*91*
Social science, law, business	6	9	14	8	9	7	6	8
Education	0	0	1	0	0.5	0	0.5	0
Humanities and arts	0	0.3	0.7	0.5	0.1	8	0.3	0.3
Other	1	0.7	1	2	0.5	0.2	0.5	1
Total publications	**751**	**2,408**	**2,022**	**4,971**	**1,047**	**462**	**1,333**	**2,570**

Source: World Bank 2014a.

To assess the research output of Ethiopia in a comparative perspective, table 4 presents the evolution of the number of citable documents relative to the population between 2010 and 2015, corresponding to the quantitative dimension of research production, and the H-index, which measures the quality and impact of that research. [9]

The data show that Ethiopia made considerable progress in terms of research output relative to the country's population over the five-year period, growing faster than all the comparator countries except Vietnam. It is starting, however, from a much lower base than most other countries. The quality and impact of the research produced by Ethiopian universities is still very low. Ethiopia's H-index is below that of most comparators, though it is about the same as Ghana and well above Rwanda.

[9] The H-index is a bibliometric index developed in 2005 by Professor Jorge Hirsch, a University of California physicist. A researcher's H-index score is the maximum number of publications for which each publication is cited at least that many times. The index is based on the set of the scientist's most cited papers and the number of citations that they have received in other publications. According to higher education expert Alex Usher, the H-index is better than many other bibliometric measures in that it considers both productivity and impact, is not biased by a small number of very successful articles, discounts the value of papers that are not influential and uses only publicly available data (Usher 2012).

Table 4. Research Output of Ethiopia and Selected Comparator Countries

Country	Citable Documents per 1 Million Inhabitants (2010)	Citable Documents per 1 Million Inhabitants (2015)	Growth rate, %	H-Index
Ethiopia	**9.1**	**15.6**	71.4	**101**
Ghana	30.0	50.1	67.0	105
Kenya	36.2	42.8	18.2	179
Nigeria	31.7	25.7	–18.9	131
Rwanda	13.1	21.6	64.9	54
Senegal	29.8	41.5	39.3	95
South Africa	224.9	278.0	23.6	320
Tanzania	17.6	21.7	23.3	122
Uganda	25.4	30.2	18.9	128
Malaysia	547.2	737.9	34.9	190
Korea	1,201.0	1,372.9	14.3	476
Vietnam	23.3	42.0	80.3	142

Source: SCImago. SJR - SCImago Journal and Country Rank.

An interesting new measure of rapid progress in scientific production, recently developed by a team working for the prestigious journal, Nature, illustrates the fact that Ethiopia still has a long way to go in terms of institutional capacity for scientific research.[10] Table 5 shows the top 25 'Rising Stars' in Africa. The results confirm that, seen from a regional perspective, no Ethiopian research institution has established the capacity to produce high-quality research in sufficient quantity yet. In addition to research institutions from South Africa (15), it includes also some from Morocco (4); Tunisia (2); and one each from Algeria, Burkina-Faso, Kenya, and Senegal.

Table 5. Institutional Capacity for Research: Top 25 Rising Stars in Africa (2016)

Country	Number of Rising Stars	Rank of the Best Institution
South Africa	15	1
Senegal	1	10
Morocco	4	11
Burkina Faso	1	15
Tunisia	2	16
Kenya	1	19
Algeria	1	23

Source: Nature. 2016.

[10] Nature Index 2016 'Rising Stars' identifies the ascendant performers in the world of science, using the power of the Nature Index, which tracks the high-quality research of more than 8,000 global institutions. The 2016 index profiles the universities, research institutions, and countries that have significantly improved their scientific output, often without the longevity and resources that benefit many of the more established institutions that are prominent in the international academic rankings. The institutions and countries analyzed in the index have significantly increased their contribution to a selection of top natural science journals—a metric known as weighted fractional count (WFC)—from 2012 to 2015.
https://www.natureindex.com/supplements/nature-index-2016-rising-stars/index#ni-articles.

The rankings of African universities confirm the low visibility of Ethiopian universities. As the UniRanking shows, only two universities appear: Addis Ababa University (No. 39) and Jimma University (No. 70).[11] Similarly, Times Higher Education's 2016 rankings of the top 15 African universities has universities from Uganda, Egypt, Morocco, Kenya, and Nigeria besides South Africa. Addis Ababa University, the country's flagship institution of higher learning, appears 16th in this ranking.

Table 6. Top 100 Universities in Africa (2017)

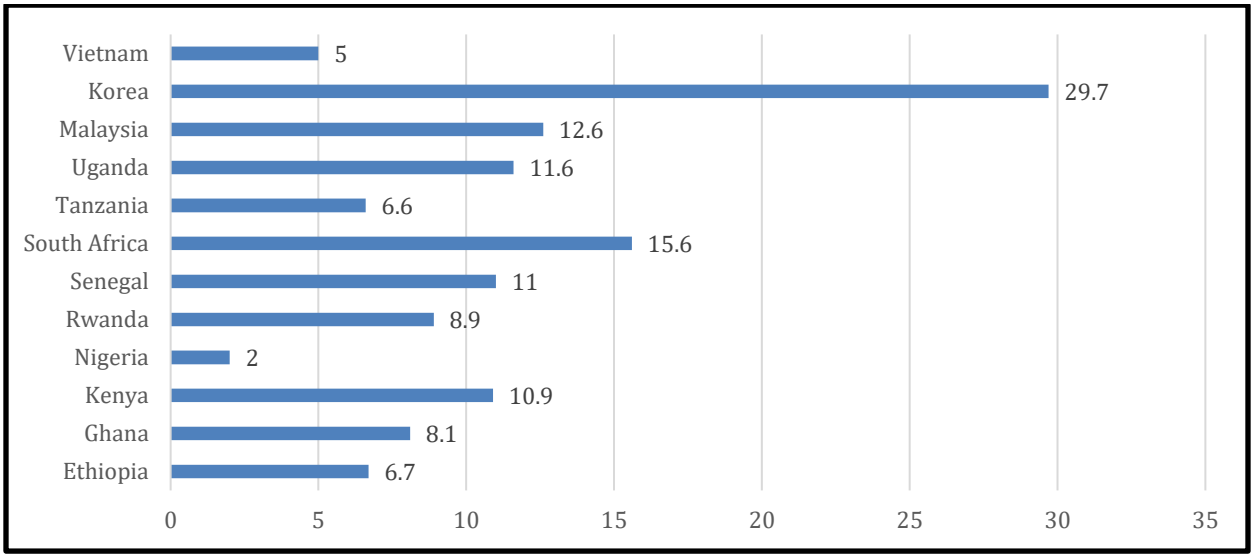
Country	Number of Universities	Rank of the Best University in Each Country
South Africa	19	1
Kenya	7	7
Egypt	15	8
Mozambique	1	16
Uganda	3	17
Nigeria	11	18
Ghana	2	21
Senegal	1	24
Tanzania	3	28
Botswana	1	34
Sudan	3	36
Morocco	6	37
Ethiopia	**2**	**39**
Algeria	14	40
Namibia	2	42
Zimbabwe	1	48
Mauritius	1	62
Rwanda	1	68
Zambia	1	76
Swaziland	1	84
Cameroon	1	96
Malawi	1	100

Source: UniRank (2017) http://www.4icu.org/top-universities-africa/.

Another useful filter through which to look at the research performance of Ethiopia concerns measuring scientific production relative to the country's GDP, which gives a fair notion of research productivity relative to economic wealth (figure 15). Here, Ethiopia is doing better than Nigeria and Vietnam; is at the same level as Tanzania; but performs below most other African comparators (Ghana, Kenya, Rwanda, Senegal, and Uganda).

[11] The UniRank University Ranking is a web-based non-academic ranking calculated on the basis of an algorithm, including five unbiased and independent web metrics extracted from four different web intelligence sources: Moz Domain Authority, Alexa Global Rank, SimilarWeb Global Rank, Majestic Referring Domains, and Majestic Trust Flow. The aim of the UniRank University Ranking is to provide an approximate visibility ranking of world universities and colleges based upon the popularity of their websites in traffic, trust, and quality link popularity.

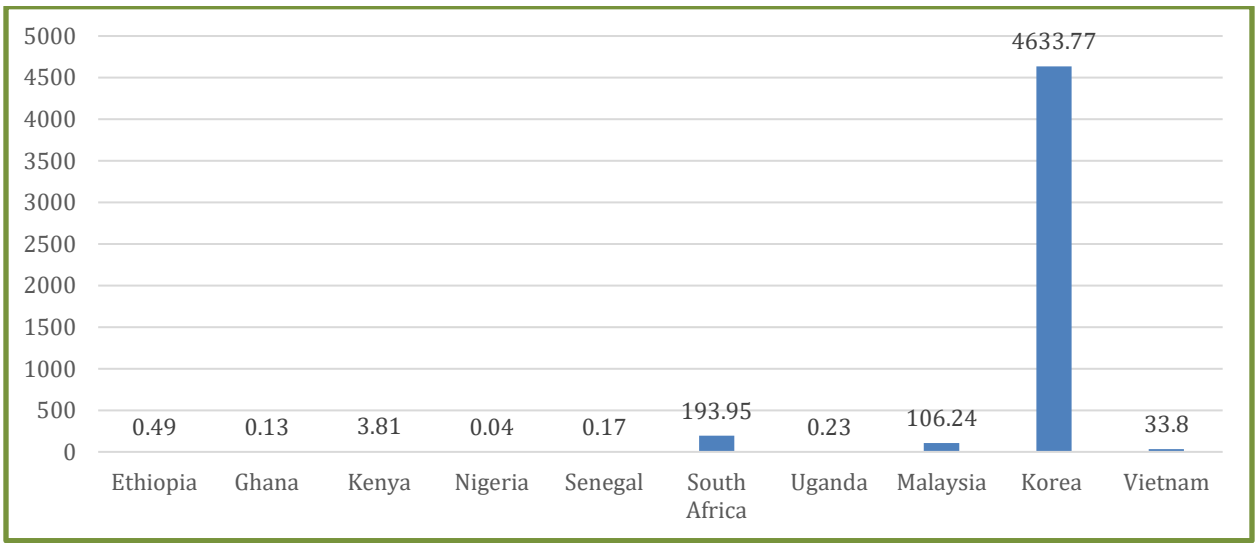
Figure 15. Number of Scientific and Technical Journal Articles Relative to Economic Performance (per billion PPP GDP) for Ethiopia and Comparator Countries, 2015



Source: GII. https://www.globalinnovationindex.org/gii-2016-report#.

Figure 16 shows the ability of Ethiopia to innovate as measured by the annual number of registered patents per 1 million inhabitants in Ethiopia and comparator countries. The most recent year for which data on Ethiopia's patent production are available is 2007, which makes it impossible to assess progress in the last decade, during which the economy has enjoyed fast growth. The comparison with the 2007 data reveals that, at that time, Ethiopia had significantly better results than most countries in the region, except for Kenya and, naturally, South Africa. Ethiopia was far behind Vietnam and Malaysia, however, and this is most likely a sign that the East Asian nation started its period of rapid economic expansion well ahead of Ethiopia.

Figure 16. Patent Applications for Ethiopia and Selected Comparator Countries (per Million Inhabitants, 2007)



Source: World Intellectual Property Indicators, 2007 (accessed March 2017), http://www.wipo.int/ipstats/en/wipi/figures.html.

Chapter 3. Advances in Science and Technology Higher Education

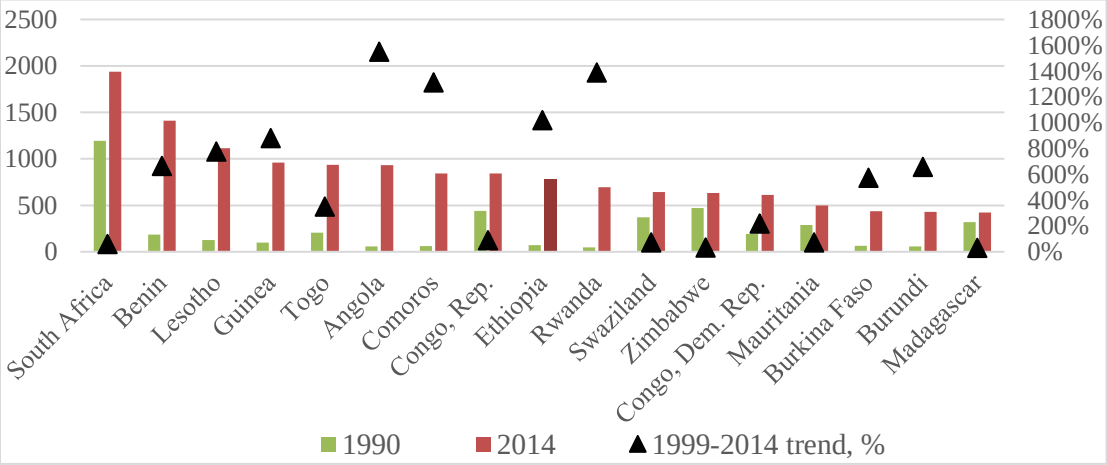
3.1. Recent Developments

The ESDP V indicates how education at all levels should contribute to GTP II. Accordingly, the priorities for higher education include

- Increasing the participation rate, from 9.4 percent in 2014/15 to 15 percent by 2019/20;
- Giving priority to sciences and technology fields;
- Developing the research capacity of universities; and
- Promoting technology transfer.

Aware of the growing importance of higher education for economic growth and productivity improvements, the GoE has continuously expanded its university network in the past two decades. Enrollment growth has been impressive, from less than 40,000 in the mid-1990s to 97,000 in 2000, 142,000 in 2005, 435,000 in 2010, and 762,000 in 2015, according to the Ministry of Education (figures 20 and 21). While only Addis Ababa University was in operation until 1985, the GoE achieved this spectacular expansion by constructing new universities across the country. Ethiopia has now 35 public universities distributed across the country, leaving only one region (Harari) still without a university. Private higher education has been also expanding, with four private HEIs officially recognized as universities, in addition to over 100 other types of HEIs. Nevertheless, the public sector is the main provider of higher education, serving more than 85 percent of the students. The enrollments, growing from a very low base, have finally reached Sub-Saharan average (figures 17 and 18).

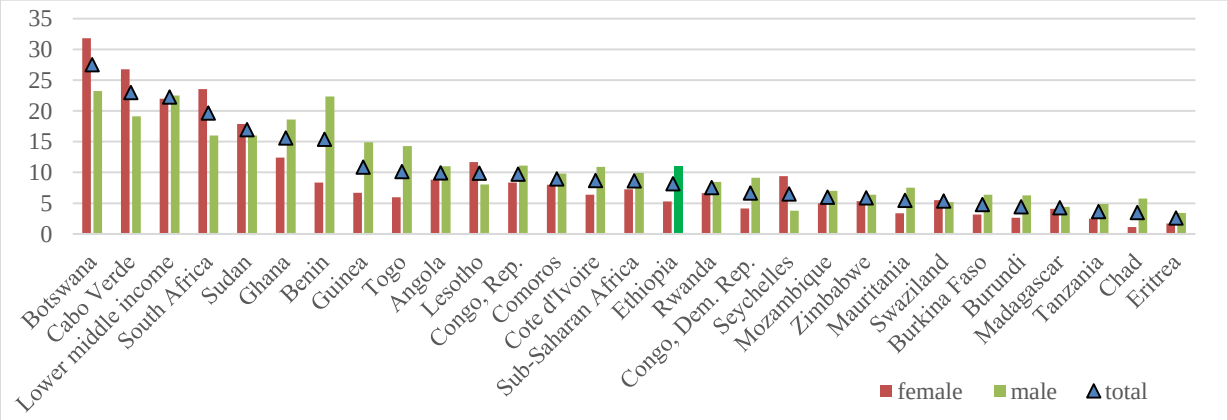
Figure 17. Enrollment in Tertiary Education in 2014 Per 100,000 Inhabitants



Source: UNESCO Institute for Statistics.
Note: Year of data: 2014 for Ethiopia, Botswana, Ghana, Mauritius, and Mozambique and 2013 for others.

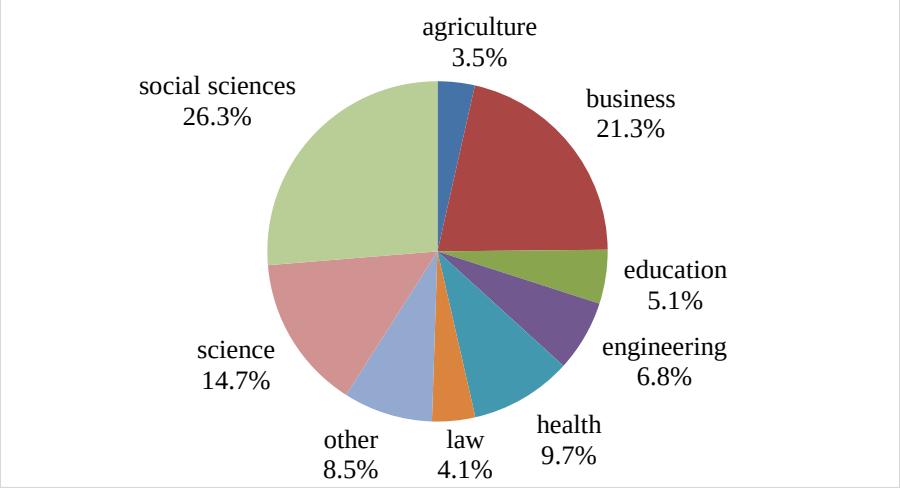
The Government has reached remarkable progress in expanding access and is making bold steps to improve quality. In line with GTPs I and II, Ethiopia implemented a 70:30 technology and science/social sciences and humanities admission ratio, which fell to a 63:37 enrollment ratio in undergraduate programs (2014 data) and translated to a 48:52 alumni composition (2013 data). Figure 19 shows that, by 2013, 51.7 percent of youth completed social sciences, business, and law programs. Another issue is that the 34 percent undergraduate enrollment rate in engineering and technology programs fell to 20 percent at the postgraduate level. On the contrary, the share of enrollment in agriculture and life science, medicine and health sciences, and natural and computational sciences increased at the postgraduate level.

Figure 18. Gross Enrollment Ratio, Tertiary (percent)



Source: UNESCO Institute for Statistics.
Note: Year of data: 2014 for Ethiopia, 2013 for Angola, Benin, Burkina Faso, Burundi, Democratic Republic of Congo, Republic of Congo , Madagascar, Rwanda, South Africa, Sudan, Swaziland, Tanzania, and Zimbabwe and 2014 for others.

Figure 19. Type of Training Received by Higher Education Graduates (ages 30 or younger)



Source: LFS 2013.

As in many developing countries, the rapid quantitative expansion has resulted in a number of challenges. From a performance viewpoint, the Ethiopian higher education system faces the following challenges: strong disparities in access and success, issues with quality and relevance, and low research output. GTP II and the ESDP V acknowledge that in light of the rapid expansion,

the quality and relevance will fall unless effective strategies are implemented to maintain standards.

In equality of opportunities, the 2016 public expenditure review found that access to higher education for the poorest groups is much lower than for the rest of the population. The disparity ratio, which measures the ratio of the proportion of students from the highest income quintile over the proportion of students from the lowest quintile, is 41; it is one of the highest in Sub-Saharan Africa (Kiringai et al, 2016). By comparison, it is 9.4 in Brazil, one of the Latin America countries with the highest level of inequality of opportunities in higher education (Salmi 2016).

The percentage of female enrollment increased from 21.6 in 2000 to 33.0 in 2015, but at the postgraduate level, women represent less than 20 percent of the students. At the undergraduate level, 59 percent of all female students choose an S&T stream, compared to 65 percent of male students (figure 21).

Figure 20. Enrollments in Public and Nongovernment HEIs

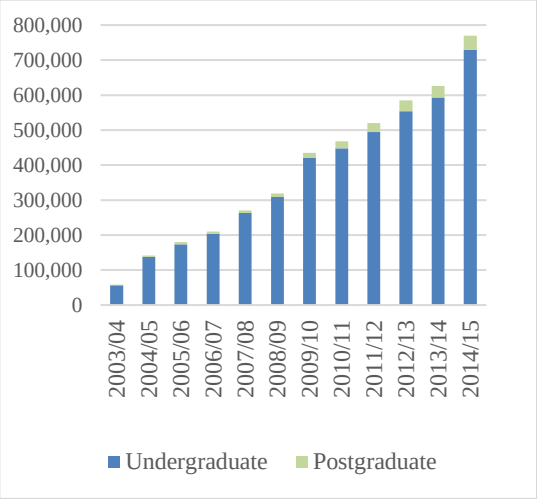
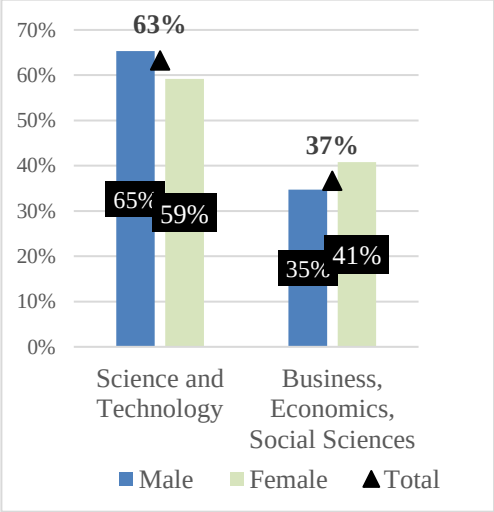


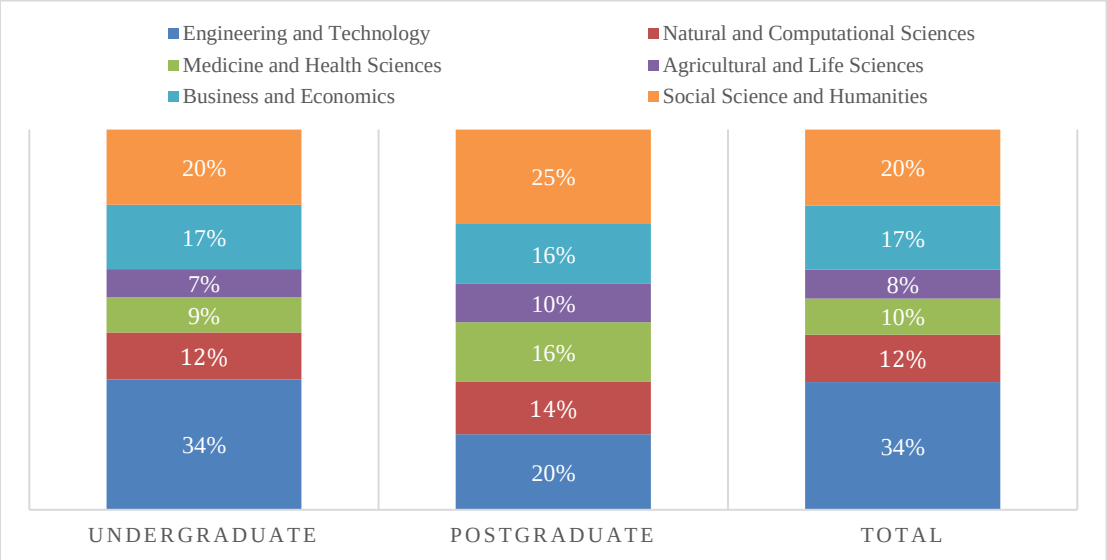
Figure 21. Undergraduate Enrollments in S&T in Public HEIs, by Gender



Source: Education Abstract 2014/15, Ministry of Education of Ethiopia.
Note: Information on private HEIs is not complete.[12]

[12] Data from 33.7 percent of the accredited nongovernment institutions is not complete or not reported at all.

