

# FORECASTING LABOR AND SKILL DEMAND BY SECTOR AND OCCUPATION

## Annexes

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## ANNEX 1

### CASE STUDIES OF NATIONAL QUANTITATIVE MODELS FOR TANZANIA AND THE NETHERLANDS

#### Case Study 1: National quantitative model – Human capital development needs in Tanzania

##### *Initiator and objective*

Commissioned by the World Bank's Global Practice for Education, a quantitative model to project labor demand was developed, to aid policymakers and planners when developing training requirements and deciding where to focus investment in education and training. The model is designed to generate labor demand projections including for broad economic sectors and occupations. Intended for use by countries across Sub-Sahara Africa, the model has been piloted for Tanzania.<sup>1</sup>

##### *Methodology and data needs*

- The methodology applied is a quantitative modelling approach (in particular, a macroeconomic inter-industry model).
- The macroeconomic inter-industry model that was applied integrates final demand for goods and services by sector to arrive at GDP and sector growth estimates, and subsequently develops projections of demand for labor by sector and occupation using, among others, projections on demographic and employment trends, labor productivity, foreign direct investment, and capital investments.
- The model incorporates data from national macroeconomic accounts and Tanzania's Integrated Labor Force Surveys, and databases from various other sources such as the International Labor Organization (ILO) and various United Nations (UN) agencies.
- Primary data sources used include demographic data up to 2010, Integrated Labor Market Surveys of 1991, 2001, and 2006, demographic data up to 2010, and the Social Accounting Matrix from 2007. Considering that these sources are relatively dated (the 2007 Social Accounting Matrix is based on input and output data originating in 1992), projections that have been developed among others by the UN and ILO have been used to arrive at estimates of key indicator for the base year of the model (2012).

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<sup>1</sup> The description of the model in this annex is based on a preliminary report on its piloting for Tanzania. See: Inforum (2014). *Uhuru: An Economic Model for Understanding Human Capital Development Needs in Tanzania. Methodological Report*. College Park, Maryland, USA

*Data generation and applications:*

- The model produces forecasts on employment including by economic sector and occupation. Findings are presented for a total of 9 broad economic sectors, and 9 classes of occupations.<sup>2 3</sup>
- Box A1.1 provides examples of the findings generated through the applied methodology.

**Box A1.1: Examples of findings – Tanzania quantitative model**

- Between 2015 and 2023, the share of persons engaged in agriculture, hunting, forestry and fishing is projected to decrease from 73 percent to 68 percent of the total working population. Nevertheless, due to population growth, their number is expected to increase by 18 percent (from 18.4 million to 21.7 million).
- Between 2015 and 2020, both the demand for technicians/associated professionals and for plant and machine operators/assemblers is expected to increase by almost 50 percent (from 528,000 to 780,000 persons and from 430,000 to 641,000 persons, respectively)
- Between 2015 and 2023, the demand for workers in the transport, storage and communication sector is expected to increase by around 17 percent (from 356,000 to 418,000 persons), and for workers in the mining and quarrying sector by approximately 15 percent (from 121,000 to 139,000 persons).

- The results of the forecast could for example inform the following education and training related policy decisions and interventions:
  - Since the larger share of the population will continue to be engaged in agriculture etc. in the foreseeable future, interventions to promote their earnings capacity will be crucial to achieve poverty reduction goals. This can include interventions related to specifically targeting rural communities for the improvement of access and quality of basic education, skills development related to agricultural production and entrepreneurship for farming households, and training to promote skills required for upgrading of the agribusiness value chain.
  - Considering the substantial expected increase in demand for technicians and plant operators/assemblers, investments to increase the quantity (and quality) of workers in these occupations are appropriate.
  - Since the increase in demand for workers in the transport and mining sectors is relatively modest, it may be appropriate to invest more strongly in improving the quality rather than the quantity of education and training.

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<sup>2</sup> The economic sectors are: 1) agriculture, hunting, forestry and fishing; 2) mining and quarrying; 3) manufacturing; 4) electricity, gas and water; 5) construction; 6) wholesale and retail trade, restaurants and hotels; 7) transport, storage and communication; 8) finance, insurance, real estate and business services; and 9) government, education, community, and social and personal services.

<sup>3</sup> Occupational categories are: 1) legislators, senior officials, managers; 2) professionals; 3) technicians, associate professionals; 4) clerks; 5) service, shop and market sales workers; 6) skilled agriculture and fishery workers; 7) craft and related trade workers; 8) plant and machine operators/assemblers; and 9) elementary occupations.

*Observations for replication:*

- The time period for which forecasts are produced by the applied model are relatively long (12 years), which implies that the model facilitates the design of systemic interventions that will structurally improve the provision of education and training, even if their positive impact is expected to take several years to materialize.
- This case study illustrates how a quantitative model can be applied in a context with quite strong data constraints related to the absence of up-to-date data and the limited frequency with which key data are collected, as well as additional challenges due to the large share of the labor force which is active in the informal sector. These data constraints have implications for the nature of the forecasts that are generated by the model, the design of the model, and future data collection and processing exercises, as follows:
  - First, to mitigate the negative impact of data constraints on the model's predictive value, results are presented by broad classifications of economic sectors and occupations. For example, the 57 economic sectors which are identified in primary data have been aggregated in nine broad economic sectors for which results are presented, under the assumption that projection errors for specific economic sectors are to a certain extent 'averaged out' by aggregating them. This implies that the policy directions that can be derived from the forecasts are also relatively broad. Policy implications derived from the projections could for example relate to interventions targeting the broad 'manufacturing' sector, rather than those sectors which are included in this definition such as the production of leather ware or electronic equipment.
  - Second, as long as data constraints limit the predictive value of the forecasts, the level of sophistication of the model's design can be relatively modest, which may reduce the transaction costs of both designing and regularly applying the model to available data. To use a metaphor, when a cook's ingredients are relatively basic, she can still prepare a tasty meal but there is little value to spending too much time in the kitchen attempting to prepare a six course dinner. Thus, whereas it needs to be ensured that the model's design is not so simple that it decreases the value of the forecasts, there is no need to apply a model that is overly sophisticated in comparison to the data that it will use.
  - Third, the process of applying the model generates useful input for improvement of future data collection and processing exercises. Recommendations in the case of Tanzania, for example, include the initiation of a process to collect input and output data (to replace the current estimates which are based on 1992 data); the more regular execution and processing of labor force surveys; the inclusion of the entire economy in published data (published macroeconomic accounts currently exclude information on Zanzibar); and making available relevant data in a format that allows there easy integration in a quantitative model (e.g. providing national accounting data in excel rather than PDF format).

## Case Study 2: National quantitative model –Labor market prognosis in the Netherlands

### *Initiator and objective*

The Netherlands' Employee Insurance Agency, UWV, is an autonomous administrative authority under the Ministry of Social Affairs and Employment, responsible for implementing employee insurances and providing labor market data and services.<sup>4</sup> Each year, the UWV produces its national 'UWV Labor Market Prognosis', a short term forecast of national labor supply, demand, and mismatches for a period of one year.<sup>5</sup> The objective of the prognosis is to facilitate the convergence of labor supply and demand through promoting transparency, which is expected to reduce the number of unemployed (and the payment of unemployment benefits) and increases the pace at which vacancies are filled.

### *Methodology and data needs*

- The methodology applied by UWV is a quantitative modelling approach.
- Expectations on macroeconomic developments that are incorporated in the model are based on projections from the quantitative model of the Netherlands Bureau for Economic Policy Analysis (CPB), which incorporates extensive data from a variety of sources.<sup>6</sup>
- The UWV model incorporates labor related data from the national accounts, which are compiled by the Netherlands Bureau for Statistics (CBS) based on a variety of databases capturing information on employees and the self-employed.<sup>7</sup> The UWV model also includes data from labor force surveys and vacancy surveys which are carried out by the CBS at regular intervals, and from its own databases on unemployment benefit recipients.<sup>8</sup>
- Forecasts of sectoral labor demand are based on projections of changes in sectoral output and labor productivity, and informed by expert consultations which allow among others the incorporation of the projected impact of forthcoming government reforms and interventions.
- The accuracy of forecasts is regularly reviewed and lessons learned are incorporated in subsequent forecasting exercises.

### *Data use and applications:*

- The model produces forecasts on employment including by sector, subsector and region, as well as on vacancies and unemployment benefits. Box A1.1 provides examples of the type of findings generated through the applied methodology.
- The model's projections are for a one-year period only, and aim to guide policy makers and other stakeholders on the short term impacts of labor trends. Among others, the model's findings aim to guide the targeting of employment services, including information-provision to job-seekers and the

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<sup>4</sup> UWV: Uitkeringsinstantie Werknemersverzekeringen

<sup>5</sup> See for example UWV (2014). *UWV Arbeidsmarktprognose 2014-2015*. (In Dutch)

<sup>6</sup> CPB: Centraal Plan Bureau

<sup>7</sup> CBS: Centraal Bureau voor de Statistiek

<sup>8</sup> Depending on the indicators, labor force survey data are available on a monthly, quarterly or annual basis. Vacancy surveys are carried out semi-annually.

provision of short-term training courses, as well as to inform the amount of funding that is expected to be spent on unemployment benefits.

