WPS7672

Policy Research Working Paper 7672

Skill Use, Skill Deficits, and Firm Performance in Formal Sector Enterprises

Evidence from the Tanzania Enterprise Skills Survey, 2015

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Education Global Practice Group
May 2016

Policy Research Working Paper 7672

Abstract

Inadequacies in Tanzania's education and training systems compromise the quality of workforce skills, giving rise to skill shortages, and constraining the operations and growth of formal sector firms in the country. This study addressed these concerns using data from a unique Enterprise Skills Survey that asked Tanzanian employers about the education, training, and occupational mix of their workforce, the skill gaps in cognitive, noncognitive, and job-specific competencies affecting their operations, and the strategies they are using to overcome these skill gaps. The study investigates the consequences for firm productivity of employers' choices about their optimal skills mix, and their strategies to mitigate shortfalls in skills supply. Compared with noninnovators and firms primarily serving the domestic market, exporters and innovators face greater skill demand and suffer from skill shortages that are more likely to constrain their operations in such areas as quality assurance, use of new technology, and introducing new products and services. In analyzing firm performance and its relation to skill mix, the study found that firms with higher shares of tertiary-educated workers are more productive; it found no impact, however, from secondary education and technical vocational education and training qualifications, possibly reflecting the universally acknowledged poor quality of secondary education in Tanzania. Employers use a range of strategies to address skill deficiencies, from hiring new workers, to training current workers in-house or externally, using high-skill expatriate workers, or outsourcing professional services. Almost all were associated with higher labor productivity. The exception, employer provided in-house training, had no measurable impact on productivity.

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Skill Use, Skill Deficits, and Firm Performance in Formal Sector Enterprises: Evidence from the Tanzania Enterprise Skills Survey, 2015

By

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JEL codes: I2, J2, L25

Keywords: skills, education, training, demand and supply of labor, firm performance

[1] The authors gratefully acknowledge the assistance provided by Yevgeniya Savchenko, Mariam Adil and Martin Moreno in analyzing the survey data, and of the DEC Enterprise Survey Team (Jorge Luis Rodriguez Meza, Silvia Muzi, Gemechu A. Aga, and Arvind Jain) in conducting the Tanzania Enterprise Skills Survey, 2015.

I. INTRODUCTION

A major focus for Tanzanian policy makers is how to attain middle-income status by 2025[2] through greater economic diversification to reduce poverty and to ensure good quality jobs for the approximately 800,000 young people who enter the labor market each year. Creation of new jobs of good quality will require more rapid economic and productivity growth and, on the demand side, growth in employment from expansion of existing firms and the creation and growth of new enterprises. The skills deficit in the labor force is acknowledged to be a constraint in Tanzania for both existing and new firms, given the low levels of educational attainment and technical skills of the population. However, there is little data on the specific skills shortages that firms face, the strategies they use to address these shortages, and the way these skill deficits impact their operations.

The most important source of systematic information on the demand for skills in African companies comes from Enterprise Surveys fielded by the World Bank.[3] The Enterprise Survey contains information on firm characteristics and performance but only limited data on workforce skills; where it shines is in detailed assessments by firms' managers of different elements of the business environment, rankings of obstacles, and their overall impact on their operations. Many elements – power outages, corruption, infrastructure, access to finance and changes in regulatory or fiscal regimes – directly constrain or introduce uncertainty into firms' operations, and as such loom large in rankings of major business environment constraints. Hence, rather counter-intuitively, the results seem to show that availability of skills is not a major constraint for firms in Africa.

This study uses a unique survey of Tanzanian businesses to investigate the demand for skills in formal-sector firms,[4] how they respond to skill constraints, as well as the effects on productivity of their strategies to meet skills deficits. The motivation for this study was to inform the policy dialogue on developing higher level skills in Tanzania, particularly in applied sciences, engineering and technology (ASET) and to support preparation of a new project "Education and Skills for Productive Jobs (ESPJ)" financed by the World Bank.[5] Another motivation was to pilot

[2] Tanzania Development Vision 2025 envisions Tanzania becoming a middle income country by 2025 (Planning Commission, 1999)

[3] The Enterprise Surveys on the links between skills and firm performance in many countries and regions have been widely used in research. For example, see Almeida (2010) on East Asia, Tan et al. (2007) on Russia, and Perotti (2014) on 29 countries in Sub-Saharan Africa. While this research has yielded important insights, it has been limited by the paucity of information on different dimensions of workforce skills and skill gaps.

[4] The formal sector is defined here as the universe of non-agricultural private enterprises producing goods and services for sale, that are registered with the authorities, and that employ five or more employees.

[5] This study on skills demand in the formal sector is one of several background papers prepared for the project. Other studies focus on the education and occupational structure of the labor force and forecasts of future supply (Meade, 2014); skills needs assessments in several sectors such as agribusiness (Temu, 2015), tourism and hospitality (Anderson, 2015), transport and logistics (Rwebangira, 2016), and construction (Lema et al., 2015); study of the informal sector (Billetoft, 2015); projections of educational attainment (Moreno and Tanaka, 2015); financing and institutional arrangement for skills development (Dachi, 2015); and assessments of the current TVET system (Mwaduma, 2015).

an enterprise skills survey which could be replicated in other countries as part of a regional approach to collect and analyze data within a common framework that would allow comparisons across countries.[6]

Conducted in 2015, the Tanzania Enterprise Skills Survey elicited detailed information from firms about the educational and occupational composition of their workforce; workers' technical and vocational training qualifications and non-cognitive competencies (such as teamwork, communication, language and IT skills) that many employers want; employer perceptions about skill gaps and constraints to operations, assessments of skills supply from education and training institutions, and their hiring and in-service training practices. The TESS survey instrument incorporates questions on firm characteristics and performance in line with the World Bank Enterprise Surveys, key questions in common with STEP employer surveys,[7] as well as some unique questions on employer strategies to address skills constraints and on their supply chain of skills and training providers. Drawing on these data, the study uses an analytic framework in which heterogeneous firms make optimizing decisions about the skill mix of their workforce given available skills supply and uncertain demand. Changing workforce composition takes time, and skill deficits arise in the short-term when the actual skills mix is inadequate, while the effect on productivity depends upon how employers respond.

Using this approach, the study addresses five broad areas of policy concern regarding enterprise skills in Tanzania's formal sector:

- *Skill Profile*: What is the educational and training composition of the workforce, and how do skills profiles vary across firms? Which factors shape employers' skills demand most: firms' productivity attributes or broader-based demand from international trade and technological change?
- *Skill Deficits*: What do employers' assessments of workforce education and training say about the adequacy and quality of skills supply, including the soft skills that many employers say they want? Do these skill deficits pose significant obstacles to the operation of firms? If so, how are these deficits distributed across firms, and do they vary systematically across firms?
- *Skill Strategies*: What strategies do firms rely on to address skill gaps – using high-skill expatriate workers, providing company-sponsored training, hiring new workers, or outsourcing professional services – and which ones are most effective?

[6] A second enterprise skills survey is currently on-going in Zambia, which will also support the preparation of a new World Bank project and contribute to the regional framework of data collection on skills. The regional framework contributes to work being undertaken under the Partnership for Skills in Applied Sciences, Engineering and Technology (PASET). PASET was launched in 2013 to address the critical need to strengthen science, and technology capability in Africa to support its socio-economic transformation. PASET convenes African governments, private sector and educational institutions; development partners; businesses from outside the continent who are investing in Africa; and new country partners from other Regions.

[7] World Bank's Skills Toward Employment and Productivity (STEP) framework).

- *Firm Performance*: How do skills and skill deficits impact firm performance? What do production function estimates reveal about the returns to employer investments in capital and different labor skill groups, and the effectiveness of alternative strategies to mitigate skill deficits?
- *Skills Supply*: How do employers assess the supply of graduates from higher education and TVET institutions, how responsive are education and training providers to the skills demands of employers, and what policy implications follow from these insights?

The remainder of this study is organized as follows. Section II provides a broad overview of the education level of the population of Tanzania and employers' views of the adequacy of education and training for their workforce. Section III describes the data source and outlines the analytic framework used to address policy concerns regarding formal sector enterprise skills in Tanzania. It describes the key variables elicited in the Tanzania Enterprise Skills Survey and how they are used in the empirical implementation of the analyses. Section IV reports the regression analyses on the determinants of employer choices about skills mix, skill deficits and strategies to mitigate them, and their impacts on labor productivity. Section V reports on qualitative survey findings on where firms source their workforce and training programs. Section VI describes the policy implications that emerge from these results.

II. COUNTRY CONTEXT

Tanzania, with a working age population of 25.8 million persons in 2014, is predominantly rural with over 12 percent of the population residing in Dar es Salaam and 26 percent in other urban areas. The agricultural sector, with 13.3 million persons, accounts for the highest share of total employment (66.3 percent), followed by the informal sector (21.7 percent) and the formal private sector (7.9 percent). Non-agricultural employment is primarily in wholesale and retail trade, and repair of motor vehicles and motorcycles with 12.7 percent of total employment, hospitality (3.9 percent), manufacturing (3.1 percent), transportation (2.6 percent) and construction (2.1 percent).[8]

Tanzania has enjoyed relatively high growth rates over the past decade, averaging over 7 percent per annum between 2002 and 2013, economic performance that is significantly better than that of Uganda and Kenya. However, growth has been driven by fiscal expansion financed by external aid, which rose from 3 percent of GDP in 2000-2001 to 12 percent in 2010-2011. Furthermore, despite sustained growth, only a few sectors have grown rapidly, notably Information and Communication Technology (ICT), financial services, mining, wholesale and retail trade, and construction. Among these, only construction and trades have generated a significant number of jobs. Agricultural growth has averaged about 3 percent per annum, implying a decline in agricultural productivity. Agriculture-related industries have also grown at a lower rate. For all these reasons, the country has made little progress in reducing poverty since the early 2000s.

The prospects for growth, however, continue to be good, despite a number of downward pressures such as the slowdown in China, which affects exports and inflows of Foreign Direct Investment (FDI), shortfalls in domestic revenues, a fall in concessional aid inflows, and increases in non-concessional borrowing.[9] Various sectors with growth potential, or sectors that support growth, include agriculture, key infrastructure sectors (energy, port, railways, roads, air transport, ICT, as well as water and transportation) and selected manufacturing sectors such as textiles, leather, fertilizers, and cement. Moreover, investments in natural gas (which are supposed to begin in 2016) are expected to yield 8,000 to 10,000 jobs in the medium term (mainly in construction) as well as between 20,000 and 35,000 indirect jobs (World Bank, 2014a).

The focus of policy has been to enhance growth of firms in manufacturing and service sectors with growth potential, as well as to improve the productivity of the agriculture and household enterprise sector, which constitute the majority of businesses in Tanzania. But the inadequacy of workplace skills is a major policy issue as the education level of Tanzania's population compares unfavorably with many of its competitors and other middle-income countries.

Clearly, inadequate workforce skills are not the only constraint on economic growth – others include access to credit, land title, reliable power, Internet and other infrastructure – but it is an important obstacle. Skills imparted by basic education, such as literacy and numeracy, are essential

[8] Tanzania National Bureau of Statistics (2015).
[9] Since 2011, aid inflows have stabilized at 9 percent of GDP.

for improving the productivity of all enterprises, especially for those in the agriculture and household enterprise sectors. Moreover, economic diversification requires a greater supply of higher-level skills, including critical technical and scientific skills.

The Skills Base of the Tanzanian Workforce

Workforce skills are the set of competencies needed to carry out the tasks and duties of a given job.[10] These competencies include cognitive (such as basic literacy and numeracy), non-cognitive skills (such as teamwork, communication, language, IT and other "soft" skills), as well as job- or occupation-specific skills. Skills are acquired through a sequence of education, training and labor market activities, with skill formation proceeding in stages, each building on the previous one.[11] Few countries, developing countries in particular, have comprehensive information on these different competencies, and research is only now beginning to develop comparable indicators of the workforce skills needed for employment and growth (World Bank, 2014c).[12]

Skills are not equivalent to education,[13] but for the most part pre-employment skills are acquired largely through education and training, especially for jobs in the formal sector. With on-the-job experience and possibly additional formal training, skills of the currently employed workforce can be significantly higher than what can be expected from their education levels. However, in general, it is accepted that there is a certain matching of education and occupations, on the grounds that people below a particular level of education would not be able to enter certain jobs, despite experience and training in their current jobs.

We therefore start by looking at what kinds of skills are available to Tanzanian firms, using educational attainment as a proxy for skills. Figure 1 shows the growth in average years of education of the population aged 25 and over in Tanzania along with a sample of other countries in Sub-Saharan Africa (SSA) and Vietnam. Tanzania's average is about 5 years of education, behind Kenya with 6 years of education and other middle-income countries of SSA with 8 to 10 years of education. It is estimated that it would take Tanzania 45 years to attain an average of 8 years of education at the pace witnessed over the most recent 20-year period.

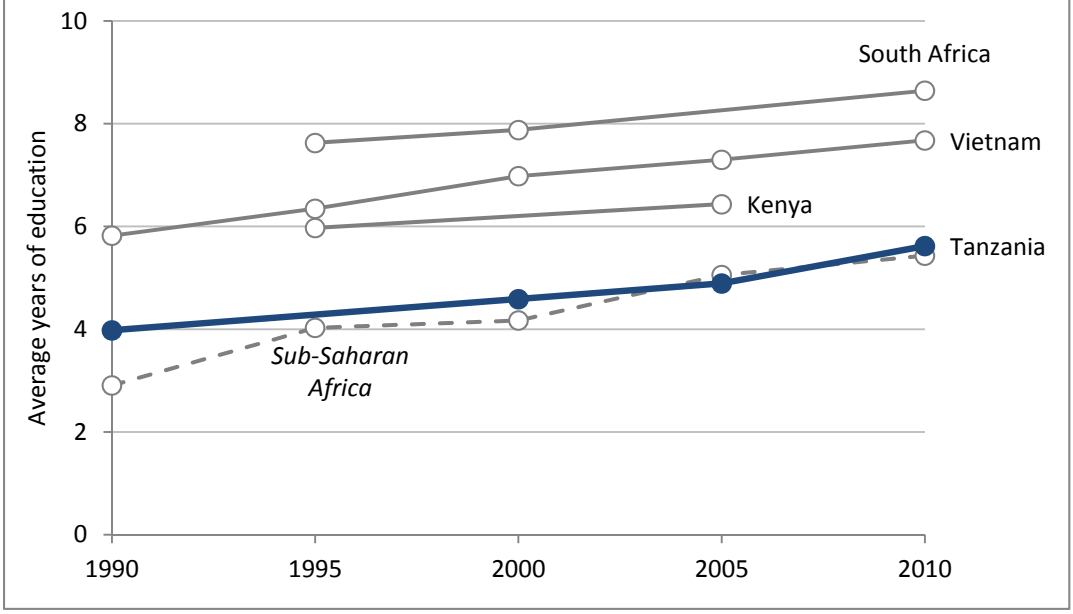
Figure 1: Average Years of Education in Tanzania and Selected Countries

[10] See the ILO's (2012, page 11) definition of skills in the International Standard Classification of Occupations, 2008 (ISCO-08).

[11] This follows the World Bank's Skills Toward Employment and Productivity (STEP) framework described by Banerji et al. (2010).

[12] STEP household and employer surveys have been rolled out in several countries since 2012 including (among others) Sri Lanka, Vietnam, Armenia, Colombia, Lao PDR, Ghana and Yunnan Province in China.

[13] For example, a job requiring engineering skills and competencies cannot be filled by a person with basic education even after 20 years of experience or training.



Note: Educational attainment for population aged 25 and over is based on authors' calculations using harmonized microdata from the International Income Distribution Database-I2D2 version 6 (World Bank 2013). Survey year is rounded to the closest year multiple of five. The estimated average schooling for South Africa is calculated using an older version of I2D2 (December 2011). The number of countries and surveys used to estimate the regional average for Sub-Saharan Africa varies every year: for example, in 1990 it was based on eight country surveys but in 2005 it included at least 20 countries.

While workers completing basic education are needed for the vast majority of small, informal businesses, higher-skilled workers are critical to the emergence of a diversified economy. Figure 2 shows the current distribution of the population aged 25 and over by different education levels for Tanzania compared to several other countries in SSA and Asia. For Tanzania, the proportion of the population with at least a secondary education is 11 percent and with a tertiary education, only 5 percent. These are very low figures compared to South Africa, Malaysia and Vietnam.