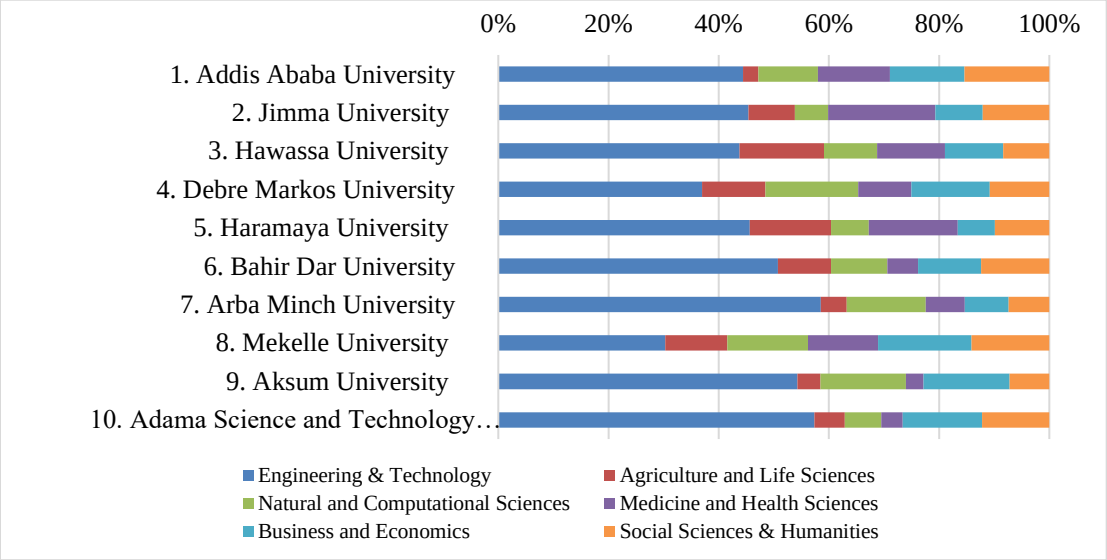
Figure 22. Enrollments in Public HEIs by Field of Study



Source: Education Abstract 2014/15, Ministry of Education of Ethiopia.

Ten public universities train 43.9 percent of all undergraduate students in public S&T programs, including 62.7 percent of all undergraduate students in public engineering and technology programs (figures 23 and 24). Addis Ababa Science and Technology University was established in 2011 with the particular mandate to play a key role in the technological transformation of the country in close partnership with industries.

Figure 23. Top 10 S&T Universities by Enrollments

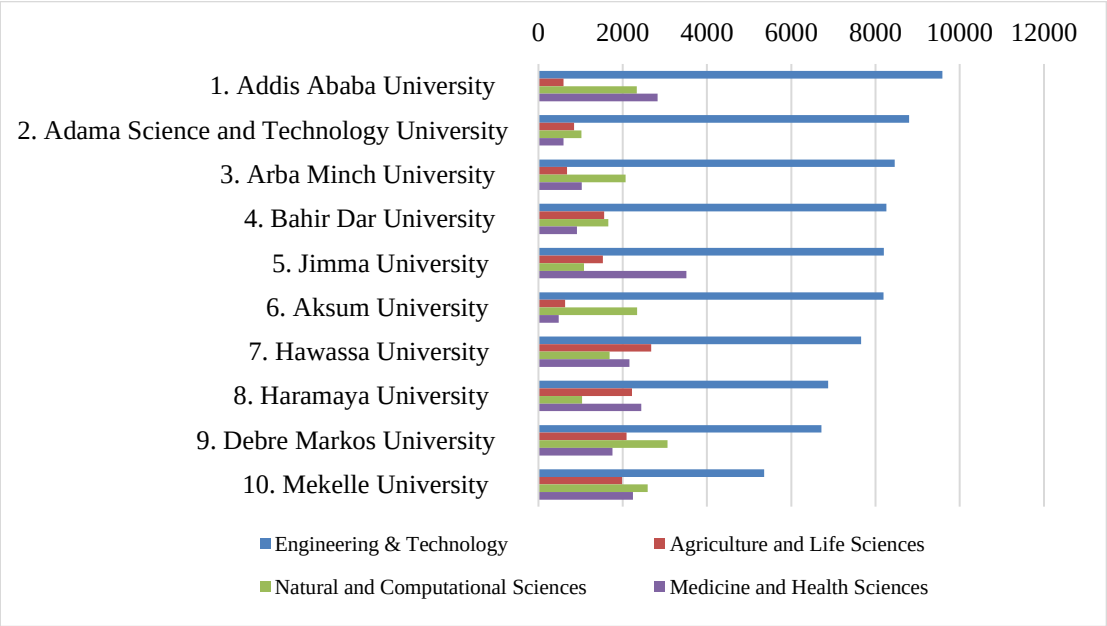


Source: Education Abstract 2013/14, Ministry of Education of Ethiopia.

Most current and planned industrial parks are built near these universities to support massive industrialization projects (figure 24 and map 1). For example, Hawassa Industrial Park houses large local and international manufacturers specializing on textile and apparel and aims to generate over US$1 billion export revenues and create 60,000 jobs. The Government has also constructed

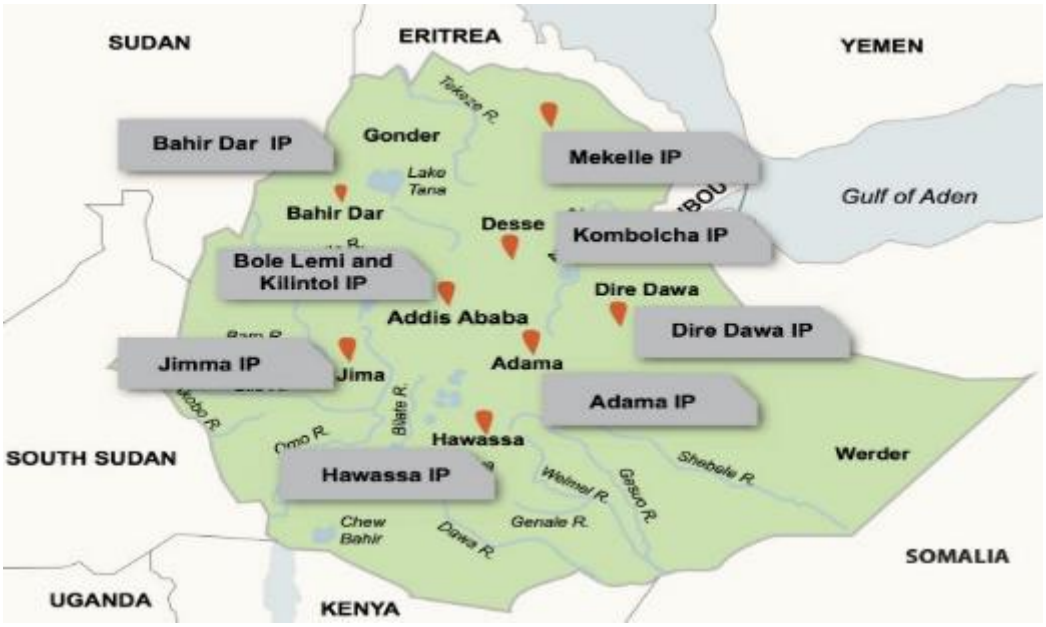
and leased the Bole Lemi-I Industrial Park in the suburbs of Addis Ababa. In addition, industrial parks in Dire Dawa, Mekelle, Adama, and Kombocha are almost complete, while Bole Lemi II Industrial Park, Jimma, Bahir Dar, Debre Birhan, Aysha Dewalle, and Kilinto industrial parks are expected to be operational in 2017/18.

Figure 24. Top 10 Public Universities Train 62.7 Percent of all Undergraduate Students in Public Engineering and Technology Programs



Source: Education Abstract 2013/14, Ministry of Education of Ethiopia.

Map 1. Major Parks Built or Under Construction by the Industrial Parks Development Corporation of Ethiopia



Source: http://www.ipdc.gov.et/index.php/en/.

These ten core S&T universities together with the newly created Addis Ababa Science and Technology University (2011) could help Ethiopia overcome the disadvantages of being a latecomer in technological catching-up and drive the industrialization, structural transformation, urbanization, and growth agenda. However, it will require concerted efforts from the Government and the universities on multiple fronts.

With respect to quality, the general root of the problem stems from the expansion and dynamism of the Ethiopian higher education system. The system is under pressure on multiple fronts and must provide more books, build more laboratories, employ more staff, increase the number of PhD holders, and focus on their career development. Ethiopian universities enroll large and growing numbers of students. This is compounded by the low level of academic preparation of incoming high school graduates; the weak mastery of English as the language of instruction; the shortage of qualified faculty; inadequate infrastructure, especially in the S&T disciplines; and public funding constraints. The staffing, resources, and infrastructural constraints are even more severe in the youngest universities.

Each year, the universities present, to the ministry, an annual expansion plan. In light of the rapid expansion of the system, a focus on buildings and administrative staff at the initial phase of constructing new campus facilities is understandable. However, a strong emphasis on academic activities and academic staff is imperative for ensuring quality.

In addition, the system is expanding without much differentiation in academic program offerings[13] and this leads to duplication of resources and redundancies (table 7). The universities are generally comprehensive. A few initiatives have been taken to sharpen the profile of some universities and introduce some specialization. For instance, Addis Ababa University is focused on graduate studies to facilitate the expansion of higher education. It has many postgraduate programs, including at the PhD level, and 16,000 graduate students, including 2,000 PhD candidates. A consortium of universities (including European and U.S. partners) is running some of these postgraduate programs.

Two S&T universities were created in recent years: the Addis Ababa University of Science and Technology, upgraded from an Institute of Technology, and the Adama Science and Technology University, split from a comprehensive university. These two universities are central to the national industrial strategy and the goal of becoming a middle-income economy by 2025. After a few years of operation, the two universities were moved from the Ministry of Education to the Ministry of Science and Technology to permit different ways of managing staff and admitting students. These two universities are expected to focus on applied research and technology transfer.

[13] The list of program offerings is available in the Education Abstract 2013/14, Ministry of Education of Ethiopia.

Table 7. Top and New S&T Academic Programs

HEIs	Engineering and Technology, and Agriculture and Life Sciences Programs
Adama Science and Technology University	Top Programs: Civil Engineering, Mechanical Engineering, Chemical Engineering, Crop Production, Land Management, and Forestry Management New Programs*: Electrical and Computer Engineering, Computer Science, Software Engineering, Information System, Plant Science, and Food Science and Postharvest Technologies
Addis Ababa Science and Technology University	Top Programs: Civil Engineering, Mechanical Engineering, Chemical Engineering New Programs: Agribusiness Value Chain Management, Natural Resources Management, Plant Sciences, Food Science and Postharvest Technologies
Addis Ababa University	Top Programs: Civil Engineering, Pre-Engineering, Electronics and Electrical Engineering, and Veterinary Medicine New Programs: Pre-Engineering, Plant Science, Horticulture, Animal S&T
Aksum University	Top Programs: Hydraulics and Water Resources Management, Civil Engineering, Electrical Engineering, Mechanical Engineering, Animal Production and Technology, Soil Resources Management, and Plant Science
Arba Minch University	Top Programs: Water Supply and Environmental Management, Civil Engineering, Hydraulic and Water Resource Management, Plant Science, and Rural Development and Agricultural
Bahir Dar University	Top Programs: Civil Engineering, Water Management, Land Administration, and Rural Development
Debre Markos University	Top Programs: Civil Engineering, Electrical Engineering, Control Engineering, Plant Science, Animal Science, and Natural Resource Management
Haramaya University	Top Programs: Pre-engineering, Water Resource and Environmental Engineering, Soil and Water Resource Management, Veterinary Medicine, and Natural Resource Management New Program: Pre-Engineering
Hawassa University	Top Programs: Civil Engineering, Pre-Engineering, Electrical Engineering, Veterinary Medicine, General Forestry New Program: Pre-Engineering
Jimma University	Top Programs: Civil Engineering, Pre-Engineering, Electrical Engineering, Veterinary Medicine, and Natural Resource Management New Programs: Pre-Engineering, Chemical Engineering, and Sugarcane Agronomy
Mekelle University	Top Programs: Civil Engineering, Electrical Engineering, Computer Science, Land Resources Management and Environmental Protection, Veterinary Medicine, and Natural Resources Management

Source: Education Abstract 2013/14, Ministry of Education of Ethiopia.
Note: Top programs as measured by the number of students enrolled; new programs are those having enrollments in Year I to Year III only.

The transition of these two institutions toward becoming research-intensive universities requires setting up a proper scientific infrastructure and reducing the teaching load to allow faculty members to focus on applied research. This is not an easy task and requires building a culture that respects and values research.

These S&T universities are more selective than the regular universities to maintain quality. For this purpose, the new undergraduate students are recruited outside the central admission process. Interested students must pass a separate test. In four to five years, these two institutions will become full-fledged universities and the Government plans to upgrade one additional Institute of Technology to that level.

These challenges explain the broadly held concerns about the performance of the higher education system. The universities have grown rapidly, and there is a need for a holistic vision and strategy for the development of their constituent colleges and research centers. This is most visible at Addis

Ababa University, which is highly fragmented. Its colleges and research centers operate independently and the university's strategic plan is a mere aggregation of individual plans for each component.

The GoE has indicated a clear commitment to continue its investment in higher education and make appropriate adjustments to ensure an effective contribution of the higher education system by establishing a strategic framework for 2016–2030 and launching a road map exercise in the summer of 2016, with technical support from the German agency *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ). The purpose of the endeavor is to elaborate a clear vision for the future development of the Ethiopian higher education system and a comprehensive plan to implement this vision. As reported in the press, "the 15-year road map is expected to help reform the structure, governance, and managerial systems in higher education and human resource development through increased access to higher education. The road map will enable Ethiopia to have effective resource and quality assurance management… It will help most…universities to become centers of excellence by producing demand-driven manpower in the country."[14]

Furthermore, the Ministry of Science and Technology is planning to establish 16 research centers as pillars of future economic growth in these universities. To be successful, these will require budget, experience, faculty, leadership, and partnerships. Each center has four to five specialized research programs and will be connected to international partners as decided by the ministry.

There is a road map for the further expansion of higher education, which identifies the capacity of each university by 2020. The limit is 20,000 for the eight first-generation universities—maximum that relevant HEIs can feed, house, and teach. The capacity for the second-generation and third-generation universities is set at 17,000 and 12,000, respectively. Eleven public universities are being planned and HERQA received 18 applications for new private institutions in 2016.[15]

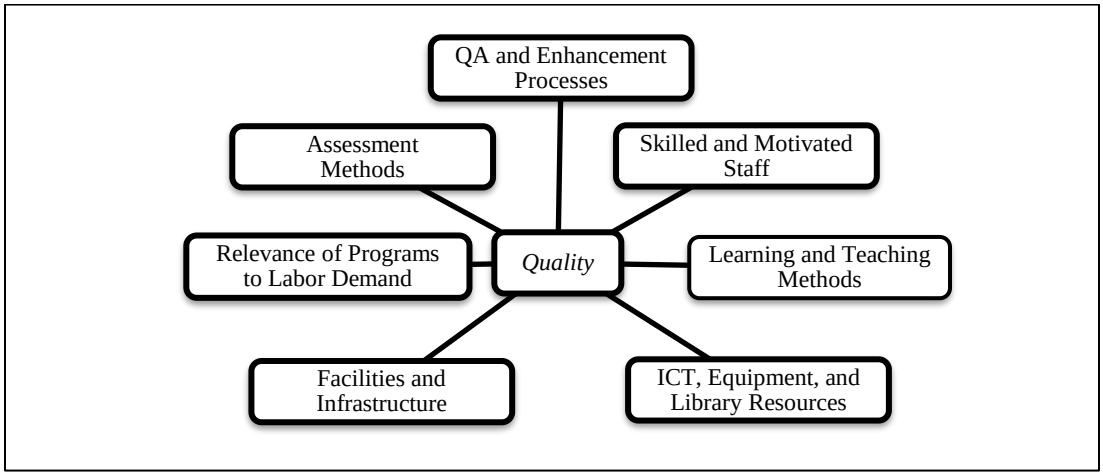
The new modalities for appointing board chairs and university presidents, which are envisaged in Proclamation 650/2009, are expected to bring more strategic leaders into these positions, who will promote institutional profiling and positioning. The Proclamation states that three candidates will be proposed to be board chair and that the Government will pick one along with the seven board members. The university presidents will be evaluated by the ministry down the line. They will be chosen for their strategic capacity.

3.2. Academic Staff

The qualifications of academic and administrative staff are the key building blocks of a quality higher education system (figure 25). This is recognized by the ministry, which funds over 3,000 PhD candidates per year. A proportion of them goes abroad to different countries for their studies.

[14] The Ethiopian Herald, September 25, 2016.
[15] Henson Vroeijenstihn, and Elmer. 2016. p, 4.

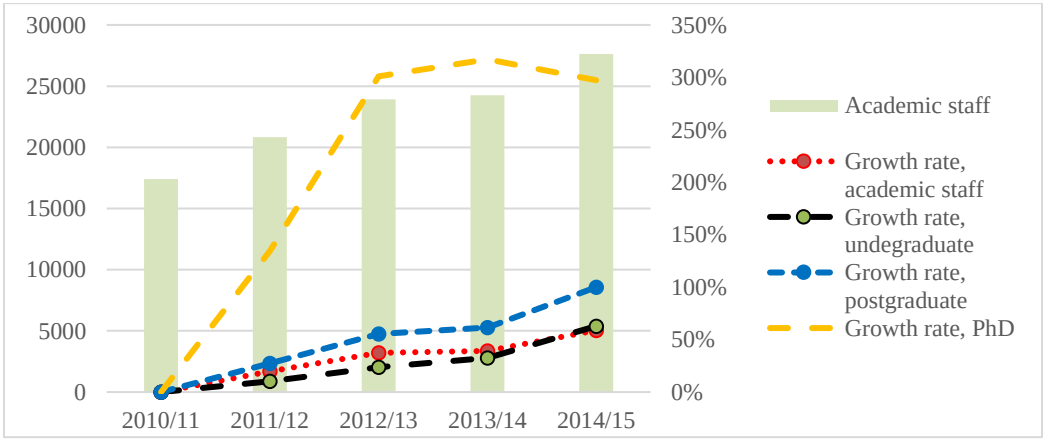
Figure 25. The Quality of Higher Education - A Conceptual Framework



Source: World Bank. 2009.

The rapid expansion of higher education in Ethiopia has increased the demand for qualified academic staff. Between 2010 and 2015, the number of academics increased by 58 percent to more than 27,000 members (figure 26), out of which 4 percent (around 1,000) were expatriates.[16]

Figure 26. Student Enrollments and Academic Staff



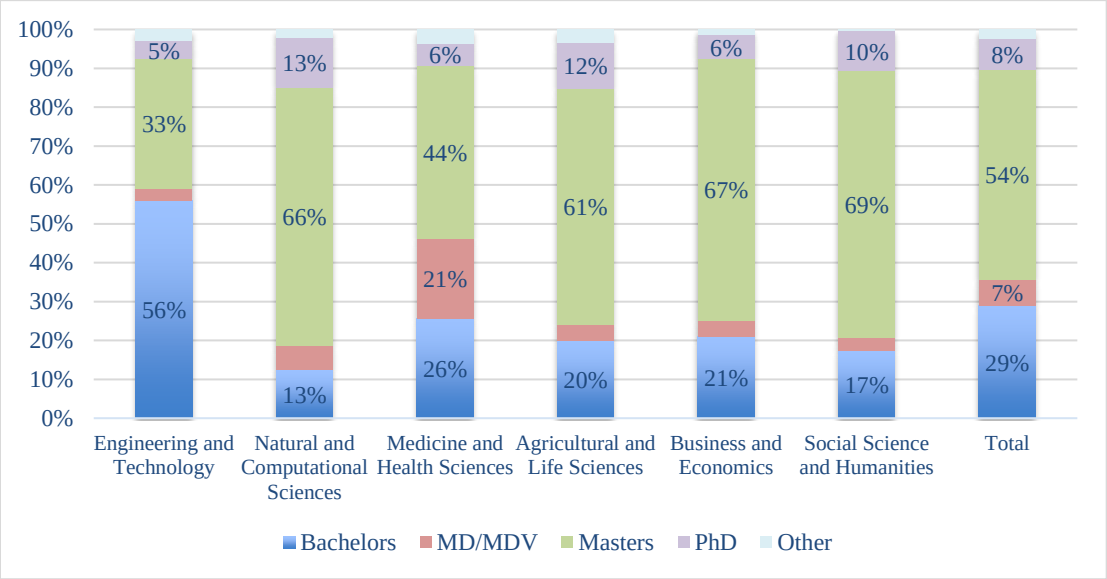
Source: Education Abstract 2014/15, Ministry of Education of Ethiopia.
Note: Information on private HEIs is not complete.

The Government has accelerated the production of postgraduate degree holders, who are the natural candidates for faculty recruitment. Enrolment in PhD programs has increased from a low base of only 258 in 2007/08 to around 800 in 2010/11 and over 3,150 since 2012/13. Still, many universities in Ethiopia do not have sufficient numbers of qualified staff, which undermines the quality of the education and training offered. In public universities, 29 percent of faculty members have an undergraduate degree. The situation is of particular concern in the engineering and technology fields, with 56 percent of staff holding a bachelor's degree (figure 27). The shortage is such that universities are hiring newly minted bachelor's degree holders to teach. Even the flagship

[16] According to the Higher Education Proclamation, an academic staff member in Ethiopia is an employee of a HEI who devotes 75 percent of his or her time to teaching and 25 percent of time to research. Employees of research centers are also included but with a reverse workload in teaching and research activities.

institution of the country, Addis Ababa University, employs only about 28 percent of academic staff with PhDs.[17]

Figure 27. Faculty Staff Composition by Fields of Study in Public HEIs



Source: Education Abstract 2014/15, Ministry of Education of Ethiopia.

The case of the Addis Ababa Science and Technology University is a good illustration of the challenges that an institution faces in an expanding higher education system with limited human resources. The majority of academic staff hold a master's degree and the university counts only 40 PhD holders among its staff. All staff have been evaluated to ensure their fitness for their position, and some have been asked to take an examination. On the basis of their examination results, some staff were let go, while others were asked to take additional courses. Those who were retained have the obligation to start a PhD program within the subsequent two years. This means that there will be a gap in the teaching capacity of the university because the PhD candidates will be relieved from some of the teaching workload. The university recruited 32 international researchers as part of the strategy to become a research institution, but the university is still faced with a shortage of qualified lecturers.

