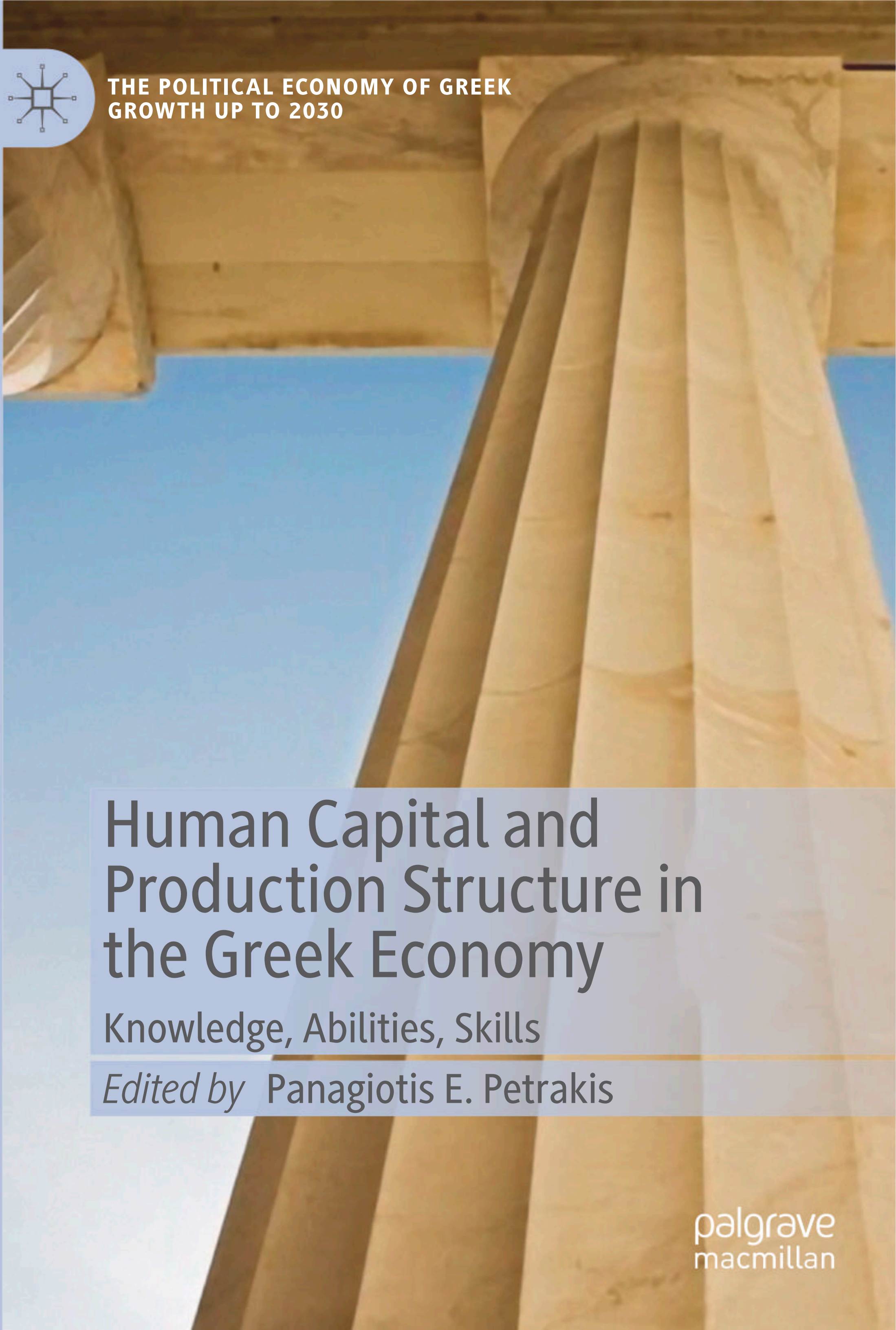

THE POLITICAL ECONOMY OF GREEK GROWTH UP TO 2030

Human Capital and Production Structure in the Greek Economy

Knowledge, Abilities, Skills

Edited by Panagiotis E. Petrakis

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The Political Economy of Greek Growth up to 2030

Series Editor

Panagiotis E. Petrakis, Department of Economics, National and Kapodistrian University of Athens, Athens, Greece

This book series analyzes the medium to long-term prospects of Greece's political economy by studying concepts such as sustainability, sustainable governance and political functioning, economic inclusivity, cultural behaviors, and economic dynamic growth through an evolutionary approach. This series also publishes policy-oriented books outlining steps for increased economic growth and a sustainable future for the Greek economy. This series stands out in that the books depict the conditions that must prevail for the Greek economy to escape the economic stagnation that has lingered from persistent economic recession.

Using Greece as a lens to discuss pressing questions, this series will be of interest to economists interested in Eurozone policies, economic growth, evolutionary economics, and more.

Panagiotis E. Petrakis
Editor

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Preface

The series of books with the general title of 'The Political Economy of Greek Growth up to 2030' analyze the medium to long-term prospects of the Greek reality—including the COVID-19 pandemic—in view of the political economy. They combine the notions of sustainability, sustainable governance and political operation, the inclusivity of the economic system, and cultural behavior, with the requirements of economic dynamic growth. The concurrent influence from those five areas, through suitable structural reforms, is a necessary prerequisite to change the production prototype of the Greek economy, which will ensure a medium and long-term economic development and growth. This viewpoint has an evolutionary foundation. The view supported is that conditions can be created for the Greek economy, after the 2008 depression, to avoid losing another decade due to COVID-19 and to create the necessary conditions for a great growth transformation up to 2030.

The target of this book series, presented in successive volumes, is to assess the current situation of the Greek economy and detect future potential for development and growth, particularly on a medium to long-term horizon. It represents the next step in a series of books: The Greek Economy and the Crisis, Challenges and Responses, P. E. Petrakis (2011), New York and Heidelberg, Springer; and A New Growth Model for the Greek Economy, Requirements for the Long-Term Sustainability, P. E. Petrakis (2016), New York, Palgrave Macmillan. These books marked the conditions in which the Greek economy entered Great Depression

(2008–2018) and put forth initial thoughts on exiting the crisis. In this current book series, conditions for the exit of the economy from the crisis are analyzed, along with its entry into a new period of development and growth.