**Box A1.1: Examples of findings – Netherlands Employee Insurance Agency**

- Despite positive economic growth, overall employment is expected to fall by 0.7 percent in 2014, due to increasing labor productivity (by 1.2 percent), cautious recruitment attitudes, and the negative impact of pending government reforms on public employment.
- Whereas some urban and semi-urban areas are expected to see an increase in employment, demand for labor is expected to fall in all regions which are located at a distance from urban economic activity.
- Positive sectoral employment growth in 2014 is expected to occur among others in education, wholesale (driven by exports and domestic investments), and hotels/restaurants (all 0.2 percent). Decreases in sectoral employment are expected among others in financial services (3.3 percent) and construction (2.0 percent).
- Projected decreases in employment in the health and care sector of 1.6 percent in 2014 are expected to be driven by decreases in the sub-sectors home-care (5.8 percent) and child care (3.0 percent), as these sub-sectors are expected to be particularly affected by ongoing and pending policy reforms.
- The nine priority sectors as identified by the Netherlands government are expected to grow in 2014 in terms of value added and exports, but employment growth in these sectors is expected to be below the national average.

*Observations for replication:*

- The approach applied for the UWV forecasts benefits from the existence of a sophisticated third party quantitative model which supplies the basic macroeconomic projections and the availability of extensive, detailed and consistently collected data. While options for replication may be constrained in environments which do not have access to a comprehensive third party macroeconomic model or where data availability is limited, a similar approach may nevertheless be applied to the extent that available resources allow.
- While quantitative models form the basis of the methodology, the UWV's model incorporates expert views that allow the model to take into account expected deviations from trends due to, for example, government interventions. These adjustments, which should be well documented and transparent to strengthen stakeholders' confidence in the forecasts, can be particularly appropriate in volatile environments where system shocks can reasonably be expected to have a significant impact on forecasted indicators.
- In addition to *generating* forecasts using an appropriate methodology, the way that forecasting results are *presented* also plays an important role in determining the usability of the findings. The UWV report, for example, includes regular descriptions of definitions and the applied forecasting approaches to clarify the nature of the forecasts. It also incorporates data on areas that are of particular interest to its stakeholders, for example on the forecasts related to the economic sectors which have been identified by the government as 'priority sectors'.
- It is recognized that while even with the use of extensive models and data and taking into account expert consultations the projections do not generate fully accurate forecasts, they nevertheless are able to provide useful insights and guidance to key stakeholders.

## ANNEX 2

### CASE STUDIES OF SECTORAL LABOR AND SKILL DEMAND FORECASTS

#### **Sector Case Study 1: Quantitative modelling – The Technical Sectors in the Netherlands**

##### *Initiator and objective*

Commissioned by the Dutch collaborative of employer and employee associations for the Netherlands' Technical Sectors ("Techniek Talent.Nu"), a forecast of labor demand in these sectors in the Netherlands was produced in 2013.<sup>9</sup> The Technical Sector is defined as the collection of economic sectors in which a large share of jobs is of a technical nature.<sup>10</sup> The purpose of the report is to project recruitment needs for the period 2013-2018, including for each of the economic clusters that are considered part of the Technical Sectors, and disaggregated by the required education level of workers in the sector and by the technical/non-technical nature of jobs.

##### *Methodology:*

- Based on historic secondary data as well as prognoses from an existing quantitative macro-economic forecasting model, the analysis incorporates trends of relevant indicators to forecast net recruitment needs within the Technical Sector. Among others, the analysis takes into account trends in sector output, labor productivity, and employment.
- New recruitment needs are calculated taking into account both the expected increased labor demand in the sectors and the need to replace workers who leave the Technical Sectors either because they move to another sector or become inactive.
- Labor demand forecasts are disaggregated by economic cluster within the Technical Sectors, by education level, and taking into account whether the job is classified as a 'Technical' or a 'Non-Technical' position.<sup>11</sup>

##### *Data use and generation:*

- The analysis relies on extensive secondary data bases from the Netherlands Bureau of Statistics (CBS), originating mostly from national accounts and labor force surveys. Data includes historic data on economic and employment trends, including on GDP; export volume; R&D expenditures; firm size; size, job profiles; employment pattern, and educational attainment of the labor force and labor market entrants (graduates); labor productivity; and vacancies.
- In addition to historic data, the analysis relies on demographic prognosis from the CBS, as well as overall economic forecasts originating from the quantitative model as developed by the government's economic research institute (CPB), a semi-autonomous agency under the Ministry of Education.

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<sup>9</sup> SEO Economisch Onderzoek (2013).

<sup>10</sup> The Technical Sector is considered to include the following clusters: Automotive and Transport, Chemicals, Construction, Electro and Machinery, Food, Metal, Other Manufacturing, and Technical Services, and Utilities.

<sup>11</sup> This is in recognition that employment in the Technical Sectors includes both technical and non-technical jobs.

- Prognoses from third parties are reviewed to assess whether the forecasts derived from the applied methodology match those generated by other parties using different methodologies.<sup>12</sup>
- Box A2.1 provides examples of the type of findings generated through the applied methodology.

**Box A2.1: Examples of findings – Forecasting demand for the Netherlands Technical Sectors**

- *Total employment* in the Technical Sector is expected to fall by 0.9 percent per year between 2015 and 2018. Forecasts vary per cluster within the Technical Sector. For example, employment in Technical Services is expected to increase 1.2 percent per year from 2015-2018, while employment in Construction is expected to fall by 1.7 percent annually in the same period.
- Although overall employment is expected to fall, the analysis forecasts a *net recruitment need* of 1.5 percent of total employment in the sector, due to the flow of labor out of the Technical Sector, among others due to retirement.
- There are pronounced differences in net recruitment demand forecasts *by education level and the (non-)technical nature of jobs*. For example, between 2013-2018, net recruitment demand for low-skilled (technical and non-technical positions) is expected to be negative between (i.e. there is a surplus of 11,000 of these workers), while net recruitment needs for medium/higher educated staff are expected to amount to 65,000 and 53,000 for technical and non-technical positions, respectively.

**Observations for replication**

A positive element of the methodology applied for the Technical Sectors in the Netherlands are its detailed, quantitative findings. Replication of the methodology requires first of all the availability of appropriate data as well as the presence of a macroeconomic quantitative model that can be used as a basis for sector forecasts. When considering replicating the methodology described in this case study, it is advised to let the level of sophistication and detail of the approach be guided by the extent to which reliable data is available. It is worthwhile noting that related to data, it is not just enough that sufficiently detailed data has been collected for a long enough period, but also that the data needs to have been clearly and consistently defined, and that collection and processing of the data has been carried out appropriately and consistently over time.

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<sup>12</sup> Prognoses used for this purpose include those of the European Centre for the Development of Vocational Training (CEDEFOP), and the Maastricht University Research Centre for Education and Labor Market (ROA).

## Sector Case Study 2: Employer Survey – the Mining Sector in Chile

### *Initiator and objective*

At the initiative of the Mining Skills Council (CCM, *Consejo de Competencias Mineras*) of the Chilean Mining Council (Consejo Minero), a study was produced to assess the gaps in human capital that the major copper, gold, and silver mining companies in Chile will face in the period 2012-2020 as a result of expected future investments in the sector.<sup>13</sup> The study served as the basis for a sector-wide approach to ensure appropriate skills supply for the sector, which includes among others public-private initiatives to strengthen training, qualification and certification frameworks.

### *Methodology*

- For the purpose of the study, detailed work-force data were collected from eleven large-scale mining companies and twenty contractor companies. The study included the main value chain processes of extraction, processing and maintenance activities. The analysis focused on ‘mining operating personnel’, i.e. it excluded engineering and construction.
- The study forecasts labor and skill demand based on (1) expected retirement of the existing work-force, based on the age profile of the work-force; and (2) expected expansion due to forthcoming new large scale infrastructure projects (23 such projects were identified to commence in the period 2012-2020).
- Data from the participating firms was then extrapolated to obtain a sector-wide analysis.
- To assess potential labor and skill shortages, the study also includes forecasts of labor and skill supply (which is not further discussed in this report).

### *Data use and generation:*

- Data collected on the current work-force included the number of workers, their occupational profile<sup>14</sup> and educational attainment, their age, and location. Surveyed firms were also requested to self-report on new large scale investment projects with a certain or high probability to start implementation by 2020.
- Box A2.2 provides examples of the type of findings generated through the applied methodology.

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<sup>13</sup> Consejo de Competencias Mineras (CCM) (2012).

<sup>14</sup> Fifteen occupational profiles were distinguished including, among others, geologist, mine extraction professional, maintenance professional, maintenance supervisor, and processing supervisor.

**Box A2.2: Examples of findings – Forecasting demand for the Chilean Mining Sector**

- The net recruitment needs of qualified human capital between 2012 and 2020 are forecasted to be 37,638 workers. This amounts to approximately one quarter of the current work-force operating within the main value chain. One third of this number is expected to be needed to replace retiring workers; two thirds are expected to be needed to work on new projects.
- Of the total identified recruitment needs, 39 percent are expected to be needed by mining firms, and 61 percent by their suppliers.
- Almost two thirds of total recruitment demand is expected to be for the occupational profiles of mechanical maintenance (15,434) and mobile equipment operators (8,589).