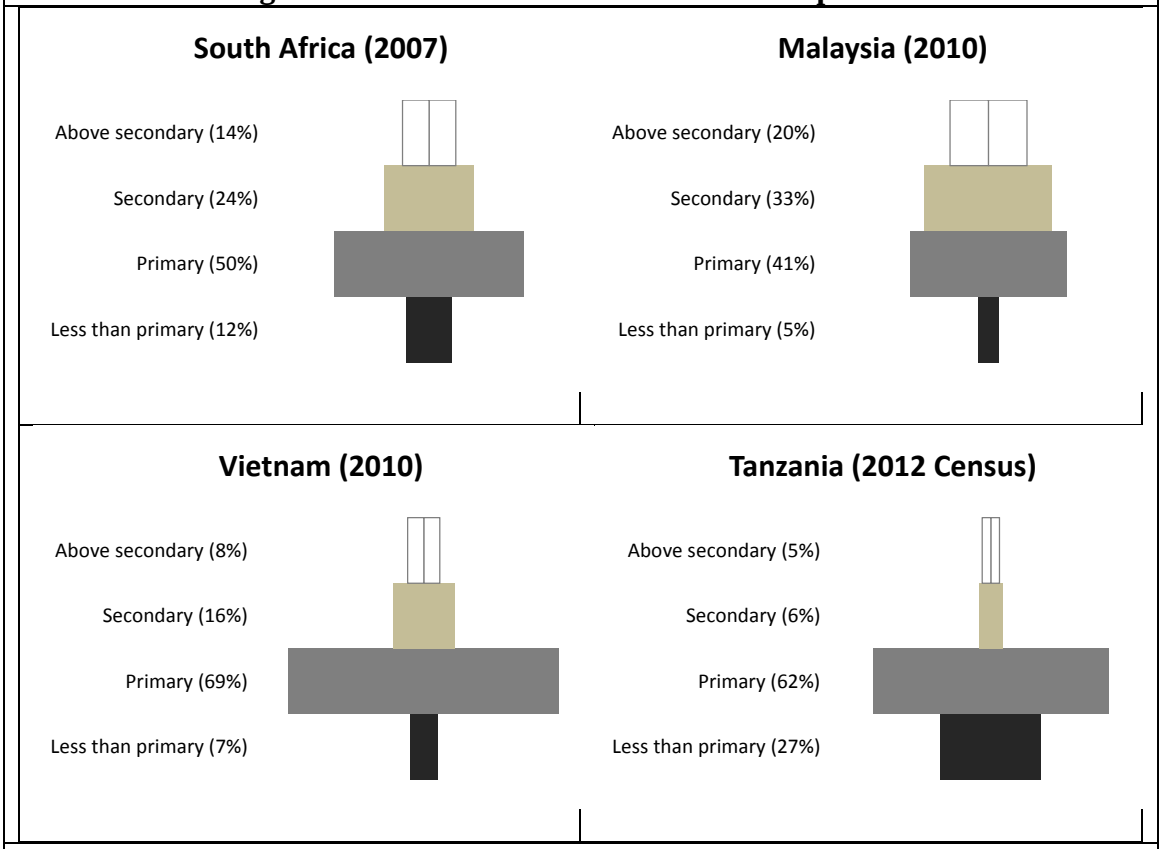
In fact, Tanzania has one of the lowest gross tertiary enrollment ratios in SSA[14] but this is beginning to change with the rapid growth of higher education, driven largely by the private sector. Progression from secondary to tertiary education is available through two routes: enrollments in universities/colleges administered by the Tanzania Commission of Universities (TCU) and in non-university technical education institutions regulated by the National Council of Technical Education (NACTE). The total number of students enrolled in degree programs in universities almost doubled from 81,782 in 2008/09 to 162,510 in 2012/13.[15] Enrollments in technical education institutions under NACTE more than tripled, from 36,586 in 2007/2008 to 112,447 in

[14] 3.7 percent (UIS 2012 data)

[15] TCU-administered universities and colleges also enroll students (about 20 percent of total enrollments in 2012/2013) in certificate and diploma programs.

2011/2012 (MOEVT, 2013). While most programs offered by NACTE institutions are at the diploma and certificate level, about 22 percent of enrollments are in degree programs, up from 9 percent in 2006/2007. This rapid growth in tertiary-level enrollments over this period was made possible in large part by the expansion, registration and accreditation of private universities, colleges, and technical education institutions.[16]

Figure 2: Education Distribution of the Population



Note: Author's calculations using South Africa and Vietnam harmonized microdata from the International Income Distribution Database-I2D2 version 6 (World Bank 2013). Estimates for Tanzania are from the 2012 Tanzania National Census. Malaysia levels of attainment are estimated using microdata from the 2010 Malaysia Labour Force Survey.

The actual availability of skills for enterprises in Tanzania is undoubtedly much lower than is suggested by the average years of educational attainment because of the low quality of education,

[16] The number of private universities increased from 20 to 34 while public universities/colleges intuitions increased from 11 to 13 (MOEVT, 2009 and 2014). NACTE also registered 528 colleges and technical institutions between 2005 and 2015, 206 of which were public and 322 private. Of these, NACTE accredited technical institutions rose from 59 to 122, of which 38 institutions were private/and or faith-based colleges (The Guardian, 2015).

from basic education to higher levels of schooling. With a rapidly expanding education system,[17] quality has been diminished by the lack of adequately trained teachers, facilities, materials, and management capacity. Only a relatively small proportion of children who complete basic education are likely to have the literacy and numeracy skills expected by that stage, due to an accumulation of learning deficits. This in turn affects the quality of graduates from secondary and post-secondary education. There are also significant imbalances in the kinds of skills being supplied by tertiary institutions relative to what is needed.[18] Only 14 percent of those enrolled in tertiary education are studying science, engineering or technology courses, and there are large shortfalls in the supply of high-skill occupations (managers, professionals, associate professionals and technicians), especially in engineering, manufacturing and construction (EMC) and the sciences.

The vocational education and training (VET) system in Tanzania is similarly limited and is estimated to supply only about 12 percent of actual national needs (Colleges and Institutes Canada, 2014). On the mainland, this is overseen by the Vocational Education and Training Authority (VETA), an autonomous government agency that operates 28 public training institutes and centers that it owns and more than 600 other for-profit private and NGO training providers that it coordinates. VETA regulates the provision of vocational education and training in the country through the registration and accreditation of TVET institutions, standards setting, assessment, and certification of skills. In Zanzibar, Vocational Training Authority (VTA) is a regulatory body for vocational education and training in Zanzibar, and operates 3 training institutions (UNESCO, 2013).

VETA/VTA is financed principally by a Skills Development Levy (SDL), which is the largest source of income for VETA (about 87 percent of total income) (Mwaduma, 2015). Formal sector enterprises with more than four employees contribute a levy of 5 percent of payroll to SDL.[19] The levy finances public provision of vocational education and training to school leavers by VETA institutions. Not only are the levies high compared to levy rates in other countries, they tend to finance training that is supply-driven and are rarely targeted to the specific skills needed by employers (Dar, Canarajah and Murphy, 2003). This is less likely to be a limitation when levies are used to finance (or reimburse) employer-directed training for its current employees, as in the payroll levy training systems of Malaysia and Singapore. VETA has recently introduced training

[17] For instance, enrollments in primary school increased from 4.8 million to 8.4 million over 10 years from 2001 to 2010, while secondary school enrollments almost quadrupled over the 5 years from 2005 to 2010 (Joshi and Gaddis, 2015).

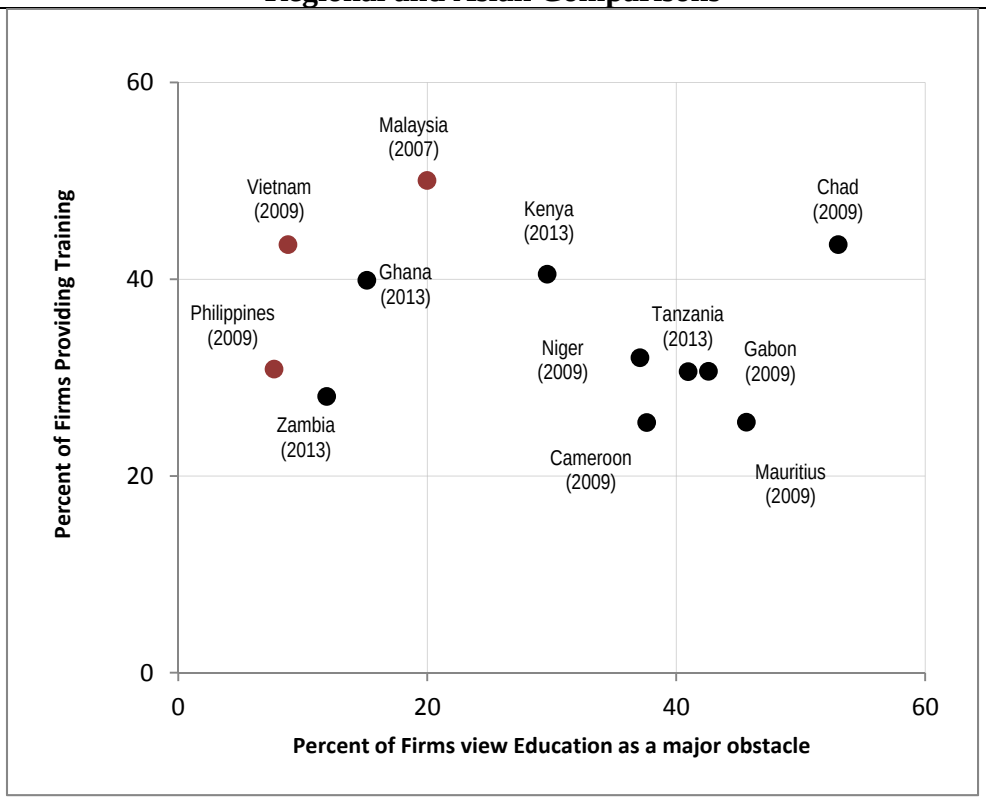
[18] See the TVETDP of MOEVT (2013) and the Skills Study by the Planning Commission (2015).

[19] The SDL is collected by the Tanzania Revenue Authority (TRA) which then channels 40 percent of SDL proceeds to the VET Fund and 60 percent for government subventions to the Higher Education Student Loans Board (Dachi, 2015). Some entities are exempted from the levy, including government agencies, diplomatic missions, charitable organization, and farm employers. While the SDL contribution was recently reduced from 6 to 5 percent, it remains high in comparison to other regional and international comparators, where training levy rates of 1 to 2 percent are more common.

schemes for current employees with co-financing from employers, but the numbers trained under such programs remain small.

Employer assessments of the adequacy of available skills were elicited in the Enterprise Surveys for a large number of countries, including Tanzania, in 2013. Using a common format across countries, employers were asked whether inadequacies in education posed a major obstacle to their operations. Employers were also asked whether they provided formal in-service training to their current workforce, training that might be used to augment deficiencies in (or to upgrade) pre-employment skills. Figure 3 presents estimates of the percent of firms reporting these two skill indicators in Tanzania and several other SSA countries, and for comparison, three other East Asian countries. Note that these figures pertain only to manufacturing firms in different time periods ranging from 2007 in Malaysia to 2013 in Tanzania, Kenya and Zambia.

Figure 3. Employers' Views on Education and Firm Training: Regional and Asian Comparisons



Source: Enterprise Surveys, various years
Note: East Asian countries are shown in the graph as red dots, African countries as black dots.

Two key observations can be made from this figure. First, Tanzania is about average among the SSA countries represented in the share of employers (41 percent) that rated inadequate education to be a major obstacle to their operations; these assessments ranged from 53 percent in Chad to 12

percent in Zambia. Tanzania is also about average in the proportion of firms that provide training (31 percent), with estimates ranging between 43 percent of employers in Chad to 25 percent in Mauritius.

Second, employers in East Asia (Malaysia, Vietnam and the Philippines) are on average less likely than their South African counterparts to consider education a major obstacle to operations. Malaysia and Vietnam are also more likely to provide formal training to their workers. This pattern reflects broad regional differences in educational investments.

To summarize, the growth and diversification of the formal sector in Tanzania will require a greater supply of higher-level skills if this sector is to play an expanded role in job creation and productivity growth in line with the country's long-term aspirations. Over 40 percent of employers report educational deficiencies to be a major obstacle to operations. Although that is about average by SSA standards, it is high relative to fast-growing Asian economies. Tanzania is also comparable to other SSA countries in providing in-service training to current employees, but it lags behind its Asian competitors. These trends are explored in greater detail in the following sections.

III. DATA AND ANALYTIC FRAMEWORK

This section begins by describing the survey designed to collect the data that have never been available before on enterprise skills. It is followed by a description of the analytic framework used to model firms' choices of skill mix and strategies to mitigate skill deficits – the mismatch between needed and available skills – and to estimate their impacts on firm performance. In this analytic framework, firms are distinguished by whether they are high-skill or low-skill firms. The section concludes with a broad overview of the data, including simple pair-wise correlations between key skill variables and indicator measures of skills demand, and comparisons of high-skill and low-skill firms in terms of their labor productivity and job creation over the past two years.

Tanzania Enterprise Skills Survey

The data needed to study the determinants and outcomes of skill shortages and strategies firms use to mitigate them are from the 2015 Tanzania Enterprise Skills Survey (TESS). Piloted by the Development Economics Vice-Presidency and Education Global Practice of the World Bank, TESS was designed to provide insights into the composition and demand for skills, and the relationship between skills (and skill constraints) and firm performance in selected economic sectors in five regions of Tanzania. The five regions include Dar es Salaam, the autonomous region of Zanzibar, and three mainland regions of Arusha, Mbeya, and Mwanza. The economic sectors are food, textiles and garments, fabricated metals, and furniture in manufacturing, and IT, hotels and restaurants, construction and transportation in non-manufacturing. Firms were classified into three sizes – small firms with 5-19 employees, medium with 20-99 employees, and large with 100 or more employees.

The survey included 424 enterprises stratified by sector, region and size, with between 40 and 76 enterprises in each sector. About half the sample (224 firms) is located in Dar es Salaam and the balance divided rather evenly across each of the remaining regions (each with about 50 firms). Overall, small firms make up 63 percent of the sample, medium-size firms 26 percent and large firms 11 percent. However, this firm-size distribution varies considerably across sectors and regions. Small firms are mostly found in textiles and garments, fabricated metals, furniture and IT, while large firms are more prevalent in food, construction, and transportation. Mbeya and Zanzibar are dominated by small and medium firms while Dar es Salaam and Arusha have most large firms.

TESS builds on the recently completed 2013 Enterprise Survey for Tanzania, retaining selected key variables on firm characteristics, firm performance and productivity, and adding an expanded module of questions on employment and skills. It elicited qualitative and quantitative information from firms about the education and occupational composition of their workforce, their perceptions about skill gaps in education as well as different cognitive, non-cognitive and technical skills and the constraints these pose for their operations, their strategies for addressing skill gaps including the hiring of new workers, use of foreign workers and outsourcing skills, and their in-house and

external training practices for current employees. Employers also provided information on the main sources of skills supply from education and training institutions. Together, these variables provide detailed insights into skills demand and supply from the perspective of employers and rich data to investigate the relationships between skills, skill deficits, strategies to mitigate them, and their productivity outcomes.

In common with other Enterprise Surveys, TESS elicited the following variables to characterize firms:

- Indicator variables for eight sectors, five regions and three firm sizes
- Firm attributes that research has suggested are related to (often unobserved) productivity attributes, including foreign ownership, female-owned firms, years in operation, and the educational attainment of the firm's top manager
- Domestic sales and sales to international markets, whether as a direct or indirect exporter
- Engagement in innovative activities such as introduction of new products or services, quality control, R&D expenditure, and technology licensing
- Key variables needed to estimate firm performance using a simple production function model. Besides total sales and employment in the last fiscal year, data was elicited on the value of intermediate inputs and fixed assets, separately for machinery and equipment and buildings.

Skills encompass the broad set of cognitive, non-cognitive (social and behavioral) and technical competencies needed to perform effectively. Skills are acquired from education and training institutions, both before entering the labor market and while employed, in company-sponsored in-service programs. The TESS elicited information on the following skill dimensions:

- Education attainment of the workforce by four levels of schooling: primary, lower secondary, upper secondary and tertiary education, and their distribution in the workforce.
- The share of the workforce with formal pre-employment TVET qualifications as a separate category.
- Skill composition by seven occupational categories: managers, professionals, technicians and associate professionals, clerical jobs, sales, production operators, and other unskilled production or service workers. Each occupational category distinguished between Tanzanian and expatriate employees.
- Qualitative indicators of the adequacy of different workforce competencies (as judged by employers), including a wide range of cognitive, non-cognitive (soft skills) and job-specific technical skills.
- Company-sponsored in-service training, either in-house or external training, the number of workers trained, and the main training provider.