Athens, Greece Panagiotis E. Petrakis

Praise for *Human Capital and Production Structure in the Greek Economy*

"This is an inspiring book, full of important insights for those of us who want to know about the upgraded role of human capital in a world that seeks sustainable development combining the environment, the economy and society. It is a must-read primer for anyone interested in the positive effects of human on the economy, social cohesion and optimal governance.

In order to improve the existing production structure, the sectors of education and innovation are highlighted as essential determinants of effective growth-enhancing policies. The Greek labour market and the production structure of the Greek economy offer the necessary background to study those relationships."

—Evangelia Papapetrou, *Professor in the Department of Economics of the National and Kapodistrian University of Athens, Greece*

"This captivating book is a modern attempt to examine the role of human capital, using knowledge, abilities, skills and working activities as the key drivers to guide an economy to its structural change. Focusing on the Greek case, the authors provide pragmatic insights on the role of human capital on economic structural change, the structural relationships and the need for restructuring and the critical role of life-long learning.

After reading it, it will impossible not to see the need for a more effective use of qualitative aspects of human capital that are linked to the effective fulfillment of the tasks required in the labor market."

—Stylianos Kotsios, *Professor and Chairman of the Department of Economics of the National and Kapodistrian University of Athens in Greece*

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Abbreviations

AI	Artificial Intelligence
CAGR	Compound Annual Growth Rate (The Average Annual Growth Rate)
DESI	Digital Economy and Society Index
DOT	Dictionary of Occupational Titles
EOPPEP	Greek National Organization for the Certification of Qualifications and Vocational Orientation
ESCO	European Skills/Competencies Qualifications and Occupations
ESI	European Skills Index
EU	European Union
ICTS	Information and Communication Technologies
ISCO	International Standard Classification of Occupations
KSAS	Knowledge, Skills, Abilities
LFS	Labor Force Survey
NACE	Nomenclature Générale Des Activités Économiques Dans Les Communautés Européennes" (Statistical Classification of Economic Activities in the European Communities)
O*NET	Occupational Information Network
OECD	Organisation for Economic Co-Operation and Development
SBS	Structural Business Statistics
SBTC	Skill-Based Technological Change
WEF	World Economic Forum

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CHAPTER 1

Introduction

Panagiotis E. Petrakis

The prevailing generation of the endogenous growth models reserves a key function for human capital. The investment in human capital could generate positive economies to scale that could reverse the decreasing returns to scale of the technical capital.

Sustainable development and the diversification of the production process incorporate the qualitative features of the human capital, namely knowledge, skills, abilities, and working activities. These features are accumulated as a result of formal education attendance, on-the-job training, or through lifelong learning in general. Essentially, the improvement of productivity through an increase in the performance of human capital is greater when the economy is technologically advanced (Nelson & Phelps, 1966). This is attainable through the specialization of human capital in accordance with technological advances.

Regarding Romer's model (1986, 1990), human capital supports a complex and diversified portfolio of products. In the model of Lucas

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(1988), hours spent in learning increase human capital's productivity. In the Schumpeterian models (Aghion et al., 2015), long-term growth is based on innovation through investments in R&D and creative destruction; thus, the quality of the inputs is upgraded by the investment in human capital. Moreover, the evolutionary model of Nelson and Winter (1982) indicates that for individuals with different abilities and skills good organization and interaction are required to effectively perform the entrepreneurial routines.

Training and lifelong learning contribute decisively to the smooth transition from one production structure to another given that skill accumulation occurs in basic training, lifelong learning, and other forms of education (Brunello & Wruuck, 2019). Hence, of great significance is the creation of favorable institutions providing on-the-job training, reskilling, and upskilling through lifelong learning education. At the same time in consideration of the rapid developments in the labor market related to the 4th Industrial Revolution and the COVID-19 crisis, the structures that provide lifelong training and education are ideal because they are effective and have a low operational cost (Giouli et al., 2021).

When policymakers examine investment in education at a microeconomic level, they should acknowledge that an individual perceives hours of education as an investment (Becker, 1964, 1975). Hence, a cost-benefit analysis occurs regarding the benefits and the costs of investing in human capital, including reskilling and upskilling. Note that the cost could be opportunity or money cost. That being, active labor market policies should take heed of further institutional issues mainly related to the new industrial organization paradigm that has been emerged as a result of the ongoing technological transformation, especially in the aftermath of the COVID-19 crisis.

Traditional approaches are based on internationally comparable statistics such as population percentages concerning the years attained in school and lifelong education, and generally, data indicating an investment in human capital (Hanushek et al., 2017; Hanson, 2008). Thus, the traditional approaches are focused on the measurable quantitative impact of the investment in human capital in the improvement of productivity and life quality. The analysis in this book is beyond the traditional approaches for the measurement and assessment of human capital.

In this book, the notion of human capital is approached through the analysis of its qualitative characteristics, namely knowledge, skills, abilities, and working activities. Such characteristics are linked to the effective fulfillment of the tasks required by a series of occupations as they are described in the O*NET database. Specifically, the USA-based O*NET database provides information on requirements in knowledge, skills, abilities, and working activities for a range of occupations.

Each one of these qualitative characteristics of human capital falls under a general and a specific definition depending on the occupation. In general, according to the O*NET database, *knowledge* is defined as the theoretical understanding of an issue as well as the accumulation of knowledge in the course of formal, lifelong, and on-the-job training. *Ability* is synonymous with potential or capacity, and concerns the ability to carry out a task. On the other hand, *skills* are classified as 'technical' and 'soft skills' depending on the nature of the task a worker is required to carry out. Finally, *working activities* refer to general types of job behaviors that apply in multiple jobs.

The point of departure (Chapter 2) is an introduction to the concept of human capital and its relationship with economic growth through a modern perspective. In this chapter, the theoretical foundations of the notion of human capital are presented up to the date present. The central role of this chapter is to demonstrate the importance of human capital as a driver of productivity and consequently economic growth. Investment in human capital allows faster innovation and the adoption of new technologies leading to positive externalities. In conclusion, Becker's theory of human capital is presented, which argues that education leads to higher wages and ultimately to higher labor productivity.

The aim of the analysis (Chapter 3) is to demonstrate the relationship between human capital and the structure of a society. As societies are organized under different circumstances, human capital could vary from one country to another. Initially, it is provided a basic record of the state of human capital nowadays. The observed differences in the accumulation of human capital at both national and international levels are noted along with the fact that different management policies result in different outcomes in terms of economic structure. At the same time, rapid technological change reinforces the importance of human capital raising the question of what are the required knowledge and skills today? To answer this question, we need to explore the notion of human capital in terms of the different fields that it is being applied. From the broadest to the narrowest, we refer to general, sectoral, professional, and entrepreneurial applications. Thus, task-specific human capital is the link between the production structure and the qualitative characteristics of human capital.