*Observations for replication*

- Employer surveys can be executed with fairly limited resources and in a short period of time, particularly in a sector where a relatively small number of firms are responsible for a large share of production,
- The well-focused scope of the analysis (mining operating personnel in the large scale mining sector) allows relatively detailed findings which form a sound basis for guiding concrete policy interventions.
- When surveys of a share of firms within a sector are used to derive sector-wide conclusions, it is important to ensure that the sample of surveyed firms can be considered representative for the sector.
- The ability of firms to accurately forecast labor demand, particularly on the medium and long term, may be questionable. In addition, depending on the objective of the survey and the nature of the questions, surveyed firms may have an incentive to exaggerate future labor and skill demand, for example if survey results are used to guide public investments in education. (For example, the report described in this section includes investment projects of which it was uncertain whether they would actually materialize to forecast labor and skill demand.)

## Sector Case Study 3: Employer Survey – Manufacturing in the USA

### *Initiator and objective*

The USA Manufacturing Institute and professional services firm Deloitte sponsored a ‘Skills Gap Study’. The study aims to assess developments in skills gaps in the USA manufacturing sector, taking into account economic trends and competitive challenges, and with the objective to serve as input for future discussions related to, among others, training and education, talent management, and community collaboration.<sup>15</sup>

### *Methodology*

- The findings of the report were generated through an online survey. According to the report, the survey polled a nationally representative sample of 1,123 executives across fifty U.S. states. Respondents included representatives of firm active in ten different industries of varying company size (as measured by annual revenue).<sup>16</sup>
- As opposed to the Chilean mining example described above, the USA Manufacturing report does not aim to produce a quantitative forecast of labor and skill demand. Instead, it aims to generate a more qualitative picture of current and projected skills gaps across the manufacturing sector, by reviewing in which production and workforce segments labor and skill gaps are considered or expected to be most constraining.

### *Data use and generation:*

- Related to current perceived workforce shortages and skill deficiencies the survey explores, among others, which *operational areas* are most negatively affected, which *employee segments* pose the most serious constraints, and which are the most important *types of skill deficiencies*.<sup>17</sup>
- For each identified workforce segment, the survey also reviews both current and anticipated shortages in labor supply.
- Looking forward, employers were also asked for which workforce segment they expected the greatest hiring challenges in the coming 3-5 years, including particularly due to retirement related replacement needs.
- Box A2.3 provides examples of the type of findings generated through the applied methodology.

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<sup>15</sup> Deloitte and Manufacturing Institute (2011).

<sup>16</sup> Industries included aerospace/defense; automotive; consumer products; energy/resources; industrial products; life sciences/medical devices; process; retail; technology, media/telecommunications; and transportation.

<sup>17</sup> *Operational areas* include, for example, maintaining production levels; achieving productivity targets; implementing new technology; and supply chain planning and management. *Employee segments* include, among others, unskilled or skilled production; production support; scientists and design engineers; and management and administration. *Types of skills* identified include problem solving skills; technical training; basic employability skills; technology/computer skills; mathematics skills; and reading/writing/communication skills.

**Box A2.3: Examples of findings – Forecasting demand for the USA Manufacturing Sector**

- 56 percent of surveyed firms expect that overall labor and skills shortages will increase in the coming 3-5 years. Only seven percent of firms expect decreased shortages. (The remaining firms responded 'no change' (26 percent) or 'don't know' (11 percent).)
- Increased labor and skills shortages are especially expected for skilled production workers (69 percent of firms) and engineering technologists (45 percent of firms)
- A large majority of firms (80 percent) expects that in the coming 3-5 years the recruitment of skilled production workers will be the greatest challenge. Substantially fewer firms expect particularly strong challenges in the recruitment of management and administration staff (20 percent of firms), unskilled production workers (17% of firms), and customer service staff (7 percent)
- Problem solving skills and technical training are most often considered the key skill deficiencies in current employees (by 52 percent and 43 percent of employers, respectively). Fewer firms consider mathematics or communication skills as the main constraints (20 percent and 19 percent of employers, respectively).

*Observations for replication*

- An online survey can substantially reduce the costs of carrying out an employer survey. However, particularly in a context where many (smaller) firms are not connected to the internet or where online contact details are not available for the majority of firms, this is likely to negatively affect the representativeness of the responding sample
- The emphasis of this survey on where labor and skill constraints “hurt most” can provide useful guidance on which segments of the workforce to focus supply interventions on. However, the lack of quantitative employment data and forecasts will make it hard to distill concrete and well-targeted policy-interventions from the survey.

## Sector Case Study 4: Combined Approach - a Value Chain Approach for Agribusiness in Swaziland

### *Initiator and Objective*

Agriculture and agricultural processing make up a large share of Swaziland's GDP and export volume, and a large share of its population relies on agriculture to generate earnings. Taking into account the potential of workers to move from agriculture to the more productive processing and manufacturing of agriculture products, the World Bank and the Swaziland Ministry of Education and Training collaborated to assess the labor and skill requirements that are required to facilitate this transition.<sup>18</sup>

### *Methodology*

- The study identifies a select number of industries that are considered to have strong agribusiness potential in the country, and subsequently applies a Value Chain Approach (VCA) to assess the labor and skill requirements required to increase productivity in these industries.<sup>19</sup>
- The VCA aims to review all key activities that are required to bring a product from conception to end use in a holistic manner, to facilitate the identification of bottlenecks within the chain which can subsequently be addressed. For agribusiness, the value chain is considered to comprise all activities to bring a product 'from farm to table', and as such includes Research and Development (R&D), inputs, cultivation, packing, processing, and distribution and marketing (Figure A2.1). A characterizing feature of the VCA is that it aims to provide a comprehensive picture of all key challenges and opportunities that affect the development of a sector. As such, even while a key objective of the analysis may be to identify labor and skill gaps, it will generally place the analysis on labor and skills within a broader context of other constraints (e.g. related to access to finance or electricity).
- The study uses (i) available quantitative data to illustrate the growth and employment context of the agribusiness sector; (ii) information gathered through expert consultations to assess labor and skill demand, and other potential constraints, throughout the value chain; and (iii) available literature to describe opportunities and challenges for agribusiness develop, as well as relevant government strategies expected to affect sector growth.
- Expert views were gathered through interviews with representatives of enterprises, industry boards and/or associations which are considered to be industry drivers within each of the selected industries. The interviews focused on identifying the key occupational areas and skills which require upgrading to facilitate increased productivity.<sup>20</sup>

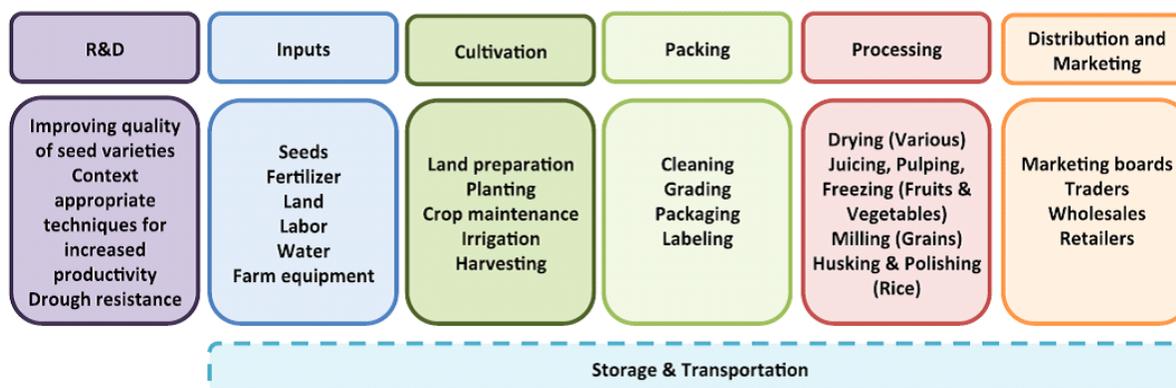
### **Figure A2.1: Generic Agribusiness Value Chain**

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<sup>18</sup> World Bank and Swaziland Ministry of Education and Training (2014)

<sup>19</sup> The selected industries are sugar, horticulture, cotton, timber and livestock.

<sup>20</sup> While not discussed in this report, the paper also reviews the relevant segments of Swaziland's education and training system, and provides options for public-private partnerships to ensure demand-responsive labor supply.



Source: Duke University Centre on Globalization (2014)

*Data use and generation:*

- Quantitative data used to describe the context of the agribusiness sector include general demographic, employment, and economic data, such as GDP and export trends, poverty and unemployment data, and labor force growth projections.
- Interviews with the selected ‘industry drivers’ generated information on the employment and skills pattern of their current workforce and on workforce expansion and skill requirements to expand the industry. Interviewees were also asked to assess the current and required labor and skill pattern, and associated challenges, within the broader value chain.
- The literature review generated information on, among others, Swaziland’s position as a country in ‘agricultural transition’ as compared to international benchmarks; its prospects as an exporting country within the Africa region; key constraints to agricultural and agribusiness growth; the institutional framework within which the sector operates; and ongoing government initiatives to promote growth in the sector.
- Box A2.4 provides examples of the type of findings generated through the applied methodology.

**Box A2.4: Examples of findings – Forecasting demand for the Swaziland Agribusiness Sector**

- Seven occupations of particular importance throughout the agribusiness value chain are identified (business manager, finance/accountant, technical managers, technical supervisor (higher level and lower level), industry technician, and food quality/safety controller). For each of these occupations, a set of key required abilities and knowledge is developed.
- A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of each of the selected industries reveals particular skill-related weaknesses, such as weak knowledge on agricultural practices and new production methods among cotton producers; lacking management capacity within medium-sized horticulture enterprises; and low skills in pasture management and poor breeding practices of livestock producers.