Skill deficits reflect a mix of demand and supply factors. To operationalize the measurement of skill deficits, TESS elicited both qualitative and quantitative information on employers' perceptions and assessments of skill deficits, and potential responses to mitigate these skill gaps, as described below.

Skill gap indicators

- *Assessments of current and needed skills*. Employers assessed the severity of educational deficiencies as an obstacle to the firm's operations and rated how well current competencies of their workforce matched the skills needed by the enterprise, in technical and job-specific skills, in soft skills such as problem solving, communication, language, as well as the work ethic of employees.
- *Operational problems resulting from inadequate skills.* Employers rated the extent to which skill deficits posed problems for several specific operational areas, including maintaining production levels, quality control, use of new technology, innovation, and sales and marketing.

Potential employer responses

- *Company-sponsored training*. Firms reported on in-service training to their current employees, whether from programs run in-house or by external providers. In-service training programs are designed to remedy deficits in pre-employment skills, upgrade existing skills, or develop new skills as requirements change.
- *Hiring new workers.* Employers reported on whether they had any job vacancies over the past two years and, if so, how many new workers were hired for each occupation. New hires represent one potential employer response to specific occupational skill shortages.
- *Use of foreign workers by occupation*. As a measure of domestic availability of specific occupational skills, employers were asked about their use of expatriate workers (and the share of foreign workers) in different occupations.
- *Outsourcing of specialized services*. Firms often outsource accounting, engineering, legal and architectural services. Such skills may not be available in-house, and there is interest in knowing whether they are sourced domestically or abroad.

A unique feature of the survey is the questions on the firm's skills supply chain. Employers were asked about the education and training institutions that provide them with most of their employees and the institutions/providers supplying most of the continuing education and training to current employees. Employers were asked to name three secondary schools, universities and technical institutes from which they hire the most, along with their location and public/private status, and to assess the quality of their graduates. They were also asked to do the same for three training institutions that provided external training for employees. This information provides insights into where employers source their skills, and whether the location of skill providers poses a constraint to employers' access to needed skills.

Analytic Framework

The analytic framework draws upon a new empirical literature that seeks to explain the growth of productivity among firms.[20] In his review of this literature, Syverson (2011) points out that there is broad consensus among researchers about the existence – within narrowly defined industrial sectors – of a pervasive dispersion in productivity levels across firms using the same measured inputs. This within-sector dispersion is much larger than mean productivity differences between sectors. While large in high-income countries, this productivity dispersion across firms in the same sector may be even larger in developing countries.[21] Productivity-level differences across firms also appear to persist over time, suggesting either that firms have persistent (but unobserved) heterogeneous productive capabilities or, alternatively, that their productivity levels may differ as a consequence of their responses to uncertain demand.

The challenge for research is to unpack this productivity "black-box" to explain what drives differences within and between sectors and how firm responses can give rise to different outcomes. Research has focused on employer responses to two broad sets of demand drivers: one from firm-specific productivity attributes and another from competitive pressures affecting numerous firms, such as trade and technological changes (Syverson, 2011). Employer responses to the first set comprise individual firm-level strategies such as the introduction of new management practices (Bloom and van Reenen, 2010), in-service training programs (Dearden, Reed and van Reenen, 2005; Tan and Lopez-Acevedo, 2003) and investing in ICT or new equipment and machinery (Bartel, Ichinowski and Shaw, 2007). These factors are under the control of the firm. Employer responses to the second set of factors focuses on strategies adopted by many firms to align with broad demand shifts affecting production and the structure of whole or multiple sectors, such as trade liberalization (Pavcnik, 2002) or technological change (Bloom, Draca and Van Reenen, 2015). These factors do not directly affect productivity, but the competitive pressures that accompany them may elicit responses from firms (such as those described above) that do. How firms respond can determine their position in the productivity distribution, whether they move up the productivity ladder and grow or fall back and exit.

Taken together, these firm responses to the two demand drivers, together with new firm entry, are thought to be the key drivers of productivity dispersion within and between firms and, more broadly, productivity growth. These two sets of demand drivers also affect skills demand and the

[20] The earlier productivity research, which relied on aggregate sectoral data, implicitly assumed that firms were homogeneous and experienced the same productivity growth profile as the aggregate sector. The recently available firm-level data indicates that this assumption is untenable. Research using firm-level panel data points to considerable heterogeneity in productivity among firms even in narrowly defined sectors, and provides insights into how productivity evolves through a dynamic process of new firm entry and growth of more productive firms, and exit of less-productive incumbent firms.

[21] Measuring within-industry productivity dispersion at the 90th and 10th percentile, Hsieh and Klenow (2009) find productivity differences of 5 to 1 in China and India as compared to 2 to 1 in the U.S.

ability of firms to respond to skills demand partly depends on the responsiveness of the education and training system.

The study contributes to this literature by investigating the productivity consequences of (i) employers' choices about their optimal skills mix and (ii) strategies to mitigate shortfalls in skills supply. In the context of Tanzania, this study helps to assess some key policy questions: first, whether the desired skills mix has an effect on the productivity of firms (and if so, which type of firms) and second, whether the firms are effective (as seen by the impact on productivity) in meeting their skills shortages. In the Tanzanian context, both these questions are highly relevant, given the limited local supply of highly educated and trained workers and demand shocks arising from trade liberalization and technological change that increase the demand for high-skill workers.

We hypothesize that exporters and innovative firms require a more skilled workforce with the capabilities to compete in international markets and/or introduce new products and services, and that these firms are more likely to face supply deficits especially of higher-level skills. There is compelling evidence for our hypothesis, beginning with the pioneering research of Theodore Schultz on the value of the ability to deal with disequilibria (Schultz, 1975), international research on skill-biased technological change (Berman, Bound and Machin, 1998), and the role of job tasks in intermediating between skills and technology (Acemoglu and Autor, 2011).[22] We also hypothesize that these deficits are largely in high-level skills.

Exporters and innovators fall into the category of firms that respond to broad shifts in demand that affect multiple sectors, through trade liberalization and technological change, mentioned earlier. We call these firms "high-skill" firms, while those who are neither exporters nor innovators are called "low-skill" firms. Data on the distinguishing characteristics of these two types of firms are presented later in the paper and offer further evidence of the usefulness of these distinctions in our analysis.

We also hypothesize that firms that are successful in mitigating their skill deficits will show better performance, as seen in higher productivity levels. We now turn to a presentation of the formal model that will test our hypotheses.

Skills Demand Model

We consider a model of skills demand based on an underlying production function with a given level of technology and different labor types.[23] The production function relates output (or sales) to technology, broadly defined, and numbers of workers with different levels of educational attainment or skill qualifications. A critical feature of this model is that technology can vary

[22] This recent refinement to the skills-technology hypothesis postulates that it is job tasks that are linked to productivity, and that the productivity benefits of skills are only realized when the appropriate skills are matched with the job tasks of the technology being used.

[23] See the Annex for a fuller discussion of the skills demand model and the derivation of the reduced form estimating equations.

significantly across firms even in the same sector because of differences in physical and intangible capital such as ICT use, modern management practices, accumulated knowledge, and other technical competencies. This perspective on technology and its associated demands for different kinds of complementary skills generates a rich menu of hypotheses for the analyses of skill deficits, skill strategies, and their impacts on firm performance, which are captured by the following four sets of equations.

- *Skill share equations*. Given this production function, cost minimization for a given level of output yields skills demand equations for the wage share of each labor type in total payroll. In this framework, the relative shares of each labor type are related to total output, the relative (shadow) wages of each labor type, and the technology used in the firm. Given the paucity of reliable wage data on the different skill groups,[24] we use a closely related specification in which skills demand is expressed in terms of skill shares of the total workforce. In its empirical implementation, skill shares are related to a set of control variables for firm size (a proxy for output), sector and region, and two kinds of technology measures: firm-specific productivity attributes mentioned earlier and indicator variables for export orientation and innovation. The analyses might distinguish skills by level of educational attainment or, alternatively, by broad occupational skill categories. The coefficients of these share equations provide insights into how firms' productivity attributes, export orientation, and innovation might affect their demand for these different types of skills.
- *Skill deficit equations*. At any point in time, firms' actual skills mix may diverge from their desired skills mix as reflected in the skill share equations. It may take time for actual skill mix to reach desired levels because employers have limited flexibility to replace incumbent workers with new hires who have the requisite skills.[25] Temporary or even persistent skill gaps can arise with constraints in the local supply of certain skills and with technology and demand shocks that increase the demand for skills. Employer assessments of whether the education and skills of their workforce are adequate and whether skill shortages pose an obstacle to the firms' operations are used to measure the presence and severity of these skill deficits. To study their determinants, we analyze whether these skill deficit measures are related to a set of control variables for firm characteristics, actual skill mix, firm productivity attributes, and demand from exports and innovation.
- *Skill strategy equations*. Employers may respond to identified skill deficits in different ways. The survey asked about strategies employers may be using to improve workforce

[24] Implementing the skill share of total payroll specification of the skills demand model requires detailed wage data for each skill dimension in the firm, as well as the prevailing wage rates of different skills groups in the open labor market. The TESS did not elicit data on mean wages of the workforce by level of education; while it asked for mean wages by occupation, these data were incomplete and were not deemed reliable. The challenging data needs have prompted other researchers to rely instead on specifications using the skill shares of total labor (for example, see Almeida, 2010).

[25] Abowd et al. (2007) exploit the availability of matched employer-employee panel data to study the responses of employers to gaps between desired and actual skills mix, using a partial adjustment model.

skills, including company-sponsored in-service training from in-house or external sources, hiring of new workers to fill specific gaps, use of high-skill expatriates, and outsourcing of professional services. The firm's choice of strategies may be studied using the same specification as for skill deficits. Such analysis offers insights into how firms with the greatest skill gaps are responding to the deficiencies identified.

- *Firm performance equations.* The impacts on firm performance of skill mix, skill deficits, and strategies to mitigate them may be analyzed within a production function framework. In its simplest form, this production function relates sales per worker to capital per worker and the labor shares of different skill groups, controlling for sector and region. Their coefficients have the conventional interpretation as the returns to employer investments in capital and different worker skills. Augmented specifications of this simple production function are estimated with and without measures of skills demand (i.e., firm productivity attributes, exports and technology) and skill strategies. This analysis provides insights into whether skill deficits associated with increased demand are effectively mitigated by employer responses.

Difference between High- and Low-Skill Firms

Inadequacies in Tanzania's education and training systems compromise the workforce skills in all firms. In this sense, *all* firms face skills deficits that arise from the quality of the supply of skills. In some cases, however, skill deficits are driven by the demand that firms face. As stated earlier, we hypothesize that these deficits are largely in high-level skills and are most pronounced among firms that are facing increased competitive pressures from trade or technological change. The way firms respond to increased skills demand from trade and technology are not independent of the individual firm strategies that different firms use; rather, they tend to complement each other, increasing the incentives for firms to respond with firm-specific strategies to enhance productivity.[26]

Table 1 shows the distribution of exporters, and innovators separately by sector, firm size and region. The most striking finding is that high-skill firms – which together make up 59 percent of the TESS sample – are found in all sectors, all firm sizes, and all regions. The share of exporters and innovators in each category ranges from 49 to 76 percent across sectors, 54 to 70 percent across firm sizes, and 36 to 73 percent across regions.

Exporters, which make up 13 percent of the sample, are more likely to be found in manufacturing (the tradable sector) than in the domestic-oriented services such as the hotel and restaurant sector (with 3 percent of exporters). However, not all non-manufacturing is oriented to domestic markets as witnessed by the high-exporter shares in construction and transportation (20 to 26 percent).

[26] Indeed, the productivity literature reviewed early has devoted considerable attention to studying different clusters of firm strategies following research by Milgrom and Roberts (1990). They argue that complementarities in organization, where doing more of one practice increases the returns to doing more of other practices, can create clusters in practices as well as discontinuities in organizational change.

Firms that are innovators (50 percent) are more evenly distributed across sectors, firm size, and region. The decision to define innovators more inclusively – by their introduction of new products and services – instead of by whether they conducted research and development was intentional. It is important to keep in mind that the many small adaptations and improvements in products and services that firms make, while minor relative to current practice, are cumulatively responsible for the bulk of productivity gains over time (Kim, 1999). It is therefore significant that most high-skill Tanzanian firms are innovators rather than exporters.

Table 1. Distribution of High-Skill Firms by Sector, Firm Size, and Region

	High-Skill Firms	Exporter Firms	Innovator Firms
Sector			
Food	0.50	0.22	0.32
Textile & Garments	0.76	0.13	0.72
Fabricated Metals	0.60	0.09	0.53
Furniture	0.64	0.10	0.60
IT	0.60	0.12	0.55
Hotels & Restaurants	0.49	0.03	0.46
Construction	0.60	0.20	0.43
Transportation	0.60	0.26	0.42
Firm Size			
Small (5 - 19)	0.54	0.07	0.49
Medium (20 - 99)	0.68	0.23	0.53
Large (100+)	0.70	0.24	0.52
Region			
Arusha	0.73	0.04	0.71
Dar es Salaam	0.61	0.18	0.49
Mbeya	0.47	0.04	0.43
Mwanza	0.36	0.16	0.24
Zanzibar	0.73	0.08	0.69
Total	0.59	0.13	0.50

Source: 2015 Tanzania Enterprise Skills Survey
Note: The column "High-Skill firms" includes firms that are defined either as Exporters, as Innovators or as both concurrently.

Table 2 presents unconditional pair-wise correlations (and their statistical significance) of selected key variables that will be the focus of the analyses. The correlations relate exporter and innovator status (a proxy for skills demand), education and skills composition, in-service training, and summary measures of skill problems and job vacancies. These unconditional correlations reveal important relationships between different variables, as described below. These will be further

investigated through the regression analysis, which will control for differences in firm size, sector, region and other firm attributes.

- *The high-skill indicator is positively (and significantly) correlated with all skill measures.* Firms with high demand for skills, not surprisingly, have higher shares of their workforce with tertiary education and TVET qualifications, and in high-skill managerial, professional, and technician (MPT) occupations. Exporter status is more strongly correlated with tertiary and TVET qualifications while innovator status is positively correlated with a higher share of technical workers. The lower share of technical workers among exporters may be related to scale: exporters tend to be larger firms, and scale of operations may dictate an occupational mix with more plant operators and sales staff than other occupational groups.

- *Skill constraints reported by high-skill firms appear to be primarily from demand-side obstacles to operations rather than from overall supply of skills, education in particular.* The variables for high-skill firms and educational problems are not correlated, suggesting that high- and low-skill firms give similar assessments of the extent to which the quality of the country's education is a big problem. In contrast, high-skill firms and innovator status are positively correlated with the number of operational problems that result from inadequate skills in areas such as maintaining production levels, quality control, use of new technology and innovation. High-skill firms and innovators that have introduced new products and services over the past three years report significantly more operational problems. [27]

- *In-service training is positive and significantly correlated with high-skill firms (exporters and/or innovators),* which already have a more skilled workforce. This suggests that employer-provided in-service training complements other activities engaged in by these firms, such as modern management and quality control practices that are critical for exporters or research and development in the case of innovators (see Tan and Lopez-Acevedo, 2003 and Tan et al., 2007).

- *There is little evidence that training is being used to remedy deficiencies in the skill base of recruits before they are hired.* If that were the case, there would be a positive correlation between in-service training and, for example, employers reporting education to be a big problem. Instead, they are negatively correlated.

- *High-skill firms are job creators.* Both exporters and innovators are associated with a larger number of job vacancies (jobs created) over the past three years. Job vacancies are

[27] Exporters are significantly less likely to both report education as a big problem and to have skills-related operational obstacles.

positively associated both with skill problems and with in-service training, suggesting that employers fill skill gaps that pose operational problems by hiring new workers and by providing training to augment existing skills in different operational areas.

High-skill firms are characterized both by higher labor productivity and greater job creation than low-skill firms. These relationships emerge by comparing the distributions of labor productivity and the number of jobs created over the past two years by the two firm types.

Figure 4 plots the distribution of labor productivity at selected percentiles for each group of firms. With the exception of the bottom 10^{th} percentile, labor productivity levels are almost always higher among high-skill firms. At the median (or 50^{th} percentile) differences in labor productivity of high- and low-skill firms translates into a productivity advantage for high-skill firms of about 28 percent. At the 90^{th} percentile, the difference in labor productivity is almost 32 percent.