Thus, the analysis in this book (Chapter 4) focuses on how the production structure of an economy interacts with the requirements regarding human capital aforementioned qualities. In this point, some basic concepts are explained related to the analysis of employment. Consequently, the various characteristics of employment are presented concentrating on knowledge, skills, and abilities. In respect of these general qualitative characteristics, a coherent conceptual framework is formed by distinguishing the various concepts from each other, stating their importance, but also pointing out the strong mutual relations among them.

By shortages in skills, abilities, and working activities, we mean a situation where the current availability measured in these qualities cannot meet the demand in the labor market. On the other hand, by surpluses in these qualities, we mean a situation where their current availability exceeds the demand in the labor market. Importantly, both shortages and surpluses in these qualities correspond to a non-optimal equilibrium in the labor market as the requirements in the available job positions do not meet the labor force qualifications.

Technological advancements generate new tasks and job openings proportionable to the production structure characteristics. During this process, some occupations are being impacted by the labor demand shifts toward technological change. In terms of labor market shifts, occupations are organized in the context of sustainable development, green economy, and the 4th Industrial Revolution (AI, cloud computing, big data, etc.). The communication channels of these developments touch on three issues (Giouli et al., 2021):

i. Where do shortages in knowledge, skills, abilities, and working activities occur?
ii. Which sectors of the economy suffer from shortages in knowledge, skills, abilities, and working activities?
iii. To what extent do workers' qualifications match the job requirements in the tasks they are expected to carry out?

The answers to these questions will allow us to form a new profile of skills in the coming years. However, targeted policies for impacting human capital contributing to economic growth are needed. Thus, the analysis is mandatory to be focused on the remaining knowledge, abilities, and working activities of human capital.

For the improvement of the existing production structure, the sectors of education and innovation are essential for developmental interventions as they are determinant factors of the efficiency of a production structure. In this direction, we encounter two important issues: the inability to support formal education through increased public spending and the ongoing technological changes which are accompanied by necessities for continued education and training of the human capital. These necessities and related issues could be covered by lifelong learning programs (Giouli et al., 2021). Lifelong learning educational structures incorporate both the (necessary) preexisting knowledge and the new knowledge according to the demands and descriptions of occupations but also, they are of low cost which results in high flexibility and adaptivity to the changing demands in human capital training, and in their industrial organization model.

Policymaking for dealing with the asymmetries in skills is initially related to three interrelated facts. Firstly, in the kind of the aforementioned required skills, abilities, and knowledge. Secondly, different requirements in skills imply new or diversified tasks and occupations and hence, new working activities. Thus, the transitioning process from one production structure to another is of major importance since an irregular transition may involve a high social cost. Thirdly, the post-COVID-19 era will be characterized by high rates of growth resulting in shifts in the labor demand in favor of the prevailing occupations.

The analysis of the qualitative characteristics of the human capital (knowledge, skills, abilities, and working activities) essentially refers to guiding the educational policies to increase productivity (Kanzola, 2021). As the circumstances in the labor market call toward technological change, we are led to a skill-based technological change (SBTC) (Violante, 2008). This situation is in favor of the skilled labor force compared to the low-skilled and unskilled labor force, a fact that reinforces negative implications on income distribution and inequalities in general (Violante, 2008). Evidently, this is confirmed during the COVID-19 pandemic and the labor market adjustment to teleworking (Bank of Greece, 2021).

At this point (Chapter 5), investigating how the changes in the production structure due to technological change result in shifts in the labor demand that affect the requirements in terms of employment characteristics and the required skills is central. Thus, there is an overview of the effects of technology on occupational requirements and its general characteristics are described. This effect is divided into two parts which are described and analyzed independently. The first part concerns the external change of employment characteristics that involve a change in the division of labor. The remainder part examines the internal change which concerns shifts in the requirements of the professions themselves—regardless of the division of labor—that arise from the industrial organization environment. Hence, even if the distribution of the various professions does not change, changes emerging from technological advancement affect the work processes a result that is reflected in the overall work requirements.

Focusing on the Greek labor market, the required restructuring (Chapter 6) generates new conditions in the labor market that are also influenced by external factors in employment. These exogenous factors consist of the strengthening of protectionism, the new digital requirements (Industry 4.0), and the wider social, environmental, and energy developments. Thus, this chapter analyzes the current employment situation reflecting the methodology for conducting projections for its future course. Initially, the effects of the Great Recession of 2008 and the strict regulations of the fiscal adjustments on the employment and occupations are studied by emphasizing the sectoral dimension of employment. In the sequel, the methodological approach for evaluating the future evolution of the key employment figures is presented.

The analysis is concentrated in the Greek economy in terms of employment evolution (Chapter 7) by generating two different scenarios: a baseline scenario and an optimistic scenario. In the optimistic scenario, more investments occur as a result of the reforms that are expected to be implemented in the Greek economy. In short, each scenario is linked to a different evolution of GDP and its components, namely consumption, exports, and investment. That being, the evolution of employment in terms of industries and occupational categories will be analyzed separately for each scenario.

Hence, in the aforementioned Chapter 7, a brief analysis of the methodology followed is presented. Also, the expected evolution of the key GDP components by 2027 is described to mainly capture their expected impact on the economic activity. In the sequel, the evolution of employment in the two different scenarios based on the evolution of the key components of the GDP is presented. The employment is analyzed at the level of sectors (1-digit and 2-digit NACE), as well as at the level of occupational categories (1-digit, 2-digit, and 3-digit ISCO). It is noted that for the results in 2-digit and 3-digit analysis NACE and ISCO, the most important changes are highlighted as well as in the Annex the total results are recorded.

The shifts in economic activity through the channels of labor supply and labor demand provide critical information about the requirements within the labor market. With reference to the Greek economy, the labor market is analyzed in terms of educational requirements for the period from 2010 to 2025 (Chapter 8). The analysis elaborates on the necessity for reskilling and upskilling of the workforce as well as on the policy implications that incorporate training and lifelong learning programs for the advancement of the qualifications of the workforce.