The demand for qualified academic staff is growing in most HEIs. To meet this demand in public HEIs, the Government has been addressing staffing needs by (a) expanding master's and PhD programs in the first-generation universities to hire their own graduates into the system; (b) training Ethiopian students abroad; (c) attracting expatriates with the required qualifications (providing higher remuneration packages compared to their Ethiopian colleagues); and (d) covering staff gaps through the contracting of academic staff on a part-time basis in other HEIs, in addition to their work in the primary employing institution.

It is important to find the right balance among local training, training of students abroad, and hiring of expatriates. Each of these options has its pros and cons. When the Government decided to

[17] The Government has set the target of bachelor, master's, and PhD teachers' qualification mix at 0:70:30 in the ESDP V.

expand access to higher education, it could not afford to send all staff abroad to support this expansion. Therefore, it mandated some universities to become hubs for graduate training. Interinstitutional cooperation has been encouraged and international foundations have supported these efforts. For instance, a block grant from the Swedish International Development and Cooperation Agency (SIDA) funds universities to send their staff to Addis Ababa University for PhD training. The grant can also be used to send staff to international conferences and to fund short mobility periods for PhD candidates.

In-country training allows easier integration of graduates into local institutions due to their knowledge of the culture, values, and expectations. However, it might limit the transfer of ideas and practices from other HEIs. This might be particularly true for Ethiopia. In countries where norms of deference to seniors are deeply engrained in culture, junior academics may be hesitant to introduce alternative perspectives and new methodologies or pursue new avenues of work (ADB 2011).

In turn, training students abroad is expensive and has raised concerns about brain drain, which depletes the stock of highly qualified staff in the country. The issue of brain drain is a major challenge in many developing countries. To tackle these issues, the GoE has recently been using the 'sandwich' model, which combines international and in-country studies. Notwithstanding that, it is important to note that scholars who remain abroad often establish ties with the Ethiopian HEIs, enriching interuniversity cooperation and the exchange of ideas and research.

Currently, having expatriates among the faculty helps with knowledge creation and addresses critical staffing gaps, particularly in engineering and technology programs. With regard to the qualifications of expatriate staff in public HEIs, more than 97 percent of them have advanced degrees, with around a half of them being represented by PhD holders. While overall the share of expatriates in public HEIs is quite small (around 4 percent), engineering and technology programs are particularly reliant on foreign PhD holders. Expatriates represent around 44 percent of PhD staff in relevant programs (figures 28 and 29).

The Higher Education Proclamation—a key regulation in the subsector—also allows contracting academic staff on a part-time basis in addition to their regular position.[18] This helps universities to cover staffing gaps, while also supporting the faculty staff financially. In general, attracting and retaining talent in the academic profession is widely recognized as a challenge in the country. Even with benefits such as transportation or housing supplements, salaries in HEIs are typically not competitive, compared with other sectors. Many staff carry out extra work, including through part-time employment in HEIs, to supplement their incomes, but, perhaps, negatively impacting the quality of their teaching. In response to these negative externalities of low academic pay, the ministry has regraded all jobs and the universities are hoping that when this new salary formula is envisaged in 2017, salaries will be adjusted upward.

[18] According to information from private universities this is allowed only in public HEIs.

Figure 28. Master's Level Staff in Public HEIs

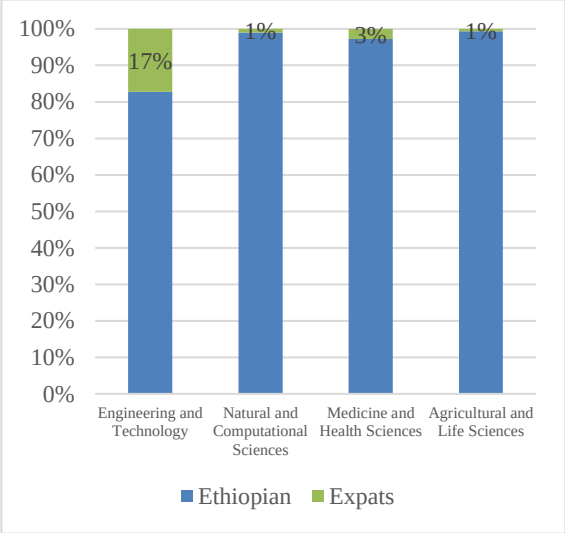
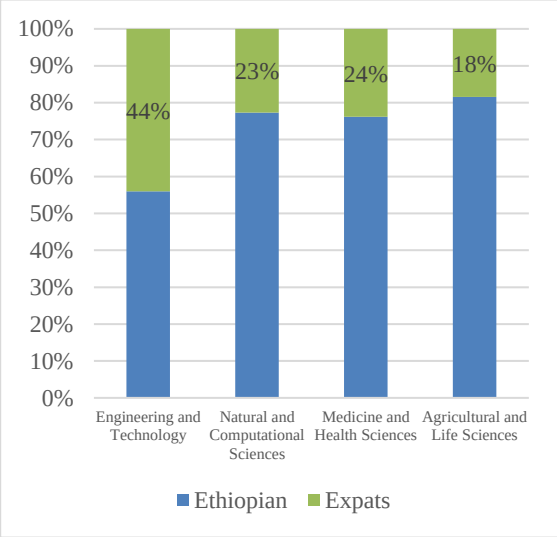


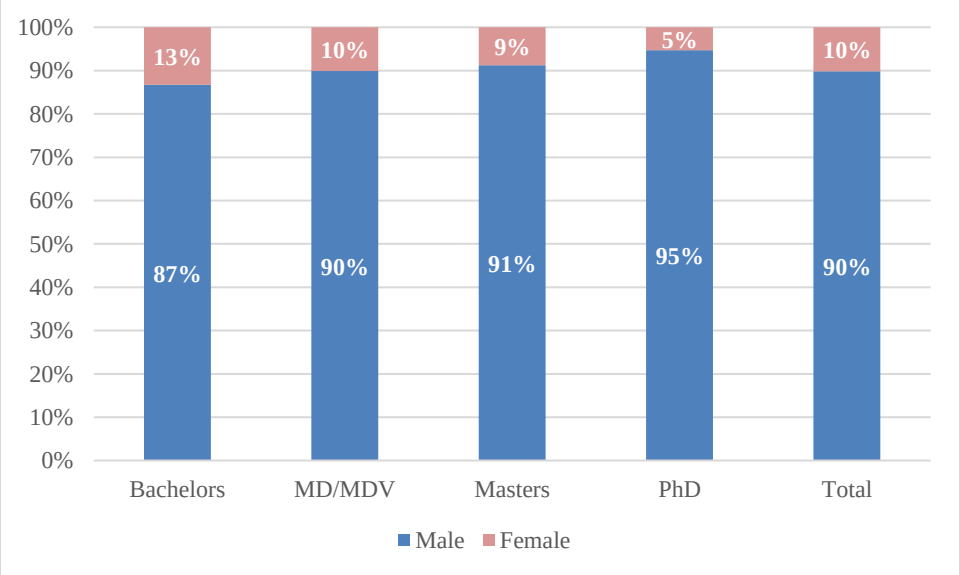
Figure 29. PhD Staff in Public HEIs



Source: Education Abstract 2014/15, Ministry of Education of Ethiopia.

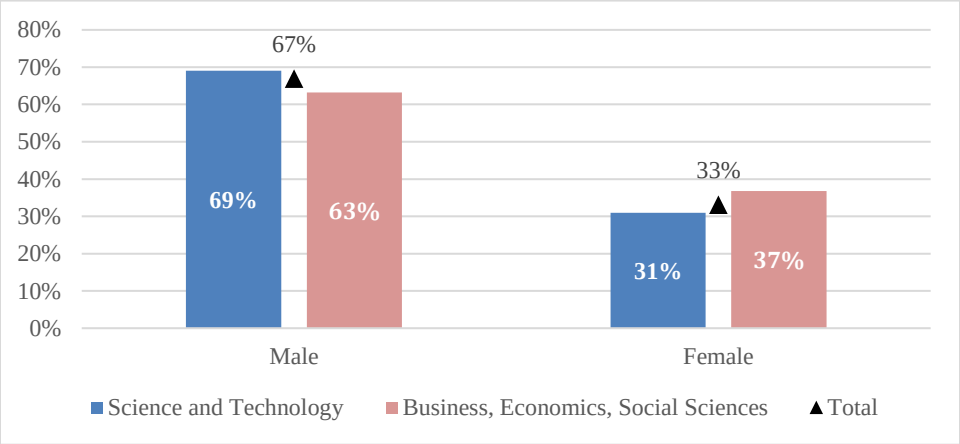
Increasing the participation of female academic staff presents an even bigger challenge for HEIs of Ethiopia. Women represent only 10 percent of academic staff (figure 30). Efforts in increasing their access to higher education can help the country fully harness its human capital. Acknowledging this, the Government is promoting gender equality at all levels of education and has set ambitious targets for female participation. The official target is to raise the share of female teachers to 25 percent and female enrollment in PhD programs to 20 percent. In master's and bachelor's programs the Government plans to increase female enrollments to 35 percent and 45 percent respectively. Currently only 33 percent of undergraduate students are females, with lower representation in S&T programs (figure 31).

Figure 30. Academic Staff Composition in Public HEIs



Source: Education Abstract 2014/15, Ministry of Education of Ethiopia.

Figure 31. Undergraduate Enrollment in Public HEIs



Source: Education Abstract 2014/15, Ministry of Education of Ethiopia.

As access expands, academic staff face a number of challenges:

- Heavier workloads. Because of the low salaries, academics often teach in several HEIs, including private ones. This leaves little time and motivation for professional development and research activities, despite the Higher Education Proclamation's requirement for academic staff to devote 25% of time for research.

- Larger student groups. Currently, the student-teacher ratio is 25:1 in public universities and 43:1 in private HEIs.

- Broader spectrum of students with unequal academic preparation. Many students are admitted with results below the 50 percent threshold in the higher education entrance examinations, with particularly low results in physics. Many academic staff lack the necessary training in pedagogy to effectively teach large and diverse groups of students.

Therefore, institutions need to create supportive environments that help staff develop professionally.

Staff Development

In Ethiopia, academic staff development consists in a semester-long training course (HDP), which is well accepted and useful in developing pedagogical skills and introducing staff to active pedagogies and student-centered learning. However, only a few universities such as Addis Ababa University are implementing it to improve the qualifications of its lecturers. The Senate of Addis Ababa University has many committees supporting teaching and research functions, including the Academic Standards and Curriculum Review Committee; Staff Recruitment, Appointment, and Promotions Committee; and Research and Publications Committee. At the same time, there is no evaluation of the delivered programs in Addis Ababa University, which is important for improving their quality and relevance. The dearth of PhD holders and the goal of developing research capacity are pressuring university lecturers (holders of a master's degree) to opt for a PhD.

Professional development is extremely important for strengthening the quality of academic staff and improving the quality of instruction in HEIs. Skills and competencies of academic staff need to be continually strengthened and enhanced. This is relevant both for young staff entering the profession and for established faculty members. Generally, staff development may cover various aspects of teaching and learning pedagogy, research methods, computer literacy, soft skills, and other competencies according to the identified needs. Importantly, professional development should be the result of a collaborative process to ensure its usefulness and commitment among the faculty, building on both top-down approaches and bottom-up innovations in teaching and learning. Also, programs in research methods are typically offered to young researchers who are about to start their master's or PhD studies.

Establishing a strong SDU within HEIs is a long-term process. Such units should be able to (a) identify training and development needs for all categories of staff and (b) develop and implement an HR development plan in line with the overall strategic plan of the university. SDUs should be staffed with highly qualified and motivated full-time academic staff, supported by administrative staff. In Sri Lanka, for example, the 'staff development center' is staffed by senior-level academics. They serve in the center for a period of three years, after which they return to their regular academic positions (World Bank 2013).

SDU should be able to conduct training programs and courses and/or help place academics in courses conducted in other universities or by suitable external providers (for example, for certain computer software, statistical analysis, or qualitative research applications). All programs should be monitored and evaluated to ensure efficiency and that the content is relevant to the needs of faculty members and their students. Each university should have an HR development plan, which should contain information on situations and measures to address the existing capacity gaps with costed implementation plans, including a general action plan for monitoring and evaluation of staff development activities.

Interuniversity cooperation is also vital to gain and maintain excellence in teaching and research, particularly in countries such as Ethiopia with a large need for staff development and relatively low experience in the field. Through interuniversity national or international networks and forums, HEIs that are new to HR development, which is the case in the younger Ethiopian universities, can learn the best strategies, practices, and experiences from others. These networks and forums support the exchange of ideas and materials on staff development programs and activities of relevant units within HEIs, strategies for staff development, and best practices in the field, as well as facilitate direct staff exchanges among the participating institutions.

In relation to staff development opportunities in the context of S&T programs relevant to the country's economic needs and priorities, it is worth mentioning the ACE Project II, which was launched in 2016 by the Governments of Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Tanzania, Uganda, Zambia, and the Interuniversity Council for East Africa, with support from the World Bank. It is a regional Higher Education Project (HEP) designed to address critical HR gaps in HEIs with the potential to become the leading scientific and academic institution in the region in their particular field and tackle shared development challenges of the participating countries (box 1). A rigorous, competitive, and transparent selection process has been conducted to identify the centers to be financed under the project.

Ethiopia was successful in obtaining four Centers of Excellence: (a) ACE for Water Management (ACEWM) in Addis Ababa University, (b) African Railway Education and Research Institute in Addis Ababa University, (c) Center for Innovative Drug Development and Therapeutic Trials for Africa in Addis Ababa University, and (d) ACE for Climate Smart Agriculture and Biodiversity Conservation in Haramaya University. Faculty and staff in the ACEs will benefit from improved teaching and research conditions and professional development opportunities. Faculty and students in STEM and other priority sector disciplinary areas are to benefit from exchange visits, collaborative teaching and research, and other knowledge-sharing activities across the ACEs organized by the ACE II Regional Facilitation Unit. ACE-hosting universities will benefit from the strengthened capacity of their ACEs and quality improvement measures, including benchmarking with other institutions initiated under the project (see box 1).

A number of initiatives can support professional development, including in-service training for academic staff, establishing communities of teaching practices, supporting innovative pedagogy and experimentation, accountability and reporting procedures to evaluate the effectiveness of teaching delivered, and the benchmarking of practices. Importantly, these initiatives will need to be implemented within the budget envelope available for the subsector, as the country already spends a large share of its education budget for higher education (around 13.5 percent in 2015 compared to 8.4 percent in 2011). Encouragingly, the quality of teaching can "start improving without a significant investment" (OECD 2012).

Box 1: ACE II

The Project Development Objective of ACE II supports the governments of eight participating countries in strengthening the selected ACEs to deliver quality postgraduate education and build collaborative research capacity in the regional priority areas. All these ACEs are expected to perform the following tasks:

- Build institutional capacity to provide quality postgraduate education with relevance to the labor market
- Build institutional capacity to conduct high-quality applied research, relevant to addressing a key development challenge/priority
- Develop and enhance partnerships with other academic institutions (national, regional, and international) to pursue academic excellence
- Develop and enhance partnerships with industry and the private sector to generate greater impact
- Improve governance and management of the institution and set up a role model for other HEIs
- Deliver outreach and create an impact to society by delivering excellent teaching and producing high-quality applied research

For example, the goals of ACEWM based in Ethiopia are to

- Strengthen Addis Ababa University's teaching and research capacity in water S&T to train human capacity required to address national and regional development needs;
- Enhance the capacity of faculty and students to conduct high-quality research and scholarly activities to help solve regional problems in water management and climate change issues, as well as provide trained research scientists and engineers to support national and regional development goals; and
- Provide training and support for the development and adoption of best practices in teaching, research, academic administration, and management through regional and international partnerships, coupled with mobilization of African diaspora scientists.

To foster female staff recruitment, ACEWM closely works with the Gender Office at Addis Ababa University and collaborates with the Gender Studies Institute. Female candidates graduating from ACEWM will be encouraged to join as future faculty of the center.

ACEWM has a number of partners such as

- In-country partners, including Ministry of Water, Irrigation, and Electricity, Arbaminch University, and Jimma University;
- Regional academic partners (University of Nairobi, Kenya, Kenyan Marine Science and Fisheries Research Institute, University of Dare Salam in Tanzania, and University of Malawi);
- International academic partners (University of Boku, Austria; University of Oklahoma, the United States; University of Johannesburg, South Africa; University College of London, United Kingdom; University of Cincinnati, the United States; Swiss Federal Institute of Aquatic Science and Technology, Switzerland; among many others); and
- National and regional private sector partners, including Alphasol Modular Energy and Midroc from Ethiopia, Lifelink and Women's Participation in Agricultural Research and Higher Education from Kenya.

Source: http://ace2.iucea.org.

Performance Assessment and Motivation of Staff

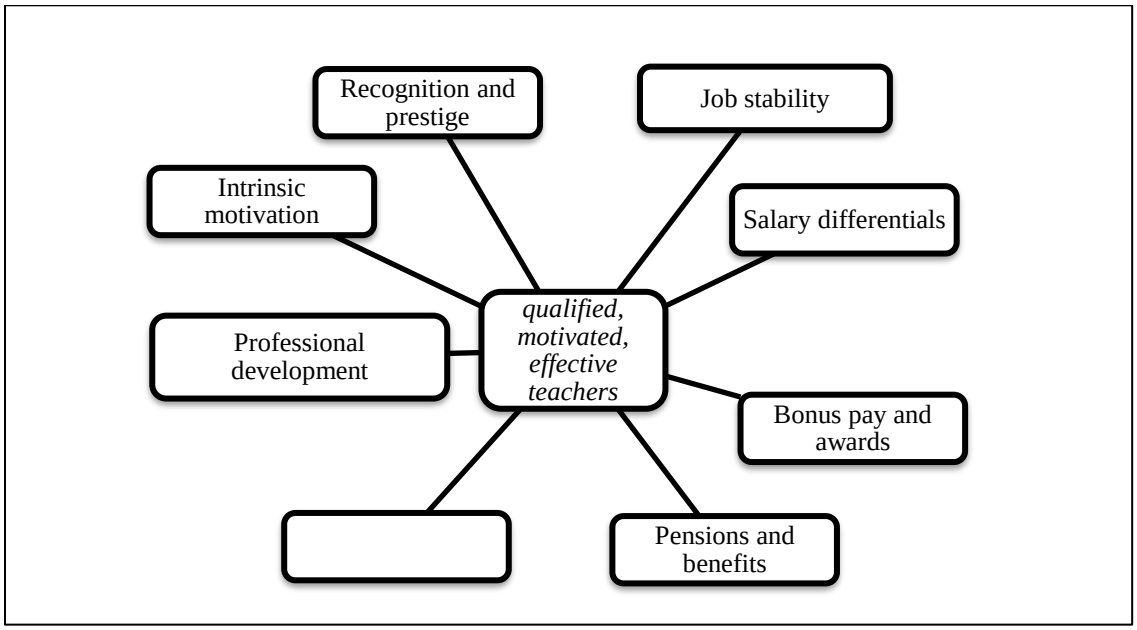
International evidence suggests that high-performing universities are characterized by their ability to attract, motivate, and retain the best in the academic profession, support improved instruction, create a favorable environment for staff development, and conduct an effective evaluation of staff performance (Salmi 2009; Altbach and Salmi 2011).

The Ethiopian Higher Education Proclamation of 2009 states that quality training, education, and service are the major guiding values of HEIs. The document further underlined that HEIs should develop an IQA system as they are responsible for the quality of education and training they offer their learners.

Performance assessments in Ethiopia include assessments by supervisors and feedback from peers and students. However, they do not work very well in practice, in large part because they are similar for all academic staff irrespective of the academic program. Adjustments of performance assessment templates are not allowed across faculties and institutes, which limit the usefulness of feedback for academic staff. The results of the assessments are not always communicated to staff members and seem to matter only during the promotion process.

To attract and retain highly qualified faculty staff, an effective incentive framework needs to be developed. Some of these incentives such as salary differential, allowances, bonuses, pension, housing, and other benefits are monetary; others are not. For example, intrinsic and extrinsic motivation, including recognition and prestige of the profession can play an important role (figure 32). Currently, apart from promotion, there are no performance incentives evident in the public HEIs of Ethiopia.

Figure 32. Performance Incentives



Source: Adapted from Vegas 2005.

If they are properly implemented, regular performance assessments of staff and aligning the results with clearly defined promotion criteria represent an important incentive to motivate staff. For example, a performance-based salary system is now widely instituted among private universities in Korea. In 2000, Pohang University in Korea introduced a faculty salary scheme that is not based on staff seniority but on his or her accomplishments in teaching, research, and community services over the previous three years, thus encouraging high performance among faculty members and supporting faculty staff's professional development.

Teaching excellence should also be recognized and rewarded. Academic staff need to be encouraged to adopt new methods of instruction and teaching. It is important to emphasize and recognize the importance of teaching quality and encourage staff to invest time and effort in modern methods of teaching. A promising approach is to support and reward teaching excellence through the use of targeted funding; this is successfully used in a number of developing and developed countries.

3.3. Internal and External Quality Assurance

Internal Quality Assurance

While quality has always been a concern in higher education, accountability is a fairly recent phenomenon. This can be explained by the fact that in many countries the higher education system has been mostly composed of public institutions and the sector managed centrally by ministries. Typically, these countries did not see the need to quality assure higher education, which, in such a context, would have been tantamount to evaluating the ministries.

However, the QA processes have quickly spread around the world since the 1980s. This development is usually attributed to several trends: the expansion, massification, and related costs of the higher education sector; 'New Public Management', which required greater accountability of public institutions in exchange for increased autonomy; and the internationalization and globalization of higher education, which placed renewed emphasis on demonstrating the quality of higher education provision (Sursock 2011, 111).

While the early stress on quality assurance focused on the creation of QA agencies, today there is an increased recognition of the importance of IQA processes. This is signaled by the emergence of two new acronyms: "EQA (for external QA) and IQA (for internal QA), in addition to the ubiquitous QA (for quality assurance in general)" (Sursock 2015, 39).

Experience shows that EQA and IQA must be thought through together so that appropriate responsibility is vested in HEIs. This means that the EQA processes must leave room for the internal processes to develop. This would alleviate the risk of alienating university staff who consider that they are spending too much time on QA rather than on their core role.

Alongside the QA processes, many countries have extended their accountability requirements. This can take the form of performance contracts between each university and the ministry or the appointment of external members of governing boards. Accountability can also take the form of new reporting requirements such as requiring institutions to produce information on the career trajectories of their graduates.

IQA in universities was developed at the initiative of the Government in 2008. This was the watershed year for a range of governmental initiatives to deal with quality issues due to the expansion.

All four universities that were visited have a QA director and the IQA processes in place. The universities have recently constituted a network of QA directors and have produced a charter. At

Addis Ababa University for instance, the QA office has two main functions: a management information system (MIS) that allows the QA office to gather data and provide an annual report to all senior management, including deans, and a quality management function that provides support to the academic units in the colleges for developing their own IQA processes. The QA office produces an action plan every five years.