*Observations for replication*

- Especially when sufficiently detailed, reliable quantitative data is scarce, a combined approach relying mostly on qualitative analysis can generate useful information to forecast key labor and skills requirements, with relatively modest resources in a relatively short timeframe (the Swaziland analysis was completed by a two-person team within a time period of three months).
- Compared to an employer survey, interviewing a select number of industry-drivers may be quicker, cheaper, and allows more in-depth discussions. On the other hand, as the sample of interviewees is generally not representative of all sector employers, it may not be justified to draw valid sector-wide conclusions from the discussions.
- The VCA can be a useful approach to identify the key challenges constraining overall sector growth, paving the way for well-targeted interventions that address key bottlenecks within the value chain. While there may be a particular focus on specific constraints (such as those related to labor and skill demand), the VCA generally reviews *all* key constraints and opportunities facing a particular sector, and as such requires a comprehensive approach, carried out by a team that is able to review the sector from a variety of angles (e.g. skills, finance, institutions, infrastructure).
- A VCA can be applied using a variety of methodologies, depending on the specific objectives of the analysis and available data. For example, in a context where detailed and reliable data are more readily available, forecasting through quantitative modelling can comprise a larger part of the analysis than was the case for the Swaziland agribusiness study.

## **Sector Case Study 5: Consultative – Chemicals and Pharmaceuticals in the European Union**

### *Initiator and objectives*

The European Commission (EC) commissioned a series of sector studies with the aim to forecast trends and developments related to innovation, skills, and jobs up to the year 2020 for sixteen economic sectors considered of particular importance for the EU's Member States. The studies were initiated against the background of the Lisbon strategy which focuses on improving EU competitiveness. One of the studies, published in 2009, focused on the Chemicals, Pharmaceuticals, Rubber and Plastic sector.<sup>21</sup>

### *Methodology*

- All sixteen sectors reviewed under the EC initiative apply the same approach, as described in Rodrigues (2007).<sup>22</sup> This comprehensive approach combines the use of secondary quantitative data, extensive literature review, and regular stakeholder consultations. It includes three 'Phases' which can broadly be described as 'context', 'future developments' and 'recommendations'. There are various predetermined steps within each Phase, as summarized in Box A2.6.
- Methodologies and analyses that are included in the report include, among others, a Value Chain Analysis, an Institutional Assessment, a SWOT analysis, the identification of key sectoral Drivers of Change (all in Phase I), the development of future scenarios for the sector, including their implications for jobs, occupational profiles and skills, and innovation (Phase II), and the identification of options and recommendations to address future skills and knowledge needs.
- Expert and stakeholder consultations included presentations and discussions at the start and end of the report development process, multi-sectoral stakeholder meetings to discuss intermediate results, and workshops to specifically guide particular sections of the study. Participating experts included industry employer and employee representatives, government representatives and researchers. In addition, the core team responsible for the development of the study comprised a team of strong industry experts, implying that internal team discussions also generated valuable expert views.

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<sup>21</sup> European Commission, Directorate General Employment, Social Affairs and Equal Opportunities (2009).

<sup>22</sup> Rodrigues, M.J (2007).

**Box A2.6: Phases and Steps of the comprehensive EU sector demand forecasting methodology**

*Phase I: Context – Trends, Developments and State of Play*

- Step 1. Identification of economic activities to be considered (i.e. sector selection)
- Step 2. Main economic and employment trends and structures by sector
- Step 3. Main drivers of change

*Phase II: Future Scenarios and Implications for Jobs, Skills, and Innovation*

- Step 4. Main scenarios
- Step 5. Main implications for employment – changes by job function
- Step 6. Main implications for skills – emerging needs by job function

*Phase III: Options and Recommendations to Address Future Skills and Knowledge Needs*

- Step 7. Main strategic choices to meet future skills and knowledge needs
- Step 8. Main implications for education and training
- Step 9. Main recommendations
- Step 10. Final Workshop.

*Data use and generation:*

- *Secondary quantitative data* used include, among others, overall and detailed sector and sub-sector specific economic data and employment and occupational data from the EU's statistics agency Eurostat, as well as sector-specific data originating from other sources such as the European Chemical Industry Council (CEFIC) and the Consultative Commission on Industrial Change (CCIC). The report includes, among others, analyses of trends in production, capital expenditures, and trade, as well as of labor costs and employment disaggregated by age, gender and job functions and firm size.
- *The literature review* served to inform a sound understanding of the scope and nature of the sector, its main drivers of change, the development of various future scenarios and their implications for labor and skill demand, and the strategic choices facing sector stakeholders in the future.
- *Expert and stakeholder consultations* served to inform the content of the analysis, including for the SWOT, Drivers of Change, and Scenario Development exercises, and to ensure buy-in of key stakeholder in the findings. As with the Observatory Groups described in the UK Construction example described above, stakeholder consultations have the added advantage that they help forge collaboration and dialogue among key stakeholders.
- Box A2.7 provides examples of the type of findings generated through the applied methodology.

**Box A2.7: Examples of findings –the EU Chemicals and Pharmaceuticals Sector**

- Labor related weaknesses and threats facing the sector include the relatively high labor costs for low skilled jobs; and the ageing workforce combined with declining labor supply, particularly of high skilled technical personnel (from Phase I, SWOT analysis).
- Technological changes related to sustainability and innovation are expected to have a substantial impact on the composition of employment and on required new skills, but not on the overall level of employment (from Phase I, Drivers of Change)
- Ten sectoral ‘Job Functions’ are identified (e.g. laborer, engineer, manager), as well as for future scenarios (e.g. ‘Green and Global’, ‘European Retreat’). For each of the scenario, the analysis forecasts both the expected volume changes by job function (e.g. the Green and Global scenario is expected to result in an increase in demand for R&D engineers), and the emerging skills and knowledge needs by job function (e.g. in the European Retreat scenario, IT Professionals will require increased knowledge on system integration, stronger social networking skills, and increased capability to take initiative). (From Phase II, Scenarios and their Implications.)

*Observations for replication:*

- There are strong merits to using a well-defined, pre-determined methodology for a collection of sectors, as it promotes consistency and comparability of findings across studies.
- The applied approach is very extensive, combining a variety of data sources and forecasting methodologies to arrive at forecasts which are both comprehensive and detailed. Particular (qualitative) approaches applied in this study which were not included in the preceding case studies include, for example, the explicit determination of sector drivers of change and the scenario development exercise.<sup>23</sup> Replication of this approach requires substantial data, time, and resources.<sup>24</sup> In case any of these inputs are scarce, it may be decided to limit either the scope or the depth of the various methodologies that are included in the EC approach.

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<sup>23</sup> See Rodrigues (2007) for guidance and templates for these (and other) approaches used in the EC methodology.

<sup>24</sup> The analysis described here was carried out by a consortium of three research firms, and took 16 months to complete.

## Sector Case Study 6: Combined Approach - Construction in the UK

### *Initiator and objectives*

The UK Sector Skills Council for Construction comprises the Construction Industry Training Board (CITB), the Construction Industry Council (CIC), and CITB-Construction Skills Northern Ireland. Its mandate is to collaborate with government, training, providers and employers to ensure that the construction industry has the required skilled workforce. They produced a forecast of output and employment growth in the construction sector for the period of 2014-2018, to serve as input for this collaboration and guide interventions and investments to address future skill needs in the sector.<sup>25</sup>

### *Methodology*

- Forecasts are generated through a quantitative (time-series) model which generates forecasts of construction output and employment requirements - the latter considered to be largely determined by the former.<sup>26</sup> The model is linked to an existing macroeconomic model, and incorporates secondary macroeconomic and sectoral data. The outcomes of expert consultations are systematically used to inform the model's design and assumptions.
- Expert consultations to inform projected output trends and associated labor needs as well as labor flows are organized through a National Group and 12 regional Observatory Groups. The groups meet semi-annually and comprise stakeholders from the industry, government, education, and other Sector Skills Councils. Expert views are sought using the Delphi method, which is a consistent and structured approach to derive forecasts from stakeholder consultations through an iterative process which aims to facilitate reaching consensus – or at least converging views – among them.
- A Technical Reference Group, including economists, academics, other forecasters, data providers, representative of the Office of National Statistics, and government departments, guides improvements in the model's design.
- The forecast includes projections of the Annual Recruitment Requirement (ARR) to produce forecasted output. In addition to employment growth, the ARR takes into account workforce flows due to movements between industries, migration, sickness and retirement. Forecasts are provided for a range of occupational groups, disaggregated by sub-sectors and geographical region.

### *Data use and generation:*

- In addition to information provided through expert consultations, the model incorporates general and sectoral economic and labor force data originating mostly from the Office for National Statistics.
- Box A2.5 provides examples of the type of findings generated through the applied methodology.

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<sup>25</sup> Construction Industry Training Board (2014).

<sup>26</sup> In fact, the model consists of several, linked, parts: one model for each English region, Wales, Scotland, and Northern Ireland, and an additional national model that enables the use of robust national level data and which serves as a framework for the regional models.