Table 2. Pair-Wise Correlations Between Measures of Skills Demand, Workforce Skills and Skill Gaps										
	High-Skill Firms (Exporting and/or Innovating)			Education and Skills of Workforce			Enterprise Training	Skill Problems and Job Vacancies		
	Exporters AND/OR Innova-tors	Exporters	Innova-tors	% Tertiary-educated workforce	% TVET in workforce	% MPT in workforce	In-house or external training	Education a big problem	# Skill problems	# job vacancies last 2 years
High Skill	1.000									
Export	0.325**	1.000								
Innovate	0.838**	-0.127**	1.000							
% Tertiary	0.084*	0.127**	0.027	1.000						
% TVET	0.055*	0.047*	0.031	0.270**	1.000					
% MPT	0.044*	-0.117*	0.096*	0.184**	0.133**	1.000				
Any training	0.161**	0.099*	0.157**	0.105*	0.017	0.028	1.000			
Education a big problem	0.014	-0.076*	-0.000	-0.128**	0.095*	-0.081*	-0.111*	1.000		
# skill Problems	0.125*	-0.065*	0.164**	-0.092*	0.026	0.029	0.006	0.099*	1.000	
# Job vacancies	0.091*	0.218**	0.045*	0.134**	0.028	-0.029	0.221**	-0.071*	0.108*	1.000

Note: Significance of pair-wise correlations: * significant at 5% level ** significant at 1% level

Figure 4. Comparison of Labor Productivity Distribution in High-skill and Low-skill Demand Firms

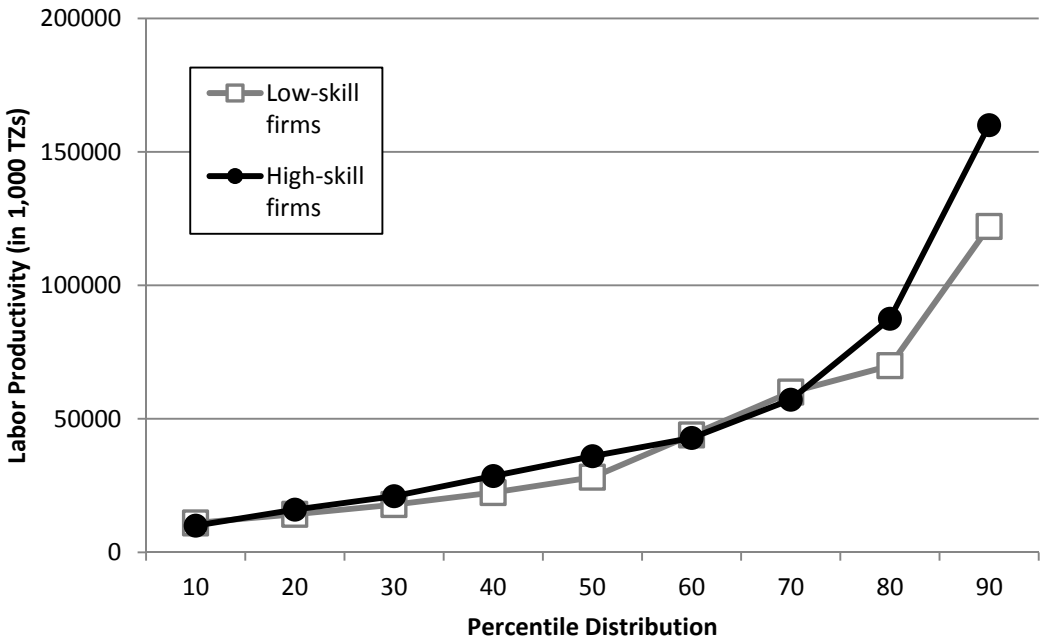
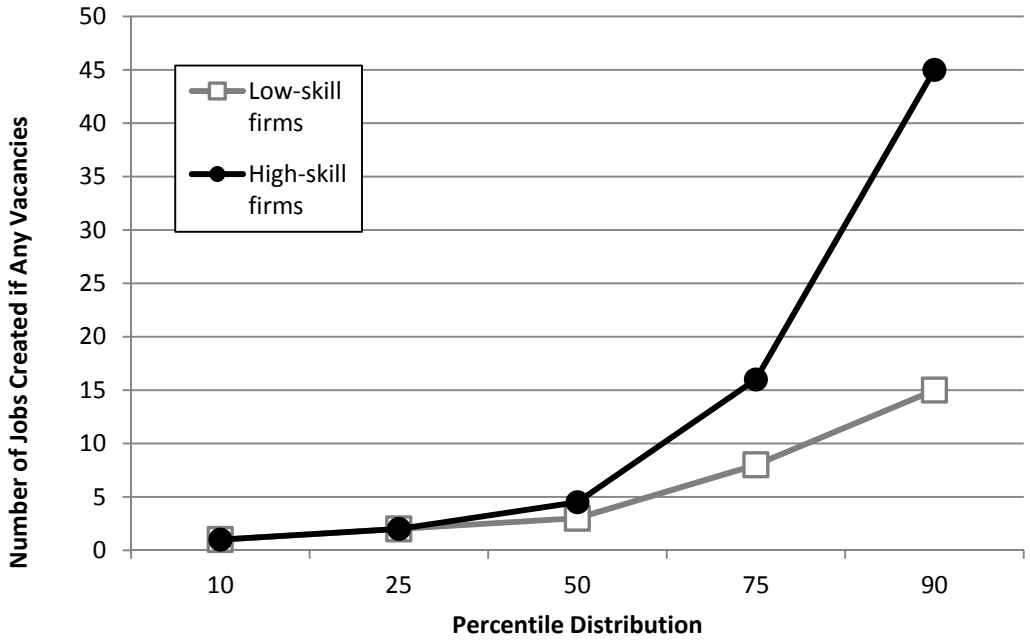


Figure 5 graphs a similar distribution of the total number of jobs created in the two groups of firms conditional upon having job vacancies. Both groups have about the same probability of job vacancies over the past two years (around 23 percent). However, when they do have vacancies, high-skill firms create significantly more jobs. At the median, the difference in the number of jobs created is small – 4.5 jobs for high-skill firms versus 3 jobs for low-skill firms – but the differences become much more pronounced at the upper end of the distribution. At the 75th percentile, high-skill firms create twice as many jobs (16 versus 8) and at the 90th percentile, three times as many jobs as low-skill firms.

Figure 5. Jobs Created by High-Skill and Low-Skill Demand Firms



The distinction between high- and low-skill firms is therefore important because it speaks directly to policy concerns in Tanzania about job creation and productivity. The distinction is also a promising way to address the issues of skill gaps and strategies used to mitigate them and to identify the impact of skills on firm performance. The simple correlations reported above are broadly consistent with our hypotheses that skill deficits are primarily demand-driven among exporters and/or innovators and that how firms respond to these deficits can have consequences for productivity and job creation. In the following section, the key relationships suggested by these correlations are investigated more rigorously by controlling for other factors that may influence these findings.

IV. DETERMINANTS AND OUTCOMES OF SKILL DEFICITS AND EMPLOYER CHOICES

In this section, we present a number of results from our skills demand model: (1) firms' demand for types of education and occupational skills, (2) the skill deficits reported by employers, and (3) strategies used by employers to mitigate identified skill deficits. Taken together, these results help identify the factors shaping employers' decisions regarding workforce education and skills. At the end of the section, we present the results of our regression analysis to identify (4) the impacts of employers' actions to improve skill mix on the firm's performance.

The regression analyses consider a broader set of choice or outcomes variables than the ones highlighted in the pair-wise correlations. The outcome variables used in each set of analyses are described first before presenting the regression results. Various regression models are used to explain these different outcomes: logistic models to estimate probabilistic binary outcomes and ordinary least squares models for continuous linear or log-linear outcomes. The regression models relate these outcomes to different sets of explanatory variables:

- *Broad enterprise characteristics*. These include identifiers for two firm sizes, seven industrial sectors and four regions, measured relative to medium-size firms, firms in the furniture sector, and firms in the Dar es Salaam region.
- *Firm attributes*. These variables are often associated in the literature with firm productivity differentials. They include education of top managers (reflecting higher quality managerial talent or management practices), foreign ownership (embodied technologies of FDI firms), multi-establishment firms (managerial talent and/or economies from integration), and female-led and young firms (in operation less than 10 years) with limited operational experience and technical capabilities.
- *Demand drivers*. These are the exporter and innovator status indicator variables used to define the high-skill firms. They measure the degree of (and the firm's response to) market competition from international trade and the diffusion of new technologies and services.

Depending on the specific models being estimated, additional sets of variables may also be included on skills composition and skill strategies:

- *Workforce skill characteristics*. These are the shares of workers with higher-level education (upper secondary and tertiary), TVET qualifications, and high-skill MPT occupations. They are included in models to estimate skill deficits, strategies and firm performance.
- *Skill deficit mitigating strategies*. These include in-house and external training, hiring new workers, using foreign MPT workers, and outsourcing services. They are included in models to estimate firm performance and the effects of skills on labor productivity.

Below we describe how each broad skill question is addressed and what estimating the different regression models reveals about the key relationships of interest. The regression findings are reported in Annex tables, showing the estimated coefficients and direction of effects (positive or negative) of each explanatory variable as well as their statistical significance on influencing the outcomes, designated by ** and * for significance at the 1 and 5 percent levels, respectively. The results for some included explanatory variables – principally the sector, size and region controls – may not be reported for clarity of presentation.

Demand for Skills

The skill mix of the workforce varies with the shares of workers with different levels of education and occupation. A simple way of categorizing educational skills is to define workers with primary and lower-secondary education as low skill, upper-secondary as medium skill and tertiary and above as high skill. Workers with TVET qualifications would be a skill category by itself. The corresponding definition of occupational skills would be to treat "other occupations not elsewhere classified (n.e.c.)" as being low skill; clerical, sales and plant operators as medium skill; and managers, professionals and technicians as being high skill.

Figure 6 displays the shares of workers with different skill levels in the workforce for low-skill and high-skill firms. The positive link between exporters/ innovations and the level of skills in the workforce reported in the earlier pair-wise correlations is also evident in this figure. In terms of education, the high-skill firms have smaller shares of workers with low education, and higher shares of medium skill, high skill and TVET-qualified workers as compared to low-skill firms. Though less pronounced, similar differences in skill mix by occupation are also found for these two types of firms

To investigate the determinants of skill composition of the current workforce, the shares of upper secondary and tertiary educated, TVET-qualified workers and high-skill MPT occupations were regressed on several sets of explanatory variables: broad enterprise characteristics including size, sector and region; firm productivity attributes and the exporter and innovator demand drivers.[28] The estimated coefficients for selected key variables are reported below in Table 3.

[28] The skill share equations are the corollary of skills demand equations from a variable cost optimization model where skill shares of total wage bill are regressed on wages, firm characteristics and demand drivers (e.g., see Caroli and Van Reenen, 2001). However, this estimation approach was not practical given missing and incomplete wage information elicited in TESS.

Figure 6. Skill Shares of Low- Skills and High- Skills Demand Firms

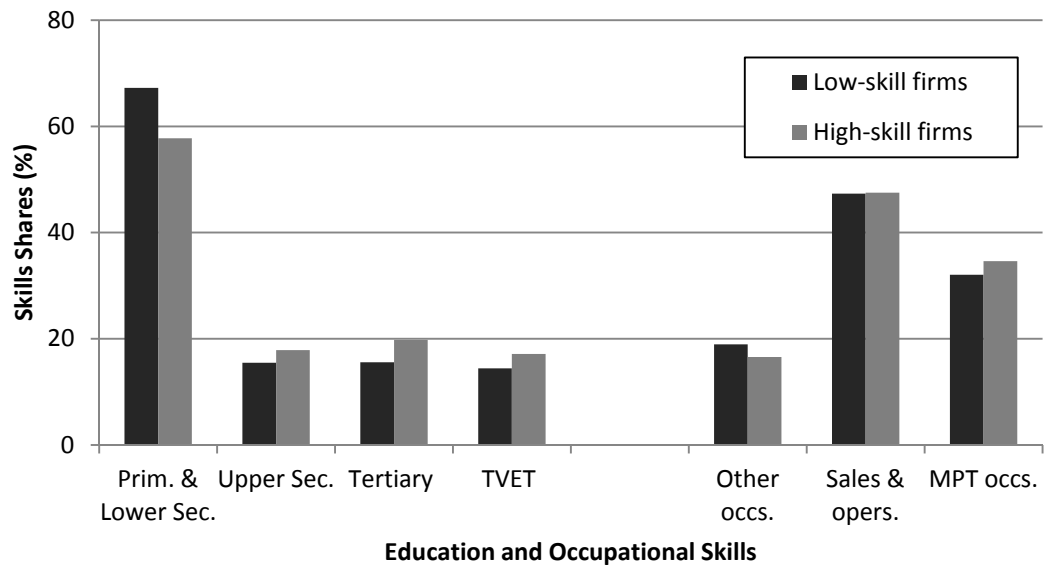


Table 3. Determinants of Shares of Educational Skills

	Primary & Lower Secondary	Upper Secondary	Tertiary Educated	TVET Qualifications
Explanatory Variables	Coef.	Coef.	Coef.	Coef.
Firm Attributes				
Top Manager Education	-6.43**	2.42*	4.027**	4.88*
Foreign Owner	-2.94	-2.13	5.07	4.26
Female Owner	-0.63	1.20	-0.57	1.82
Multi-Unit Firm	-10.01**	2.85	7.16**	2.70
Young Firm	-0.40	-0.40	0.81	2.33
Demand Drivers				
Exporter	-5.57	-1.21	6.78*	-0.49
Innovator	-8.58**	4.58**	3.99	1.07
Constant	99.08**	8.76*	-7.82	-1.09
Sample Size	388	388	388	326
R-squared	0.3290	0.0968	0.3182	0.2559

Note: * and ** denotes statistical significance at the 5% and 1% levels respectively

Among firm attributes, education of top managers and multi-unit firms are the most important drivers of employers' choice of skill mix. Firms with more educated top managers choose a skill mix with fewer primary- and secondary-educated workers, and more upper-secondary, tertiary and TVET-qualified workers. Educated top managers may simply have higher innate managerial talent,[29] or their management practices may require a more highly skilled workforce (Bloom and Van Reenen, 2010). Their role in the choice of skill mix by occupation (see Annex Table A.2) is however not significant. A similar pattern is also evident for firms with a multi-unit structure where horizontal or vertical integration of production may necessitate a more highly skilled workforce. These firms have a smaller share of workers with low educational attainment and a higher share of tertiary-educated workers and use relatively few workers in low-skill occupations.

The most striking result is the choice of skill mix in exporters and innovators, which face competitive challenges from trade and technological change, and thus greater incentives to respond. Both exporters and innovators have a skill mix with lower shares of less-educated workers and higher shares of medium- and tertiary-educated employees. Some estimates are statistically significant, with exporters choosing higher shares of tertiary-educated workers and innovators choosing fewer primary- and secondary-educated workers and more workers with upper-secondary education. This bias towards more highly skilled workers among exporter and innovators is consistent with the hypothesis that technological change is skill-biased (Berman, Bound and Machin, 1998).

Some remarks on the other included (but not reported) determinants of skills demand are warranted (for details, see Annex Table A.1 and A.2). First, skill shares by education do not vary significantly by firm size when the effects of other explanatory variables are held constant. The exception is the share of MPT occupations, which is higher in small firms than in large ones. As noted above, this may reflect greater employment of workers in lower-skill occupations in large firms because of scale economies. Secondly, there are systematic differences in skill mix across sectors, possibly reflecting sectoral differences in the organization of production, with higher shares of tertiary-educated workers in IT, hotels and restaurants, communications and transport sectors; greater use of TVET qualified workers in metal fabrication and construction; and a lower share of MPT occupations in hotels and restaurants, transportation and food.