The Addis Ababa University course approval process looks rigorous. It goes through the department's academic commission, then to the college's academic commission, and to the vice-president; a graduate program goes to external reviewers and then to stakeholders; both undergraduate and graduate programs are approved by the senate. Course outlines and continuous assessments are monitored very closely. Syllabi are evaluated every three years; this review includes stakeholders and goes through the same accountability chain as new programs. The university has developed a range of policies that are posted on the website (for example, research policy, gender policy, promotion, strategic plan, and so on).

Addis Ababa University has conducted two searches that introduced a new process: an application, public lectures, and an evaluation of the candidates by the audience.

The administrative staff undergo an evaluation. The legislation prescribes that academic staff must be evaluated by their students, their peers, and their department head. The latter can provide advice and send staff for training if required. The aggregate data are presented to the dean and play a role in the promotion process.

The student evaluation form is a standard questionnaire used by all universities in the country. It would be best to promote a sense of ownership by ensuring that each institution develops its own questionnaire with the input of staff and students. Annex 3 presents a set of good practices in seeking student feedback. These include good practice in student questionnaires and other formal and informal ways to ensure that the students' views are taken into account.

In addition, a good internal quality system includes many different aspects such as the following:

- Information provided to students on the institution's study programs (for example, number of students and staff involved in a program, staff to student ratio, intended learning outcomes, qualifications granted, teaching and learning and assessment methods, external learning opportunities such as internships, employment prospects, accessibility and support of students with disabilities, and so on)

- A good management and information system that collects information about student profile (for example, age, gender, educational, and socioeconomic background); progression and success rate; student to staff ratio by departments/faculties and tracer studies.

- Evaluation procedures to cover, at minimum, the quality of teaching and learning, including the learning resources (for example, libraries, laboratories, computing facilities) and student support services.

- Structures to support such procedures, including a senior academic in charge of oversight (for example, vice-president) who chairs a university committee, a

centralized QA unit and QA officers in faculties, and a unit responsible for supporting academic staff development.

- Processes to ensure wide ownership and engagement in the QA processes through the formal participation in governance and advisory bodies of academic and administrative staff, university and faculty leadership, students, external stakeholders, and alumni. This should include formal and informal communication about the results of the IQA processes so that everyone understands their value.

- Processes to ensure links with strategic management and planning through the use of key performance indicators and ensuring that the university and faculty leadership are informed regularly of results of the evaluations and are required to provide a response.

- A systematic process for designing new study programs and improving the established ones, often with the help of external stakeholders. Today, such procedures include the development of learning outcomes and their assessment.

While many reports have looked at effective ways of supporting university-industry collaboration to promote applied research and knowledge transfer, little work has been done on employer engagement for curriculum improvement purposes. A recent study in the United Kingdom fills this gap with noteworthy findings (see box 2).

Box 2: Good Practices of Employer Engagement for Curriculum Improvement Purposes

A recent study in the United Kingdom has identified four main categories of employer engagement in higher education provision (course development and delivery):

- Giving accurate and up-to-date information, advice, and guidance to students about the knowledge and skills needed to enter particular industries and professions
- Facilitating and supporting work placements and internships to provide students with valuable work experience
- Developing curricula, pedagogy, learning materials, and learning-related research projects
- Establishing learning and teaching facilities aimed at providing students with the specialist skills they need in the workplace, often with financial support from firms

Experience shows that successful and sustainable partnerships require specialist staff, ongoing relationship management, and significant development time.

Typically, this engagement will take place with companies near the university. While research and knowledge transfer activities are often administered centrally and are thus highly visible in universities, employer engagement activities tend to be managed at faculty level or below.

The five case studies documented in the report yielded the following findings:

- Collaborations should be designed to respond to a strategic need recognized by all partners. This need will often be a shortage of graduates with the skills required by a particular company or group of companies, but it may encompass areas of research, particularly in advanced manufacturing or engineering. There may also be more specific needs such as identifying innovative delivery methods.
- Collaborations require strong leadership from the senior teams of all the organizations involved, including the recognition that developing and implementing projects of this kind will be time-consuming and that engagement will need to be sustained indefinitely to keep curricula current.
- Co-location of staff and joint appointments can support the culture change required to work together effectively and speed up decision making.
- External funding streams can be important to give initial impetus to the partnership and give all organizations the confidence to release their own funds.
- Benefits to business can include availability of graduates with relevant skills, recruitment efficiencies, and access to other university/business services. Benefits to universities include the development of an up-to-date and relevant curriculum, which will increase student recruitment and progression outcomes and enhance the university's reputation.

Source: University Alliance 2015.

External Quality Assurance

HERQA was established in 2003 and is responsible for four processes:

- Accreditation of new programs and institutions
- Unannounced visits
- Quality audits based on ten standards
- Document authentication

Views about the agency were collected from the universities, the ministry, and the senior leadership of the agency itself. There is very broad consensus about the strengths and weaknesses of HERQA.

HERQA is commended for closing some private programs and five institutions (for example, teachers' training and some distance education institutions) and putting another 11 private universities on probation. It is also credited for promoting internal quality processes in institutions as well as some important social values such as gender equity and access through its 10 audit standards.

However, there are widespread concerns which are all linked to the agency's limited resources:

- HERQA has a limited number of staff and does not have the resources to hire staff with the appropriate qualifications. The accreditation approach needs to be streamlined and rely on more than a single external expert, which means that, at present, the evaluation of programs can be held hostage to fortune.

- The limited resources result in difficulties in attracting good or committed experts (who receive a very low per diem) and training them to ensure that the institutions do not receive a discouraging stream of contradictory recommendations from one evaluation to the next.

- The lack of resources leads the agency to focus on the private institutions and ignore the weaker public institutions. This is referred to as the 'dichotomy problem'.

- Linked to the dichotomy problem is the issue of balance between improvement (support and attention to the development of new universities) and control for quality.

Furthermore, the agency is not sufficiently autonomous from the ministry. HERQA's board includes three ministers and the director general of the agency, which means that there is lack of independence and potential conflicts of interests. There are no representatives from business and no international members.

HERQA confirmed the quality concerns in both the public and the private sectors. Given the limitations in HR (both staff and experts), it can only control threshold standards. As a result, they concentrate on private institutions, which need more regulations.

The ministry is aware of these challenges and has made a request to the Ministry of Public Service to get more staff. There are suggestions to introduce a standardized exit exam for all students which might help solve the dichotomy problem and expose the weaker institutions. There is already such an exam in law and medicine.

HERQA was reviewed in 2016 and received a useful report, which confirms the weaknesses identified above (Henson, Vroeijenstihn, and Elmer 2016). The review report also noted that HERQA has the word 'relevance' in its name but "… while it is quite clear that HERQA is the guardian of quality for—at least—private HEI and has explicit activities that relate to this, it is less clear how HERQA explicitly discharges responsibilities in the area of relevance" (Henson Vroeijenstihn, and Elmer 2016, 5). This is primarily because the legal responsibilities assigned to HERQA are not sufficient to address the needs of the national higher education strategy (Henson, Vroeijenstihn, and Elmer 2016, 7). The report offers a range of recommendations to be implemented in a step-by-step fashion within the next 20 years (see box 3). However, such a long-

term horizon might be compromised by the rapid changes being experienced in higher education worldwide.

Box 3: The 2016 HERQA Review

The report praised staff for executing HERQA's mission within challenging resource constraints and provided 31 recommendations, including the following:

(a) The governing body of HERQA should be autonomous from the ministry and the agency should report to Parliament rather than the ministry.

(b) An international perspective should be ensured through an advisory body.

(c) Higher education relevance would be best addressed through a dedicated directorate in the Ministry of Education, which would be responsible for serving as a filter for the establishment of new private institutions and new programs (these would be tested for their relevance). HERQA would no longer have 'relevance' in its name. Other functions such as data collection and the authentication/equivalence responsibilities should be transferred to other agencies.

(d) The rest of HERQA's activities need to be streamlined and reviewed. The agency needs to achieve a better balance between improvement and accountability and support the IQA processes in the institutions. The public and private institutions should be treated in the same way.

(e) Regional HERQA offices should be distributed across Ethiopia, the structure of the agency should be simplified, and an IQA process developed.

(f) Audit fees should be collected from the for-profit private institutions. Any surplus would go to HERQA.

(g) HERQA should produce an action plan and undergo a follow-up review. In parallel, if the recommendations contained in the report are implemented, the Government will need to redeploy certain activities and issue a new Proclamation.

Source: Henson, Vroeijenstihn, and Elmer. 2016.

3.5. Role of Cooperation and Partnerships

Cooperation and partnerships are important tools to maintain and improve the quality and relevance of a higher education system. Three types of cooperation can be distinguished: national, international, and with external stakeholders (such as economic, social, and cultural actors).

First, with respect to national cooperation, the leadership of the Ministry of Education has supported the networking of public universities through ICT. The long-term goal of this very useful initiative is to network all public universities so that students have access to library resources and virtual labs and to promote international partnerships. So far, the eight oldest public universities are networked nationally.

Second, internationalization strategies appear to be inexistent even if the universities acknowledge that international partnerships are essential to address their current challenges. Currently, international partnerships are driven by individual staff who have studied abroad and use their professional networks. In the case of the two S&T universities, it is the Ministry of Science and Technology which is shaping their internationalization strategy. Undergraduate student mobility does not seem to be a practice because it is too expensive.

Third, regional cooperation between university and industry is a key development goal. The leadership of the Ministry of Education noted that there has been progress in building research capacity as measured by the increase in the number of papers published in high-impact

international journals. The first goal, however, is to promote regional development through technology transfer. This does not entail new discoveries but in applying research outcomes to local problems. The two public universities that were visited have dedicated units to support these links through consultancy activities and community service. The university-industry links remain weak and the Government is looking at ways of bolstering these links. It is focused on four aspects: internships; externships (faculty going to industry); industry trainer (guest lecturing at university); and joint business (that is, spin-offs).

ACE projects complement other regional initiatives in Africa that focus on developing S&T skills through collaboration and partnerships. These include the World Bank-supported PASET which seeks to build a technical and scientific skilled labor force for priority sectors, from technical/vocational to higher education levels as well as research, to support the structural transformation of Africa (see box 4). The ACE II project collaborates with the benchmarking exercise overseen by PASET to seek best practices in science education. To date, one Ethiopian University—Jimma University—has already benefitted from the benchmarking exercise. Its results are presented in the following paragraphs.

Box 4: PASET

PASET was launched in 2013 by African Governments with facilitation by the World Bank to accelerate the creation of a critical mass of highly skilled workforce for the socioeconomic development of Africa. It aims to address systemic gaps in skills and knowledge in priority applied sciences, engineering, and technology fields and build the capacity of African education and training institutions to train high-quality technicians, engineers, and scientists in line with countries' demands. Over 20 African countries and representatives of Brazil, China, India, and Korea have participated in PASET's consultations and regional forums.

In 2015, Senegal, Ethiopia, and Rwanda and later Kenya and Côte d'Ivoire have committed financially to the PASET Regional Scholarship and Innovation Fund (RSIF), which aims, among others, to help participating countries build capacity of faculties of African universities through training of academically talented staff who lack PhD education. This will be achieved through partnerships with universities that have the capacity in applied science, engineering, and technology through both international and in-home study ('sandwich model'). The target is to train about 10,000 PhD holders over a 10-year period. The RSIF will provide further support to PhD graduates once they return to their faculties to undertake high-quality applied research in priority development sectors. The programs will also focus on development of entrepreneurial skills.

PASET has also launched the Regional Benchmarking Initiative to identify strengths and inadequacies of participating institutions through the assessment of institutional performance(inclusion, learning achievement, labor market outcomes, research output, and technology transfer) and institutional health (access and retention strategy, curriculum and pedagogical practices, internationalization, IQA, relevance, skills mismatch and links to the economy, governance and management, and financing).

Source: http://www.worldbank.org/en/programs/paset.

3.6. Benchmarking for University Performance Improvement

One internationally tested approach for improving performance of universities is participation in benchmarking. In 2016, more than 30 Sub-Saharan universities participated in a benchmarking exercise conducted in collaboration with the World Bank and Shanghai Jiao Tong University in the context of the Africa-led PASET initiative. Jimma University was the only Ethiopian university that volunteered to take part.

From a methodological viewpoint, the benchmarking analysis makes a fundamental distinction between the results of tertiary education institutions (their performance indicators) and the drivers

of performance that account for these results (institutional health indicators). Examining the performance indicators results can help Jimma University assess how well it fares in attaining the expected outputs. From the institutional health perspective, the benchmarking results can be used to understand how well the key inputs that the university has invested, together with its main processes and enabling factors in its environment, reflect conditions that are known to bring about favorable outcomes (table 8).

Table 8. Conceptual Framework for Benchmarking Tertiary Education Institutions in Sub-Saharan Africa

Focus of Benchmarking	Main Dimensions of Analysis
Institutional Performance	Inclusion Learning achievement Labor market outcomes Research output Technology transfer results
Institutional Health	Access and retention strategy Curriculum and pedagogical practices Internationalization Internal Quality Assurance Relevance, skills mismatch, and links to the economy Governance and management Financing

Source: Salmi, Cheng and Liu (2016).

The benchmarking results are examined in two ways. First, for each of the performance and institutional health indicators, the participating universities can see where their institution fits into one of three broad bands: the top 25 percent (that is, greater than the third quartile); the middle 50 percent (that is, between the first quartile and the third quartile); and the bottom 25 percent (that is, less than the first quartile). Second, the time evolution perspective is incorporated into the analysis, whenever possible, by comparing the indicators for the most recent data period to those of the period five years earlier. This allows the participating universities to understand the evolution of performance and its determinants over time and identify those indicators that are improving or deteriorating at different paces. Table 9 shows Jimma University's results with respect to the performance indicators for which it provided data.

Table 9. Performance Indicators

Performance Category	Benchmarking Result
Proportion of female graduates	Middle 50%
Proportion of graduates passing professional examinations successfully	Bottom 25%
Student satisfaction	Bottom 25%
Number of high-impact scientific papers	Middle 50%
Proportion of master's graduates	Top 25%
Number of patents in past 3 years	Bottom 25%
Number of spinoffs in past 3 years	Bottom 25%
Jobs created through technology commercialization	Bottom 25%

The benchmarking results reveal that the only area where Jimma University's performance is above average is in the production of research master's graduates. This reflects the GoE's strategy to boost the research production by building up the capacity to conduct research. When it comes to its research output, Jimma University's results, as measured by the number of high-impact scientific papers, are average compared to the other universities in the benchmarking sample. Of

concern is the fact that the university's results are below average in two of its main three categories of outputs: teaching and learning and technology transfer. The low student satisfaction and proportion of graduates successfully passing professional exams reflect the pressure on quality brought about by the rapid increase in student enrollment. The patents, spin-off, and job creation indicate that the university is not very successful in its technology transfer activities.

The determinants of performance. Table 10 provides information on the main factors explaining the above performance.

The best results achieved by Jimma University with regard to the institutional health indicators are in the areas of accessibility for wheel-chair bound students, the graduation rate for bachelor's students, the proportion of foreign academics, the proportion of academics publishing at least one paper a year, and the proportion of academics involved in technology transfer activities. However, the low on-time graduation rate confirms the impression of poor quality of teaching and learning indicated by the results of the satisfaction survey and professional exams.

The combination of a high proportion of academics involved in technology transfer activities and low technology transfer outputs reveals a disconnect that the university leadership needs to investigate. Either work on applied research has only recently started, which would explain the absence of tangible results to date, or the technology transfer and commercialization activities are not properly organized and focused to achieve good results.

Jimma University has below-average results in a number of domains, including the proportion of students receiving needs-based financial aid, the proportion of foreign students, the proportion of academics with a PhD, the proportion of the university's budget spent on research, and the time of study lost to strikes and other political disturbances. These issues reflect the lack of focus on low-income students in the financial aid policy, the lack of internationalization policy to attract foreign students, the struggle of all universities in the country to train, find, and retain Ethiopian academics with a PhD, as well as lack of funding for research in the budget that the universities receive from the Government.

This benchmarking analysis of Jimma University's performance suggests that, if the university wants to become a research-intensive university, it needs to invest heavily in training and attracting qualified academics with a doctorate, provide them with adequate resources (funding and scientific infrastructure) to stimulate their research output, and create postdoctoral positions. Special attention must be paid to translating the research results in technological applications that are relevant to the needs of the local economy and community.

Table 10. Institutional Health Indicators

Institutional Health Category	Benchmarking Result
Proportion of first-year female undergraduate students	Middle 50%
Accessibility for wheel-chair bound students	Top 25%
Proportion of students receiving needs-based financial aid	Bottom 25%
Proportion of students receiving merit-based financial aid	Middle 50%
Student-teacher ratio	Middle 50%
Use of innovative pedagogical practices	Middle 50%
Proportion of academic staff having received pedagogical training	Middle 50%

Institutional Health Category	Benchmarking Result
Graduation rate (bachelor level)	Top 25%
On-time graduation (bachelor level)	Bottom 25%
On-time graduation (master's level)	Middle 50%
Quality of educational facilities	Middle 50%
Proportion of students during an internship	Middle 50%
Proportion of foreign academics	Top 25%
Foreign academics with a master's or PhD	Middle 50%
Proportion of students doing a semester abroad	Middle 50%
Proportion of foreign students	Bottom 25%
Proportion of joint international publications	Bottom 25%
Proportion of graduate students	Middle 50%
Proportion of academics with a PhD	Bottom 25%
Proportion of academics who publish at least one paper a year	Top 25%
Internal research funding per academic staff	Middle 50%
Proportion of institutional income spent on research	Bottom 25%
External research funding per academic	Middle 50%
Successful research grants applications	Middle 50%
Proportion of academics involved in technology transfer activities	Top 25%
Proportion of institutional budget spent on technology transfer activities	Middle 50%
Technology transfer income	Middle 50%
Proportion of students involved in community service as part of the curriculum	Middle 50%
Income from continuing education	Middle 50%
Study time lost because of strikes	Bottom 25%
Per-student expenditures	Middle 50%

Finally, the benchmarking results also show those areas where Jimma University does not have the relevant data and needs to build its MIS. For example, in terms of performance, the university does not track data on the socioeconomic origin of its students and graduates. It does not have information on the labor market results of its graduates, which is a serious limitation. The university also failed to report on its IQA system and the number of accredited programs, which may be due to the lack of QA tradition so far. Furthermore, many of the data available for recent years were not collected in the past, which makes it difficult to look at the historical evolution of Jimma University's performance and institutional health indicators.

3.7. Student Support Services and Career Counselling

At the moment, it is broadly recognized that the students entering higher education need to be prepared better. There is widespread consensus that many lack mastery of English—the language of instruction—as well as the basic foundation of knowledge and skills that would allow them to

succeed in higher education.[19] The country's ESDP V, reported that "many students joined higher education institutions with results below the 50 percent threshold in the higher education entrance examinations". The problem is particularly serious in certain fields. In physics, a basis for engineering studies, students' results are extremely low. For example, "the average score for test takers in the fields of mathematics and physics were 48.3 and 50.5, respectively." (Woldegiyorgis 2017).

The leadership of the Ministry of Education has directed the universities to expand access and to be inclusive, among others, of students with disabilities, those who come from the four emerging regions of the country, and girls (33 of public university students are women). The senior leaders of the public universities were clearly cognizant of these goals. Universities have opened gender offices and launched many initiatives to support students.

According to the leadership of the institutions, the first-generation universities get the best students, while the private universities get the weakest. This was confirmed during the visits to both the public and private universities. The private universities explained that the admission system is based on a maximum of 700 points; the ministry decides what should be the cutoff point but this is sometimes set too low, which results in admitting very weak students into private institutions. The private institutions also point to the unfair competition between the public and private institutions, because students get free tuition in public institutions, while those enrolling in the private institutions cannot get a private loan to fund their education.

At the request of the ministry, universities in Ethiopia have taken many initiatives to ensure students' success. This includes modularization and continuous assessment, as well as developing a number of student support services. Universities also mentioned that they are introducing active learning gradually. These initiatives are reported to have reduced the attrition rate (for example, at Addis Ababa University from 30 to 5 and at the University of Science and Technology, a remarkable 2.3)[20].

Nevertheless, some Addis Ababa University teachers think that the three-year bachelor's degree is too short and should be extended by one year to address the needs of the weaker students. The national policy of using English as the language of instruction is reported to be a challenge to both staff and students. The rapid expansion of the system presents its own challenges. Thus, teaching laboratories at the science and technical university are now almost fully equipped, but some lack qualified technicians or adequate space to use the equipment. So, they send students to other universities for their laboratory work.

The universities have developed a range of services and initiatives to support students. While some are more advanced than others, all are worthy of further development:

[19] The level of student learning outcomes remains low and should be further improved for a country like Ethiopia aiming to become a middle-income country in the next decade. The level of proficiency of many students in both Grades 4 and 8 are 'Below Basic'. Analysis of test item distractors shows that a significant number of students in Grade 4 did not grasp fundamental concepts such as how to calculate an area of a shape. Similar misunderstanding led to a sizable share of Grade 8 students not being able to calculate the volume of an object (World Bank 2016).
[20] According to information from the representatives of these universities.

- Libraries are digitalized at the public institutions and the first-generation universities are able to share their online learning resources and virtual medical laboratories.

- Student support services and initiatives include bridging courses in English, tutorial, peer advising, a disability office, and a gender office. With respect to bolstering English language skills, one university noted that, despite best efforts, it is difficult to bring the students up to the university level when their foundation is very weak.

- Academic staff members are asked to hold regular office hours and offer academic development courses (Chapter 2); their attendance in class and that of their students are monitored in at least some of the institutions.

- The awareness of gender issues and the need to provide support to female students was remarkably strong at all levels of the universities, including the students. To signal the importance of this, the Addis Ababa University gender office reports directly to the President. Such offices provide assertiveness training, academic advising, and tutorial for students, as well as financial help, as required. A private university mentioned that a woman always leads their student service division and that it requires gender balance in the student union leadership and for student representation in the senate.

- Similarly, students with disabilities are receiving a great deal of attention. For instance, the Addis Ababa University disability office handles a very large caseload of 400 students. At Addis Ababa University, sight-impaired students share a narrow campus road with cars, while students in wheelchairs are seen waiting at the foot of buildings. The Ministry of Education is aware of these challenges and reports that efforts are being made to address these infrastructural needs.

With respect to student life, each class has its own representatives and there is student representation in the university senates and academic commissions. There are student residences and canteens on campuses as well as a number of student clubs, which provide opportunities for cultural and social life.

Interviews with the students revealed a number of issues related to their campus experience.

- With respect to their curricular activities, there is no active learning in large classes but rather reliance on lectures and theoretical learning and limited access to up-to-date learning resources.

- In case of academic difficulties, they turn to their friends rather than to academic staff and make little use of office hours. Their knowledge of the available support services seemed patchy and female students are reported to be particularly hesitant to bring up the challenges they may be facing.

- With respect to their extracurricular activities, the students mentioned that it is difficult to create student associations because there is too little funding and too many

bureaucratic requirements. They complain that the student residences are "not comfortable or interesting" and the canteen food is not good.

The following two case studies in box 5 present initiatives to ensure the retention of at-risk students. Annex 4 presents an institutional checklist for student retention initiatives.