**Box A2.5: Examples of findings – Forecasting demand for the UK Construction Sector**

- Employment in the UK construction sector is expected to rise on average by 1.2 percent annually from 2014-2018.
- The ARR over the 2014-2018 period in the UK is expected to include 2,680 painters and decorators, 1,880 plant mechanics / fitters, and 1,170 civil engineers.
- The strongest employment growth is expected in the East of England (2 percent annually), driven among others by strong output growth in industrial construction (8 percent annually). The growth in demand for labor is expected to be particularly strong for scaffolders, construction process managers, and plant mechanics/fitters (between 4.7-4.9 percent per year for each of these

*Observations for replication*

- As opposed to the combined approach for the Swaziland agribusiness described approach, which mainly relies on expert consultations to forecast labor and skills demand, the combined approach for the UK Construction Sector relies on a quantitative model which is partly informed by expert views. The UK approach therefore implies stronger demands on both the availability of reliable data and on the design of the quantitative model.
- Expert opinions can usefully be applied to improve the predictive value of quantitative models, especially in relatively volatile contexts and in case available quantitative models are relatively simple and are not necessarily able to capture important developments related to for example substantial changes in investment levels or in labor productivity.
- The formal structure of the National and Observatory Groups, and the periodic updating of the forecasts, allows for consistency in methodology and the continuous improvement in forecasting methods. The development of forecasts by experts through well-structured stakeholder consultations using the Delphi approach promotes consistency and transparency of methodology. In addition to the contribution that expert consultations make to the predictive value of models, approaches that regularly convene a variety of stakeholders – such as the UK Observatory Groups, can also prove useful to facilitate overall stakeholder dialogue and collaboration.

## ANNEX 3

### CASE STUDIES OF LABOR AND SKILL DEMAND FORECASTS IN STEM FIELDS

#### **STEM Case Study 1: Quantitative model – Workers with STEM Qualifications in the UK**

##### *Initiator and objective:*

Commissioned jointly by the UK Council for Industries and Higher Education (CIHE), the Engineering Technology Board (ETB), and the Department of Innovation, Universities and Skills (DIUS), a report was developed in 2013 by the Warwick Institute of Employment Research to present benchmark projections of quantitative demand for workers with graduate level qualifications in STEM subjects.<sup>27 28</sup> The projections span the period from 2007 to 2017. The overarching aim of the report was to provide insights on potential mismatches between the demand and supply of skilled labor in STEM fields.

##### *Methodology:*

- Based on Labor Force Survey (LFS) data for the period 2001-2007 combined with existing employment projections that were developed through the UKs 'Working Futures Project', the approach applies a quantitative model to produce employment forecasts for STEM workers with graduate and post-graduate qualifications.<sup>29</sup>
- The projections under the Working Futures Project are based on a multi-sectoral, regional macroeconomic model which combines time-series econometrics with an input-output model, complemented with occupational projections based on an occupational employment and replacement demand model.<sup>30</sup>
- The combination of the LFS analysis with the Working Futures projections allowed for the projections to disaggregate forecasts by the field/discipline of qualifications, the level of qualifications (degree or post-degree), as well as by occupational category and broad economic sector.<sup>31</sup> The disciplines that are considered to be included under the definition of STEM are medicine, biological sciences, agricultural sciences, physical environmental sciences, mathematical sciences and computing, engineering, and technology. The model uses patterns of employment (i.e. past trends) by discipline to develop projections of employment numbers by discipline for various occupational and sectoral categories.

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<sup>27</sup> CIHE includes representatives of business, universities and colleges and aims to promote collaboration between the private sector and higher education institutions. ETB partners business, government and the engineering and technology community to, among others, promote the role of engineering and technology in society as well as demand-responsiveness of engineering and technical training and education.

<sup>28</sup> Wilson, R. (2009). *The Demand for STEM Graduates: Some Benchmark Projections*. CIHE, ETB, DIUS, IER.

<sup>29</sup> Sponsored by the UK Commission for Employment and Skills and the UK Learning and Skills Council, the Working Futures Project provided a series of detailed and comprehensive labor market projections, including by industries, occupations, qualification levels, and gender.

<sup>30</sup> See also Wilson, R., Homenidou, K., and Dickerson, A. (2006). *Working Futures 2004-2014 National Report*. Warwick Institute for Employment Research.

<sup>31</sup> Due to sample size issues, the 67 industries originally distinguished in the Working Futures analyses were aggregated into 6 broad sectors: primary sector and utilities; manufacturing; construction; distribution and transport; business and other services; and non-marketed services.

- The approach also includes a ‘shift-share analysis’ to assess the extent to which projected changes in STEM demand are due to changes in scale (i.e. the size of overall employment), the sectoral composition of the economy, the occupational structure of employment, or the qualifications structure of employment.

*Data use and generation:*

- The analysis relies on LFS data for the period 2001-2007, generated on a quarterly basis by the UK Office of National Statistics. Particular data used for the labor and skill demand forecasts include information on educational attainment (including qualification level and discipline) and employment status (including sector and occupation).
- In addition to LFS data, earlier projections generated through the Working Futures Project use data from population census and business surveys (Annual Business Inquiry)
- Box A3.1 provides examples of the type of findings generated through the applied methodology.

**Box A3.1: Examples of findings – Workers with STEM qualifications in the UK**

- Graduate and post-graduate STEM workers as share of total employment is expected to increase from approximately 11% in 2007 to around 14 percent in 2014. This is likely the result both of increased demand and increased supply.
- At the post-degree level, particular strong employment increases are expected for the disciplines agricultural sciences (87%), biological sciences (69%), technology (51%), engineering (43%). Expected employment growth for post-graduates in medicine, physical environmental sciences, and mathematics is lower than the average for workers with postgraduate qualifications (37%), but still substantially higher than the expected overall employment growth rate of 6%.
- At the degree level, the STEM disciplines expected to display employment growth which is higher than the degree-level average of 25% are agricultural sciences (111%), biological sciences (86%), mathematics (57%) and technology (43%).
- For all STEM disciplines, total expected recruitment needs substantially exceed the structural growth in employment, due to replacement needs of exiting workers mostly due to retirement. The STEM disciplines and qualification levels with the highest expected recruitment need over the period 2007-2017 are degree level medicine (1.0 mln), mathematical sciences and computing (0.6 mln) and biological sciences (0.6 mln).
- The business and other services sector accounts for the largest number of degree and post-degree level STEM workers (not including STEM workers in medicine who often work in the non-marketed services sector). Their number is expected to grow by 44% from 1.03 mln in 2007 to 149 mln in 2017, with high projected recruitment needs for degree and post-degree level mathematical and computing scientists (270,000 and 69,000 respectively), and degree-level biologists (146,000) and engineers (69,000).
- The main driver of projected increased demand in STEM workers are increases in the share of STEM workers in sectors and occupations across the labor market. Increases in total employment and changes in the occupational structure of employment explain a significant but more modest part of demand increases. The impact of shifts in industry structure (e.g. relatively strong growth in those sectors which employ proportionally large shares of STEM workers) are generally small.

### *Observations for replication*

A strong positive aspect of the applied approach includes the level of detail of the forecasts, allowing projections by qualification level, discipline, and economic sector, as well as an assessment of the reasons behind projected changes in employment and recruitment needs (i.e. replacement needs, or effects of scale, industry, occupation, or qualification). The approach relies heavily on comprehensive datasets collected by a third party (among others a series of comprehensive labor force surveys) and on a pre-existing quantitative model for general economic and employment forecasts. The possibility for replication in other contexts depends on whether databases for sufficient number of years are available which allow distinguishing workers with STEM qualifications from other workers.

## **STEM Case Study 2: Quantitative model – SET workers in the UK**

### *Initiator and objective:*

The Royal Academy of Engineering produced a report in 2012 on the demand for and shortages of Science, Engineering and Technology (SET) workers in the United Kingdom.<sup>32</sup> With the explicit aim “to provide evidence of the value of engineering skills to the economy, and to examine analytically the concerns expressed by leaders in business and industry about the shortage of such skills”, the report sets out to prove the importance of SET workers for economic growth and the existence of quantitative shortages of SET workers throughout the economy, even during the economic recession that the UK experiences during the time that the report was written. The forecast focuses on quantitative demand for technical and professional level SET workers, both economy-wide and disaggregated by broad economic sector.

### *Methodology:*

The report includes the result of a quantitative model to forecast quantitative demand for SET workers over the period 2010-2020. The demand forecasts are based on projections of employment growth by broad economic sector as generated by the UK Commission for Employment and Skills (UKCES) through a pre-existing quantitative multi-sectoral macro-economic model of the UK economy. The projected *expansion demand* for SET workers by economic sector is calculated taking into account the sector employment growth derived from the UKCES “Working Futures” model and the latest available data on the share of SET workers in each sector as share of total sectoral employment. Total forecasted demand is subsequently estimated by the addition of estimated *replacement demand* with the estimated expansion demand.

In addition to the model, the report uses labor force and economic output data to describe historic trends in employment outcomes of SET workers, and growth patterns of those economic sectors in which SET workers are disproportionately employed. While these data and analyses are not used to produce *forecasts*, they are used to illustrate the (growing) importance of SET workers and the sectors in which they constitute a relatively large proportion of the labor force, in order to highlight the importance of continuing and increased investments in producing SET-qualified workers in the future.

### *Data use and generation:*

- Data used for the UKCES forecasting model derive mostly from detailed national and regional accounts and labor survey data.<sup>33</sup> The added specifications related to SET workers also derive from labor force surveys.
- Box A3.2 provides examples of the type of findings generated through the applied methodology. Note that while the approach in this case study is based on the same model as the first case study in this Chapter (on STEM-qualified workers), it derives more generic, less-detailed results.