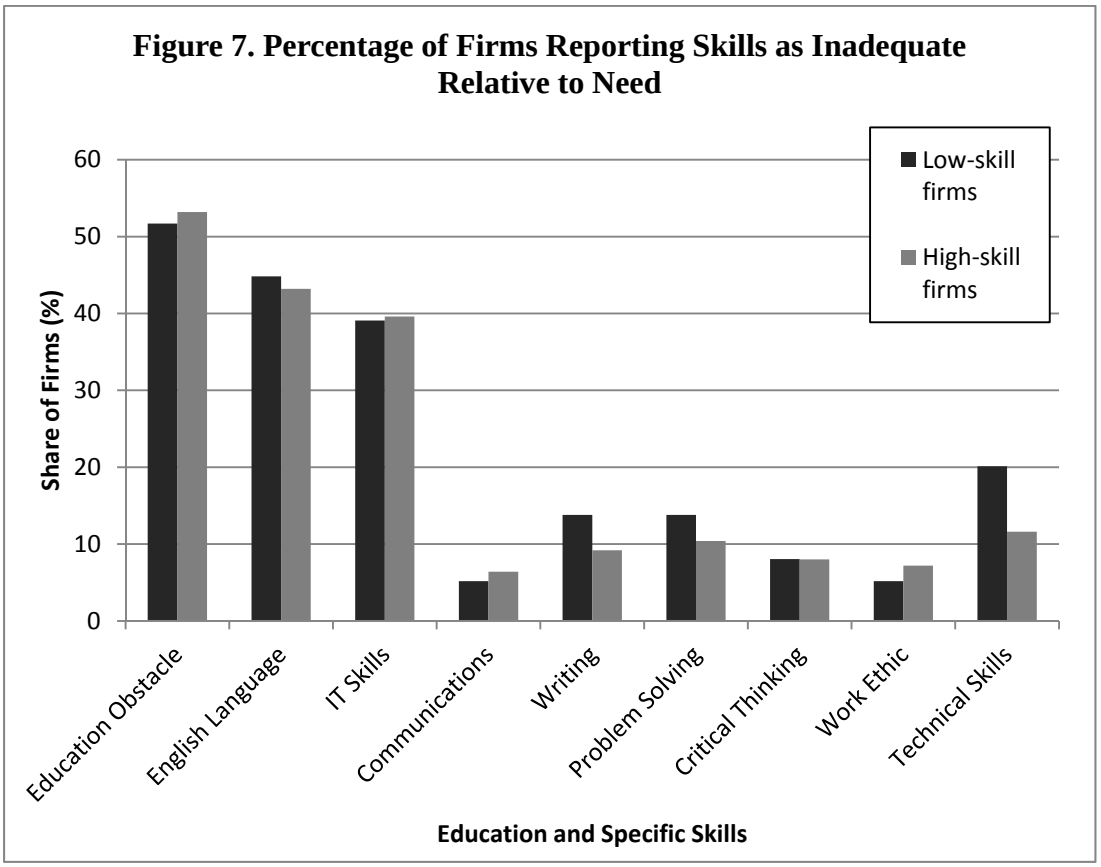
Skill Deficits and Operational Constraints

How do employers assess the skill deficits and operational constraints posed by the skills composition of their current workforce? Figure 7 summarizes the results of survey questions that asked employers to rate the adequacy of their workforce skills in different areas. There are surprisingly minor differences in the results for low-skill and high-skill demand firms. Over 50 percent of all employers rated education a big obstacle, and among the soft and hard skills, about

[29] Managerial abilities may reflect the greater ability of educated individuals to deal with uncertainty, as suggested by Nobel-prize economist Theodore Schultz, and cited by Bartel and Lichtenberg (1987).

40 percent assessed English and IT skills as being inadequate relative to firms' needs. A much lower percentage of employers – between 5 and 15 percent – rated teamwork/communications, writing, problem solving and critical thinking, work ethic and technical skills as inadequate relative to the firms' needs.

Figure 7. Percentage of Firms Reporting Skills as Inadequate Relative to Need



The results of estimating these relationships by a logistic model are reported in Table A.3 in the Annex.

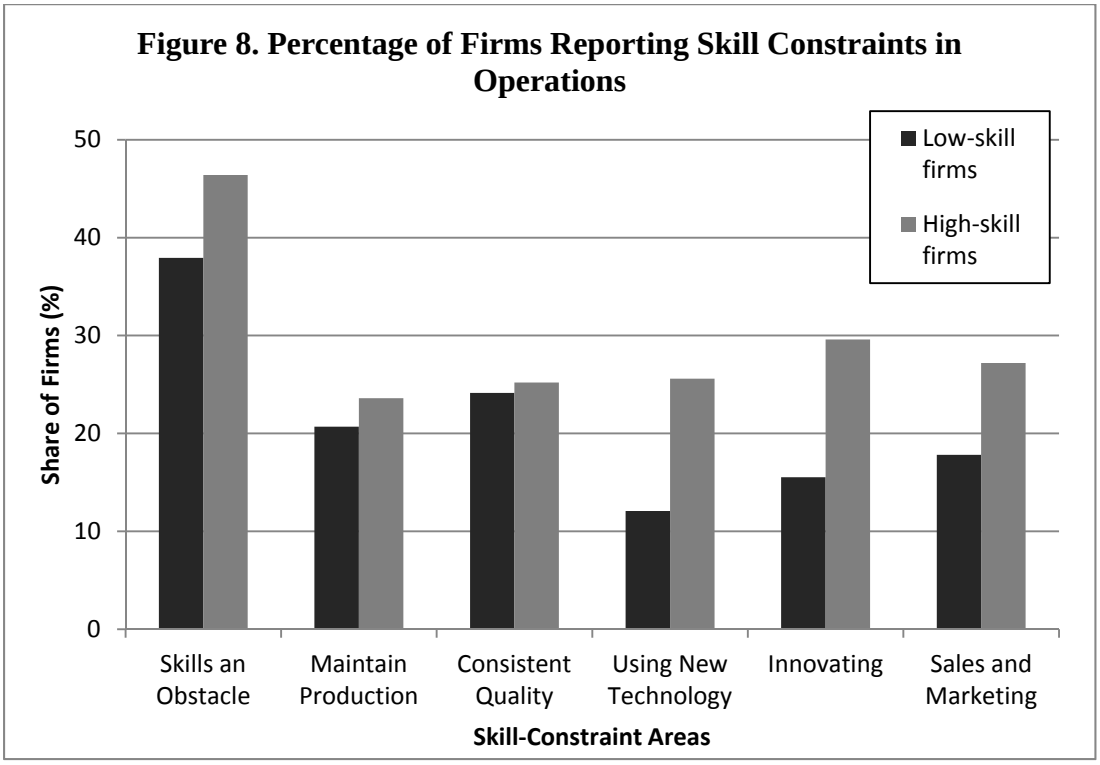
Firms with highly educated top managers were more likely to rate education deficiencies as a big obstacle, consistent with their need for higher-level skilled workers. Possibly because they already have a more educated workforce, English language and IT skills of their workforce are rated more highly by educated top managers, by firms with some foreign and female ownership, and by multi-unit firms.

Among high-skill firms, skill deficits differ for exporting firms and innovating firms. Exporters, for example, were more likely to rate teamwork, communications, and writing skills as inadequate, possibly because they rely on high-performance work organizations that rely on these specific

skills. Innovators, on the other hand, are more likely to find the English language and IT skills of their workforce inadequate to their needs.

Employers also assessed the operational areas where skill deficiencies posed the greatest problems for the firm. Here, there were strong differences between high- and low-skill firms. As shown in Figure 8, over 45 percent of high-skill firms judged skills to be a major operational obstacle compared to just 37 percent of low-skill firms. This resembles the earlier finding from simple pair-wise correlations between high-skill firms and education deficiencies and skill-related obstacles to operations. High-skill firms are marginally more likely to assess skills as an issue for maintaining production and quality consistency; however, they are much more likely to find skills inadequate in using new technology, innovating, and effective sales and marketing. The relationship of these assessments of skills constraints to firm types and characteristics was also investigated within a regression framework. (For more detailed results, see Table A.4 in the Annex.)

Figure 8. Percentage of Firms Reporting Skill Constraints in Operations



Employers with a high share of tertiary-educated workers are less likely to rate skills as being an obstacle to operations such as quality control, use of new technology, and effective marketing and sales. Sales and marketing problems are also diminished in firms with a higher share of secondary-educated workers. Among firm attributes, multi-unit firms are more likely to assess skill deficits as an obstacle across all operational areas, possibly reflecting the vertically or horizontally integrated nature of their operations across multiple firms. University-educated top managers also

identify skills as being a constraint in maintaining production levels and effective sales and marketing.

Also, exporters and innovators differ in their assessments. Exporters are less likely than non-exporters to judge skills as being an obstacle in all areas of operations, particularly when it comes to quality control. Innovators, on the other hand, are significantly more likely to flag skills as an obstacle in virtually all areas, including the areas of operations most closely related to their innovator status: use of new technologies and production processes, and introducing new products and processes.

Strategies for Developing Skills

Firms use a variety of strategies to address their skill deficits: augmenting skills of existing employees through in-service training, hiring new workers to fill skill gaps, using high-skill expatriate managerial, professional and technical (MPT) workers with needed expertise not available domestically, or out-sourcing professional services. Information on the skill deficit-mitigating strategies used by the two types of firms are presented in Figures 9 through 11.

Figure 9 shows the share of firms that sponsor any in-service training for their current workers. By any measure, firms with high-skill demand are more likely to provide in-service training, whether in-house or externally, than firms with low-skill demand. For high-skill firms, defined as those that export and/or innovate, over 35 percent provide some form of in-service (vs. 21 for low-skill firms), 28 percent provide in-house and 12 percent provide external training (vs. 16 and 10 percent). If high-skill is defined strictly by exporter status or by innovator status, 41 percent of high-skill firms (exporters) offer in-service training versus 28 percent of those that do not export; similarly, 37 percent of high-skill firms (innovators) offer training versus 16 percent of non-innovators.

Figure 9. Training by Type of Firm

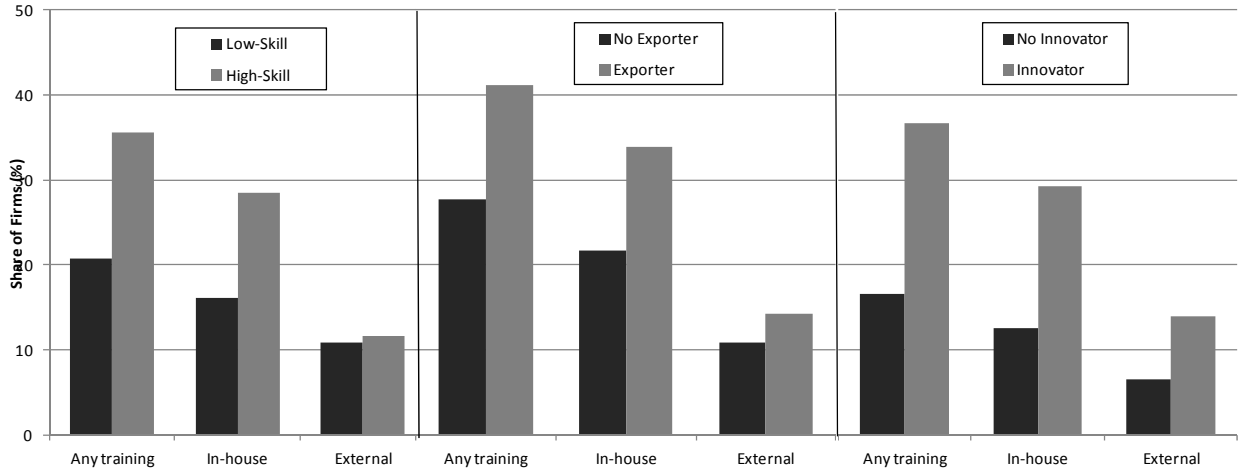
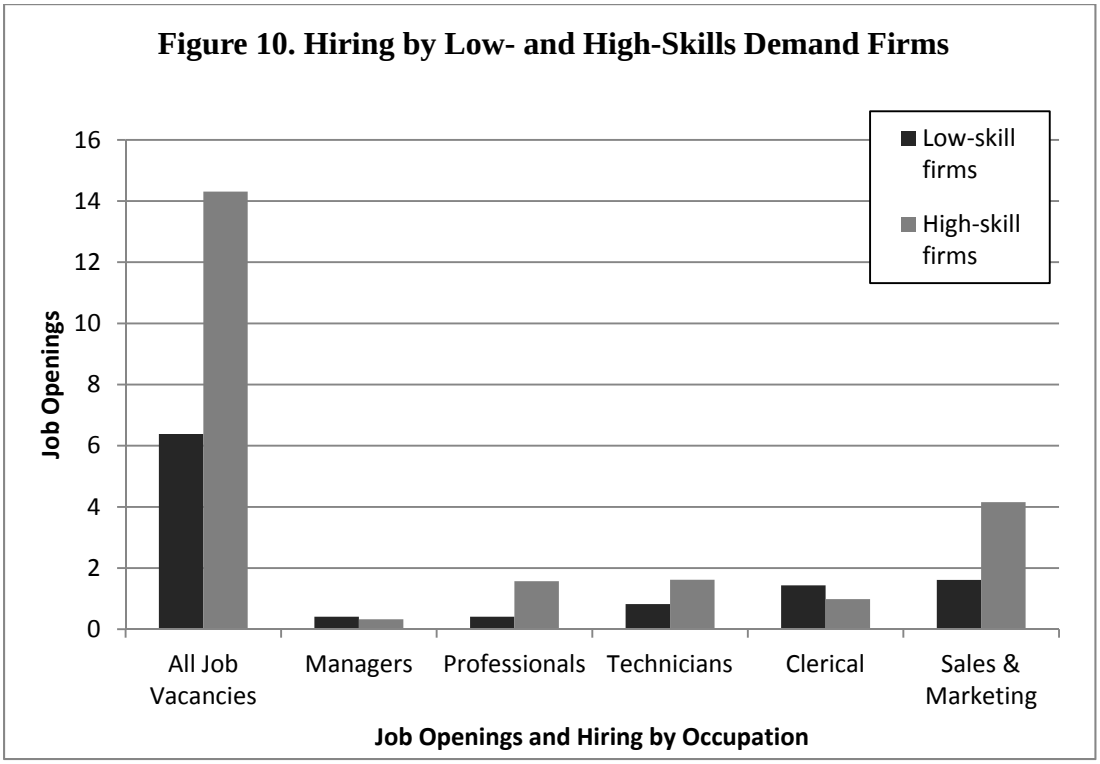


Figure 10 compares high- and low-skill firms in terms of their hiring practices to fill specific occupational gaps in their workforce. It shows the total number of job vacancies reported and filled over the past two years, conditional on having vacancies. An equal share of high- and low-skill firms (23 percent) had job vacancies. On average, high-skill firms reported (and filled) a total average of 14 job vacancies across all occupational groups as compared to just 6 vacancies in low-skill firms. On average, high-skill firms created more jobs in the professional, technical, sales and marketing, plant operators and other occupations as compared to low-skill firms. The only exception was in clerical occupations, where high-skill firms had fewer job vacancies.

Figure 10. Hiring by Low- and High-Skills Demand Firms



Logistic regression models are used to estimate the probability of employers providing in-service training, in-house and from external providers, and hiring new workers to fill skill gaps. The number of new hires is estimated by ordinary least squares regression. The analyses of the determinants of these two skill strategies are reported in Table A.5 of the Annex.

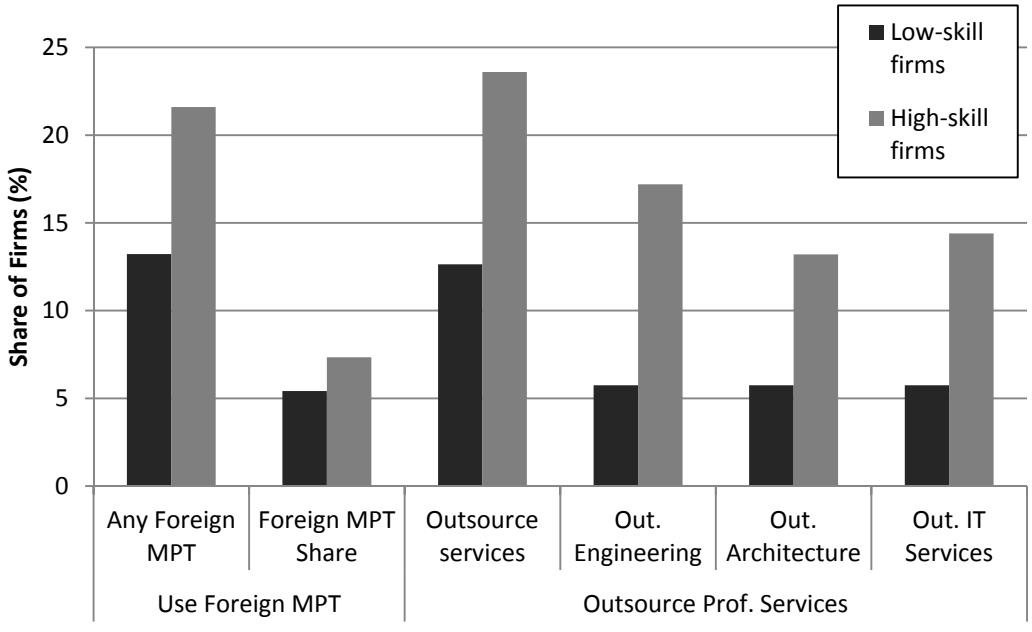
The results in Table A.5 suggest that firms with university-educated top managers or that are female-owned are more likely to respond to skill deficits by sponsoring in-service training, especially in-house training. Foreign-owned firms, however, rely more on training from external sources. They are also more likely to hire new workers to fill specific skill shortfalls. Hiring new

workers as a skill strategy is also more likely among firms with a higher share of tertiary-educated workers.