In today's ever-evolving society, requirements on knowledge, skills, and working activities are growing rapidly along with the constant changes in the labor demand. Thus, the modernization of EU policy in the field of lifelong learning is challenging for the Union but also, necessary. Upgrading the skills of the workforce is urgent as we strive to meet the challenges of the twenty-first century related to the consequences of the 4th Industrial Revolution, the recovery from the COVID-19 pandemic, and the movement toward a more sustainable and resilient European Union. Therefore, the role of lifelong learning is critical for the strengthening of the skills of the individuals, but also it serves a higher purpose due to social and psychological reasons. It is a fact that education is closely linked with the freedom to evolve one's abilities and skills. That being, Chapter 9 describes the above issues and presents how lifelong learning is taking place in Europe as well as how policymaking related to lifelong learning could lead to the restructuring of the European economies.

The book is closing (Chapter 10) with an analysis of the knowledge requirements for production structure transformation in the aftermath of the Greek economic crisis from 2010 to 2020. The Greek production structure of 2018, in terms of a sectoral analysis based on the employment concentration in each sector, has an equivalent in the professions that exist. Hence, it is possible to identify the knowledge requirements of the Greek economy for 2018 based on the structure of employment during this year. The 2018 production structure is characterized by the aftermath of the crisis from 2011 to 2015 which was particularly strong for the country. In addition, based on the available methodology and projecting the picture of employment and occupations for 2027, we can generate an estimation for the new map of knowledge requirements for the 2027 production structure. That being, the differences between the two production structures are identifiable meaning that any gaps in the knowledge content could be predicted. These results are valuable to design formal, lifelong, and informal education policies to facilitate the operation of the production model and possibly influence its restructuring.

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PART I

Human Capital and Structural Change

CHAPTER 2

The Role of Human Capital in Economic Development in the Twenty-First Century

Eleni Giouli

2.1 Introduction

With the development of economic thought from the 1950s onward, the need to pay due attention to the issue and the importance of human capital is emphasized. Human capital, although intangible, is a critical feature of economies as its utilization is a determining factor of economic development and growth. Human capital also incorporates in various ways skills and talents, knowledge and education, culture, health, communication, social structures and innovation, etc.

This chapter makes a first introduction to the concept of human capital which shows its importance for the development and growth of economies through a modern perspective. Human capital is roughly

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described, while the historical development of its concept by Adam Smith to date is presented (Section 1.2). The central role attributed to human capital for the development of productivity and the growth of economies in the economic theory of the twentieth century is demonstrated. In addition, the relationship between human capital and knowledge and productivity is presented, which is the foundation for economic growth (Section 1.3). Finally, Sect. 1.4 refers to the relationships between the notions of human capital, knowledge, intangible capital and productivity.

2.2 Human Capital and Economic Development: Theoretical Approaches

The concept of "human capital" refers mainly to the abilities or skills of people and the productive wealth that is embedded in work, knowledge and skills (United Nations, 2009). The theory of human capital focuses not only on education (formal or non-formal) but also on the health of the individual as an input to economic production, while the development of human capital (expenditure on education or training) refers to the acquisition and increase of the population that has skills, knowledge and experience that are critical to a country's economic development (Adelakun, 2011).

Its effects on economic development and growth are an issue that has been strongly debated in literature. The beginning was made by the contribution of Adam Smith (1723–1790), but also other philosophers and economists of the eighteenth century on the basis of which labor productivity contributes to the creation of surplus wealth for economies. Smith argues that the process of growth is based on microeconomic bases driven by the interaction of individual interests, the establishment of institutions (property rights) and ultimately, the specialization and division of labor. He argued that economic activity is fueled not only by the workforce, but by the skills and qualities of all members of society. Smith recognized three advantages of the division of labor that lead to great economic growth: (a) increase of every employee's skills, (b) saving time and (c) better use of capital equipment. For Smith, labor productivity depends on its division and is a key source of growth. Productivity improvement can occur through job specialization, as then each employee is engaged in the work where he may be most productive.

Edwin Chadwick (1800–1890) was the first to understand the importance of introducing general educational systems to increase the quality of human capital. Therefore, he highlighted the role of human capital accumulation, institutions and preferences (financial incentives).

The idea that education can provide benefits, including financial benefits, is nothing new. However, the use of human capital to reflect the economic impact of education and training began to develop mainly from the late 1950s onward. Most economists, prior to World War II, considered the benefits of education to be primarily political and moral rather than economic, while tending to ignore the role of education in their economic views (Harberger, 1998). After World War II, however, there were signs of growing familiarity with the concept of human capital as an intangible asset and the economic value of education (Bowman, 1966).

Knight (1941) linked economic freedom with the accumulation of human capital. Harrod (1943) used human capital to examine its relationship to unemployment and living conditions, emphasizing that unemployment could lead to a devaluation of human capital. Friedman (1943) used the concept of human capital and linked it to fiscal policy as well as to choice, opportunity and personal income distribution (Friedman, 1953). Fisher (1946) stressed the economic dimension of educational policy and the need for education to be considered an economic policy tool. He believed that education not only improves the performance of the human factor, but also improves equality in income distribution. Spengler (1950, 1955) also made several references to human capital in relation to qualitative population analysis.

In 1950, Solow (1956) and Swan (1956) developed the external neoclassic model of development (Dimand & Spencer, 2008). Solow's development model states that long-term development is achieved through capital accumulation, skilled labor (human capital), increase of the population and technological progress (Solow, 1956).

Since the 1960s, investment in human capital has begun to gain increasing attention. Becker's (1964) research was fundamental to the notion of the concept of human capital. With his book Human Capital, which was an important step in establishing his reputation and provided a comprehensive picture of what had already become known as the theory of human capital, Becker said that individuals make choices by investing in human capital based on the rational benefits and costs involved in making a return on investment, as well as the cultural dimension. Becker (1964, 1975) defined human capital as activities that affect future financial and mental income by increasing resources toward humans, and its main forms were considered to be learning and training within work, although he also included medical care, immigration and search for information on prices and income into his view. He focused on developing a general theory of investing in human capital and not just assessing the return of these investments. His work included an explanatory framework for concentrating investments in human capital at a younger age and the personal distribution of income, based on the process of human capital accumulation, thus continuing Mincer's work (1957, 1962). Furthermore, Becker (1975) dealt with the estimation of the rate of return of investments in human capital, which is analyzed in several previous studies or researches of human capital and became the cornerstone of education economics (Blaug, 1985). He focused on the case of general training (provided that the case of specific training could be done in a similar way), analyzing how the returns and costs of human capital could be inserted into an equation representing the present value of the net profits of an individual's entire life.