### **Box A3.2: Examples of findings –SET workers in the UK**

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<sup>32</sup> Royal Academy of Engineering (2012). *Jobs and Growth. The Importance of Engineering Skills to the UK Economy.*

<sup>33</sup> See Annex 3, Case Study 1, for more information on the UKCES Working Futures model.

*Data generation from quantitative model:*

- Between 2010 and 2020, the total forecasted expansion demand for SET workers is 180,000, of which 110,000 SET professionals and 70,000 SET technicians. Including replacement demand, the total recruitment need for SET workers is estimated to be a total of 1.28 million over the period from 2010-2010, of which 830,000 SET professionals and 450,000 SET technicians.
- Economic sectors which employ a relatively large share of SET workers which are expected to grow both in terms of output and employment include the Construction, the Computing and Telecommunications, and the Business Services sectors.
- Sectors in which SET workers make up a relatively large share of workers for which employment is expected to decline include the Manufacturing and the Electronic & Precision Engineering sectors.

*Findings generated from analyzing historic employment and output trends:*

- Economic sectors with labor productivity and wages that above the national average, generally employ a relatively large proportion of workers in SET occupations.
- There is an economy-wide wage premium of 33 percent for workers in Technology occupations, and of 15 percent for those working in Engineering occupations. There is an additional wage premium for workers with STEM qualifications, especially for those employed in STEM occupations (10-14 percent wage premium).

*Observations for replication*

The approach applied in this study illustrates the benefits of an existing economy-wide quantitative model, since either the model or its projections can serve as a basis for generating projections for specific occupations, such as SET workers. Using the forecasts from the existing model as a starting point, the additional work to develop forecasts for SET workers comprised generating data on the share of SET workers in each economic sector; combining these data with the employment forecasts from the existing model; and estimating replacement recruitment needs. The applied method does not appear to take into account potential changes over time in the occupational composition of particular sectors (e.g. the share of SET workers in each sector seems to be assumed constant). While this may disregard ongoing trends and thus to some extent affect the reliability of projections, this omission does not harm the value of the forecast in this case as its purpose is to illustrate broad trends rather than achieve accuracy in predications.

The report also highlights how historic data and trends can be used to shed light on expected future developments even without carrying out a concrete forecasting exercise. The UK SET report, for example, does not include any forecasts on wages, but uses historic data on the wage premiums for SET workers to stress the importance of continuing investments in SET education and training.

On a non-technical note, the case study illustrates the importance of ensuring credibility of the forecasting results. Both the organization responsible for publishing the report (Royal Academy of Engineers) and the report's stated goals (proving the value of engineering skills) can potentially result in reservations about the objectivity of the applied methodology. For similar actors wishing to ensure the perceived credibility of their forecasts, recommendations include carrying out the exercise in collaboration with other partners

(such as academia, research institutions, employers' organizations or government entities), and ensuring sound transparency and replicability of the applied methodology.

### **STEM Case Study 3: Employer Survey – IT workers in the United States**

#### *Initiator and objective:*

The Computing Technology Industry Association (CompTIA) is a non-profit trade association with the aim to advance the global interests of IT professionals and IT channel organizations, among others through providing IT certifications and business credentials, IT education, research, and promoting linkages between industry experts. In 2012, CompTIA produced a report to provide a better understanding of the IT skills that are in demand on the USA's labor market, and to identify existing and future IT skills shortages.<sup>34</sup> In particular, the report sought to review which IT skills are and will be most important to employers; how well IT staff skill sets are aligned with current and future employer demand; and current skill development practices. The report does not produce quantitative forecasts of labor and skill demand, but instead focuses on priority areas within the IT sector and the type of IT skills for which skill gaps are (expected to become) most pressing.

#### *Methodology:*

The study is based exclusively on the results of an online employer survey among approximately 500 IT and business managers involved in managing IT or IT staff. The survey was conducted over a six week period.<sup>35</sup> The survey questionnaire included questions related to the following three areas:

- *Context:* The current and anticipated importance of technology for business success (including by IT sub-areas), and satisfaction with current use of technology and IT staff skills;
- *IT skill gap causes and trends:* changes in IT gaps in the past 2 years, importance of gaps in IT skills compared to skill gaps in other areas, priority 'hard' (technical) and 'soft' (behavioral) IT skills; IT sub-areas where skill gaps are of the highest concern, business areas most affected by skill gaps, and perceived causes of IT skill gaps;
- *Addressing skill gaps:* existing systems to identify and address skill gaps, including through training.

#### *Data use and generation:*

- Data required to initiate the survey applied in this example is limited to the identification of firms to establish a representative sample of employers (see also under 'observations for replication' below).
- Box A3.3 provides examples of the type of findings generated through the employer survey.

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<sup>34</sup> CompTIA (2012). *State of the IT Skills Gap: Full Report*.

<sup>35</sup> The survey was carried out simultaneously in Canada, Japan, South-Africa, and the UK among an additional 559 managers. The findings of these surveys are not included in the report that is described in this case study.

### **Box A3.3: Examples of findings – Forecasting demand for IT workers in the USA**

- The share of employers which thinks the technology will be ‘very important’ for business success in 2014, is significantly higher than the share of employers which thinks it was ‘very important’ in 2011/12 (46 percent and 36 percent, respectively).
- Forty two percent of employers find that IT skill gaps increased over the past two years; 30 percent of employers perceive skill gaps in IT to be higher than in non-IT fields.
- The priority concern on skill gaps among IT-firms relates to database/information management; for non-IT firms the priority concern is skills gaps on (cyber)security.
- About half the surveyed firms seek to improve hard (technical) and soft (behavioral) IT skills in equal measures; 34 percent focus mostly/only on hard skills, 19 percent mostly/only on soft skills.
- Employers rate work ethic, motivation and initiative, and customer service as priority soft IT skills.
- Firms of all sizes report reduced productivity as the main implications of IT skill gaps. Particularly for small firms this reportedly translates into reduced profitability. Medium size firms report relatively substantial negative implications for cybersecurity and innovation capacity.
- Factors that are perceived to contribute to IT skill gaps by all employers include fast changing technology (46% of firms), lack of resources for IT skills development (43%), IT education and training does not lead to improved productivity on the work floor (39%), and difficulties in providing on-the-job training (23%).
- There are pronounced differences in perceived causes of skill gaps for firms with different sizes and between IT and non-IT firms. For example, micro enterprises report a lack of resources as the main cause for IT skill gaps, while small, medium and large firms report fast changing technology as the main cause. IT-firms more frequently than non-IT firms report that education does not result in improved productivity and that there is too much competition for skilled staff.

#### *Observations for replication*

An online survey can significantly reduce the costs and time associated with carrying out the survey. As with other employer surveys, the data requirements to initiate the survey in this sample are limited to having sufficient firm data to identify a representative sample of employers. Particularly in low and middle income contexts with large numbers of informal firms, this may however still not be an easy task. Even in the USA example described in this case study, the CompTIA report provides no information on the representativeness of the sample used, and it is thus unclear to what extent the survey results provide a reliable picture of IT skill demand and constraints across firms in the country.

An interesting feature of the questions included in this survey is that, while some of the questions explicitly focus on employers’ perceptions on future skill needs and gaps, a majority of questions relates to *current* skill needs and gaps. This is likely to improve the reliability of the approach, as respondents are more likely to accurately describe their current situation than project future developments. While answers to these questions do not constitute *forecasts*, they can be applied to guide skill development interventions. For example, the finding that micro firms particularly face financial constraints in their effort to upgrade skills can be included as justification for providing financial incentives for skills development interventions to firms of this size; similarly, perceived current priority skill gaps related to cybersecurity, database management, customer service, and staff initiative can be used as guidance for revising the content of IT-related education and training programs.

## STEM Case Study 4: Combined Approach – Technicians in the Netherlands

### *Initiator and objective:*

The Dutch Association of Universities of Applied Sciences (“Vereniging Hogescholen”) represents the 37 (public) Universities of Applied Sciences in the Netherlands. It aims to improve the quality of education and practical research of its members, among others through knowledge generation and dissemination. In 2013, it commissioned a series of reports on each of the six identified clusters for which education programs are offered by its members, with the aim to assess the alignment between training supply and skill demand. This effort reflects agreements between the Association and the Ministry of Education on the regular publication of this type of cluster-specific studies. One of the identified clusters concerns technicians, defined as bachelor-level graduates of technically oriented education programs (i.e. graduates of post-secondary technical education).<sup>36 37</sup> In addition to providing a comprehensive picture of trends and the current state of graduates’ labor outcomes and perceptions, the report provides quantitative labor demand forecasts and an assessment of the alignment between students’ skills acquisition and competencies demanded on the labor market. Distinctive features of the analyses are (i) its firm embedment in a sound public-private partnership institutional framework and draws on findings from analyses that are structurally carried out for a range of purposes (see Textbox A3.4 below); and (ii) the extent to which the analysis draws on the findings of an annually executed graduate tracer survey to measure various aspects of labor outcomes and the alignment between qualitative skill demand and supply along a number of dimensions.