Box 5: Widening Participation and Improving Retention

Uniminuto University, Colombia, was created with the explicit purpose of offering good-quality education to young people from low-income families living in disadvantaged areas.

The Integrated Focus Model—a program of academic support dedicated to at-risk students—operates during the entire course of studies and provides students with the following support services:

- **Academic counseling,** including (a) monitoring academic results before the first midterm exam, (b) monitoring of unusual absence and low grades, (c) tutoring and mentorship, (d) academic strengthening workshops, (e) counseling on course selection and attendance and career counseling more generally, (f) counseling in case of conflict with professors, and (g) individualized study contracts where students commit to applying themselves to their studies.
- **Financial support** can take three forms: (a) help with getting a student loan from the country's national student loan agency (the first ever such institution in the world, founded in 1951), (b) loans from Uniminuto's own funding cooperative, and (c) scholarships from Uniminuto for students experiencing very difficult economic situations.
- **Psychological support** is offered in four ways: (a) psychological counseling, (b) counseling for students with special needs, (c) workshops with the parents of first-year students to talk about student autonomy and financing options, and (d) meetings with parents at their initiative.
- **Life project course.** All students are required to take the life project course during their first year. This course is designed to help them formulate a clear vision of their professional and personal goals and identify, on that basis, the educational options that best meet their needs.
- **Remedial courses.** Over the years, Uniminuto observed that the main areas of weakness of incoming students were their level of mathematics and their ability to communicate in writing and orally. Therefore, it has put in place a series of remedial courses to overcome these deficiencies among at-risk students. These courses are available on a voluntary basis. In addition, students who find themselves struggling in key courses in their undergraduate major can get relevant remedial help.

A deputy vice-chancellor oversees the implementation of the Integrated Focus Model. Each faculty or school has a dedicated person responsible for coordinating the relevant interventions. The program reduced the dropout rate from 31.1 to 11.1.

University of Bío-Bío (Chile)

The University of Bío-Bío launched the First-Year Induction and Integration program in 2007, with the objective of improving student retention and employability while maintaining the quality of education. The program consists of the following phases:

- **Transition phase**. During the first induction period (four days), relevant university authorities welcome the new students and brief them on the learning style and requirements in their chosen academic path.
- **Identification of initial difficulties**. During the second phase (one to two days in the middle of the first semester), the main objective is to identify, through participative methodology workshops, the difficulties encountered by the new students and help them overcome the challenges through relevant advice provided by peer tutors.
- **Academic counseling and planning.** Organized at the beginning of the second semester, this third induction session gives the new students the opportunity to self-assess their achievements so far and outline the challenges they have faced, and seeks to offer positive motivation from the peer tutors to stimulate their integration into their new academic and university life.

- **Identification of at-risk students**. In the middle of the second semester, the induction program teams identify students at risk of not passing their first year and determine remedial actions to help them overcome their academic deficit at that point.

The First-Year Induction and Integration program has been strengthened through four complementary interventions:

- Organizing the basic science curriculum (mathematics and physics) into shorter, self-contained modules that allow students who have trouble understanding the science curriculum to take a remedial course and repeat a module before moving on to the next level.
- Developing a bridge program for the local high schools. The university works with interested students to help them understand the range of academic options available to them and become familiar with the university environment.
- Offering remedial interventions with peer tutors and professors.
- Offering cultural and professional internships organized specifically for new students from the lowest two income quintiles, with the goal of widening their cultural horizons and giving them the opportunity to become familiarized with the world of work.

Source: Learning Excellence 2015.

In sum, the efforts to provide a very diverse student population with a supportive environment are very commendable and it is highly encouraging that issues of equity are a concern everywhere. It would be useful to explore this area in greater depth and evaluate the extent to which the student support activities and campus environment could serve the students' success better and if the low attrition rate is a sign of lowered standards.

Career Counselling

Boosting the employability of graduates requires a joint approach between the universities and industries. At the moment, career advising was found in the two private universities but not in the two public ones because of a feeling among the latter that their graduates were able to find jobs easily. With respect to contacts with employers, the students in public universities mentioned that some companies do come to campus but to advertise their products rather than take an interest in the students and that they have not seen any guest lecturers from industry.

Anecdotal evidence pointed to a good practice in one private university that closely monitors their students when they are placed in an internship, while public university students mentioned the case of fellow students who ended up doing irrelevant internship work. They noted that courses in entrepreneurship are taken but that this is not sufficient because they need capital to launch a business.

These issues are clearly acknowledged by the authorities, which commissioned a study on the labor market and anticipating labor market needs. Career advising has been flagged as a support service that should be offered in all universities. Lifelong learning opportunities exist but a detailed analysis would require further data collection. Based on these preliminary findings, it is clear that, at minimum, the universities should be developing their career services (including tracer studies and career advising), bolstering their links with employers, and developing a monitoring framework for internships. Graduate tracer studies and employers' surveys serve the purpose to get better information about the distribution of skills among new hires, as well as the demands for those skills from different economic sectors, to support the design of skills development policies and improve employability and productivity.

The national observatory that the Government is planning to create would provide significant support to the universities' activities in this area. Box 6 and figure 33 illustrate how a career guidance system and a labor market observatory could operate.

Box 6: Establishing a Career Guidance System and a Labor Market Observatory

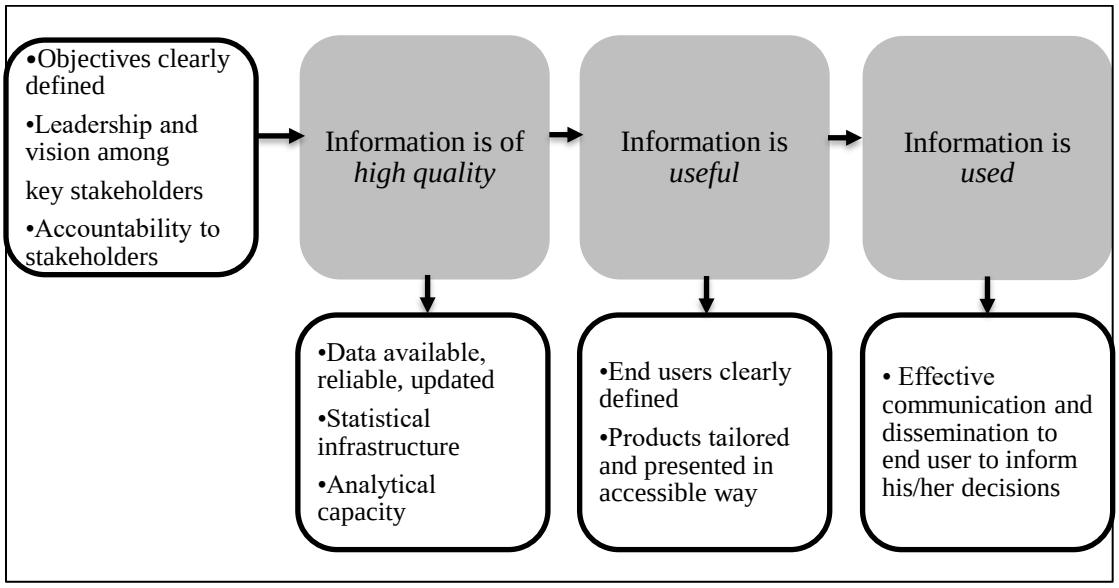
Establishing a career information system and a labor market observatory is essential to perform the information management functions that are needed to guide the higher education and Technical and Vocational Education and Training (TVET) subsystem. A career information and guidance system can be defined as a set of tools and services intended to assist individuals of any age to make educational, training, and occupational choices and manage their careers. To operate in an effective manner, the career information and guidance system must be designed and put in place as a coherent system linking all necessary stakeholders (Ministry of Education and Science, Ministry of Labor, Ministry of Economy, city authorities, higher education and TVET institutions, Chambers of Commerce, Association of Employers, and so on) together. It must rely on sound measurement tools for assessing quality throughout the system, including the quality of the specialists and the quality of the information offered to students and graduates.

The system should facilitate information access; allow for self-help and self-development; lead to increased use of ICT; and promote interaction among HEIs, TVET institutions, the private sector, and nongovernmental organizations (NGOs). Finally, it would be important to use evidence-based processes through which the system could track who uses what information and to what extent the services offered are based on client demand and usage.

As part of the career guidance system, the labor market observatory would monitor the labor market outcomes of higher education as well as technical and vocational education and training graduates on a continuous basis, widely disseminate information about careers and pathways, and advise decision makers on necessary adjustments at the level of higher education and TVET institutions as well as labor market policies. The labor market observatory could function as an independent policy research body or as a policy research institute attached to a university.

Source: Watts and Fretwell 2004.

Figure 33. Labor Market Observations: Best Practices



Source: Adapted from Hoftijzer (2015).

Furthermore, it would be useful to encourage universities to develop two complementary approaches to bolster employability:

- To embed employability in the curriculum by developing courses that meet the need of industry and ensure that soft skills such as communication, teamwork, and so on are taught across the curriculum. In this context, it would be helpful if universities could identify the key attributes of their graduates.

- To work with industry to offer students opportunities for work placements, paid internships, alumni, and guest speakers. A framework for monitoring and evaluating work placements and internships would need to be developed to ensure that students' training needs are ensured (see box 7).

Box 7: Ensuring Graduates Are Employable Through Experiential Learning and Cocurricular Learning

Nelson Mandela Metropolitan University (NMMU)

NMMU is located in the Eastern Cape, one of the poorer areas of South that suffers from very high unemployment levels. The students who come to NMMU are mainly from deprived catchment areas and are mostly first-generation university students.

NMMU has a two-pronged approach to learning: experiential learning through cocurricular activities (education, learning, and development acquired from out-of-classroom activities) and experiential learning embedded in academic programs (service learning, internships, and work-based placements).

Both cocurricular activity and experiential learning are universitywide and are managed by means of a decentralized integrated management model composed of

- The cooperative Education Unit within the Centre for Academic Engagement and Collaboration,
- Faculty academic staff, and
- Academic administration.

A central university committee approves activities and outcomes, which are then recorded.

Students are prepared for experiential learning so that they have the necessary skills and are clear about their roles and obligations, as well as the nature of the industry in which they will work. Learning criteria and specific outcomes are documented to give guidance to the students, mentors, and employers. Employers are visited regularly to ensure that the learning takes place in accordance with the prescribed standards and criteria. Employers are required to sign off on any logbooks or similar documents. There are guides for how to design and structure work-integrated learning for the workplace.

The work is monitored by faculty staff through visits to the workplace, discussions with students, employers, and mentors; these are documented. Logbook entries, presentations, or other agreed evidence for portfolios or artifacts are used to assess student progress. Interim and continuous assessment may occur throughout the experiential learning period. Finally, structured and recorded feedback by students and employers serve as a review of QA.

Experiential learning is evaluated by faculty staff members and records of experiential learning are approved by academic department heads or program coordinators in the normal way before being sent to the Examinations Office for entry in the student's record; they are thus subject to regular university QA processes. Program Advisory Boards and professional body requirements also help ensure that the experiences are relevant. The experiential and especially work-based learning components of qualifications are further subjected to cyclical quality reviews (in a 3–5-year period). Many of these reviews are conducted by external professional bodies.

Source: Learning Excellence UK 2015.

In addition, the following initiatives would strengthen accountability and ensure evidence-based decision making:

- Asking HEIs to publicly report their graduates' employment rates for different fields of study and conduct tracer studies to understand their graduates' labor market

outcomes. This will help adjust education programs and make them more responsive to the needs of economy.

- Completing the Higher Education Management Information System (HEMIS) and Labor Market Information System to collect evidence on the effectiveness of various programs, including in S&T streams.

- Conducting an enterprise survey to assess employers' satisfaction with the skills of recent university graduates, particularly in S&T programs.

Through the provision of relevant information on the quality of education and training institutions (graduation rates, salaries, job satisfaction) as well as on occupations, wages, and sector of employment, education and training institutions can become more accountable and transparent while leading to better career and educational choices among the population. This would not only enhance productivity in Ethiopia but also make the country more attractive to international firms seeking to invest in Africa (Geiger and Moller 2015).

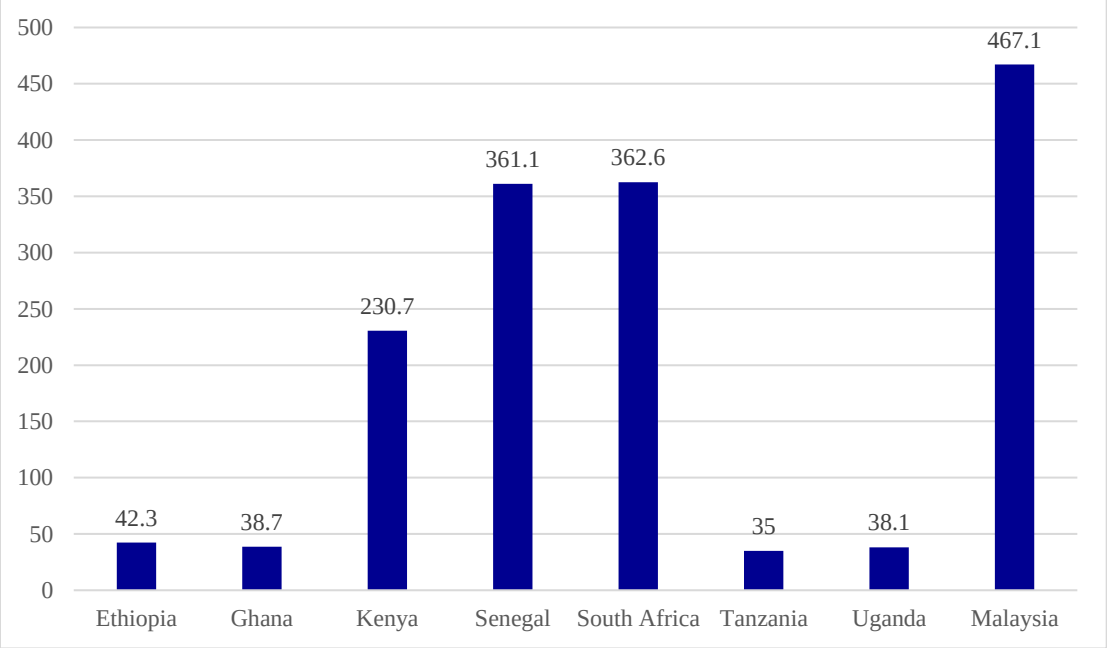
Chapter 4. Determinants of the Present Research Performance

The outstanding results of well performing universities—highly sought graduates, leading-edge research, and dynamic knowledge and technology transfer—can essentially be attributed to three complementary sets of factors: (a) a high concentration of talent (academics and students); (b) abundant resources to offer a rich learning environment and support advanced research; and (c) favorable governance features that encourage strategic vision, innovation, and flexibility, enabling institutions to make decisions and manage resources without being encumbered by bureaucracy. While the configuration of results—research, learning and technology transfer—depends on the nature and specific mission of each HEI (research intensive, teaching, applied science, and so on), the alignment of the three sets of factors is a requirement for any type of HEI (Salmi 2009, Salmi 2012c). This analytical framework can be used to understand the research performance of Ethiopian universities.

4.1. Talent Development

The first measure of talent development is the stock of researchers. Figure 34, which calculates the number of researchers relative to the overall population, shows the low proportion of researchers in Ethiopia, on par with Ghana, Tanzania, and Uganda. Ethiopia is significantly behind Kenya and Senegal in this respect.

Figure 34. Researchers Per Million Inhabitants in Ethiopia and Comparator Countries (2010)

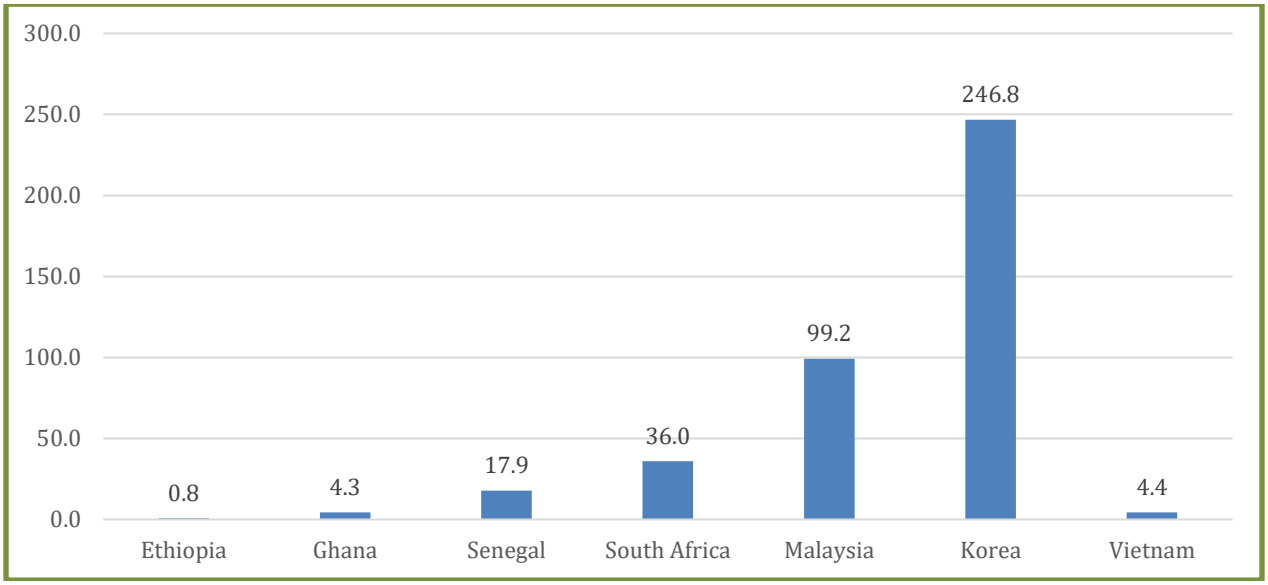


Source: http://data.uis.unesco.org/ (accessed February 2017).

The situation is not likely to improve rapidly, because the number of Ethiopian PhDs trained in the country and overseas, relative to the population, remains very low. Figure 35 presents the number of PhD graduates for Ethiopia and relevant comparator countries per million inhabitants, for the few countries for which data are available. The statistics clearly show that Ethiopia needs

to ramp up the production of graduates with a doctoral degree. Ghana and Vietnam presently produce 5 times more PhDs per million inhabitants than Ethiopia every year and Senegal 22 times.

Figure 35. PhD Graduates Per Million Inhabitants, 2012



Source: http://data.uis.unesco.org/ (accessed February 2017).

The low proportion of academics with a doctorate is one of the major constraints for the training of Ethiopians at the postgraduate level. Overall, only 6.3 of academics have a PhD. Table 11 provides the proportion for the principal disciplinary areas. The three domains with the highest proportion are natural and computational sciences, agricultural and life sciences, and the social sciences and humanities. At the same time, engineering capacity is an issue.

Table 11. Proportion of Academics with a PhD by Disciplinary Area (2014/15)

Disciplinary Area	Proportion of Academics with a PhD
Engineering and technology	2.8
Natural and computational sciences	10.2
Medicine and health sciences	4.4
Agricultural and life sciences	9.9
Business and economics	3.1
Social sciences and humanities	9.0
Total	6.3

Source: Ministry of Education of Ethiopia.

Data from the nine oldest universities confirm this diagnosis (table 12).

Table 12. Proportion of Academics with a Master's or PhD in Top Ethiopian Universities (2015/16)

University	Proportion of Academics with a Master's	Proportion of Academics with a PhD
Adama	52.2	13.7
Addis Ababa	42.3	27.6
Arba Minch	49.1	9.1
Bahir Dar	57.5	11.3
Gonder	48.2	3.4
Haramaya	71.5	13.2
Hawassa	68.1	15.4
Jimma	54.0	7.5
Mekelle	33.0	13.9

Source: Ministry of Education of Ethiopia.

There is serious lack of academic and research capacity in Ethiopian universities. Another way of measuring the gap between Ethiopia and other Sub-Saharan African countries is to analyze how Addis Ababa University fares in relation to the flagship university of other countries (table 13). Even though the data for the other universities are older than those for Addis Ababa University (2011/12 and 2015/16, respectively), they clearly illustrate how imperative it is to accelerate doctoral training to prepare the next generation of Ethiopian academics.

Table 13. Proportion of Academics with a PhD in Flagship African Universities

Flagship University	Proportion of Academics with a PhD
University of Botswana	65
Addis Ababa University	**28**
University of Cape Town	63
University of Dar Es-Salam	43
Eduardo Mondlane University	17
University of Ghana	50
Makerere University	43
University of Mauritius	42
University of Nairobi	45

Source: Ministry of Education of Ethiopia; Buntin, Cloete, and van Schalkwyk (2013).

Academic inbreeding, the practice of recruiting academics who are graduates of the same university, is a serious issue at the oldest Ethiopian universities, especially at Addis Ababa University. Studies of academic inbreeding have demonstrated that this tradition is not conducive to innovation and high performance. In the words of one of the leading researchers on this topic, academic inbreeding promotes "institutional parochialism and intellectual isolation" (Horta, Sato, and Yonezawa 2011, 37). Universities that have lower levels of inbreeding tend to have a higher scientific production.

Women are underrepresented in S&T higher education. Gender disparities is another dimension that affects the size and quality of the talent pool for Ethiopian universities. Table 14 shows the evolution of the gender gap between academic year 2004/05 and academic year 2014/15, the latest year for which official statistics are available. While the situation has improved significantly over the past 10 years, the loss of talent that the low proportion of females represents remains of concern. Women account for only 10 academics with a master's degree and only 7 of those with a PhD. A worrisome decrease is also seen when the proportion of women enrolled in postgraduate

programs is compared to the proportion that actually graduates (24 versus 17). This gap did not exist in 2004/05. It would be important for university leaders to investigate the factors that prevent women from graduating.