Schultz (1961) and Mincer (1958, 1974) contributed to the role that knowledge and skills play in improving productivity, while at the same time contributing to the study of the impact of human capital on the formation of an individual's income. Subsequently, various scientific approaches were developed to a wide range of topics. These are issues related to a number of productive inputs such as the role of learning that a person acquires at work, as well as the individual health reservoir, but also issues such as that of immigration as a form of investment in human capital. In addition, issues such as the contribution of education to the improvement of the society's standard of living and to the formation of high rates of economic growth were developed.

More recently, various researchers (Easterly & Levine, 2001; Hall & Jones, 1997) have argued that the difference in income between different countries is due to different rates of technological change. This is closely linked to the quality and skills of human capital, which enable this change to be driven or adapted (Nelson & Phelps, 1966; Romer, 1989, 1990).

Particular emphasis on the role of human capital is given by theories of endogenous growth (Lucas, 1988; Mankiw et al., 1992) based on which economies should improve the quality of their educational system, give more opportunities to individuals to participate in production and facilitate socio-economic development. Such actions are expected to have a positive impact not only on human capital, but through their contribution to it are expected to have a significant impact on the overall economy.

Two categories of growth models have recently been developed (Lucas, 1988; Romer, 1990). According to the first category of models, the accumulation of human capital is the one that has the ability to sustain the development process. In other words, these models treat human capital as a productive factor that sustains and enhances economic growth. Within this category of models, new knowledge, which is considered an essential component of the productive process, enhances the productivity of both the workforce and capital (Lucas, 1988).

Lucas (1988) places particular emphasis on the accumulation of human capital, that is, the acquisition of new knowledge, as an alternative source of sustainable development. Regarding this process, there are two main sources of knowledge which are education and learning by practice (learning by doing). According to Lucas (1988), human capital has two types of effects: the internal productivity effect and the external productivity effect. This means that the reservoir of human capital held by an individual makes him capable of boosting the productivity of the labor force through two channels. On the one hand, he can increase his individual productivity (internal effect), while on the other hand, through its diffusion, human capital increases the productivity of other employees.

In the second category of models, economic growth depends on the already existing reservoir of human capital, which has the ability to create new knowledge or to constitute the appropriate condition in order to make it easier to imitate/adopt foreign technologies. Their main difference compared to the previous category lies in the consideration of the already existing reservoir of knowledge as a source of creation of the positive externalities created by human capital. That is, in these models, the two main factors that can cause knowledge increase are, on the one hand, human capital and, on the other hand, the already existing reservoir of knowledge. The main representative of these models is Romer (1990), who argued that on the one hand knowledge cannot be kept secret and on the other hand, that the productivity of human capital in the process of producing new knowledge will be increased in cases of large initial knowledge reservoirs.

The study of Nelson and Phelps (1966) is also included in the same category of models, where they share the view that economic growth is caused by the reservoir of human capital, affecting the ability of economies to promote innovation, enabling them to bridge the gap with other, more developed economies. According to their own approach, the growth rates of productivity and the growth rates of innovation are positively linked to the level of education, mainly to secondary and tertiary education. Moreover, in the work of Nelson and Phelps (1966), human capital is not considered exclusively as a simple input of the productive process, but is treated as the main source of innovation. Therefore, since the growth rates of an economy are positively related to the growth rate of innovation and the rates of diffusion or adoption of the already existing knowledge, the level of human capital that exists in an economy is of particular importance (Aghion & Howitt, 1998).

2.3 Human Capital and Sustainable Development, Sustainable Governance, Inclusive Development and Development-Friendly Human Behaviors

The first quarter of the twenty-first century is the time when the economic science that deals with growth is based on the endogenous, micro-grounded approach to development. Thus, the prevailing theoretical construction seeks the main sources of growth in knowledge and innovation, when human behavior is based on individual rationalism, while the concept of endogenous development was developed, introducing, at the same time, elements such as technology change and population growth rate (Petrakis, 2020a). Economics, in its effort to expand its capabilities, has focused on the inclusion and investigation of human behaviors, such as the role of psychological behavior of individuals in making economic decisions (Petrakis, 2020a).

Social sciences and especially economics, in great historical moments of their evolution, relied on conceptual loans from related scientific fields for the analysis of concepts and behaviors (expectations, animal instincts, economic behavior, etc.) (Petrakis, 2020a, b). It is therefore clear that interdisciplinary research that recognizes the diversity of interconnected forces that operate at multiple levels is necessary. However, since we accept the need for a general and integrated growth approach, it makes sense to look for theoretical constructions that can describe and interpret the general context of the coexistence of different synthetic elements and behaviors of societies.

A modern perception of political economy and a structured version of the comprehensive analysis of development and growth for an economy should take into account the role of human capital in these four areas of policy analysis and implementation.

Sustainable development (Petrakis, 2020b; Petrakis & Kostis, 2020a, b) is an attempt at a holistic approach to human activity in relation to the environment, the economy and society. Thus, it perceives these three dimensions as equal, in a single system where one factor influences the other and all are interconnected. In this context, the structure of production and consumption is directly related to the quality of the environment and the availability of natural resources. On the other hand, the environment is directly related to the quality of life and the level of health of human capital and all this together drastically determine the productivity and development of the economy. At the same time, sustainable development "leaves no one behind," that is, avoids exclusions and attaches great importance to reducing economic inequality in an effort to increase the percentage of society that enjoys the fruits of development.

As Osiobe (2019) notes, human capital is an essential component for achieving sustainable economic development, as it is based on the optimal use of available resources (Arrow et al., 2004), and meeting the needs of the present without limiting the capacity future generations to meet their own needs. Essentially, according to Kawano (2013), there is no country capable of achieving a continuous course of economic development without significant investment in human capital. Lucas (1988) suggests that the accumulation of human capital is translated into sustainable economic development and that education is the main mechanism through which knowledge is accumulated. Romer (1989, 1990, 1994) showed that human capital stimulates economic development and can lead to innovation. At the same time, population and workforce increase is a positive factor in stimulating economic growth as a larger workforce means more productive workers, while a larger aggregate population increases the potential size of the domestic market.