### *Methodology*

- The applied methodology combines a quantitative model to generate quantitative labor demand forecasts, with information from graduate tracer studies to provide information on recent graduates’ employment outcomes and qualitative skill demand.
- ‘Technicians’ are defined as graduates of universities of applied science from a total of 45 disciplines, grouped in 8 educational programs.<sup>38</sup>
- The *quantitative model* incorporates projections and data from a variety of sources (see below), and generates forecasts of both replacement and expansion recruitment needs, taking into account among other occupational changes in sectoral employment. The model generates an ‘indicator for labor market prospects’. This indicator is based on expected labor inflow, short term unemployment, and expected recruitment needs, and estimates labor market prospects for graduates from particular educational programs or disciplines on a scale from 1 to 5, with lower numbers implying better prospects. Evaluations of the predictive value of this indicator show that in the past it was assessed correctly in 40 percent of the cases, and that for another 40 percent the actual value was 1 digit lower or higher than according to the predictions.

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<sup>36</sup> Allen, J., Van Thor, J., Verhagen, T. (2013). *Sectorrapportage Hoger Technisch Onderwijs*. Researchcentrum voor Onderwijs en Arbeidsmarkt (ROA), Maastricht, Netherlands

<sup>37</sup> Other clusters on which reports were made are Economics, Health Care, Agriculture, Pedagogy, and Social Work.

<sup>38</sup> The 8 programs are: laboratories, construction engineering, civil engineering, mechanical engineering, information technology, chemical technology, and transport and logistics.

#### **Box A3.4: Institutional settings for TVET labor and skills forecasts in the Netherlands**

The quantitative model and graduate tracer survey which serve as input for the study on technicians are developed through a long history of collaboration between public, private, and education sector stakeholders in the Netherlands.

**Quantitative model.** Since 1989, a partnership of public, semi-public, private and education sector partners have commissioned demand forecasts which are generated through a quantitative model. The composition of the stakeholders has varied over time, and currently includes the Ministry of Education, the Ministry of Social Affairs and Employment, the Ministry of Interior, the Netherlands Employee Insurance Agency, private employment agency Randstad, and the Foundation for Cooperation Vocational Training and the Labor Market (*Samenwerkingverband Beroepsonderwijs Bedrijfsleven*, SBB). The SBB is a collaboration between representative of industry and vocational training institutions with the aim to improve the efficient delivery of market-relevant training. The forecasting exercises are guided by a strategic committee including members from the financing parties and representatives of, among others, academia and the Netherlands' statistical institute.

**Graduate tracer survey.** Starting in 1998, annual tracer surveys of graduates from universities of applied science have been conducted to assess graduates' labor market outcomes. While the association of universities of applied science supports the exercise, each individual university decides whether or not to participate in (and finance) the survey. Recently, participating institutions have represented approximately 92 percent of students which graduate each year. In addition to a generic questionnaire which is applied to graduates from all participating educational institutions, schools can opt to add extra questions which serve their specific information needs.

**Dissemination.** The results of the analyses are disseminated in various ways:

- Both the quantitative model and the tracer survey are executed by the Maastricht University Research Centre for Education and Labor Market (*Researchcentrum voor Onderwijs en Arbeidsmarkt*, ROA). This has the advantage that the results from both methodologies can be cross-checked and combined to produce comprehensive assessments and forecasts, which are updated and published every 1-2 years.
- Each school participating in the graduate tracer survey receives the school specific-findings from the survey, benchmarked against a self-selected group of comparator schools.
- The questionnaire and anonymized data from the tracer survey are made available, upon request, to interested third parties such as research institutes and academia.
- Stakeholders can commission more in-depth analyses of the data, for example on specific sectors or qualifications – the report on technicians presented in this case study is a pertinent example.

- The *graduate tracer study* focuses on post-secondary professional education graduates. Partly due to a relatively intensive pursuit by mail and email and the possibility to submit the survey online, a high response rate of approximately 40 percent is achieved. Rather than providing forecasts, the tracer study generates information on current labor outcomes of graduates, including on graduate perceptions on qualitative skill demand, and the extent to which their education provided them with the skills that are required on the labor market.

*Data use and generation:*

- Data incorporated in the model include economic growth and labor market participation forecasts from the Netherlands Bureau for Economic Policy Analysis (CPB); labor force trends from the Netherlands Bureau of Statistics (CBS); and projections on the number of labor market entrants by educational level and discipline from the Ministry of Education. The contact details of the graduates for the tracer survey are provided by the participating educational institutions.
- Textbox A3.5 provides examples of the type of findings generated through the applied methodology.

**Box A3.5: Examples of findings – Forecasting demand for technicians in the Netherlands**

*From the graduate tracer study*

- From 1998 to 2010, unemployment rates of graduates from technical disciplines have consistently been below the unemployment rate of the total of graduates from universities in applied science.
- Among the competencies that are required on the job, ‘ability to work independently’ is rated highest among technicians, followed by ‘ability to reason logically’.
- Based on graduate’s perceptions, skill demands on technicians are generally lower than skills demanded from non-technicians; this may be due to reduced employers’ expectations concerning technicians caused by their relative shortage on the labor market.
- When comparing skills acquired through education and those that are required on the job, the largest share of graduates (34%) mentions the ability to work within a budget or planning, followed by knowledge of their own discipline (33%). Relatively few graduates perceive shortages related to ‘productive collaboration with others’ (15%) and ‘learning new things’ (14%)

*From the quantitative model*

- Of the 8 identified groups of technicians, the labor market prospects until 2016 are forecasted to be ‘very good’ for laboratory technicians and chemical engineers, and ‘fair’ for construction engineers.
- For transport and logistics technicians, recruitment demand until 2016 is expected to be substantially influenced by the large number of current employees which are expected to retire.

*Observations for replication*

The sound institutional setting and the use of a graduate survey are two distinguishing features of this approach. While these take time in an emerging forecasting system to establish, even in settings where forecasts are just being initiated, several lessons learned can be taken into account:

- Collaboration between stakeholders, including for example through a ‘strategic committee’ which guides the objectives, content, and dissemination of forecasting exercises, can greatly benefit the extent to which forecasting exercises can be used by stakeholders.
- In the case study example, the participation of schools in the tracer survey on a voluntary basis, and the possibility for them to add specific questions to the questionnaire, can be a good approach to ensuring their buy-in as well as the usefulness of the survey.

- Graduate tracer studies are complicated to establish on a national level, considering that in many cases graduates' contact details are not available. One option to introduce the mechanism is through gradually building capacity to trace graduates in individual schools.

## STEM Case Study 5: Combined Approach – IT and IT enabled Services in India

### *Initiator and objective:*

The National Association of Software and Services Companies (NASSCOM) is a trade association of the Indian Information Technology (IT) and business process outsourcing industry. With over 1,500 members, NASSCOM facilitates business and trade in software and services and encourages the advancement of research in software technology. In partnership with the Indian National Skills Development Council, NASSCOM takes part in the Sector Skills Council for IT and IT-enabled Services (IT-ITeS) which aims to develop the workforce for this industry. Among its activities to promote industry growth and workforce development, NASSCOM regularly conducts labor and skills demand-supply analyses for the sector, to influence policy and operational decisions aimed at aligning labor and skill supply with demand in the sector. The analyses provide quantitative and qualitative demand forecasts, based among others on industry growth projections and disaggregated by geographic regions, industry sub-sector, business area, and firm size. The analyses are characterized by the strong integration of labor and skill demand assessments with analyses and recommendations related to skills supply and recruitment practices.<sup>39</sup>

### *Methodology:*

- The analyses which NASSCOM regularly produces are interlinked and vary in scope and depth. For example, a comprehensive talent demand-supply analysis including forecasts for the period 2013-2020 was conducted in 2013; in 2014, these findings were enriched through forecasts for the year 2015 using an approach of more limited scope.<sup>40</sup>
- The *comprehensive talent demand-supply analysis carried out in 2013* was based on a variety of sources and methodologies, combining primary data from an online employer survey, expert consultations, and a review of company websites, with secondary data collected from the research of both NASSCOM and third parties.<sup>41</sup> Stakeholders from which information was collected include industry representatives, academia, regulators, and government institutions. The data obtained from these various sources was subsequently triangulated, checked for consistency and analyzed in the report.
- The *smaller-scope approach applied in 2014* was based on data generated through a small sample exploratory internet-based employer survey, conducted in May-June 2014, over 100 of NASSCOMS members responded to the survey.
- Exercises to generate and analyze is executed regularly, to take into account the dynamic nature of the industry and ensure data relevance. For example, data from secondary sources is updated at least every two years, and employers are requested to respond to the employer survey at least every three

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<sup>39</sup> For a summary of the results related to skills supply and recruitment strategies, refer to [https://pursuite-production.s3.amazonaws.com/media/cms\\_page\\_media/178/V3Analysis%20S\\_D\\_Final%20NSDC\\_29082013.pdf](https://pursuite-production.s3.amazonaws.com/media/cms_page_media/178/V3Analysis%20S_D_Final%20NSDC_29082013.pdf) or [http://survey.nasscom.in/sites/default/files/researchreports/softcopy/Indias-IT-BPM-Talent-Trends\\_July14.pdf](http://survey.nasscom.in/sites/default/files/researchreports/softcopy/Indias-IT-BPM-Talent-Trends_July14.pdf)

<sup>40</sup> See NASSCOM (2013). *2013: HR TRENDS - Changing Talent Paradigm*; and NASSCOM (2014). *India's IT-BPM Talent Trends: Annual HR Survey 2014*.