More detailed analysis shows that exporters and innovators respond differently to skill deficits. Exporters tend to hire new workers, and more of them (exporters are usually larger firms), while innovators are more reliant on addressing current skill deficits by providing in-service training, especially in-house training. This is consistent with empirical evidence on the critical importance of in-house training to the learning-intensive process of modifying and adapting technology to develop new products and services (e.g. see Tan, 2005; Toner, 2011).

When skill gaps cannot be filled locally, employers can respond by using expatriate MPT workers and outsourcing key professional services to external providers, whether local or foreign. The first skill strategy may be characterized by an indicator variable for the use of foreign high-skill managers, professionals and technicians, and by the expatriate share of MPT workers. For the strategy of outsourcing professional services, we define indicator variables for any outsourcing and separately for outsourcing of engineering, architectural and IT services. Comparative use of these two skill strategies is presented in Figure 11.

Figure 11. Share of Firms that Outsource Professional Services



As the figure shows, exporters and innovators are more likely to use expatriate MPT workers and to outsource professional services than low-skill firms. High-skill firms use expatriate MPT

workers more frequently (21 percent) and they make up 7 percent of the firms MPT workforce; low-skill firms use expatriate MPT less frequently (13 percent) and expatriates are 5 percent of their MPT workforce. Exporters and innovators are also twice as likely to outsource as low-skill firms, and two to three times as likely to outsource engineering, architectural, and IT services. (See Table A.6 for the regression analyses for these two strategies.) Outsourcing of professional services, and IT in particular, is more likely for firms with higher shares of tertiary-educated and MPT workers and for firms with university-educated top managers. Young firms in operation less than 10 years are less likely to outsource any professional services.

Foreign and female-owned firms are more likely to rely on expatriate MPT workers, and more of them, than other firms. The reliance on foreign MPT is understandable in firms with foreign ownership, but it is less clear why female-owned firms do so. One reason may be that female managers, on average, have less experience in industry than their male counterparts.

Among high-skill firms, exporters are more likely to use expatriate MPT workers and to outsource services, especially engineering and IT services. Innovators are also more likely to use expatriate MPT workers and outsource, but these relationships are not statistically significant. When they outsource, innovators typically outsource engineering services that are so critical for firms that are introducing new products and services.

Firm Performance

Thus far, the analyses have identified several key firm attributes and demand-side factors shaping employers' decisions regarding workforce education and skills, perceived skill deficits, and skill-deficit mitigating strategies. This naturally raises the question of whether workforce skills, skill deficits, and strategies to address them actually matter to firm performance.

These questions are addressed within a production function framework. In its intensive form, production functions relate the log of labor productivity (sales per full-time worker) to log capital per full-time worker,[30] measures of skill composition, and other explanatory variables including firm attributes and sector dummy variables to control for differences across industries.

This simple production function model[31] may be augmented to estimate the separate productivity effects of firm investments in the education and occupational skills of its current workforce, and of strategies to mitigate skill deficits arising from demand-side factors. (For a more detailed

[30] Capital per worker is defined as total fixed assets (sum of machinery, equipment and buildings) divided by the number of full-time workers. Because of missing values, the value of machinery and equipment and of buildings had to be imputed, either from information about the cost of replacing them or using a STATA program to impute missing values from the sample with no missing data, by sector, size, region and number of full-time workers.

[31] The production function is assumed to be Cobb-Douglas with constant returns to scale (CRS) so that, irrespective of firm size, the returns to inputs of capital and labor are identical. The CRS assumption obviates the need to control for firm size in estimating the production function.

description of our research methods, see the technical annex on the Skills Demand Model.) The following four specifications are used in the model:

(1) In the baseline specification, which is the production function typically estimated from establishment census data, log labor productivity is regressed on the log of capital per employee, measures of education and skill composition of workers, and sector dummy variables. The estimated coefficients of capital per worker and skill shares provide estimates of the returns to capital and to different skill investments.

(2) A second specification adds a set of measures to capture the productivity differences across firms arising from skill deficits. Informed by the previous analyses of skill deficits, several drivers of skills demand are included: a set of firm attributes – education of top managers, foreign and female ownership, multi-firm organization, and young firms – and indicator variables for high-skill firms – their exporter and innovator status.

(3) The third specification replaces the set of firm attributes and demand-drivers in (2) with employers' responses to these skill deficits. Skill-deficit mitigating strategies include firm provision of in-house training, external training, employment of expatriate MPT workers, outsourcing of professional services, and hiring of new workers. Their estimated coefficients provide insights into the productivity impacts of these different skill mitigation strategies.

(4) The final specification adds back the firm attributes and demand-drivers to (3). This specification provides insights into how much of the demand-driven productivity differences across firms are explained by skill-deficit mitigating strategies and whether different firm attributes and demand-drivers have residual productivity effects independent of their roles in employer decisions about skills and skill strategies.

The results of this analysis are summarized in Table 4. Before turning to the findings on skill deficits and skill strategies, consider the two estimated results of capital and skills composition in the baseline production function:

- *Capital intensity is positive and statistically significant in most specifications*, suggesting that workers are more productive (by about 6.6 to 7.5 percent) the higher the amount of fixed assets (equipment, machinery and buildings) that each worker gets to work with.
- *The share of tertiary-educated workers is significantly associated with higher labor productivity (0.8 to 0.4 percent) but not those of the other skill variables* (upper secondary, TVET qualified and MPT shares). The lack of any statistical significance either points to the possibility of measurement error or suggests that the productivity effects of the latter are not different from that of lower-educated workers (with primary or lower secondary education) or those working in lower-skill jobs (sales, plant operators and other unspecified occupations). This absence of a productivity impact may reflect well-known deficiencies in the formal education and training of these skill groups documented in Section II.

These results highlight several firm characteristics that appear to improve labor productivity:

- *University-educated top managers and foreign-owned firms are associated with higher labor productivity.* These findings are consistent with the hypotheses that better-managed firms and foreign ownership (with greater technological capabilities) are more productive, while young firms are less productive because they have not accumulated sufficient operational experience.
- *Of the high-skill firms, only exporting firms are significantly associated with higher labor productivity*, a relationship that research suggests may reflect their higher pre-export productive capabilities, learning from exporting, or some combination of the two productivity sources. *However, surprisingly, innovator status is not associated with higher productivity*.
- *Employers' skill-deficit mitigating strategies are, with one exception, uniformly positive and significantly associated with higher labor productivity*. These findings suggest that external training, use of foreign MPT workers, hiring of new workers, and outsourcing of professional services can be effective strategies to mitigate skill deficits in the current workforce. The use of expatriate MPT workers is especially significant statistically and points to important deficits in the domestic supply of high-skilled MPT workers. The one exception is employer provided in-house training, which has no measurable impact on productivity. This finding is troublesome in light of empirical evidence showing the causal links between in-house training, innovation, and productivity growth (Dearden, Reed and Van Reenen, 2005; Tan and Lopez-Acevedo, 2003), and suggests an area for further research and closer policy attention.
- In examining whether firm attributes and demand-drivers have residual productivity effects independent of their roles in employer decisions about skill mix and skill strategies, *only foreign ownership and young firms remain significant when skill-deficit mitigating strategies are controlled for*. These results may reflect innate differences in their productive capabilities: the higher productivity of foreign firms may be attributed to their greater technological capabilities, while productivity is lower in young firms that have not been in operation long enough to build up a stock of productive capabilities.

Table 4. Skills and Firm Performance				
Production Function	Model 1	Model 2	Model 3	Model 4
Constant	16.383**	15.988**	15.923**	15.769**
Log (Capital/Worker)	0.045	0.065*	0.066*	0.075*
% Upper Secondary	0.000	-0.001	0.000	-0.001
% Tertiary	0.008**	0.004	0.004*	0.002
% TVET Qualifications	0.003	0.002	0.004	0.004
% MPT Workers	-0.002	-0.002	-0.001	-0.001
Skill Strategies				
In-House Training			-0.095	-0.120
External Training			0.419*	0.390*
Use Expatriate MPT			0.715**	0.543**
Outsource Services			0.310*	0.272*
Hire New Workers			0.288*	0.212*
Firm Attributes				
Manager Education		0.275*		0.197
Foreign Owner		0.847**		0.466*
Female Owner		-0.042		-0.138
Multi-Unit Firm		0.149		0.123
Young Firm		-0.299**		-0.218*
Demand Drivers				
Exporter		0.316*		0.252
Innovator		0.083		0.050
Sector indicators	Yes	Yes	Yes	Yes
Sample Size	416	416	416	416
R-squared	0.1810	0.2697	0.2909	0.3246
Note: * and ** denotes statistical significance at the 5% and 1% levels respectively.				

V. SOURCES OF SKILLS AND TRAINING

It is widely recognized that higher education and TVET institutions are unequally distributed in the country (MOEVT, 2013; UNESCO, 2011).[32] This raises the question of where employers go to fill job vacancies for these different occupations or find training providers to upgrade worker skills? Are skill sources available locally within the region or are they less accessible and available only from Dar es Salaam, other regions in Tanzania or even abroad? Employers were asked for the main skill sources used for new hires over the past two years, and the names of up to three universities, three TVET or other tertiary institutes, and three secondary schools they turn to as sources of new hires and training. Similar information was elicited on in-service training programs.

Where Are Most Training Sources Located?

The geographic accessibility of skill sources is tabulated in Table 5 by mapping the region of the firm against the locations of each skill source, separately for the skill type of each source.[33] To simplify exposition, the locations of skill sources are aggregated into four categories: in the same region as the respondent, the Dar es Salaam region, the rest of Tanzania, and International. The resulting region-location matrix reports the percentage share of skill sources in these four location categories for all respondents in a given region.

The most striking finding is the heavy reliance of firms across the country on Dar es Salaam as a skill source for university and TVET personnel, primarily managers, professionals and technicians. Between 33 and 43 percent of university skill sources reported by firms from Mbeya, Mwanza, and Zanzibar are located in Dar es Salaam; for TVET and other tertiary-institute sources, the corresponding figures are 43 to 67 percent. Geographic remoteness from sources of higher-level skills can translate into economic costs for firms located in regions outside Dar es Salaam, costs in identifying needed skills and matching available skills to their desired skill mix, with attendant skill deficits and loss of productivity.

For less-skilled occupations, most firms cite local secondary schools as the primary source. The exception is Arusha, where firms still attribute 50 percent of secondary school sources to Dar es Salaam schools.

Most firms rely heavily on local training providers for their in-service training needs, which might be expected given the cost (and work disruption) of releasing employees to attend outside training courses. However, this local reliance varies greatly across regions, from 71 percent in Arusha to 29 percent in Mbeya. Dar es Salaam continues to account for a large share of training providers

[32] Universities and colleges are located primarily in Dar es Salaam and other urban areas, and in the eastern part of the country. Just five relatively urbanized regions (Dar es Salaam, Iringa, Arusha, Kilimanjaro and Mwanza) are home to almost 55 percent of VTCs, enrolling 67 percent of all VET trainees in VET in 2010/11.

[33] We organized responses on skill sources and training providers into a data base with each named skill source as the unit of observation, with multiple observations per respondent, for a total of 704 named skill sources. Each skill source is categorized into one of four skill types: (1) universities, (2) TVET and other tertiary institutes, (3) secondary schools, and (4) external training providers.

for firms in the other regions – 29 percent in Arusha, 30 percent in Zanzibar and 20 percent in Mwanza – suggesting that these regions are poorly served by qualified training providers, both public and private, offering appropriate training in needed skill areas.

Further evidence of shortfalls in the local supply of high-skill workers is that some firms turn to foreign skill sources (e.g. UK, Kenya, Uganda, India, China and Turkey) for university and TVET skills and training. These firms are primarily from Zanzibar, Dar es Salaam and Arusha, a reflection of widespread shortfalls in the local supply of higher-level skills.

Table 5. Location of Major Skill Sources Relative to Region of Respondent

	Region of Firm Respondent (% of total sources)				
Location of Skill Source	Arusha	Dar es Salaam	Mbeya	Mwanza	Zanzibar
1. Universities					
Same region as Firm	37.5	54.3	0.0	33.3	37.9
Dar es Salaam	25.0		33.3	43.3	33.3
Rest of Tanzania	25.0	41.1	66.7	23.33	4.6
International	12.5	4.6	0.0	0.0	24.2
2. TVET & Other Tertiary					
Same region as Firm	16.7	71.4	33.3	50.0	48,9
Dar es Salaam	50.0		66.7	50.0	42.6
Rest of Tanzania	33.3	28.6	0.0	0.0	2.1
International	0.0	0.0	0.0	0.0	6.4
3. Secondary Schools					
Same region as Firm	33.3	65.8	100.0	87.9	77.6
Dar es Salaam	50.0		0.0	9.1	9.0
Rest of Tanzania	16.7	34.2	0.0	3.0	10.4
International	0.0	0.0	0.0	0.0	3.0
4. External Training					
Same region as Firm	71.4	79.4	28.6	60.0	45
Dar es Salaam	28.6		14.3	20.0	30.00
Rest of Tanzania	0.0	5.9	57.2	20.0	5.0
International	0.0	14.7	0.0	0.0	20.0

Source: TESS, 2015.

What Kinds of Organizations Do Employers Use to Fill Job Vacancies and Provide Training?

Of interest to policy makers is the extent to which employers are using VETA/VTA training institutions[34] as a source of high-skill talent and training. After all, employers pay a levy for such services. The survey asked them how often they benefited from these institutions to fill specific TVET vacancies or train their employees. Table 6 provides those numbers, for job vacancies and for in-service training.

Table 6. VETA/ VTA as a Major Skill Source for TVET Vacancies and In-Service Training

	Region of Firm Respondent					
Skill Sources	Arusha	Dar es Salaam	Mbeya	Mwanza	Zanzibar	Tanzania
1. TVET Job Vacancies						
VETA/VTA institutions	4	24	1	5	12	46
All TVET sources	6	56	3	6	47	118
2.In-Service Training						
VETA/VTA institutions	1	4	1	1	0	7
All external training sources	7	34	7	5	20	73

Source: TESS, 2015.
Note: Figures are counts of institutions according to the type of skills sources

As the data show, VETA/VTA institutions are a major source of pre-employment TVET skill vacancies in most regions, accounting for between 26 and 83 percent of skill sources in this category. In Dar es Salaam, firms listed VETA institutions 24 times out of 56 skills sources, Mbeya firms cited VETA as 1 of 3 skill sources, and Arusha firms cited VETA 4 out of 6.

The survey also asked employers whether they used VETA/VTA institutions as a source of training. The results presented in Table 6 show that few firms cite VETA/VTA as a source of in-service training, even in Dar es Salaam where VETA institutes are only cited 4 times out of 34 sources. In the autonomous region of Zanzibar, firms cite VTA institutions as a major source of TVET graduates in 12 out of 47 skill sources, but never as a provider of in-service training (0 out of 20 sources). In other words, despite the levy, employers receive little support in developing the skills of their workforce.

If firms are not going to VETA/VTA institutions for their training, what other organizations are providing training? Employers cited several options:

[34] "VETA/VTA training institutions" refer to public training centers and institutions under VETA or VTA.

- Company training staff are the main providers of training programs delivered in-house, followed by private-sector trainers and consultants.
- Industry associations are the most important source of in-service training for both textiles and garments, and hotels and restaurant sectors, but not for construction or transportation sectors. However, there are differences across regions. Industry associations are key providers of in-service training for firms in Dar es Salaam, Zanzibar and Mwanza but negligible in Arusha and Mbeya.
- Public TVET institutions, industry associations and other unidentified sources are the main providers of external training.
- Universities are almost never cited as a source of external training.[35]

Low Demand for Training

Survey results revealed a surprisingly low incidence of in-service training among small firms (17 percent for in-house training and 7 percent for external training), as compared to 28 and 14 for medium firms and over 48 and 28 percent, respectively, for large firms. The low incidence of in-service training among smaller enterprises is not unique to Tanzania; similar patterns of training by firm size have been widely documented in economies across all regions and in high-income as well as developing countries.[36] See Table A.7 in the Annex for more detailed results on in-service training.

The survey explored the reasons for such low training rates to determine whether it was primarily a lack of providers or whether there were other obstacles to providing training. Table 7 presents the results for firms of different sizes. The difficulty of finding training sources was cited by 17 percent of all firms (and 12 percent of all firms), but the most frequently cited reason was the high expense and low cost-efficiency of training (33 percent of small firms and 35 percent of all firms). Besides those reasons, about an equal fraction of firms of all sizes (about 20 percent) thought training would not be useful, suggesting that they have few incentives to invest in worker training of questionable value. Some firms (about 16 percent) also claimed they did not train their workers out of concern that other companies would "poach" their skilled employees.