Sustainable development depends on sustainable governance (Petrakis, 2020b; Petrakis & Kostis, 2020a, b). The sustainability and development of the economy depend on the structures that support it, setting the framework and goals. In other words, it depends on political and economic institutions. The effectiveness and culture of these institutions largely determine their resilience to adapt to new situations but also the economy's and the country's resilience (Petrakis, 2020a).

Governance consists of the traditions and institutions through which power is exercised in a country. The role of human capital is crucial for governance as it relates to: (a) the process by which governments are selected, monitored and replaced, (b) their ability to design good policies and implement them successfully and (c) the level of respect by society and the state to institutions and the economic and social interactions between them. The better the governance of a country, the more effectively it can respond to internal and external challenges, absorb vibrations and adapt to new situations. Coherent and long-term policy-making is the vehicle for the transition of society and economy toward sustainability. But this does not happen automatically. On the contrary, it requires strong political will to support institutional structures and undertaking initiatives, which are a great challenge for governments. At the same time, it is necessary to claim long-term policies from as many parts of society as possible and especially from the middle classes of countries.

Inclusive growth (Petrakis, 2020b; Petrakis & Kostis, 2020a, b) examines social cohesion, focusing on issues of income inequality, inequality of opportunities and social mobility. The well-being of the citizens that fuels economic development is largely shaped by indirect non-income factors, which are, however, necessary for the exploitation and creation of economic opportunities. Key examples are education, health, infrastructure, social activism, social cohesion, impartial justice, gender equality, etc. Everyone should have the same opportunities and be able to take advantage of them. However, despite the increase in prosperity and wealth for most societies and economies of the world, there are still various problems that prevent inclusivity in terms of equal opportunities for exploitation for all. For example, in most developed economies, there are issues related to high income inequalities, the reduction of the size of the middle class, unequal opportunities between men and women, access to education, etc.

When we adopt development without exclusions, poverty and income inequality are two of the most important indicators to monitor. These two factors affect access to opportunities but also the potential for social mobility with implications for social organization and individual elevation. Individual elevation (social status) depends on policies that promote social mobility in countries, as the latter is able to affect education, career prospects, quality of health and generally, the opportunities and dimensions of the individual that shape his well-being. Social mobility is directly related to income mobility from changes in wealth and income and may involve downward or upward movements in social stratification.

The elaboration of development-friendly social behaviors is the last place where the political economy of development and growth is developed.

The exact magnitude of the influence that culture has on economic development is an issue that requires an interdisciplinary approach, engaging scientists in economics (Schumpeter, 1934), psychology (McClelland, 1961) and sociology (Weber, 1958). The cultural background consists of the set of values and perceptions that prevail within a group of people. It constitutes the common values, the demands, but also the expected behaviors. The cultural characteristics of each society were formed gradually and in the overtime, shaped by factors such as historical conditions, language, philosophy and religion. The cultural syndromes of societies are the link between these distant factors and today's reality. Culture can have specific and significant influences on economic development, either as a support or as a deterrent. One of the most important properties of culture is its durability over time, as it reflects psychological and social stereotypes that have been formed over the centuries. These stereotypes themselves are generally highly resistant to change or redefinition (Kafka & Kostis, 2021; Kostis et al., 2018). The long-standing nature of the stereotypes that shape the cultural background can be explained by two alternative interpretations. The first has to do with the exogenous character of the forces that have shaped them (environment, climate, etc.), while the second presents the cultural background as an endogenous creation of human civilization (Petrakis & Kostis, 2013, 2014).

In conclusion, both the "portfolio" of cultural syndromes that are cultivated and reproduced within a society and the specific weight that each of them carries within this framework are extremely important for economic growth, especially in countries that need to accelerate their economy with usually restraining character mainly due to their ability to change in the long run.

2.4 Human Capital, Knowledge, Intangible Capital and Productivity

The prevailing view in literature is that human capital is one of the most important factors of productivity and other economic results, especially in recent years when economies are highly dependent on the education of their members.

In recent years, more and more economies are using new technologies which they combine with developing the skills of their inhabitants and improving their way of life. As a result, competition between countries is greatly intensified. Economies need to focus on catching up with international competition as the demands of their residents grow as they look forward to strategies that will keep their economies in a high position internationally.

Such a strategy could be to improve the quality of formal and non-formal education resulting in better trained workers, which would result in a higher return on investment for the same amount of money and thus increase human capital productivity. Benhabib and Spiegel (1994) note that a more educated workforce is able to innovate faster.

The level of education and literacy of a country generally reveals and reflects the knowledge, skills and level of economic development and freedom enjoyed by the human capital of that country (Bloom et al., 2014). Essentially, human capital training allows individuals to manage existing physical capital more efficiently, while at the same time leading to the creation and diffusion of new technologies but also to the ability to imitate successful techniques used in other developed economies (Romer, 1990). Nelson and Phelps (1966) argue that the ability to adopt new technology is determined and facilitated by the reservoir of human capital that produces it. Of course, in order to achieve satisfactory levels of education and literacy, a series of policy interventions are required which aim at improving the quality of education, increasing participation in it and especially at high levels of education (tertiary). Such policies are directly linked to increasing knowledge, skills and competencies and are expected to improve the level of human capital productivity by improving the economic performance of countries (Glewwe et al., 2014; Olamosu & Wynne, 2015; Sarquis & Arbache, 2002).

The theory of human capital that was developed in the early 1960s argues that human capital—as intangible capital—is one of the key determining factors of economic growth through the improvement of the workforce's quality and the increase of its productive capacity. Thus, human capital education is a factor that drives the increase of productivity in neoclassic growth models where technological progress is exogenous (Mankiw, 1995). Human capital and productivity models are based on the assumption that knowledge and skills embedded in human capital directly increase productivity and increase an economy's ability to develop and adopt new technologies (de la Fuente, 2011). This argument was based on the existing theory of human capital which considers tertiary education as an investment good whose evaluation depends on perceived productivity beyond alternative investments. Recognizing the difference in productivity leads the job employer to reward tertiary education with a higher income. However, the relationship between tertiary education and productivity remains questionable in the literature. It is argued that tertiary education helps to identify the individual with specific qualities, and once recognized, tertiary education has absolutely no effect on these possibilities during the school period (Devadas, 2015; Menon, 2016).