Table 14. Evolution of the Gender Gap in Higher Education (2004–2014)

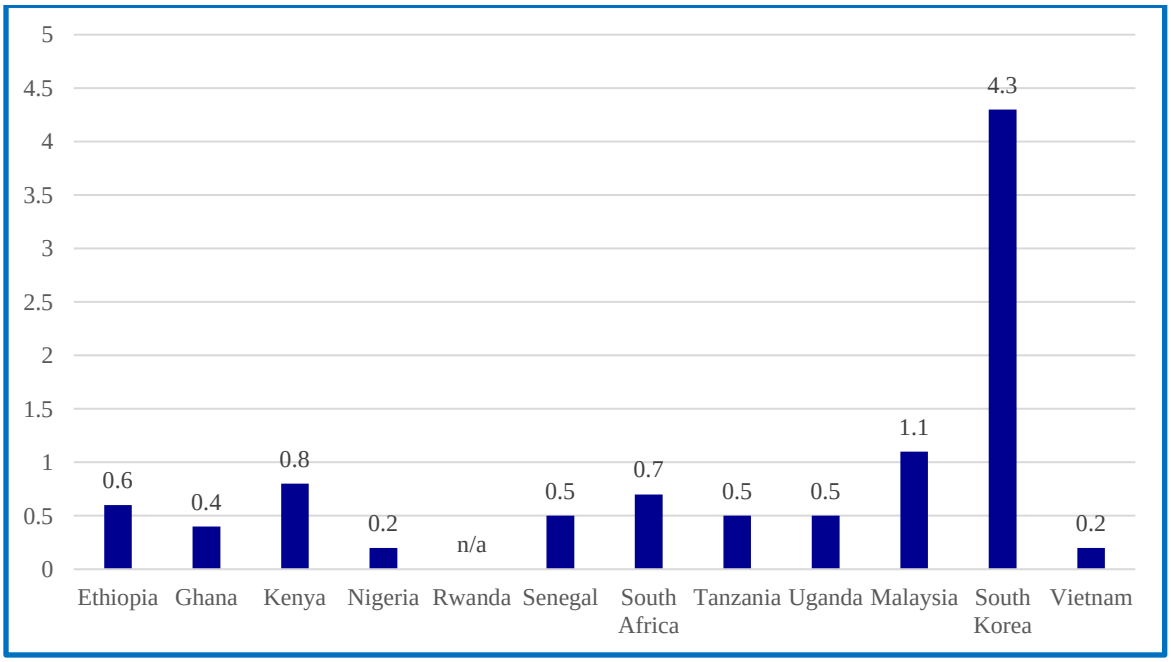
Proportion of Females	2004/05	2014/15
Undergraduate students	24.0	34.7
Undergraduate graduates	14.8	28.9
Master's and PhD students	9.2	23.8
Master's and PhD graduates	9.0	17.2
Academics with a master's	n.a.	10.2
Academics with a PhD	n.a.	7.2

Source: Ministry of Education of Ethiopia.

4.2. Research Funding

In 2006 the member states of the African Union endorsed a target of investing 1 percent of GDP for R&D. Still, Sub-Sahara African countries tend to invest less than 1 percent of their GDP to fund R&D activities, unlike European countries that manage to spend on average 1.9 of GDP. At 0.6, Ethiopia is among the better performers, almost on par with the leading African countries, Kenya at 0.8 and South Africa at 0.7 (see figure 36).

Figure 36. Gross Expenditure on Research and Development as of GDP for Ethiopia and Comparator Countries (2014)



Source: GII, https://www.globalinnovationindex.org/gii-2016-report#.

However, universities receive a very small share of that funding. The 0.6 percent of GDP spent on R&D corresponds to about US$369 million of public and research funding for 2015. But the competitive research allocation provided by the Ministry of Science and Technology is less than US$2 million a year.

In addition, very few universities have sufficient number of researchers and the scientific infrastructure necessary to conduct research in a meaningful manner, even among the nine most ancient universities in the country. Out of Ethiopia's 34 public universities, 3 of them (Addis Ababa University, Mekelle University, and Addis Ababa Science and Technology University) capture the lion's share of the competitive research funding provided by the Ministry of Science and Technology since its formation a few years ago.

Table 15. Competitive Research Allocations (2014/15 and 2015/16)

University	Amount (ETB, millions)	Share of Total (%)
Addis Ababa University	34.7	31.1
Mekelle University	15.7	14.1
Debre Birhan University	5.1	4.6
University of Gondar	0.8	0.7
Addis Ababa Science and Technology University	20.4	18.3
Semera University	4.2	3.8
Jimma University	0.9	0.8
Non-university research institutions	29.9	26.8
Total	111.7	100.0

Source: Ministry of Science and Technology.

The field visits revealed that, despite significant efforts to invest in new laboratory facilities, many departments lack the up-to-date scientific equipment needed for advanced research, even in the two new S&T universities. Access to broadband is unequal across the universities. However, Addis Ababa University has made significant progress in recent years to strengthen the library and ICT facilities. The ministerial initiative to network the university libraries is a positive development.

4.3. Governance Dimensions

At the national level, the Ministry of Science and Technology is the main authority in charge of coordinating, encouraging, and financing research. However, its influence is very limited as the research budget that it allocates to universities represents less than 1 percent of the country's total research effort.

The GoE has embarked on an ambitious policy to establish and develop a number of Centers of Excellence to boost research in priority areas in the country's development agenda. In addition to those centers financed directly by the Government, Ethiopia has received World Bank support to set up four Centers of Excellence. Three of them operate within Addis Ababa University, with a focus on railways engineering, water management, and innovative drug development and therapeutic trials. Haramaya University hosts the last one, devoted to climate smart agriculture and biodiversity conservation.

The field visits brought out a number of obstacles at the institutional level, linked, in great part, to the lack of autonomy characterizing Ethiopian universities. Staffing autonomy (that is, the capacity of universities to manage their staff), in particular, is quite limited, which makes it difficult to develop the research output. The grade structure and corresponding remuneration conditions are very rigid, leaving the universities with little room for maneuver to offer internationally competitive packages and manage academic staff in a flexible manner. Seniority, rather than track

record, is the main criterion for fitting incoming academics into the salary scale. Faculties and departments cannot easily decide on staff deployment and assignments based on the respective strengths and profiles of academics. The 'civil service' status of university staff is also a complicating factor for some of the administrative staff, such as information technology specialists and lab technicians, whose remuneration levels and conditions of employment are not attractive compared to the private sector. The academics and senior administrators met during the visits all decry the cumbersome procurement and financial management practices that hinder efforts to improve the quality of teaching and research.

One positive development, at Addis Ababa University, has been the establishment of a grants coordination office to help researchers with information and resources about grant opportunities and support for grant implementation.

Because of the rapid quantitative expansion at all universities, academic staff have heavy teaching loads and cannot make much time, if any, for research. In addition, the low salaries drive many of them to teach in private universities or take on consulting assignments to make ends meet. This is a major impediment to the development of the research capacity of Ethiopian universities. It presents a risk, particularly for the new Centers of Excellence mentioned earlier, which may find it difficult to mobilize researchers because of their many teaching commitments.

When Addis Ababa University of Science and Technology and Adama University of Science and Technology were transferred to the Ministry of Science and Technology, their staff received a special remuneration package that placed them in a more favorable situation than the academic staff of the other public universities. But this special status, meant as an incentive to encourage them to devote 30 percent of their time to applied research, lasted only two years as the salaries of academics in the other public universities were adjusted upward. Today there is no difference between the academic staff of universities under the Ministry of Education and those under the Ministry of Science and Technology. Therefore, the rationale for having universities operating under two separate ministries is not clear.

Generally speaking, the Ethiopian universities have few links with industry. Recent efforts to boost the research output have focused on scientific publications, much less so on knowledge and technology transfer activities. There is also little collaboration among the universities, although some donor projects do support collaborative arrangements.

Another challenge faced by Ethiopian universities is the high degree of similarity and duplication in program offerings and disciplines across the sector. In the case of Addis Ababa University, the physical dispersion of the university buildings is not conducive to bringing academics from various disciplines closer. This does not favor the kind of concentration of efforts and resources needed for achieving critical mass in funding, talent, and infrastructure that are the hallmark of excellence in research.

The lack of information on research funding and activities is a paramount problem throughout the university system both at national and institutional levels. Neither the Ministry of Education nor the Ministry of Science and Technology have the overall picture of research expenditures and research output in Ethiopia. This is the direct result of the universities' lack of capacity to track the publications and other research products of their academic staff.

4.4. Policy Options for Building Research Capacity

Contribution of Research to Innovation and Competitiveness

In July 1945, Vannevar Bush wrote the following statement in his pioneering book Science, the Endless Frontier: "a nation which depends upon others for its new basic scientific knowledge will be slow in its industrial progress and weak in its competitive position in world trade." While the book was written with the United States in mind, other nations heeded the call for developing scientific capacity, especially in Southeast Asia.

Rapid technological progress, the spread of global value chains, and the increasing importance of knowledge-based capital mean that knowledge has become the most important factor in economic development, not only technical knowledge but also knowledge about attributes, that is, the informational characteristics that support analysis and decision making (World Bank 1999).

The innovation strategy recently articulated by the OECD (2015) outlines five priorities: (a) the need to strengthen investment in innovation and foster business dynamism, (b) the importance of investing in an efficient system of knowledge creation and diffusion, (c) the opportunity of capturing the benefits of the digital economy, (d) the need to foster talent and skills, and (e) the urgency to improve the governance and implementation of innovation policies. A strong tertiary education system is vital to support the second and fourth priorities.

More specifically, tertiary education supports knowledge-driven economic growth and poverty reduction strategies by (a) training a qualified and adaptable labor force, including high-level scientists, professionals, technicians, and teachers in basic and secondary education and future government, civil service, and business leaders; (b) generating new knowledge through basic and applied research; and (c) providing the platform for accessing existing stores of global knowledge and adapting this knowledge to local use. Tertiary education institutions are unique in their ability to integrate and create synergy among these three dimensions.

The success of East Asian economies illustrates the symbiotic relationship among tertiary education, innovation, and growth through the production of research and skills. A recent World Bank report analyzed the positive links between economic growth and tertiary education as measured by the tertiary gross enrollment ratio, science test scores, levels of R&D investment, and the number of scientists and engineers relative to a country's population. Firm innovation surveys undertaken in Indonesia, the Philippines, and Thailand showed that the most active innovators are those with higher levels of R&D expenditures, more highly qualified staff, and located in more R&D-intensive industries (World Bank 2012b).

As far as research is concerned, the same World Bank report on East Asia found that universities and other tertiary education institutions not only added to the knowledge stock, but also helped raise the technological capacity of low-income countries and supported countries with medium technology capacity in the transition from technology assimilation to innovation through consulting services, hosting incubation facilities, and customizing foreign technologies for local requirements (World Bank 2012b).

National Policy Dimensions

To urge the universities to build up their research capacity, the GoE must consider three prerequisites: (a) a clear S&T development strategy, (b) innovative funding for research, and (c) a more flexible governance framework for the research-intensive universities.

S&T Policy

Ethiopia cannot live up to its economic growth ambitions and commitment to the SDGs unless the country is prepared to accelerate its efforts toward forming a pool of high-level researchers trained either in the top national universities or overseas. The example of Brazil is very relevant in that respect. In the past three decades, the Coordination of Improvement of Higher Level Personnel (*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior,* CAPES) Foundation, operating as an arm of the Federal Ministry of Education, has coordinated the country's interventions to improve the quality of Brazil's academic staff through grants and rigorous evaluations programs. More recently, the Government stepped up its efforts through the Science without Frontiers initiative, which finances 25,000 annual scholarships for overseas studies at the master's and PhD levels.

The establishment of the Ministry of Science and Technology is an important step forward. The road map document on the future of higher education, which is under preparation, will undoubtedly include a strategy and detailed plans for improving the research contribution of Ethiopian universities. It will also be critical to decide how many research universities the country should have and how many the country can afford to fund adequately.

To facilitate the insertion of young doctoral graduates into dynamic research teams, Ethiopia must consider funding postdoctoral schemes. In doing this, it would be emulating government programs operating in other parts of the world, which give accredited universities the opportunity to hire promising young researchers for up to two years, at no cost or little cost, as happened, for instance, in Pakistan in the first decade of the new century.

Uganda's experience with its Millennium Science Initiative (MSI) offers relevant lessons on research promotion. The Uganda MSI project, which was implemented between 2007 and 2013, made use of innovative funding mechanisms such as competitive grants to enhance research capacity through high-powered teams and collaboration. The project aimed to accelerate the training of better-qualified science and engineering graduates and the production of higher-quality and more relevant research. The first component of the project (US$16.7 million) focused on developing research capacity through competitively awarded grants. Its second component (US$16.7 million) aimed to improve public understanding and appreciation of science and strengthen the institutional capacity of Ugandan universities and research centers. The project design was adapted to the Ugandan context and the country's level of scientific development (World Bank 2014c).

The main policy innovations supported by the MSI project included

- Building human capital by linking research with postgraduate education to develop the country's scientific future;

- Building the capacity of research teams for high-quality scientific research; and
- Encouraging statistical and policy analysis through scientific research.

The MSI achieved major results. Over a six-year period, Uganda was able to significantly increase its human capital in S&T, raising the number of researchers from 261 to 720 and the number of S&T students from 24 to 41 at the PhD level, from 245 to 633 at the master's level, and from 3,241 to 4,892 at the Bachelor's level. The Government established a fully functional competitive funding mechanism operating with high scientific standards as grant proposals were evaluated by top Ugandan and international scientists. The ratio of applicants to funded proposals was 11:1, which allowed for the selection of high-quality research proposals only. The initiative also facilitated the development of the capacity of the Uganda National Council for Science and Technology for national statistics on science, technology and innovation and the Uganda Industrial Research Institute, where the number of services offered increased fourfold and revenue increased from UGX 0 to UGX 67 million to enhance efficiency and self-sustainability.

An example of the new strategy, proposed in 2015 by the Prime Minister of Australia, illustrates the range of measures that a comprehensive research promotion strategy incorporates (annex 5).

Research Funding

It is important to underline Ethiopia's capacity-building efforts to protect funding from interferences and maintain stable funding levels over the years. A number of arrangements exist around the world to fund university-based research. These comprise instances in which instruction and research are funded together, performance-based research block grants, competitive research grants, direct funding of Centers of Excellence, demand-side funding, and excellence initiatives.

- **Combined funding for teaching and research.** This is perhaps the most common and traditional approach for financing campus-based research, whereby universities use some of the public resources they receive to pay for the conduct of research in addition to expenditures for academic instruction and institutional operations. Most countries around the globe fund research together with instruction as part of their negotiated budgets or funding formulas. Joint funding of instruction and research has the strength of being the research funding method most likely to integrate teaching and research efforts. Its downside is that the Government has little leeway to influence the direction of research or the efficient use of resource funding.

- **Performance-based block grant funding.** Under this mechanism, which very few countries in the world rely on, universities receive a block grant allocation for research that is not differentiated or earmarked but is based on the past performance of institutions or academic units. Eligibility for the block grant is usually linked to institutional demonstrated capacity. Faculties have wide latitude in setting their own priorities for the use of these funds. The amount of public research funding for each university is based on a periodic peer-reviewed assessment of collective faculty capacity to conduct research in an innovative fashion. In Australia and England, for example, the 'blue skies' approach for allocating research funds—allowing researchers to choose their areas of investigation without being restricted by specific

national areas of priority defined by the Government as in the case of the competitive funding available through the research councils—is based on the results of the Excellence in Research for Australia assessment and the Research Excellence Framework in the United Kingdom, conducted every five to seven years to measure the quality of the research produced at different universities.

- **Competitive research grants.** This is one of the most common ways of allocating public resources for research. Faculty members apply for funding for specific research projects, which are granted based on peer reviews of proposals. By measuring the quality and potential of proposals in an objective way, the process is somewhat insulated from political pressures. Multiple agencies are usually responsible for funding peer-reviewed research projects. Funding is sometimes provided on a matching grant basis, whereby government funds are complemented by institutional or private sources. This matching grant approach is used in Singapore (three from the Government and one from private sector), Hong Kong SAR, China, and New York State in the United States, for instance. The main risk with peer-reviewed projects lies in the homogeneous selection of peers, with those in the establishment excluding dissenters, which could stifle innovation, result in narrow research agendas, and detract from the quality and relevance of the projects funded.

- **Centres of Excellence.** Another way of allocating research funds through block grants is to fund Centres of Research Excellence at particular institutions that often specialize in certain fields or endeavours. In the United States, the Federal Government and a number of states have adopted this approach as a way to supplement the research funding embedded in their core funding. New Zealand and the Netherlands are examples of OECD countries that have funded much or all of their academic research through Centres of Excellence. Centres of Research Excellence have the potential of achieving critical mass and improving the relevance of research if the focus of the centres accurately reflects national and regional needs. Some nations, Canada for example, also fund chairs of excellence. Finally, countries such as France and Germany have traditionally maintained a large network of separate research institutes and centres—the National Center for Scientific Research (Le Centre National de la Recherche Scientifique, or CNRS), Max Planck Institute—that operate independently from the universities.

- **Demand-side funding.** In a number of countries, university-based research is funded indirectly through the provision of scholarships, fellowships, and research assistantships in support of graduate students. Canada, the United Kingdom, and the United States are prime examples of this demand-side approach in which the multiple agencies that fund research typically have various programs of graduate student support.

- **Excellence initiatives.** As explained earlier, excellence initiatives are hybrid funding mechanisms, which provide significant additional funding to a select group of universities or Centres of Excellence in the countries involved. With a few exceptions (that is, Thailand where nine universities were designated as recipients of the

additional funding), the selection of beneficiaries is usually done on a competitive basis.

The sources of research funding are also varied, including (a) national and state governments through the education/higher education ministry or the funding buffer body, (b) national and state research bodies or councils, (c) industry and commerce, and (d) foundations and charities. Table 16 presents a summary analysis of how research funding is distributed in nine OECD countries with high levels of research performance.

Table 16. Research Funding Mechanisms in Selected Countries

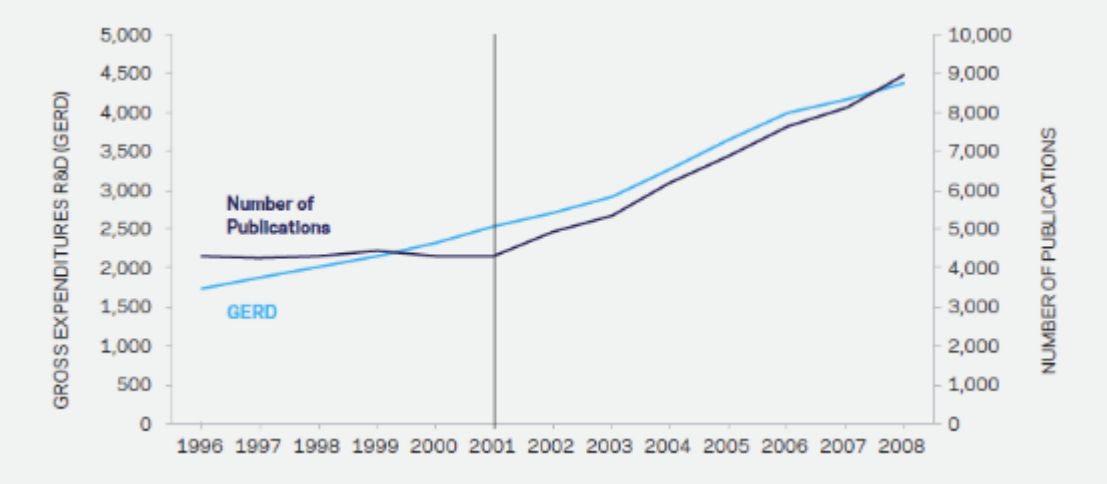
Countries Research Funding Modality	Australia	Canada	Denmark	Germany	Netherlands	Norway	Switzerland	United Kingdom	United States
Combined funding for teaching and research		✓		✓	✓		✓		✓
Performance-based block grant funding	✓		✓			✓		✓	
Competitive research grants		✓	✓			✓		✓	✓
Centers of excellence/Chairs of excellence		✓			✓				
Demand-side funding		✓			✓			✓	✓
Excellence initiative	✓	✓	✓	✓		✓			

Source: Elaborated by Salmi for this report.

At present, the GoE relies principally on competitive research grants through the Ministry of Science and Technology and the establishment of the four new Centers of Excellence with World Bank funding. The Government should carefully review all possible mechanisms described in table 16 and box 9 and opt for the configuration that is most appropriate to the national conditions and ambitions.

Data from South Africa clearly show how the level of research funding and the type of allocation mechanism chosen combine to enhance research output (World Bank 2014c). Figure 37 includes data on the growth of research products because of increased funding and the introduction of performance-based funding mechanisms in 2001 that provided incentives to researchers.

Figure 37. Research Funding and Output in South Africa (1996–2008)



Source: World Bank 2014c.

To complement this picture, data from Mozambique (box 8) and Uganda illustrate the direct correlation between level of funding and research output. In both countries, the research output is higher in health than in STEM disciplines generally, because of the lower amount of available funding. This is in sharp contrast with Malaysia, which dedicates much more research funds to S&T than to health.

Box 8: Quality, Innovation, and Excellence Receive Attention: Quality Enhancement and Innovation Fund in Mozambique

In 2002, the Government set up a competitive fund called the Quality Enhancement and Innovation Fund (QIF), which was designed to encourage innovation in teaching programs and research projects. QIF was succeeded by two competitive funds—the Institutional Development Fund (IDF) for higher education and the National Research Fund (NRF) for science, technology, and innovation.

Over the past three years, the IDF has financed a range of projects among public and private HEIs. The total allocated funds amount to approximately US$5.3 million. About 60 percent of this amount was allocated to HEIs outside Maputo.

From 2006 to 2012, the NRF financed 233 research projects by students at both the undergraduate and postgraduate levels. The fund has also financed several activities designed to promote the visibility and acceptance of science in society. The NRF disbursed US$7.4 million from the World Bank (69 percent), Sweden (27 percent), and Finland (4 percent).

The Provincial Scholarship Fund was launched by in 2002 as a way to encourage underprivileged academic achievers from provinces outside Maputo to pursue higher education. The scheme provided the basis for the establishment of the Institute for Scholarship (IBE), a government program, which started to operate in 2008. Currently, through IBE, about 3,000 students benefit from scholarships of which 33.7 percent are funded by the Higher Education Science and Technology Project. About 80 percent of the beneficiaries are from households that earn less than US$270 per month; 39 percent are women and 42 percent are enrolled in science, engineering, and health.

Source: World Bank 2014b.

Box 9: The Power of Competitive Funds

Well-designed competitive funds can greatly stimulate the performance of tertiary education institutions and can be powerful vehicles for transformation and innovation to improve the quality of teaching, learning, and research. One of the first funds promoted by the World Bank, Argentina's Quality Improvement Fund (Fondo para el mejoramiento de la calidad universitaria, or FOMEC), was instrumental in encouraging universities to engage in strategic planning for the strengthening of existing programs, the creation of new interdisciplinary graduate programs, and the strengthening of research. Within universities, faculties that had never worked together started cooperating in the design and implementation of joint projects. In Egypt, the Engineering Education Fund helped introduce the notion of competitive bidding and peer evaluation in the allocation of public investment resources. The fund promoted, in an effective manner, the transformation of traditional engineering degrees into more applied programs with close links with industry through relevant consulting and joint research projects.

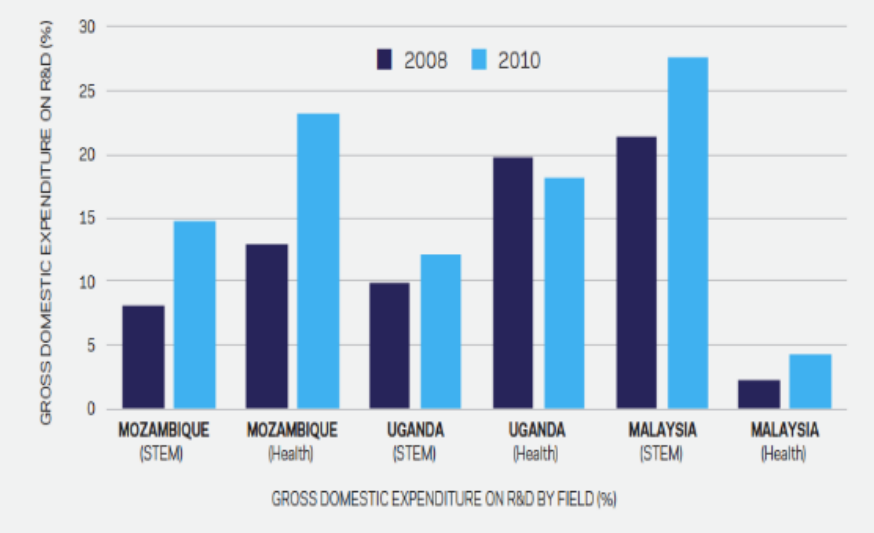
A fundamental prerequisite for the effective operation of competitive funds—and one of their significant benefits—is the practice of transparency and fair play through the establishment of clear procedures and selection criteria, as well as the creation of an independent monitoring committee. In Chile, a second wave of tertiary education reforms was in the early 2000s by a competitive fund for quality improvement in research upgrading in all public universities. Brazil, Ghana, Mexico, and Uganda have encouraged the formation of advanced human capital in S&T through competitive funding mechanisms. In all these cases, the participation of international peer review experts figured prominently.