<sup>41</sup> Sources of third party research include the Union Ministry of Human Resource Development, the University Grants Commission, and the All-Indian Council for Technical Education.

years. Where possible, for example for some labor supply data from educational institutions, data is automatically uploaded and processed in the NASSCOM Workforce Market Information System.

*Data use and generation:*

- Demand-related data generated from primary sources and collected through secondary sources include information on the global industry outlook, general employment and recruitment projections, and forecasts on trends in demand for particular occupations and skill types, disaggregated by industry sub-sectors and geographical regions.
- Box A3.6 provides examples of the type of findings generated through the applied methodology.

**Box A3.6: Examples of findings – Forecasting demand for IT–IteS in India**

*From the 2013 Combined Approach Analysis (2013-2020)*

- Depending on trends in labor productivity, sectoral employment is expected to increase by between 2.3 and 4.0 million persons in the period from 2013 to 2020, resulting in total employment of between 5.3 and 7.0 million persons by 2020.
- By 2020, 35 percent of recruitments are expected to be hired to produce for the national (Indian market), compared to 21 percent in 2013.
- Of the total workforce employed in the ITeS sub-sector, the share of those working in service-oriented architecture, web-services, e-commerce, software deployment and support is expected to increase from 11 percent in 2013 to 20 percent in 2020. This is expected to lead to a spurt in demand for skilled talent in these occupations.
- Until 2020, no major deficits in quantitative supply are expected in the industry; however, qualitative skills shortages are expected to become increasingly pressing, especially related to generic skills and in highly-specialized occupations (such as e-commerce and data science) and in particular regions including Delhi and Tamil Nadu.

*From the 2014 Employer Survey*

- The IT-Business Process Management sector is expected to add approximately 175,000 persons to the workforce in 2015. Employment growth is forecasted to be particularly strong for small and medium enterprises (7-8 percent compared to an industry average of 6 percent).
- Employers will increasingly seek to hire experienced workers rather than new labor entrants, considering increased demand high level specialized skills.
- Among the identified technical skills, employers place high and increased importance (compared to one year earlier) on skills related to platform engineering, migration to new technology, and user experience design. Among soft skills, employers attach high and increased importance to skills related to English language communication, project management, and leadership.

*Observations for replication*

The applied combined methodology allows for the development of forecast on both quantitative and qualitative aspects of labor and skill demand, without the need for elaborate data sets as is required for a quantitative model. Regular repetition of the forecasting exercise allows the gradual improvement of

the predictive value of the forecasts as lessons learned in previous assessments are incorporated in subsequent analyses. Combining comprehensive longer term forecasts with explorative employer surveys focusing on a shorter time-span, with the findings of each analysis serving as input for the next one, provide a balanced mix of (on the one hand) consistency between different analyses and (on the other hand) the opportunity to incorporate new insights from one analysis into the design of the next.

Replication of the explorative employer survey is likely to be relatively straightforward, provided that the scope of the sector and occupations are well defined, and a representative sample of business can be identified. Replication of the more comprehensive, combined approach would benefit from a relatively substantial body of existing relevant analyses and documentation. In addition, replication of the overall approach in which forecasts are conducted regularly and systematically require a sound institutional setting. In low-income contexts, replication of this approach may have the highest likelihood of success for occupations which are concentrated in a small numbers of sectors and firms (such as for example IT or mining), as a relatively small number of stakeholders could reduce the costs of the essential coordination efforts.

## STEM Case Study 6: Combined Approach – Engineering Occupations in New Zealand

### *Initiator and objective:*

The New Zealand Department of Labor in collaboration with the Institution for Professional Engineers of New Zealand (IPENZ) and the Association of Consulting Engineers New Zealand (ACENZ) published in 2008, for the first time, an analysis of the labor market for engineering occupations.<sup>42</sup> The aim of the report was to assist development and planning within the engineering profession by providing projections on both quantitative demand and supply of engineers in the country. The analysis forecasts quantitative employment trends for the period from 2008-2013, distinguishing various engineering professions and industries.

### *Methodology:*

- The demand related analysis in the report relies heavily on a review of secondary literature and data, complemented by a quantitative model and expert consultations. *Secondary data* are largely applied to depict recent trends and the current employment situation within industries which employ large shares of workers in engineering occupations. *Secondary literature combined with a quantitative model* is used to forecast industry and employment trends, whereas stakeholder views were sought on the validity of the analysis.
- In particular, the various sources and approaches applied include the following:
  - *Secondary data* are used among others to depict employment levels, recent employment growth trends, replacement rates, trends in salaries for engineering related occupations, and to assess whether recent trends in employment for particular engineering occupations are due to either the growth in particular industries or changes in the share of engineering occupations in particular industries.<sup>43</sup>
  - *Secondary literature* is used to identify industry drivers for six identified industries which employ a relatively high number of workers from engineering disciplines.<sup>44</sup> The analysis for each industry comprises a description of the general economic outlook, based among others on expected trends in expenditures, and drivers which may impact the demand for the engineering workforce over a 5 to 10 year time period. The combined data is used to generate a medium-term outlook for the selected industries, including whether the outlook for specific engineering occupations in these industries is positive or negative (see table A3.1 below).
  - *A quantitative model* complements the forecasts generated through the literature review by projecting employment growth for engineering occupations for the period 2008-2013, distinguishing high, medium and low growth scenarios.
  - Finally, limited *industry stakeholder feedback* on the outlook is included in the report.

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<sup>42</sup> Department of Labor, IPENZ, ACENZ (2008). *Engineers in the New Zealand Labor Market*. New Zealand.

<sup>43</sup> The report distinguishes 18 engineering occupations including for example electrical engineers and computer systems technicians.

<sup>44</sup> The industries comprise: transport; manufacturing; aeronautical engineering; electricity, gas and water supply; telecommunications; and construction.

- The report focuses on forecasting *quantitative* demand. While there is some mention on stakeholders' perception on *qualitative* issues, such as the practical experience of recent graduates, these elements are not included in the forecasts.

*Data use and generation:*

- The secondary data used for the description of recent trends and for the quantitative model are mostly from the Department of Labor. Sources for the secondary literature and other documentation include publications from sector ministries and agencies such as the New Zealand Transport Agency and the Electricity Commission; data on employment trends and opportunities published by "Careers New Zealand" (a public entity under the Ministry of Education with the aim to better link education and training to the labor market); and information on labor and skill demand trends as provided by institutes of technology and polytechnics to the Tertiary Education Commission.
- Box A3.7 provides examples of the type of findings generated through the applied methodology.

**Box A3.7: Examples of findings – Forecasting demand for engineering occupations in New Zealand**

- Due to expected high expenditures in the transport and railway sector, the medium-term forecast for employment of roading and structural engineers and clerks of works in this sector is positive. In the manufacturing sector on the other hand, the weak international economic climate is expected to result in continued low growth, which translates into a negative employment outlook for, for example, mechanical and chemical engineers and technicians. *(from: secondary literature review)*
- Under a medium-growth scenario, annual average employment of engineering *professionals* is projected to increase by 3.6% per year between 2008 and 2013. This is more than twice the projected growth for all occupations over this period (1.5 percent). The estimated number of these professionals which will be employed in 2013 is 37,966, up from 31,599 in 2008. In contrast, employment growth for engineering technicians is forecast to decline in the same period, by 0.4 percent per year: the number of physical and science technicians is forecast to be 21,943 in 2013 compared to 22,128 in 2008. *(from: quantitative model)*
- Industry stakeholders do not agree with the flat employment outlook for technicians. They suggest that the lower growth in employment is due to shortages in supply rather than demand.

**Table A3.1: Medium term outlook for major industries that employ engineers\***

Industry	Industry outlook	Occupations	Outlook for occupation
Telecommunications	High levels of broadband and cellular network capex forecast over the next 6 years	- Electronic and telecoms engineer - Telecoms technicians - Other electronics engineering technicians	😊 😊 😊
Construction	Following a buoyant period, building and construction will decline and remain relatively flat for 2-3 years, and follow NZ property market trends	- Structural engineer - Heating / ventilation / refrigeration engineer - Clerk of works - Quantity surveyor - Draughting Technician	😞 😞 😞 😞 😞

\* Adapted from Department of Labor, IPENZ, ACENZ (2008)

### *Observations for replication*

Various features distinguish the approach applied for the New Zealand engineers from the other case studies described so far: (1) the extensive use of available secondary analyses and prognoses from a variety of sources; (2) a combined approach applying a literature review and quantitative methodology, where the results of the quantitative model are presented as complementary - rather than 'superior' - to the findings from the literature review; and (3) the reflection of differing forecasting outcomes from various sources (in this case: reflecting stakeholder views which are not fully aligned with the prognosis from the quantitative model), rather than combining various approaches to arrive at a single forecast.

A positive aspect of combining a collection of secondary prognoses and analyses from various sources is that it is a cost- and time-efficient option to generate forecasts, provided that a sufficiently large body of such analyses exists. The drawback of the approach is that the methodologies used to develop the various prognoses are likely to differ from each other, so that there are issues with comparing the outcomes from the various sources. This disadvantage is somewhat mitigated by complementing the secondary analyses with forecasts from a quantitative model and stakeholder perceptions; rather than combining the outcomes of the various methodologies into a single forecast, the outcomes of all approaches are reflected and allow the reader to draw conclusions based on this collection of resources.