Lucas (1988) argues that the level of productivity in an economy is determined by the average level of human capital that produces it. He emphasizes that the average human capital reservoir at the economy level increases productivity at the business level by keeping the company's human capital reservoir stable. Azariadis and Drazen (1990), and indirectly Lucas (1988), also point out that younger people are likely to benefit from the knowledge and skills that older people have accumulated, thus creating potentially important intergenerational externalities that work both at home and at school. Romer (1990) notes that improving productivity depends on the number of people who spend their time accumulating new ideas and the existing reservoir of ideas. At the same time, Mankiw et al. (1992) argue that the reservoir of human capital creates innovation. Thus, a nation with a higher reservoir of human capital tends to experience higher productivity. Becker's (1962) theory of human capital argues that productivity-improving education is due to the correlation between education and wage improvement.

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CHAPTER 3

Human Capital and Structural Economic Transformation

Yorgos Pisinas

3.1 Introduction

The concept of human capital is acquiring ever-increasing importance in economic theory, assuming a central role in the ongoing discussion of sustainable growth (Buta, 2015; Maremveliotakis & Manioudis, 2021), with particular relevance to the countries of the Global South (World Bank, 2019). Contemporary literature, which treats the subject matter from several angles, is particularly abundant, offering very useful material for planners of economic policy (Dui, 2020). Human capital is a central concept in today's economic theory that may not only lead to economic growth, but plays an integral part in that process (Galor & Weil, 2000; Romer, 1990; Stokey, 2020).

The scope of this chapter to present how human capital is related to the economic structure of a society, and how both usually differ from a

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country to another. In this chapter, we will unravel this relation of human capital to economic development. Meanwhile, we will try to provide a more delicate conceptualization of human capital instead of conceiving at as mere accumulated knowledge. Doing so, we will find how it relates differently to different economic structures.

Initially, in Sect. 2.2, human capital and its application to growth theory are shortly introduced and its current state is briefly presented. Next, in the Sect. 2.3, we delve our understanding of human capital deeper. In this part, we present how historically our understanding of human capital has evolved, and how we conceived it differently based on its field of application. Five different categories of human capital are introduced: General, Firm-Specific, Industry-Specific, Occupational, and finally, Task-Specific human capital. In Sect. 2.4, we reconstruct our understanding of human capital, based on the previous historical analysis and synthesize human capital theory to occupational analysis. Finally, in Sect. 2.5, we employ this understanding of human capital to comprehend its relation to different national economic structures at a first, broad way. There, contrary to theorizing how a mere accumulation of human capital leads to economic development, we focus on how the refiguration of production structures affects human capital needs.

3.2 Human Capital Matters

In short, we may say that the pioneering work of R. Solow during the 50 s on matters of economic growth (Solow, 1956) led to the accounting of growth and the uncovering of the "residual" (Romer, 2018). Solow's residual is the portion of (per capita) economic growth which cannot be accounted for by the increase in factors of production. Today, 70 years later, Solow has paved a path for the study of the subject matter of growth.[1]

The size of the residual in the previous century indicated that economic growth remains largely unexplained by the accumulation of capital.

[1] At the same time, a series of great methodological issues and criticisms arose which have become known as the two Cambridges' debate. In short, the criticism could be said to concern the inability to arrive at aggregate production and it concludes, among other things, that the residual is arbitrary. As a matter of correct scientific practice, we ought to point this out, as well as pay homage to this largely disregarded moment of contemporary economic science (Fine, 2016, pp. 110–127, Lavoie, 2014, pp. 47–70).

Indeed, the size of that residual has significantly increased in the course of time (Goldin, 2016). If capital accumulation cannot explain growth, then economists need to turn to other categories in order to understand the dynamic course of economies. One such concept, to which economists turned to better understand growth, is that of human capital. Indeed, it is argued that incorporating in models growth in terms of human capital (e.g., investments in education) may reduce the "residual"[2] up to 20% for the previous century,[3] while the outcomes of education will have to be considered even greater if the positive externalities which they present are also added (Goldin, 2016). Research has ascertained that 22% of per capita income in sub-Saharan Africa can be attributed to human capital while, respectively for OECD countries, that percentage is 33% (Dui, 2020).

The initial conception of human capital was as a main factor of production (knowledge and skills), investments in which were accumulated and boosted the productive capacity of economies. From a macroscopic, historical perspective, the accumulated quantity of human capital in the last two centuries (particularly from the twentieth century on) has certainly catapulted (Goldin, 2016). Today, however, the state of human capital is not ideal, despite the massive spread of schools during the previous century across the entire face of the planet, which has led to a significant increase in the overall levels of human capital overall (Winthrop et al., 2018, Goldin, 2016). Two of the most pronounced features which perplex researchers are the intense inequality in skills, as well as the uncertainty regarding the skills provided by the current educational system internationally.

As regards the inequality of skills, it is thought that there is a 100-year gap between rich and poor in terms of the levels of education they receive (Winthrop et al., 2018). This gap emerges on the basis of both quantitative and qualitative terms, as it relates to both admission and dropout rates, as well as the outcome of one year of education. Although this gap largely concerns the difference between the Global North and

[2] The residual, by definition, measures every time the deviation of the true growth indices from those of the model used. Thus, the incorporation of different categories ought to reduce the quota of non-explainable growth.

[3] However, human capital does not significantly reduce the residual in periods preceding the twentieth century. One possible explanation for this peculiarity is that there was no correspondingly significant accumulation of human capital in those periods.

Global South, a significant part of the inequality comes about through internal inequalities in the various nations. One characteristic case is that of India which despite having almost 40% illiteracy has five times as many graduates of tertiary institutions as China, which has wiped out illiteracy (Asuyama, 2011). Yet, the issue is not restricted to the Global South as, at the opposite side of the international spectrum, US students evince the greatest deviation with 66% of prosperous students attaining to high levels of mathematical ability by contrast to almost 25% of poorer children (Winthrop et al., 2018).

As to the matter of uncertainty, the breakneck technological developments (Winthrop et al., 2018) which affect the work environment to a significant degree—as do the wider sociopolitical developments of the twenty-first century (González-Salamanca et al., 2020; Winthrop et al., 2018)—prompt an extensive and thorough debate on the restructuring of educational policy, in both form and content.