In countries with a diversified tertiary education system with unequally developed types of institutions, as is the case in Ethiopia, there may be a compelling argument for offering several financing windows with different criteria, or for setting up compensatory mechanisms to create a level playing field between strong and weak institutions. In a project supported by the World Bank in Indonesia during the 1990s, three different schemes were designed to serve universities according to their actual institutional capacity. In the last tertiary education project financed by the World Bank in China in the early 2000s, the top universities were required to form a partnership with a university in a poor province as a condition for competing. In Egypt, the competitive fund in the Engineering Education Reform Project had a special window for technical assistance to help less-experienced engineering schools prepare well-formulated proposals. In Chile, a special window was opened to provide preparation funds for universities requiring assistance in strategic planning and subproject formulation.

The voluntary nature of competitive funds is an important success factor. The availability of additional resources can encourage tertiary education institutions to embrace reforms and innovations, while leaving out those not willing or ready to transform themselves.

Source: Salmi 2016.

Figure 38. Gross Domestic Expenditure on Research by Field



Source: World Bank 2014c.

Ethiopia could also bear in mind some useful lessons from the experience of Singapore. Among other critical decisions, the city-state adopted a long-term view in building up its research capacity and focused on strengthening basic research as the indispensable foundation to support the nascent innovation system (annex 6). To promote relevant research and close links with industry, the GoE could also consider the experience of a few OECD countries that have set up 'innovation vouchers' as financial incentives for that purpose (annex 7). Innovation vouchers are small lines of credit provided by the Government to small and medium-sized enterprises (SMEs) to purchase services from knowledge and technology providers with a view to introducing innovations (new products, processes, or services) in their business operations.

Research Governance

At the national level, the GoE could consider three measures to improve the governance of research: (a) setting up a single coordination authority for university research, (b) granting increased autonomy for research universities, and (c) organizing a comprehensive MIS to monitor and evaluate research results.

In the first place, it would be highly recommended to bring all the universities destined to become research-intensive institutions under a single government agency, with a unified regulatory framework. The main responsibility of that agency would be to offer the universities strategic guidance and appropriate incentives to stimulate significant progress in research production and technology transfer. In that context, it would be useful to encourage Addis Ababa University to be more proactive in supporting the research capacity-building efforts of the other Ethiopian universities through appropriate partnership arrangements.

A recent evaluation of how governments can best support the development of effective university-industry links, based on the European experience, underscores the following three elements (Science Business Innovation Board 2012):

- **Stay the course.** Policy makers need to ensure a predictable, stable environment of funding and regulation for long-term strategic partnerships to thrive.

- **Give institutional autonomy.** It is important to allow universities the autonomy to operate effectively and form partnerships with the industry. The best people to decide a university's strategy are its own board and faculty heads, not government ministries. Without freedom to operate—with appropriate checks and balances—they cannot form effective partnerships.

- **Reward dynamic, successful collaborative universities.** Funding incentives work: government policy should reward, or at least not discourage, universities and companies that form strong partnerships.

Second, to improve their research performance, Ethiopian universities must enjoy the ability to make decisions in a more autonomous manner and manage their academic and financial resources with more flexibility. Institutional autonomy is a key element in the successful transformation of public universities (Salmi 2009). Autonomous institutions are more responsive to incentives for performance improvement and efficient use of available resources. It would be important for

Ethiopian universities to be free to determine their own employment conditions, such as hiring and staff remuneration, and the remuneration conditions to encourage academic staff to engage in research. Flexible procurement rules are needed to accelerate and simplify the purchase of goods and services funded under both the public budget and donor projects. Finally, the Ethiopian universities must have independent fiscal control, including the ability to reallocate resources internally according to self-determined criteria. Independent fiscal control is necessary so that institutions can strengthen weak academic units, cross-subsidize programs, and fund new initiatives quickly and flexibly in response to evolving needs.

The GoE can consider two options to introduce performance elements in the personnel status of researchers. The first one would be to maintain the civil service status of academic staff but allow universities to establish benefits and rewards to recognize performance levels and contributions of individual staff. The second one would be to eliminate the civil service status of academic staff and make each university the employer of its academic and administrative staff.

- Public universities in several Western European countries have brought in additional benefits to reward outstanding academic performance. In France and Germany, for example, universities benefiting from the excellence initiatives initiated special incentives to support postdoctoral researchers, create tenure tracks for talented young researchers, and offer salary supplements for senior professors. The University of Montpellier set up attractive postdoctoral programs, tenure tracks, and high profile positions combining higher incomes and dedicated research support. Heidelberg University, for instance, developed a new HR policy whereby progression is not linked directly to seniority anymore but associated with a performance-based system of bonuses that recognizes good research and teaching and successful participation in administrative tasks. In a way, many faculties in the Ethiopian universities already have a system of salary supplements but the reform proposed here would involve full transparency and consistency in designing, implementing, and monitoring these practices as an objective system of rewards and bonuses.

- The second approach consists in removing the academic and administrative staff from the civil service status and transforming them into employees of their university, as happened in Finland for example. This means that each research-intensive university in Ethiopia would develop and post its own criteria for recruitment and establish its own salary scale and package of benefits. The creation of two S&T universities under the Ministry of Science and Technology could have been a right move in that direction, but as mentioned earlier the special salary remuneration conditions offered at the beginning were not maintained. It is not too late to consider a more favorable personnel status for these universities, to help them establish themselves as dynamic and high performance institutions of teaching, research, and technology transfer.

With respect to the third dimension of governance reform, it would be important to design and implement a comprehensive MIS on research funding, research activities, and research products. The MIS would link all research-intensive institutions and Government agencies. Progress on this front can happen only if the ministries and the universities are willing and able to develop a culture of openness about information and data sharing.

Progress at the Institutional Level

Talent Development

The most important factor in any university's strategy to strengthen its research capacity is its ability to attract and retain top-rate academics—young promising researchers and experienced proven researchers—who can contribute to building critical mass of excellence in research and knowledge transfer. While progress has been achieved in a few faculties and institutes, Addis Ababa University and the other universities likely to become more research intensive need to have a clear capacity-building program in place and provide adequate incentives to encourage and reward high-impact research. These incentives, which would signal a cultural shift in favor of research, could include financial rewards for good research performance, flexible schedule arrangements that would allow productive researchers to have a reduced teaching load, especially those linked to Centers of Excellence, and opportunities for academic mobility and participation in international research networks.

The university leadership teams ought to put in place special programs to attract more qualified female academics into research, combining financial and non-monetary measures to remove existing obstacles. At the national level, the state can implement affirmative action policies to promote women's entry into academic institutions as students and ensure that university faculty, administrative staff, and leaders have a greater gender balance. A quota system could further strengthen the balance among faculty and staff. Underscoring the importance of equal opportunities, the GoE can also conduct targeted outreach campaigns across communities to build awareness about educational opportunities for girls. Campaigns focusing on girls' access to tertiary education at the secondary level can especially help introduce young women to STEM subjects (Fredua-Kwarteng and Effah 2017). In addition to building awareness, the state must also address access issues that hinder women's educational attainment (cost of studies and living expenses, transport, safety, and so on).

At the institutional level, universities can put in place key policies to address gender imbalance, but they first need to establish a comprehensive understanding of the context. A thorough gender analysis or gender audit can allow institutions understand where gaps exist and which areas need to be addressed. On this basis, institutions are in a better position to draft a targeted action or strategic plan, monitor progress against the original gender audit, and hold themselves accountable. Gender mainstreaming policies are significant in ensuring that gender is considered in all institutional activities—from hiring procedures to admissions and curriculum building (INASP 2017).

To ensure greater gender balance in enrollment and completion, universities can modify admission requirements for women or allow them conditional access based on their completion of pre-entry or bridging courses that allow women to gain the additional skills and knowledge they may be lacking due to limited opportunities at the secondary level (Fredua-Kwarteng and Effah 2017). Mentorship programs, knowledge sharing, networking opportunities, and transparent and targeted hiring practices can address gender imbalance in faculty and staff. Additionally, institutions can strive to ensure a safe learning and teaching environment for all students, especially for women who face gender-based sexual violence or harassment (Taiwo 2014).

At both the institutional and state level, gender-focused research can complement the abovementioned policies by providing a financial and institutional commitment to gender equity in tertiary education. Grants supporting women scholars and gender-focused research will provide greater opportunities for access and contribute to the goals of mainstreaming gender in academia. Table 17 shows a range of possible measures at the national and institutional levels.

Table 17. Policy Measures and Good Practices to Promote Gender Equity

Policy Measures \ Instruments	Policy	Financial Incentives
National Level		
Quotas and/or affirmative action	X	X
Gender-specific access issues (funding, safety, transport, lodging)	X	X
Grants for gender-focused research		X
Grants for women postdoctoral scholars and young researchers		X
Institutional Level		
Affirmative action	X	
Community links, bridges, and outreach programs, especially in STEM subjects	X	
Gender research unit for analysis/audits/strategic plan/monitoring and evaluation	X	
Gender mainstreaming	X	
Mentoring and networking opportunities for female academics		
Addressing gender-specific access issues (funding, safety, transport, lodging)		X
Ensuring safety of learning environment	X	
Effective grievance procedures for sexual harassment	X	
Support for faculty and students returning from maternity leave		
Diversity and equity training		

Source: Elaborated by Salmi for this report.

Several Ethiopian universities have followed the lead of Addis Ababa University in appointing a vice-president for research, responsible for coordinating and promoting research activities. Those universities keen on increasing the intensity of research activities may want to establish a dedicated research coordination and development office to support the efforts of the vice-president. Box 10 illustrates the benefits of this kind of structure.

Box 10: Coordinating Research Activities at Imperial College

The research office of Imperial College of London is an impressive example in terms of organizational structure and success rate. Imperial College of London has been granted €76 million from the Horizon 2020 program and it ranks second among the top 50 universities receiving Horizon 2020 funds. These outstanding results are due to a well-structured research office, which gathers 34 full-time equivalent professionals, including a European Union specialist unit of 6 full-time equivalent professionals. The centralized office relies on European Union dedicated teams located in each faculty.

The office has developed many practical tools to provide expert guidance and services, for example, information on funding sources, preparation of research project proposals, costing and pricing, and project management. The research office also coordinates a mobility program to boost exchanges for both researchers and students, with a specific emphasis on relations with selected universities, among which are UC Davis, Heidelberg, Wageningen, and Barcelona.

Source: http://www.imperial.ac.uk/research-and-innovation/research-office/.

To improve the quality of teaching and research, several measures can be envisaged to reduce inbreeding in the Ethiopian universities, especially at Addis Ababa University. At the national level, the state can use the QA system by incorporating, among the new accreditation criteria, guidelines about the maximum proportion of 'inbred academics' in each university, faculty and even academic department, a desirable minimal proportion of foreign academics or foreign-trained Ethiopian academics, and academic mobility more generally. In addition, the state can offer a range of financial incentives to support employment opportunities in other universities for recent PhD graduates and young researchers, promote short-term outbound academic mobility for academics without international academic experience, subsidize the recruitment of foreign academics and/or Ethiopian scholars employed in foreign universities, fund research projects that involve international collaborations, and encourage nonacademic institutions (research institutes, state agencies, and companies) to hire scientists.

To reduce inbreeding at the institutional level, universities can define rules to limit the number of PhD graduates recruited directly after they finish their research degree, establish promotion criteria that take into consideration the experience in foreign academic settings—including at least a short stay at a good quality foreign university—, provide guidelines on the maximum proportion of 'inbred academics' in each department, and set up joint doctoral programs with partner universities. To accompany these policies, universities can set aside funding for academic mobility and collaborative research projects. At the end of the day, the best mechanism to prevent inbreeding is to have, in place, a fully transparent and meritocratic recruitment and promotion process that allows for open competition on the basis of objective measures of academic achievement. Table 18 shows the full range of possible measures at the national and institutional levels.

Table 18. Policy Measures and Good Practices to Reduce Inbreeding

Policy Measures \ Instruments	Policy	Financial Incentive
National Level		
Accreditation criteria	X	
Recruitment of foreign academics/Ethiopian scholars from the diaspora	X	X
Short-term outbound academic mobility	X	X
Grants for postdoctoral and young researchers		X
Grants for collaborative research projects		X
Subsidies to encourage nonacademic institutions to hire scientists		X
Institutional Level		
Transparent, meritocratic recruitment procedures	X	
Limits on the recruitment of own PhDs	X	
Minimum of outside academics in each department	X	
Promotion criteria	X	
Compulsory mobility for PhDs and postdoctoral scholars	X	X
Short-term outbound academic mobility		X
Joint doctoral programs among several universities	X	
Participation in collaborative research projects		X

Source: Elaborated by Salmi for this report.

Multidisciplinary

During the field visits, several academics mentioned multidisciplinary as an important priority, giving examples of research programs that bring multiple disciplines together. But it appears that these are the exception rather than the rule. University leadership teams should encourage, through appropriate financial and academic incentives, the design of research programs based on solution-focused research questions directly linked to the main development challenges of Ethiopia in general and those of the regions where the universities are located. This would allow a more systematic meshing of disciplines across faculties and institutes that would result in higher-impact research.

Each research-focused university should also try to define areas of concentration that are different from the other universities and that are directly relevant to the regional environment. An important lesson from the experience of research universities that have rapidly achieved a high level of performance is that they have managed to concentrate their efforts to reach excellence on niche programs and research areas (Salmi 2011). Through this niche-seeking strategy, Moscow Higher School of Economics and Hong Kong University of Science and Technology, for example, have successfully built a critical mass of excellence in teaching and research much faster than comprehensive universities in their respective countries.

Strategic Partnerships

As many universities in the world tend to do, Addis Ababa University and the other first-generation universities have a large tradition of signing Memoranda of Understanding (MOUs) with universities in other countries. Very often, the MOUs focus on academic and student mobility. To ensure that international collaboration serves to fully support the Ethiopian universities' efforts to build up their research output and improve the quality and impact of the research, the universities could envisage entering into a few long-term strategic partnerships aligned with their key

development priorities. Strategic partnerships are deep relationships with carefully chosen institutions that are not necessarily at the same level of development but that share a common vision and similar values. The principal objective is to undertake common activities in research and knowledge transfer that are mutually beneficial. From the Ethiopian universities' viewpoint, these partnerships should have an institutional strengthening dimension through the development of joint academic programs and/or double degrees, joint supervision of graduate students, collaborative research projects, joint services to the community, and possibly joint benchmarking exercises that could help the Ethiopian universities in the definition of stretch goals. Strategic partnerships are not restricted to other universities, but can include government entities, NGOs, companies, and community groups.

Open Science Mindset

In recent years, the Open Science movement has been challenging conventional modes of knowledge acquisition, generation, and dissemination. Open Science represents a novel approach to scientific development, based on cooperative work and information distribution through networks using advanced technologies and collaborative tools. Rather than restricting the 'ownership' of discoveries and scientific advances, Open Science seeks to facilitate knowledge acquisition through collaborative networks and encourage the generation of solutions based on openness and sharing. Figure 39 proposes a representation of how the various dimensions of Open Science are connected and interact.

Drawing from a pioneering analysis of publications over the past three decades, Jonathan Adams announced the 'fourth age of research', the age of collaborative research and international research networks, following the age of individual researchers, the age of the research institution, and the age of the national research enterprise (Adams 2013). Collaborative research yields faster results and facilitates a quicker transfer of these results, thereby serving the needs of both producers and users of knowledge in a more effective and efficient manner.

Figure 39. Open Science and Related Phenomena

Source: Salmi 2015.

This trend represents a great opportunity for Ethiopian universities, which can work together within international research networks and develop joint research projects of a multidisciplinary nature to address big challenges that are common to countries, using open data sources. These new, collaborative approaches also represent a unique opportunity to explore innovative ways of integrating teaching, research, and service activities.

Open Science is also a useful framework to build up the research infrastructure. Because of the high expenses involved in establishing modern laboratories for advanced science, the Ethiopian research universities ought to explore ways of sharing resources and collaborating in an open science spirit. In a growing number of fields, expensive equipment can be accessed through fast Internet in a distance mode, allowing for the development and organization of shared labs within and among universities. Ethiopian universities can even be linked to research labs in industrial countries, allowing PhD students to have access to the best possible scientific equipment at a much reduced cost.

Stronger Links with Industry

The leading Ethiopian universities must strengthen their R&D activities to build their capacity to engage with the local economy and support the national and regional innovation system. They can play a critical role as one of the key pillars of the country's innovation strategy. Indeed, the presence of strong universities is important to regional development, through both direct links and spillover effects. The successful experiences of technology-intensive poles such as Silicon Valley in California; Bangalore in Karnataka State, India; Shanghai in China; and Campinas in São Paulo State, Brazil, attest to the positive effects that the clustering of advanced human capital alongside leading technology firms can have.

In addition to contributing to the local economy through salaries and the purchase of goods and services, universities can be essential economic agents through relevant applied research and the training of highly qualified professionals who can help make the local firms more innovative and productive. The universities can fulfill this role in several ways, not only by participating in new innovations, but perhaps even more importantly by facilitating technology upgrade and absorption.

By setting up their own incubators or linking up closely with the industrial parks under development, the strongest Ethiopian universities could contribute directly to inventing innovative ways of producing goods and services. This implies systematic efforts to undertake industry-oriented research and seek opportunities for technology commercialization.

Conducting research that results in patents and licenses that allow firms to make new products and develop new lines of business is important, but it is not the only manner in which technology transfer can take place. Firm-strengthening ideas pass between the academic world and companies through other forms of collaboration. The contribution of Ethiopian universities to technology upgrade and absorption can best be achieved in two ways. First, involving employers in curriculum design and having them take on students as interns strongly increases the probability that firms will employ qualified graduates. These graduates, in turn, will be agents of technology transfer, bringing new techniques and know-how to firms, especially small and middle ones. At the end of the day, the best conduit for moving ideas back and forth between universities and firms is through the students and graduates themselves.

Second, by opening their doors to firm representatives and organizing technology information and diffusion events, the universities can act as knowledge exchange platforms which, despite the often informal character of interaction between academics and industry people, can have a significant technology transfer influence on industry and services.

In supporting the transformation of the existing economic sectors and the creation of new ones, the contribution of universities can take several forms. Table 19 provides a summary description of the principal modalities of collaboration on knowledge transfer and technology commercialization that Ethiopian universities could consider developing. It also indicates what role the national and local authorities must play to facilitate these collaborations. A more detailed matrix is presented in annex 8.

Table 19. Most Effective Knowledge- and Technology-Transfer Mechanisms

University-Industry Links	Role of National and/or Local Authorities	Comments
Public space function for networking and dissemination	• Develop and fund programs to create and support clusters	• With education and training, this function is seen by firms as the most important contribution of universities
Human capital formation (students and firm employees	• Priority setting and incentives for establishment of new programs • Targeted scholarships • Funding and tax incentives to facilitate insertion of PhD graduates	• Primary role of universities in support of innovation
Research Problem-solving and consulting	• Matching grants and tax incentives • Criteria for evaluating the performance of researchers • Support for cluster formation • Targeted assistance to SMEs	• Increased returns at the intersection of traditional disciplines
Sharing of technical infrastructure	• Funding	• Need for clear revenue-sharing arrangements within universities
Knowledge commercialization	• Appropriate Intellectual Property Right legal framework • Technical assistance • Financial autonomy of public universities	• More likely to happen in biotechnology, nanotechnology, new materials, and information technology

Source: Elaborated by Salmi for this report.

To build trust, as part of their efforts to develop closer links with economic partners, Ethiopian universities could emulate the practice of intellectual capital statements (ICS) initiated in Austria (annex 8), as a way of rigorously assessing their scientific potential and competencies and presenting it to the outside world.

Conclusions

To build the research and technology transfer capacity of the Ethiopian universities, it is important to act on two levels. At the national level, the GoE could focus its interventions on the following three aspects: (a) elaborate a clear S&T development strategy; (b) innovative funding for research, preferably through competitive research grants such as those offered by the Ministry of Science and Technology; and (c) establish a more flexible governance framework for the research-intensive universities, which would give them the necessary autonomy to operate with more flexibility

At the institutional level, the universities keen on becoming research intensive must define a realistic talent development plan that includes substantial efforts to train academics at the master's and PhD levels, especially in S&T areas, and courageous measures to reduce inbreeding. Universities should be encouraged to forge partnerships with leading institutions in other countries for capacity-building and joint research purposes and develop close links with the productive sectors, particularly in the key priority areas of economic growth identified in the Government's strategy.

Chapter 5. Conclusions and Policy Recommendations

The preceding chapters presented an analysis of the S&T higher education developments in Ethiopia and its links to the country's economy. To maximize the contribution of its universities to economic and social development through S&T, the GoE needs to carefully manage expansion to ensure quality and relevance of education. Policy recommendations in the priority areas are summarized in the following paragraphs.

5.1 Adequately Preparing and Deploying Academic Staff

HEIs need to make the most effective use of their human resources, especially their academic staff. Increased access and the rapid expansion of higher education require even more attention to maintain and strengthen the quality of academic staff. Teachers must be ready to meet the changing learning needs of a wider and more diverse student group. It is important to ensure that staff obtain advanced education and phase out lecturers with only undergraduate degrees, as well as keep attracting high-quality staff in areas demonstrating significant shortages, particularly within the S&T streams (at the PhD level). SDUs should be established and staffed with experts capable of organizing and delivering professional staff development programs.

It is important to ensure evidence-based staff-related decision making. This includes routine collection and utilization of HEMIS data on various dimensions of academic staff quality (including staff qualifications, research outputs, disciplinary orientation, inbreeding, and so on), participation in benchmarking exercises within the PASET and ACE initiative and beyond, as well as undertaking specialized studies to provide robust evidence on issues such as job satisfaction of faculty member—essential for their motivation—attraction and retention of talent in HEIs, effectiveness of staff development programs, innovative pedagogy and experimentation, and quality of the interaction of academic staff with the students.

Fostering collaborations for staff development and quality improvements through ACE II; PASET; and other interuniversity, national, regional, and international networks and forums could be particularly beneficial for Ethiopia. It is important to gain and maintain excellence in teaching and research, considering the large need for staff development and relatively low experience in the field. Ethiopian HEIs, presently at the beginning of the learning curve in HR development, can benefit from good practices and experiences from other countries and institutions. These networks and forums support the exchange of ideas and knowledge on staff development programs and the work of relevant units within HEIs, strategies for HR development, and best practices in the field and facilitate direct staff exchanges programs among the participating institutions.