Finally, firms mentioned the difficulty of releasing workers from work to take training courses. This is especially true for firms that are far from most training sources, most of which are located in Dar es Salaam. Training workers at long distances from their workplace would entail considerable workflow disruption.

[35] The exception is a medium-size exporter in the fabricated metals sector in Dar es Salaam that cites a University as the main source of external training for the firm.
[36] See Almeida et al. (2012), Perotti (2014), and Sabarwal (2013) for Tanzania.

Table 7. Firms' Reasons for Not Providing Training				
Reason for No Formal Training:	Small (5-19)	Medium (20-99)	Large (100+)	All Firms
Too expensive / not cost efficient	83	38	10	131
	(33.1)	(39.6)	(30.3)	(34.5)
Training programs / trainers not available	42	4	2	48
	(16.7)	(4.2)	(6.1)	(12.6)
Training would not be useful	53	22	6	81
	(21.1)	(22.9)	(18.2)	(21.3)
Trained workers would leave	39	16	8	63
	(15.5)	(16.7)	(24.2)	(16.6)
Cannot afford to release workers from work	34	16	7	57
	(13.5)	(16.7)	(21.2)	(15.0)
Total	251	96	33	380
	(100.0)	(100.0)	(100.0)	(100.0)

Challenges and Opportunities

These constraints pose several challenges for training policy: promoting the supply of market-relevant skills from public and private-sector providers, addressing the uneven geographic distribution of skills supply and training providers, and developing cost-effective training programs tailored to the needs of the under-served population of small and medium enterprises (SMEs). It is also clear that the solution cannot be dramatically expanding the number of public training institutions throughout the country, which is, in any case, not realistic given constraints on the public purse. Nor is it necessarily desirable that job training be provided by the government. The state can facilitate the private sector, both training providers as well as industry, to play a greater role in training, and particularly in improving coordination of information, financing, and know-how. VETA's Skill Enhancement Program (SEP) for the training of employees, co-funded by VETA and employers and delivered by industry experts and qualified training providers, is a promising start.

Tanzania should also look to other regions of the world that offer successful models of payroll levy systems, public-private partnerships, and more targeted training programs that have broad regional coverage. For example, several countries, especially in East Asia, have introduced payroll levy systems that are more responsive to employers' needs for continuous upgrading of worker skills, and that give employers greater control over how levy resources are used. These levy systems have the additional benefit of creating a more vibrant post-employment training market with public and private training institutions competing for an expanded pool of training resources. A successful example of such a system is Malaysia's Human Resource Development Fund (See Box 1.)

Box 1. Malaysia's Human Resource Development Fund

The Human Resource Development Fund (HRDF) was established in 1993 to promote increased enterprise-based training among firms, first in manufacturing and then more recently in service sectors as well. The Act created a council (HRDC), with representatives from the private sector and from responsible government agencies, and a Secretariat to administer the different HRDF schemes. Eligible employers with 50 or more employees are required to contribute 1 percent of payroll to the HRDF from which they are then eligible to claim a portion of allowable training expenditures up to the limit of their total levy payments for any given year. The HRDC set rates of reimbursement, varying by type of training and higher for smaller firms.

The HRDF requires firms to spend a minimum amount on training or lose their levy contribution, thus creating incentives for firms to train rather than "poach" skilled workers from other employers. It offers different schemes that give employers flexibility in training in-house, or using a variety of external public and private sector providers including second-tier public-private intermediaries such as state- level skill development centers. This funding had the additional effect of creating a vibrant training market, with public and private sector providers competing for resources. It addresses information constraints through public information campaigns, subsidized delivery of training need assessments (TNAs) to small and medium enterprises (SMEs), certification of training providers and wide dissemination of their offerings, and electronic billing to keep employers informed of their levy use status. Recognizing the funding constraints of SMEs, the HRDC enlists certified providers to act as its agents, collecting from users the fees for which firms are responsible and claiming the reimbursable balance from HRDF, thus reducing up-front cash outlays from SMEs.

Source: Tan and Gill (2000)

An excellent example of industry-government collaboration for the delivery and financing of training is the Penang Skills Development Center in Malaysia (see Box 2). It demonstrates the potential of private education and training institutions being used for public training purposes in cases where they are not viable in themselves as private commercial undertakings, and it does so without creating the facilities in the public sector.

Box 2. Penang Skills Development Centre

First established by the Penang State Government and private industry as a joint training center, the Penang Skills Development Centre (PSDC) has evolved into a purely private education institution providing certificate and diploma level training. The Malaysian Government invests in the Center and uses it to carry out public training programs. PSDC, with more than 100 member companies, now runs both standardized and customized programs. It charges at cost and is basically self-financing. Companies recoup their training expenditure from the Human Resource Development Fund (HRDF), a training fund financed by a 1 percent levy on payrolls.

The initiative for PSDC came from the Penang State Government, which provided the land and buildings. The founder members included large multinational companies with training traditions of their own. Members donate equipment, laboratories, training modules and trainers. They have access to shared training facilities without having to duplicate with their own in-house capability. SMEs enjoy technology transfer from and can benchmark their standards against multinationals. Multinationals, in turn, receive better support services. Vendors donate equipment to familiarize the company workforce with their products and promote sales.

None of this is to say that the PSDC is easily replicated. Eleven other Malaysian States (out of 13) have launched similar centers, with varying degrees of success, usually a function of state government commitment, regional growth, and private sector ingenuity (for example, the State of Johor invited equipment suppliers to stock and update equipment used in the JDC so training equipment was always current and comparable to those used in companies). As usual, the success of this sort of enterprise depends on a number of circumstances, most importantly the people initiating and managing the process. Centers like PSDC cannot be imposed; they need to grow in already fertile ground.

Source: Pillay (2005)

The state can also play an expanded role in helping organize tailored training programs that target groups of SMEs operating in the same sector and geographic regions. This is already being done on a limited scale by SIDO, Tanzania's Small Industries Development Organization.[37] It might enlist the help of existing industry associations, such as those in the textile and garments sector, or help establish new industry associations when none exist. It would work with industry associations and SMEs to identify their skill and other technical needs and match them with the most qualified training providers, either public or private. Training would be group-based to reduce unit costs

[37] Five enterprises cited SIDO as a major source of TVET skills and a provider of external training, for hotels and construction in Zanzibar, transportation in Arusha, textiles in Mwanza and fabricated metals in Dar es Salaam.

and delivered in a format that is least disruptive to the production needs of SMEs. Following the example of SEP, the training would be co-funded by SMEs and VETA.

Similar initiatives have been used successfully in the Republic of Korea to organize Training Consortiums for group-based training of SMEs, with the costs of training financed in part by a payroll levy-rebate scheme (see Almeida and Cho chapter in Almeida et al., 2012). Mexico's Integral Quality and Modernization Program (CIMO), now renamed PAC, is another example. It provides insights into how the SME training program achieved broad regional coverage with minimal investments in capital infrastructure. It also demonstrates how the program evolved from a traditional training program into one offering SMEs an integrated package of training and industrial extension services. Impact evaluations have found the CIMO program to be a cost-effective training strategy, with tangible post-training improvements in several measures of firm performance (see Box 3).

Box 3. Mexico's Proactive Training Programs for SMEs

The Integral Quality and Modernization Program (CIMO), established in 1988 by the Mexican Secretariat of Labor, has proven effective in serving the training needs of small and medium-size enterprises (SMEs). Set up initially to provide subsidized training, CIMO quickly evolved when it became apparent that lack of training was only one of many factors contributing to low productivity among SMEs. By 2000 CIMO was providing an integrated package of training and industrial extension services to over 80,000 small and medium-size enterprises each year and training to 200,000 employees, involving more than 300 business associations, up from 72 in 1988. While the program ceased to exist after a change in government, it offers some important lessons for training policy.

The CIMO program was designed to have broad regional coverage with minimal bureaucratic infrastructure. All states had at least one CIMO unit, each staffed by 3-4 promoters, housed in business associations, which contributed office and support infrastructure. Promoters organized workshops on training and technical assistance services, identified potential local and regional training suppliers and consulting agents, both public and private, and actively sought out SMEs to deliver assistance on a cost-sharing, time-limited basis. An initial diagnostic evaluation of firms was conducted as the basis for organizing training programs and other consulting and technical assistance. The government did not deliver this training; instead, its role was to identify qualified local training providers to deliver the training usually on a group or association basis so as to reduce unit training costs. This strategy was deliberate since one of the program's objectives was to promote the development of regional training markets able to serve the needs of local enterprises.

Several rigorous evaluations have found CIMO to be a cost-effective way of assisting SMEs. While CIMO firms tended to have lower pre-program performance than a comparison group with similar attributes, their post-program outcome indicators tended to show relative improvements in indicators like labor productivity, capacity utilization, product quality, wages and employment.

Source: Tan and Lopez-Acevedo (2005)

VI. POLICY IMPLICATIONS

Improve the quality of secondary education

The analysis reveals that a worker with secondary education or TVET qualification makes no greater contribution to firm's performance, on average, than a person with primary education. This finding most probably reflects the universally acknowledged poor quality of secondary education.[38] Most secondary-school graduates entering the job market have inadequate skills; those who manage to gain the required academic and other competencies to continue their education do so, but they comprise just 5 percent of the population. This represents a substantial loss to households or the government, which have borne the cost of educating these students.

This recommendation is especially relevant in light of the Tanzanian government's recent commitment to universalize secondary education. In such an ambitious expansion of the secondary education system, the government must not lose sight of the importance of improving the quality of that education. Quality improvement should focus especially on improving English and IT skills that have broad application in many jobs, as well as ensuring basic proficiency in writing, critical thinking and problem solving. As various other studies have shown, the lack of qualified mathematics and science teachers and English teachers is one of the key factors undermining quality at the secondary level. TVET education and training requires reforms in curricula, faculty recruitment and training as well as instructional practice oriented to industry requirements. In addition, an improvement in the knowledge and skills of incoming secondary students will also improve quality. If the quality of secondary and TVET education improves, firms could hire secondary graduates into jobs requiring higher skills than primary graduates and thereby improve their productivity.

Expand the pool of tertiary-educated people across geographical regions

Study findings show that tertiary-educated workers have an impact on productivity, but the pool is currently very small in Tanzania compared to its competitors. University-educated top managers are also associated with higher labor productivity. Because they recruit more skilled workers, they are most likely to rate education deficiencies as a big obstacle, possibly because they are aware of the gaps between what is available in Tanzania and the rest of the world. A significant finding is the heavy reliance on Dar es Salaam for tertiary educated workers, which raises costs for firms in other regions, pointing to the need for greater coverage of the country by institutions providing

[38] Poor learning outcomes at the primary level are well-documented in Tanzania through various learning assessments, such as UWEZO and the Early Grade Reading and Math Assessments. Learning assessments at the lower secondary level are not available. Examinations are not a reliable indicator of student learning, as one of their main aims is to regulate student flow to higher levels. Nevertheless, they provide some information on quality for employers and policy makers. According to the Government of Tanzania's education national key results report, pass rates of the Certificate of Secondary Education Examination (CSEE) declined from 90 percent in 2007 to 35 percent in 2012. These data show that Tanzania has a critical issue of quality in service delivery of education (World Bank, 2014b).

tertiary level education. As with secondary education, however, expansion must be managed without sacrificing quality, and equally importantly, ensuring relevance for the labor market.

Enhance the role of VETA/VTA in employee training and make the payroll levy system more responsive to employer needs

Improving the overall quality of education and training will take a relatively long time and cannot remedy the immediate skill shortages of exporters and innovators. Significantly, in Tanzania, such firms exist in all sectors and regions, and may be small, medium or large. In the short run, the skills deficits faced by these firms affect their performance, in using their plant and machinery, in maintaining quality standards or introducing new technology. Firms that try to meet their skills deficits through a variety of ways (except for in-house training) are able to increase productivity. However, many firms choose not to upgrade workforce skills because of the high cost of the various options available to them (such as hiring foreign workers, the remoteness of education or training institutions and the paucity of good quality external training) and the lack of information on providers.

A program focused on meeting the needs of these firms could improve productivity. VETA/VTA could play an enhanced role in employee training through coordination and aggregating skills needs (by sector/ cluster and/or geographic area), by increasing the flow of information and developing cost-effective training programs, especially for small and medium enterprises that currently have the greatest need. This would require an adjustment in VETA/VTA's current focus on pre-employment training of TVET students to work more closely with firms. Examples from Malaysia, Mexico and Korea provide useful guidance in this regard. In order to enable and incentivize VETA/VTA to play such a role, the payroll levy system may need to be modified to reserve a greater share for enterprise training and to involve enterprises in needs assessments and design of programs that meet their needs.

Improve in-house training and complement it with external training

In-house training is singularly ineffective in Tanzanian firms. The finding that such training has no impact on productivity may reflect measurement errors (for example, firms may classify simple orientation programs as training) or the poor quality of in-service training that results from the lack of appropriate training needs assessment, limited expertise of training staff, and poor training materials. Firms without in-house staff trainers may also have little recourse to, or financial resources for, outside training providers with the requisite expertise to run on-premise training programs tailored to the specific skill needs of enterprises. Those that do avail themselves of external providers for in-house training turn to consultants and industry associations. The training role of industry associations could be expanded, possibly in partnership with VETA/VTA, to help organize and deliver both in-house and external training programs for industry members.

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ANNEX TABLES

Table A.1 Determinants of Educational Skills Demand								
	% Primary & Lower Secondary		% Upper Secondary		% Tertiary		% TVET	
Explanatory Variables	Coef.		Coef.		Coef.		Coef.	
Size, Sector, Region								
Small	-0.187		1.025		-0.850		0.016	
Large	-3.671		1.456		2.207		2.273	
Food	-4.372		-1.224		5.596		-10.300	*
Textile & Garments	6.404		-6.840	*	0.438		9.001	
Fabricated Metals	-0.695		-5.675		6.389		10.486	*
IT industry	-23.069	**	-1.289		24.360	**	2.595	
Hotels & Restaurants	-9.415	*	-1.754		11.169	**	-1.321	
Construction	-21.701	**	-2.342		24.045	**	17.539	**
Transportation	-21.232	**	3.307		17.925	**	3.080	
Arusha	-1.187		-0.089		1.275		-11.298	*
Mbeya	-3.607		5.819	*	-2.215		6.260	
Mwanza	-3.574		0.127		3.444		18.118	**
Zanzibar	-3.545		0.699		2.843		-2.759	
Firm Attributes								
Top Manager Education	-6.435	**	2.416	*	4.017	**	4.878	*
Foreign Owner	-2.941		-2.133		5.068		4.256	
Female Owner	-0.629		1.200		-0.573		1.821	
Multi-Unit Firm	-10.006	**	2.852		7.163	**	2.696	
Young Firm	-0.404		-0.404		0.807		2.333	
Demand Drivers								
Exporter	-5.574		-1.215		6.782	*	-0.486	
Innovator	-8.581	**	4.578	**	3.997		1.070	
Constant	99.083	**	8.756	*	-7.822		-1.086	
Sample Size	388		388		388		326	
R-squared	0.3290		0.0968		0.3182		0.2559	
Note: * and ** denote statistical significance at the 5% and 1% levels								

Table A.2 Determinants of Occupational Skills Demand						
	Other Unspecified Occupations		Clerical, Sales and Plant Operators		Managers, Professionals and Technicians	
Explanatory Variables	Coef.		Coef.		Coef.	
Size, Sector, Region						
Small	-10.200	**	2.025		8.399	*
Large	4.505		4.914		-9.327	*
Food	11.723	*	4.914		-16.578	**
Textile & Garments	11.234	*	-11.362	*	-0.056	
Fabricated Metals	9.089	*	-7.807		-2.388	
IT industry	1.129		-9.948		8.697	
Hotels & Restaurants	8.121	*	13.406	**	-21.481	**
Construction	8.976		-12.463	*	3.487	
Transportation	7.403		7.068		-14.506	**
Arusha	3.974		-9.972	*	6.087	
Mbeya	5.708		-0.951		-4.434	
Mwanza	-5.460		16.588	**	-10.779	*
Zanzibar	8.012	*	-12.423	**	4.596	
Firm Attributes						
Top Manager Education	-1.184		0.387		0.811	
Foreign Owner	-2.895		-4.756		7.784	
Female Owner	0.822		-5.139		4.453	
Multi-Unit Firm	-6.986	*	2.909		4.475	
Young Firm	2.571		-1.698		-0.719	
Demand Drivers						
Exporter	-3.284		9.795	*	-6.278	
Innovator	-2.632		4.594		-1.539	
Constant	21.314	**	43.703	**	34.245	*
Sample Size	406		406		408	
R-squared	0.1110		0.1715		0.2171	
Note: * and ** denote statistical significance at the 5% and 1% levels						

Table A.3 Education Obstacle and Assessments of Soft and Hard Skills												
Explanatory Variables	Education a Big Obstacle		Negative Assessment of Soft and Hard Skills									
			English		IT Skills		Communications		Writing Skills		Technical Skills	
Firm Attributes												
Univ. Manager	0.249	**	-0.263	**	-0.284	**	-0.111		-0.206		-0.188	
Foreign Owner	-0.602		-1.314	*	-0.651		1.057		-1.619		-1.270	
Female Owner	-0.289		-0.370		-0.816	**	0.399		0.139		-0.230	
Multi-Unit Firm	0.156		-0.930	**	-0.980	**	-0.837		0.022		-0.199	
Young Firm	0.062		-0.404		-0.279		-0.302		0.209		-0.287	
Demand Drivers												
Exporter	-0.432		0.034		0.334		1.416	*	1.007	*	-0.658	
Innovator	0.137		0.482	*	0.715	**	0.567		-0.500		-0.138	
Constant	-0.950	*	0.958	*	0.403		-4.579	**	-1.993	**	-1.185	*
Size, Sector, Region	Yes		Yes		Yes		Yes		Yes		Yes	
Sample Size	424		424		424		337		337		378	
Pseudo R-square	0.1489		0.293		0.3247		0.176		0.1002		0.1514	
Note: Assessments of critical thinking, problem solving and work ethic analyzed but not reported here.												

Table A.4 Assessments of Workforce Skills as Operational Constraints												
Explanatory Variables	Any Skill Problems		Maintaining Production		Quality Control		Use Technology		Innovating		Sales/Marketing	
	Coef.		Coef.		Coef.		Coef.		Coef.		Coef.	
Education & Skills												
% Upper Secondary	-0.007		-0.006		-0.006		0.000		-0.007		-0.016	*
% Tertiary	-0.008		-0.008	*	-0.020	**	-0.018	*	-0.006		-0.017	*
% MPT	0.008		0.001		0.000		0.007		0.001		-0.004	
Firm Attributes												
University Manager	0.125		0.128	*	0.160		0.098		0.132		0.247	*
Foreign Owner	-0.280		0.063		0.215		0.438		-0.478		0.362	
Female Owner	0.460		0.223		0.439		0.366		0.422		0.688	*
Multi-Unit Firm	1.018	**	0.516	**	0.622	*	0.899	**	0.940	*	0.572	*
Young Firm	-0.100		-0.089		-0.226		0.136		-0.402		0.003	
Demand Drivers												
Exporter	-0.401		-0.385		-0.926	*	-0.162		-0.585		-0.151	
Innovator	0.570	*	0.616	**	0.315		1.353	**	1.346	**	0.965	**
Constant	-0.661		0.832	*	-0.990		-3.031	**	-2.201	**	-2.280	**
Size, Sector, Region	Yes		Yes		Yes		Yes		Yes		Yes	
Sample Size	424		424		376		374		424		424	
R-square	0.1885		0.2134		0.1515		0.1958		0.1942		0.1704	

Table A.5 Strategies to Address Skill Deficits - In-service Training and Hiring New Workers										
	In-Service Training						**Hiring New Workers**			
Explanatory Variables	Any Training		In-House Training		External Training		Any Hiring		# New Hires	
	Coef.		Coef.		Coef.		Coef.		Coef.	
Education & Skills										
% Upper Secondary	-0.010		-0.011		0.009		-0.003		0.024	
% Tertiary	0.002		0.003		0.003		0.011	*	0.030	
% MPT	0.005		0.003		0.007		-0.001		0.006	
Firm Attributes										
University Manager	0.191	*	0.380	**	0.180		0.040		-0.784	*
Foreign Owner	0.707		0.262		1.057	*	1.162	**	2.302	
Female Owner	0.605	*	0.681	**	0.301		0.447		1.067	
Multi-Unit Firm	-0.466		-0.476		-0.090		0.264		-0.175	
Young Firm	-0.135		-0.239		-0.226		-0.555		-1.498	
Demand Drivers										
Exporter	0.607		0.668		-0.195		0.828	*	5.276	**
Innovator	0.657	**	0.693	**	-0.041		-0.261		1.436	
Constant	-1.755	**	-2.592	**	-4.975	**	-2.133	**	1.999	
Size, Sector, Region	Yes		Yes		Yes		Yes		Yes	
Sample Size	424		424		424		424		424	
R-square	0.126		0.1525		0.1791		0.2049		0.1986	

Table A.6 Strategies to Address Skill Deficits - Using Expatriate MPT and Outsourcing Professional Services												
	Use Expatriate MPT				Outsource Professional Services							
Explanatory Variables	Use Expatriates		% Expatriates		Outsource		Engineering		Architectural		IT Services	
	Coef.		Coef.		Coef.		Coef.		Coef.		Coef.	
Education & Skills												
% Upper Secondary	-0.003		-0.039		-0.011		-0.013		-0.006		0.007	
% Tertiary	-0.008		0.007		0.014	**	0.005		-0.006		0.020	**
% MPT	0.003		-0.032		0.005		0.009		0.006		0.024	**
Firm Attributes												
University Manager	0.043		0.557		0.229	*	0.222		0.344	*	0.392	*
Foreign Owner	2.152	**	13.765	**	-0.285		-0.465		-0.364		-0.236	
Female Owner	1.003	**	5.284	**	-0.416		0.291		0.073		-0.453	
Multi-Unit Firm	-0.161		-4.209	*	-0.292		-0.063		-0.108		0.055	
Young Firm	0.160		2.098		-1.174	**	-0.839	*	-1.378	**	-1.524	**
Demand Drivers												
Exporter	0.428		6.239	*	0.556		0.928	*	0.578		1.590	**
Innovator	0.383		0.411		0.450		0.657	*	0.399		0.344	
Constant	-2.835	**	4.240		-3.599	**	-4.451	**	-5.271	**	-6.412	**
Size, Sector, Region	Yes		Yes		Yes		Yes		Yes		Yes	
Sample Size	373		424		424		424		424		424	
R-square	0.4048		0.1883		0.2187		0.2135		0.1902		0.2803	

Table A.7 In-House and External Training – Incidence and Major Sources of Training													
	% In-house Training	Main Provider of in-house training						% External Training	Main Provider of External Training				
Firm Size		Firm Staff	Public TVET	Private TVET	Industry Assoc.	Other			University	Public TVET	Private TVET	Industry Assoc.	Other
Small (5-19)	16.9	31.1	20.0	26.7	4.4	17.8		7.1	0.0	21.1	21.1	26.3	31.6
Medium (20-99)	28.8	25.0	15.6	18.8	31.3	9.4		14.4	6.3	43.8	12.5	25.0	12.5
Large (100+)	47.8	50.0	18.2	22.7	4.6	4.6		28.3	0.0	30.8	7.7	15.4	46.2
Sector													
Food	22.0	18.2	27.3	36.4	18.2	0.0		22.0	0.0	45.5	18.2	27.3	9.1
Textile/Garments	26.1	33.3	0.0	8.3	50.0	8.3		4.3	0.0	0.0	0.0	100.0	0.0
Fabricated Metals	24.6	50.0	7.1	14.3	14.3	14.3		10.5	16.7	16.7	33.3	16.7	16.7
Furniture	20.6	46.2	23.1	0.0	15.4	15.4		1.6	0.0	0.0	100.0	0.0	0.0
IT	26.2	18.2	27.3	45.5	9.1	0.0		16.7	0.0	28.6	14.3	28.6	28.6
Hotel/Restaurants	23.7	50.0	16.7	22.2	0.0	11.1		7.9	0.0	50.0	0.0	50.0	0.0
Construction	10.0	0.0	25.0	75.0	0.0	0.0		15.0	0.0	33.3	16.7	0.0	50.0
Transportation	32.0	18.8	25.0	25.0	0.0	31.3		18.0	0.0	22.2	0.0	0.0	77.8
Region													
Arusha	22.9	54.6	27.3	18.2	0.0	0.0		12.5	0.0	100.0	0.0	0.0	0.0
Dar Es Salaam	23.2	40.4	9.6	23.1	11.5	15.4		10.7	4.2	12.5	8.3	29.2	45.8
Mbeya	17.6	22.2	55.6	22.2	0.0	0.0		5.9	0.0	66.7	33.3	0.0	0.0
Mwanza	16.0	0.0	25.0	25.0	0.0	50.0		6.0	0.0	0.0	66.7	33.3	0.0
Zanzibar	37.3	21.1	15.8	26.3	36.8	0.0		23.5	0.0	33.3	16.7	25.0	25.0
All firms	23.3	33.3	18.2	23.2	13.1	12.1		11.3	2.1	31.3	14.6	22.9	29.2
Source: Author's calculations from employer responses in 2015 TESS.													

Technical Annex

The Skills Demand Model

This technical annex outlines the economic model that we use to derive a system of reduced form equations to investigate workforce choices that firms make in response to demand from producing in international markets and innovation. These include equations on the optimal skills mix of the workforce, skill shortfalls relative to desired skills mix as perceived by employers, strategies that they employ to address these skill deficits, and the productivity consequences of their skill choices and skill-deficit mitigating strategies.

Consider the following simple model of a firm making choices about the skill composition of its workforce. It faces the following production function relating output (or sales) to technology, broadly defined, and numbers of workers with different levels of educational attainment or skill qualifications:

$$Y_j = F(Zj \ , \ L_{1j} \dots L_{bj}) \qquad (1)$$

where Y_j is output in firm j, Z represents the technology of the firm, and L_{bj} the number of workers of different types b. In this model, technology Z can vary significantly across firms even in the same sector because of differences in physical and intangible capital such as IT use, modern management practices, accumulated knowledge, and other technical competencies.

Skill share equations. Given this production function and treating Z as quasi-fixed in the short-term, cost minimization for a given level of output yields (by Shepherd's lemma) the following skills demand equations for different worker types:

$$S_{bj} = G(Z_j, \ Y_j, \ w_1 \dots w_b) \qquad (2)$$

where S_b is the share (or cost share depending upon function G) of each worker type b, Y_j is output, and w_b represents the relative shadow price of each worker type. Given the paucity of reliable wage data on the different skill groups, we use a closely related specification in which skills demand is expressed in terms of skill shares of the total workforce.[39]

In the empirical specification of this equation, we include several sets of control variables and indicator variables for export and innovation status to test the hypothesis that such firms are more likely to demand a high-skill mix than other firms:

[39] Implementing the skill share of total payroll specification of the skills demand model requires detailed wage data for each skill dimension in the firm, as well as the prevailing wage rates of different skills groups in the open labor market. The TESS did not elicit data on mean wages of the workforce by level of education; while it asked for mean wages by occupation, these data were incomplete and were not deemed reliable. The challenging data needs have prompted other researchers to rely instead on empirical specifications using the skill shares of total labor (for example, see Almeida, 2010).

$$S_{bj} = \alpha_1 + \alpha_{2b} IND_j + \alpha_{3b} X_j + \alpha_{4b} HSD_j + \mu_{jb} \quad (3)$$

where IND is a vector of control variables for sector, region and firm size, D is a vector of controls for firm-specific productivity attributes (managers' education, foreign and female ownership, and multi-establishment firms), HSD are indicator variables to reflect high-skills demand from exporting and innovation, and μ is an error term.[40] The analyses might distinguish skill shares by level of educational attainment, TVET qualification or, alternatively, by broad occupational skill categories. The α_{4b} coefficients of these share equations provide insights into how export orientation and innovation might affect demand for these different types of skills.

Skill deficit equations. At any point in time, firms' actual skills mix may diverge from their desired (or optimal) skills. It may take time for actual skill mix to reach desired levels because employers have limited flexibility to replace incumbent workers with new hires who have the requisite skills.[41] In the Tanzanian context, this may take a considerable amount of time given the limited local supply of highly educated and trained workers (see Section II) and demand shocks that increase the demand for workers, especially those with higher-level skills.

Denoting the firm's desired skills mix as S_{bj}^*, the divergence between actual and desired skill mix may be represented as follows:

$$\Delta S_{bj} = \gamma_{bj} (S_{bj}^* - S_{bj}) \quad (4)$$

where ΔS_b denotes the skills gap of type b workers, and γ_b indexes the extent of this divergence for each skill type b. The desired skills mix S_{bj}^* is not known, but we have detailed qualitative information on employers' assessments of whether the education and skills of their workforce are adequate relative to their needs and whether skill shortages pose obstacles to different dimensions of the firms' operations. We thus proxy ΔS_{bj} by ΔS_{cj} where c represents rankings of the adequacy of education and training or the severity of operational constraints posed by skill deficiencies. These skill deficit equations may be specified as follows:

$$\Delta S_{cj} = \alpha_1 + \alpha_{2c} S_{bj} + \alpha_{3c} IND_j + \alpha_{4c} X_j + \alpha_{5c} HSD_j + \in_{jb} \quad (5)$$

which include measures of current skills mix S_{bj} as well as the control variables IND and X from the skill share equation (3). Controlling for the effects of these other variables, the α_{5c} coefficients test the proposition that skill deficits, at least as perceived by employers, are more likely among high-skill demanding firms that export and/or innovate.

[40] This follows Syverson (2011) who identified two sets of demand drivers used by researchers in the productivity literature, one from firm-specific productivity attributes and another from competitive pressures affecting numerous firms, such as trade and technological change.

[41] Abowd et al. (2007) exploit the availability of matched employer-employee panel data to study the responses of employers to gaps between desired and actual skills mix, using a partial adjustment model.

Skill strategy equations. Employers may respond to identified skill deficits in different ways. The survey asked about strategies employers may be using to improve workforce skills, including (1) company-sponsored in-service training whether from in-house or external sources, (2) hiring of new workers to fill specific gaps, (3) use of high-skill expatriates, and (4) outsourcing of professional services. The firm's choice of strategies d, where d = 1 to 4, may be estimated using probabilistic (logit) models and the same specification as for skill deficits:

$$STRAT_{dj} = \alpha_1 + \alpha_{2d} S_{bj} + \alpha_{3d} IND_j + \alpha_{4d} X_j + \alpha_{5d} HSD_j + \emptyset_{jb} \qquad (6)$$

where STRAT denotes (1,0) indicator variables for whether a firm choses to use skill-deficit mitigating strategy d. As before, controlling for the effects of S_{bj}, IND_j and X_j, the estimated α_{5d} coefficients test the hypothesis that high-skill demanding firms that export and/or innovate are more likely to employ strategies to mitigate skill-deficits than low-skill firms that do not face the same skill deficiencies or operational constraints.

Firm performance equations. The impacts on firm performance of skill mix, skill deficits, and strategies to mitigate them may be analyzed within a production function framework such as that of equation (1). A simple (intensive-form) specification of this production function relates sales per worker to capital per worker and the labor shares of different skill groups:

$$Y_j/L_j = F(Z_j,\ K_j/L_j,\ S_{1j} \ldots S_{bj}) \qquad (7)$$

where Y_j is sales, Z_j the level of technology, K_j and L_j are inputs of fixed capital and labor (total number of full-time permanent workers), and S_{bj} are the shares of different worker skill types b.

In the empirical analysis, a logarithmic form of this production function is used, with controls for S_{bj} and IND_j (sector only) in the base model specification. We experiment with augmented specifications of this base model, including firm-specific attributes X and high-skills demand indicators HSD in some specifications, and a set of skill-deficit mitigating strategies $STRAT_{dj}$ in others. The fully augmented specification of the firm performance equation is shown below:

$$\ln(Y_j/L_j) = \alpha_1 + \alpha_2 \ln(K_j/L_j) + \alpha_{3b} S_{bj} + \alpha_4 IND_j + \alpha_5 X_j + \alpha_6 HSD_j + \alpha_{7d} STRAT_{dj} + \varepsilon_j \qquad (8)$$

The coefficients α_2 and α_{3b} of $\ln(K_j/L_j)$ and S_{bj} have the conventional interpretation as the returns to employer investments in capital and different worker skills b, controlling for sector-level differences in labor productivity. In augmented specifications of this simple production function, the coefficients α_5 and α_6 of measure the productivity levels of different firm-specific attributes and of high-skill firms that export or innovate. The final set of coefficients, α_{7d}, estimates the

productivity impacts of different $STRAT_{dj}$, and thus provides insights into the effectiveness of alternative skill-deficit mitigating strategies.