5.2. Strengthening the Relevance and Quality of Higher Education

The current efforts focused on improving the quality of primary and secondary schools are essential. Without good-quality schooling, it will be challenging to build quality higher education.

The quality of academic and administrative staff is the backbone of the quality of universities. Therefore, great attention should be placed on reviewing the incentives, benefits, salaries, and training that they receive.

The efforts to increase and broaden access are commendable. The inclusion of students with disabilities requires that the infrastructure and the support meet their needs. It is also important to get more women into the academic pipeline and up to the highest steps of the academic and leadership ladder.

More efforts are required to ensure student success by offering a range of activities such as bridging courses, more complete student services, orientation, and better information to students about these activities. It would be useful to evaluate the extent to which the campus environment could better serve the students' success and if the low attrition rate is a sign of lowered standards.

Crucially, greater participation in higher education should match the labor market requirements. The destination of university graduates must be tracked and students provided with career support services. At minimum, the universities should be developing their career services (including tracer studies and career advising), bolstering their links with employers, and developing a monitoring framework for internships. It will be important to complete the HEMIS and Labor Market Information System to help collect evidence on the effectiveness of various programs, including in the S&T streams and assess employers' satisfaction with the skills of recent university graduates, particularly in S&T programs.

While the development of the doctoral level is strategic, it is also essential to increase the number of PhD candidates in a deliberate way to ensure quality supervision. In addition, the universities that are allowed to open PhD programs must demonstrate that they have the appropriate policies in place to ensure the quality of these programs.

Such policies include criteria for admissions, as well as all aspects of supervision, student assessment, and funding.

The internal quality system could be bolstered by focusing on ways to ensure that academic and administrative staff and students feel a sense of ownership of these processes and ensuring that a more exhaustive QA framework is implemented than just the current evaluation of staff.

The accreditation of professionals involved in areas of health and safety (for example, medical professions, engineers, architects) must be reviewed and aligned with international practice.

HERQA was reviewed in 2016 and received a report containing very cogent recommendations that need to be implemented. It would be useful to require the agency to produce written reactions to this review and an action plan and to foresee a follow-up review in four years. The report offers a range of recommendations that will be implemented in a step-by-step fashion within the next 20 years. However, such a long-term horizon might be compromised by the rapid changes being experienced in higher education worldwide. In addition, agency staff should be encouraged to connect with international peer agencies to keep abreast of international development.

5.3. Building Up Research Capacities

As Ethiopia's first university, established 60 years ago, Addis Ababa University's trajectory has been impressive. It has become the country's flagship university and has trained most of the leaders and academic staff of the other universities in the country. Addis Ababa University and the other

first-generation universities have aspirations of strengthened research capacity. At the same time, their ability to perform optimally as autonomous and dynamic institutions appears to be somehow constrained by the prevailing centralized governance framework and arrangements and limited public research funding because of the ambitious national expansion program to increase higher education enrollment.

Ethiopia is therefore at a crossroad. If the country wants to fulfill its ambition of developing a few full-fledged research universities to serve the national innovation system, it needs to modify the governance framework and grant more institutional autonomy. By removing the constraints that prevent Addis Ababa University and the other aspiring research universities from operating at their full potential, the GoE can empower its top universities to achieve the highest levels of performance that they legitimately aspire to. Additional funding is also indispensable to support the leading universities' efforts to train more PhDs, build up their scientific facilities, and engage in relevant research.

Within the universities, a number of adjustments ought to be made to improve their mode of operation and performance as research institutions. More emphasis should be placed on excellence in research along the current priority of expanding access. Addis Ababa University, in particular, should be allowed to focus on increasing the share of graduate programs and students and developing a strong culture of research through appropriate incentives and resources. The S&T universities could also be supported through competitive capacity-building grants responsive to national development goals (PhD training, laboratory equipment, partnerships with industry, partnerships with foreign universities) and competitive research grants in S&T domains aligned with country's priorities.

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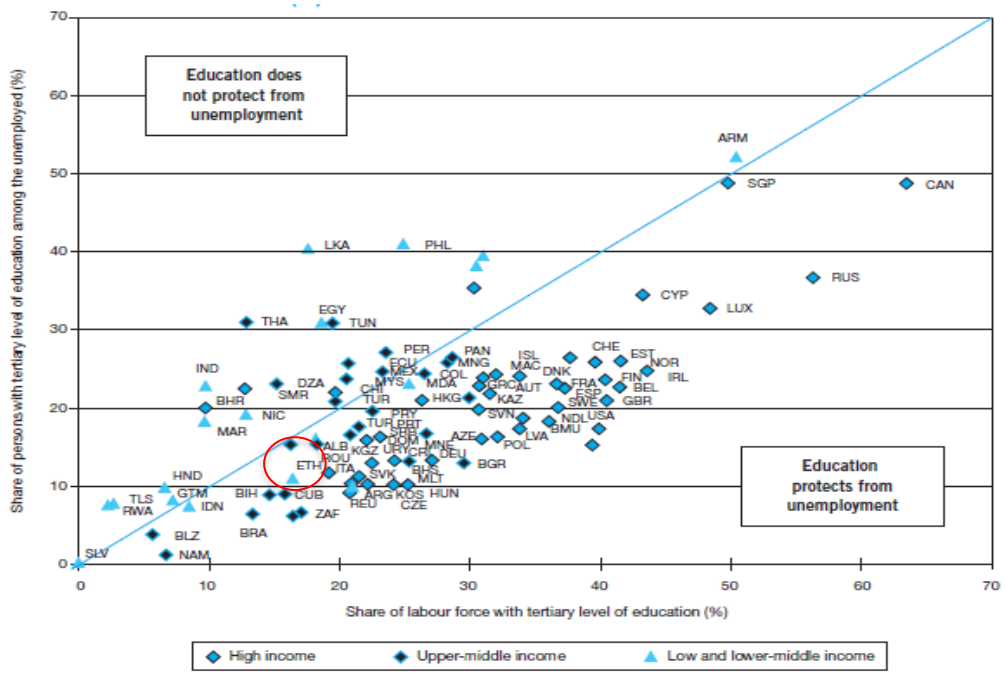
Annex 1: Meetings and Field Visits

The team met with the State Minister for Higher Education and the Minister of Science and Technology on two occasions, as well as with the leadership of HERQA (the QA agency) and the Secretary General of the Chamber of Commerce. Meetings were organized with the senior leadership, deans, academic staff, students, and the heads of support services of Addis Ababa University and Addis Ababa Science and Technology University. At Addis Ababa University, the team also visited the three newly selected African Centers of Excellence (railways engineering, health sciences, and water management); the Institute of Science and Technology; the Ethiopian Institute of Architecture; Building Construction and City Development; and the College of Business and Economics. In addition, the team met with the university's grants coordinator. Meetings were also held with the leadership of Saint Mary's and Unity University College.

Annex 2: Share of Labor Force and Unemployed with Tertiary Level of Educational Attainment



Source: International Labour Organization 2016.

Annex 3: Good Practice in Student Evaluation[21]

Student Questionnaires

Student questionnaires have become a popular way of collecting student feedback.

Standard questionnaire design principles include the following:

- Identifying its purposes. Is the focus on the individual module (individual unit of study), the course (composite of units that constitute the degree award), or the student's (learning) experience as a whole? Is it focused on the teaching, the resources, the learning, or all these elements? Defining the purpose will be the primary factor in determining the content.

- The frequency of the questionnaire should be thought through. A single questionnaire that is used too frequently for all classes every term will bore students and probably result in a very low response rate. This may mean that not every module is surveyed in every semester it is delivered.

- Questions should be meaningful to the students, unbiased, and unambiguous. Staff should feel that the questions are fair and useful. Therefore, student and staff input during the design phase is important.

- The questionnaire should be piloted before it is rolled out.

Apart from these standard design issues, the institution might also consider the following important principles:

- A focus on learning, rather than just teacher performance, will encourage students to think about their engagement in the learning process.

- While a standard questionnaire is often used across an institution, it is important to have a flexible instrument, adapted to the different disciplines. One way of achieving this goal is to give the different disciplines the opportunity to add or adapt some of the questions to specific teaching practices (for example, clinical training versus mathematics education).

- Online questionnaires are convenient to score but may result in a lower return rate than the paper version. Appropriate solutions to ensure a meaningful response rate are important. This usually requires communicating about the confidentiality of the process and finding a way for students to easily access the online questionnaire at an opportune time.

[21] Adapted from the Good Practice Guide of the University Quality Assurance Board (UQAIB), the QA body in Dubai's free zones, elaborated by Andrée Sursock.
https://www.khda.gov.ae/CMS/WebParts/TextEditor/Documents/UQAIBStudentfeedback_English.pdf.

- Measurement is important but so is the use of results.
    - One of the critical parts of feedback to students is to explain that their contributions through surveys and other means are designed to improve student learning and their success. Therefore, a useful technique is to inform students about how the data are used for enhancement, to motivate them to provide meaningful feedback.
    - Without equating student feedback with remedial activities for staff, it is a good idea to develop training and advisory services to teachers who are interested in improving their teaching skills. An academic development structure such as a 'Leaning and Teaching Unit' would offer workshops and individualized training to interested teachers, as well as a library of relevant material and equipment. It could also provide a tutoring service for students (group and individual sessions) to help students improve their study skills, time management, computer skills, and discipline-based skills. The combination of these two functions within a single unit would serve to ensure synergy and cross-learning.
    - The QA officers and senior office holders would normally look at emerging themes and identify what needs to be done, how, by whom, and when. This would be appropriate to the level and scope of the issue: ranging from action by individual teachers and heads of departments to major decisions at the institutional board level.

Informal Midterm Questionnaires

In addition to the formal questionnaires, it is useful to encourage academic staff to conduct their own evaluation during the term to reorient their teaching if necessary. This is usually done a few weeks within the term. An instructor would, for example, stop class a few minutes early and ask students to respond anonymously and in writing to questions such as:

- What was the most important thing you learned during this class?
- What important question remains unanswered?
- What classroom activities or assignments have been most/least effective in helping you learn this term, and why?

Each teacher would normally be able to develop the midterm questionnaire to suit his/her needs and the needs of the students. The results need not be communicated to the administration. In some cases, the midterm feedback may be a discussion with the teacher rather than a questionnaire, depending on factors such as the size of the class, the level and nature of the module, and the purpose of the feedback process. It is important, however, to stress students' anonymity and safety. They should be safe from recriminations, either personally or as a class. Students must be advised about their responsibility to take the surveys seriously and the rewards for doing so (a better learning experience).

Oral and Informal Feedback

Informal discussions with students can be an effective way to elicit feedback from them. These can be organized in a variety of ways as the following examples illustrate:

- The deans and vice deans would meet regularly with student representatives.
- A faculty could organize three feedback meetings a year to which all academic and administrative staff are invited. The meetings would be focused on a specific theme but would allow the student representatives to extend the agenda by voicing any student concerns.
- Teachers should have office hours and consult students informally.
- An external teacher could meet with a group of students, at the end of a module or the beginning of a semester, to discuss what they liked and did not like and their recommendations. The actual teacher would not be present during these conversations but would get a summary of the discussion.

Student Participation in Committees

The student questionnaires would normally be part of a package of instruments for evaluating teaching and learning: a package that would include analyses of written instructional materials (for example, course descriptions that include learning targets, reading material, description of activities, assignments, and examinations). These are usually examined in curricular committees that could include academic staff, students, and external stakeholders (for example, employers).

In addition, students would normally be part of the self-study groups when the institution undertakes an external evaluation or accreditation or in any internally organized quality review that is focused on aspects related to learning and teaching.

Annex 4: Improving Student Retention: An Institutional Checklist for Self-Reflection

This checklist was developed by Thomas, Jones, and May (2010, 40) for a joint African-European project on student access and success. The checklist is based on a literature review of institutional approaches aimed at improving student retention and reflects the major factors identified by the authors that contribute to student success.

1. Do we, as an institution—directly and through our partnerships—ensure that students are sufficiently prepared to make the transition into higher education (HE)?
Issues to review include:

- 1.1 Pre-entry information, advice, and guidance (IAG)
- 1.2 Pre-entry preparation for HE-level study
- 1.3 Induction and transition support
- 1.4 Recruitment and admissions processes (including clearing)

2. Is the curriculum designed and delivered to promote the success of all students?
Issues to review include

- 2.1 Learning, teaching, and assessment practices
- 2.2 Curriculum content, development, and organization
- 2.3 Academic skills development
- 2.4 Academic support

3. Do the formal and informal extracurricular activities support students and promote the engagement of all students in the HE experience?
Areas to reflect on include

- 3.1 Peer engagement, friendship, support, and learning
- 3.2 Access to appropriate learning and social spaces
- 3.3 Integration of students living both on and off campus
- 3.4 Pastoral and financial support
- 3.5 Provision and accreditation of nonacademic student experience to promote engagement

4. Is the student learning experience managed and coordinated to promote student success?
Issues to consider include

- 4.1 Policy development and integration
- 4.2 Use of institutional data to identify and support students/modules/courses/departments /faculties
- 4.3 Institutional processes and reporting structures
- 4.4 Staff engagement
- 4.5 Student engagement
- 4.6 Evaluation

5. Is the HE system set up to facilitate student retention and success?
Issues to consider include

5.1 Funding and performance review models support institutional flexibility and student choice
5.2 Institutions are able to respond flexibly to the needs of diverse students
5.3 Students have flexibility and choice, for example, to move in and out of HE and between HE providers

Annex 5: A New Research Agenda in Australia

The Australian Government in 2015 announced a National Innovation and Science Agenda backed initially by AUD 1.1 billion (US$790 million) over four years, aimed at encouraging 'smart ideas that create business growth, local jobs, and global success', signaling the start of an era of systematic ongoing—rather than stop-start—funding for science, with a permanent watchdog established at the heart of government. It will include a flexible funding stream for university research and a program to support the training of the next generation of researchers and innovators.

Through the National Innovation and Science Agenda, the Government will invest in the following four priority areas:

- Culture and capital, to help businesses embrace risk and incentivize early stage investment in startups
- Collaboration, to increase the level of engagement between businesses, universities, and the research sector to commercialize ideas and solve problems
- Talent and skills, to train Australian students for the jobs of the future and attract the world's most innovative talent to Australia
- Government, as an exemplar, to lead by example in the way the Government invests in and uses technology and data to deliver better quality services

Prime Minister Malcolm Turnbull said: "The government's National Innovation and Science Agenda will help to create a modern, dynamic, 21st century economy for Australia." He said the opportunities for Australia have never been greater. But Australia could improve in key areas. "Australia is falling behind on measures of commercialization and collaboration, consistently ranking last or second last among OECD countries for business-research collaboration. Our appetite for risk is lower than in comparable countries, which means Australian startups and early stage businesses often fail to attract capital to grow. And participation in science, math, and computing at high school is declining."

A Government statement said while innovation is at the heart of a strong economy it is "not just about new ideas, products, and business models; innovation is also about creating a culture where we embrace risk, move quickly to back good ideas, and learn from mistakes." The National Innovation and Science Agenda had therefore put forward a package of initiatives in the four key areas. "We're backing our entrepreneurs by opening up new sources of finance, embracing risk, taking on innovative ideas, and making more of our public research. We're increasing collaboration between industry and researchers to find solutions to real world problems and to create jobs and growth. We're developing and attracting world-class talent for the jobs of the future." And the Government will lead by example by "embracing innovation and agility in the way we do business." According to the Department of Education and Training, the agenda will ensure that high-quality research drives innovation "that saves lives, answers social and environmental imperatives, improves economic productivity and growth, and creates the jobs of the future." The agenda includes a number of measures that will be delivered by the Education and Training portfolio:

- Ongoing funding for the National Collaborative Research Infrastructure Strategy, (NCRIS), as part of a broader package of AUD 2.3 billion over ten years in new, sustainable funding for national-scale research infrastructure, including the AUD 1.5 billion for NCRIS

- AUD 885 million in 2017 for a new Research Support Program to Australian universities as a flexible funding stream to support the costs of research

- AUD $948 million in 2017 for a new Research Training Program to support the training of the next generation of researchers and innovators

- More than AUD 64 million to encourage young Australian students to study science, technology, and math subjects at school to embrace the digital age and prepare for the jobs of the future.

Source: O'Malley 2015.

Annex 6: Lessons from Singapore's Experience in Building a Strong Research Base

In interview with the Irish Times in 2015, Professor Seeram Ramakrishna, one of Singapore's foremost scientists, shared his thoughts on Singapore's success. Maintaining a global vision and putting more money into science are essential for any country that wants to have an international impact on research and innovation. Any economy could be at risk of missing the boat if it fails to invest at a higher lever and abandons basic research in favor of research that delivers short-term returns.

Singapore had a slow build to reach its current research intensity. "We felt we needed to innovate so we went to the multinationals and asked what they would need, high-quality manpower, access to international markets, and a good environment to operate, for example power facilities and a stable financial system." Singapore then looked to see how it might invest to build its research and innovation capacity. Higher education was an early target for funding. Through the 1970s, the country had one university, a second was built in the 1980s and another in the 1990s, and now it has five, one per 1 million in population.

Internationalization became a key theme. "We took internationalization very seriously, attracting faculty members from abroad, international students and research partnerships with universities and industries outside Singapore. We have been pursuing this for the past 10 years."

"We also kept our eye on global excellence from the start. We think we have to do things in a global way, meaning global benchmarks and global standards. And we invested quite a bit in this. Typically, we are investing 2.7 percent to 3 percent of GDP in research and that translates into a high research intensity." Funding poured into PhD and graduate education.

The Government also prioritized research, taking a whole-of-government approach with management of the national research effort set at prime minister level. "The prime minister's office chairs the meetings at cabinet looking at all aspects of science and innovation. The idea of reducing research investment was never considered. Singapore is primarily an export economy. The view is you have to look at the long term. You have to invest more to prepare for the future," says Professor Ramakrishna. The national policy protects blue skies research but also supports applied and orientated research, he says. "We provide opportunities for both. It comes down to money but you need a broad approach."

Source: http://www.irishtimes.com/business/lessons-for-state-in-singapore-s-scientific-research-investment-1.2120342

Annex 7: Innovation Vouchers for SMEs

A few OECD countries (for example, the Netherlands, Ireland, and the United Kingdom, among others) have used innovation vouchers as an instrument to stimulate collaboration between small and medium firms and universities. Innovation vouchers are small lines of credit provided by the Government to SMEs to purchase services from knowledge and technology providers with a view to introducing innovations (new products, processes, or services) in their business operations. The amount of these vouchers is usually around €10,000.

SMEs tend to have limited exposure to universities and research organizations as they may see such institutions as irrelevant to their business activities or be unwilling to invest in the costs involved in identifying and contracting relevant providers. Innovation vouchers are helpful to provide SMEs with a platform for solving minor technological problems or scoping out larger technological issues. They can also serve the wider innovation strategy in which voucher recipients can reach further stages of business innovation. Examples include collaborative research programs, incentives for internal R&D, clusters and networks for innovation, and so on.

While they differ from country to country, voucher schemes have, in general, the following characteristics: (a) widespread advertising in the press and through the Internet, (b) simple electronic application, (c) lottery system to determine the recipients of vouchers when the number of applicants greatly exceeds the funding available, (d) a time limit of 6–12 months to use the voucher, and (e) limited reporting requirements by the firm and the knowledge provider, taking into account that innovation vouchers offer small amounts of funding.

The evaluation results of these schemes have identified a number of success factors such as (a) simple administration and implementation procedures, (b) active involvement of universities and research organizations in the design of the scheme, (c) simple applications and selection procedures, and (d) dedicated staff to manage the program and link the voucher scheme with innovation policies at the national and local levels.

The experience has also demonstrated the following risks: (a) the vouchers strategy only facilitates one-off, subsidized, industry-university cooperation (short-term effects), which is often not enough to transform the long-term attitude of SMEs toward R&D and innovation, (b) when the scheme is restricted to knowledge institutions from the same country or region as the firm, this can limit the search patterns of SMEs and their ability to find an effective solution to their technological problems.

Source: http://www.oecd.org/innovation/policyplatform/48135973.pdf.

Annex 8: Matrix of Knowledge- and Technology-Transfer Mechanisms

University-Industry Links	Role of National Government	Role of Local Authorities	Comments
Public space function • Contacts and networking • Conferences, fairs, and forums • Publications and dissemination of findings • Alumni associations	• Develop and fund programs to create and support sectoral clusters and networks		• With education and training, this function is seen by firms as the most important contribution of universities
Human capital formation • Student participation in firm R&D (internships and co-op programs) • Employment of first-level and master's graduates • Employment of postdoctoral graduates in R&D • Participation of industry practitioners in teaching and curriculum development • Joint diploma thesis or PhDs • University researcher participation in firm • Participation of firm employees in university training course (on-campus or on-site)	• Priority setting and incentives for establishment of new programs (emerging and interdisciplinary fields) • Targeted scholarships • Mobility scholarships • Employment flexibility (sabbaticals, leave without pay)	• Funding and tax incentives to facilitate insertion of PhD. graduates	• Primary role of universities in support of innovation
Research • Research contracts • Joint R&D projects • Research consortia • Industry researchers seconded to university labs	• Funding (direct/matching) • Tax incentives • Assessment of research capacity of universities • Criteria for evaluating the performance of researchers	• Funding • attracting 'anchor tenants' • Helping cluster formation • Targeted support for SMEs • Intermediary agencies	• Increased returns at the intersection of traditional disciplines
Problem-solving and consulting • Consulting contracts • Testing, standards, prototypes, and proof of concept designs			
Technical infrastructure • Use of university labs • Common lab • Common use of machines (on campus or in firm) • Science parks	• Funding	• Funding • serviced land and infrastructure	• Need for clear revenue-sharing arrangements within universities
Knowledge commercialization • Licensing of university-held patents • Incubators • Start-ups • Spinoffs	• Intellectual Property Right legal framework • Financial autonomy of public universities	• Funding • Technical assistance	• More likely to happen in biotechnology and biomedical sciences, also nanotechnology, new materials,

			and information technology

Source: Elaborated by Salmi for this report, with some material from Yusuf and Nabeshima (2007) and Agrawal and Cockburn (2002).

Annex 9: Intellectual Capital Statements in Austria

ICS, which are widely used in Austria, allow for incorporating intangible assets into internal reporting and management procedures. The basic idea behind an ICS is to represent the value of institutions' intangible assets such as knowledge and competences and thereby complement financial reporting procedures. One model of ICS has been developed by the Austrian Research Center. In this model, intellectual capital is captured through quantitative and qualitative measures and a narrative part within the ICS.

Taking the institution's overarching vision as a starting point, knowledge objectives and related measures (covering intellectual capital, results, and impact) are derived. The ICS developed this way can then be used to provide external stakeholders with knowledge on the institution and support internal management processes. In Austria, ICS have been made part of the yearly reporting duties of public HEIs to the Ministry for Education, Science, and Culture.

Source: Pircher and Pausits 2011.