Thus, human capital is one of the most crucial categories taken up by economists in relation to issues relating to growth and, more broadly, to the development of societies and of the economies which support them. It is clear that its importance is not merely theoretical but has many important inroads in the application and exercise of economic policy. Particularly for countries which aspire to develop speedily and bridge the gap with Western developed economies, the correct application of policies for the development and management of human capital may lead to thoroughly different paths of development. As Asuyama notes while comparing two diametrically opposed policies for the development of human capital in China and India, "examining quantity, quality, and distribution of skills and the mechanisms of how these skills are generated in an economy, has important implications for understanding the path of economic development in the past and the future" (Asuyama, 2011).

With technological change taking place at a rapid rate, especially at present, the significance and productivity of human capital are estimated to be particularly upgraded (World Bank, 2019). Today, the relative returns of a year of high school education remain at approximately the same levels as in 1900, despite any changes in the intervening time (Goldin, 2016). The returns of education, besides expressing human productivity, are subject to the laws of offer and demand. The importance of education today, therefore, remains central despite criticism of its form and contents as this has not substantially changed from the last century (Goldin, 2016; González-Salamanca et al., 2020). Despite the enormous rise in the offer of human capital in the preceding century, it appears that it lags behind in relative to technological developments. At the beginning of last century, the productive structure required people who could read blueprints and possess basic arithmetic and literacy skills so as to print scribbled notes, but today the needs for different kinds of knowledge and skills have evolved to a completely new level. To analyze this type of changes, however, a more in-depth incursion into the concept of human capital is necessary. In the next few paragraphs, we will present such a more detailed analysis of human capital along with the historical development of that concept. A more thorough investigation of the contents of human capital opens yet another field of analysis in terms of the planning of relevant policies. Thus, in addition to the motives, extent, intensity and time-frame, connection with labor, etc., the contents of such policies may also be subjected to thorough analysis.

3.3 Conceptualizations of Human Capital Based on Its Field of Application

Leaving aside the issue of health, as noteworthy as it may be, and focusing on the features of knowledge and skills, which are variable, it can be observed that the evolution of the concept of human capital increasingly tends to revolve around the characteristics of employment and the corresponding demand in competencies.

The theoretical treatment of human capital in the literature that came in the wake of G. Becker's seminal work, in 1964, concerned two types of working skills: the "general" kind which was employable by every employer and the "firm-specific" kind which specifically related to a specific business (Becker, 1994). In his work, Becker analyzed the general type of human capital and its importance, and in these terms, the analysis of the overall investments in education is indeed of particular value. According to these models, investments in human capital may be approached through the addition of years of someone's participation in an educational process and the assessment of the average quality of those services,[4] while another possible approach involves the differentiation

[4] For an analysis regarding years of schooling and levels of education, see Goldin (2016) and World Bank (2019), for the nineteenth-twentieth and twentieth-twenty-first centuries, respectively.

of the labor force on the basis of levels of education and the consequent treatment of human capital (Acemoglu & Autor, 2010; Asuyama, 2011). As we will see, however, these approaches cannot discern the content of educational policies and, therefore, of the human capital that is accumulated and made available to the markets.

Current research has the capacity for a more detailed approach to human capital and the transferal of skills (Nawakitphaitoon & Ormiston, 2016). This direction was initiated by K. Shaw when she introduced the concept of "occupational investment" in relation to human capital, noting the presence of common elements based on the distance separating two different occupational activities (Shaw, 1984). According to this approach, it is estimated that there is the possibility of transferable skills in the course of changing an employment position, which bears on the proximity (or distance) between two different work posts. Shaw noted the high explanatory value of the concept she introduced compared to a simple index of employment experience. Thus, the returns (and, hence, the productivity) of workers can be much better analyzed on the basis of the different paths of knowledge and experiences which the individuals have chosen to follow in their career, rather than the sum total of that experience in temporal terms. Based on this approach, if someone deals with an object that is related to the career path the person has chosen overall, it is anticipated that they will have a higher performance due to the relevant experience they have accumulated in the past. By means of this reasoning, an important step was taken, going beyond the initial, oversimplifying approach to human capital, which distinguished between a perfectly specific type of the concept (not useful when someone changes their job, e.g., how a company operates, the names of people in key positions, etc.) and a perfectly general type (which could be useful in all kinds of employment positions such as knowing the alphabet and knowing how to talk and dress).

Empirically verifying Shaw and furthering her findings, D. Neal posits that there are indeed transferrable skills as employees who lost their job and were rehired are remunerated according to their previous work experience (Neal, 1995). As he notes, it is amiss of the literature up to that point to restrict its scope to a particular type of human capital that is firm-specific, instead of focusing on various occupational skills.

Thus, the concepts emerge of "industry-specific" and "occupation-specific" human capital which are categories of human capital with a wider field of application than the firm-specific type as encountered in Becker—though not a universal one, like the high-level abstractions bequeathed by classical political theory (Maremveliotakis & Manioudis, 2021; Smith, 2007; Spengler, 1977)—which are utilized in the analyses we described at the beginning. According to this approach, the knowledge and skills which people accumulate are put to use within a branch (e.g., knowledge of foreign languages in the tourism industry or knowledge of biochemistry in pharmaceutical companies) or in comparable positions of employment (e.g., the organization of work timelines by secretaries).

Thus, we have a range of different approaches to human capital based on their scope of application. There is firm-specific human capital, industry-specific human capital, occupation-specific human capital, and finally, the general type of human capital which has a general application. Leaving the last one aside, the degree of explanatory value of these types in relation to the workers' earnings has been compared in order to arrive at which one is the most important for workers' development and the increase of their productivity. Both Neal's research (1995) and research conducted several years later concur that the occupation-specific human capital approach is crucial in determining income and even appears to be more important than the firm-specific or the industry-specific types (Kambourov & Manovskii, 2009).

Yet another way of conceptualizing human capital is undertaken by Gibbons and Waldman (Gibbons & Waldman, 2004) who introduce the notion of "task-specific human capital," linking the accumulation of human capital with the particular tasks of a given occupation. The distance between this category and that of "occupation-specific" human capital is fairly small[5]; however, the latter category especially makes possible further analysis regarding the required human capital (in terms of knowledge and skills) based on the particular characteristics of every occupation. According to the reasoning introduced here, rather than distinguishing the various fields of application of human capital on the basis merely of abstract occupational categories or branches, Gibbons and Waldman note that the application (or not) of a type of knowledge or competency (i.e., one unit of human capital) is linked to the various tasks which the employed are charged with carrying out.

[5] And if one considers that the occupational tasks are distributed equally among the workers of an occupation, or that they have a cyclical distribution, as Gibbons and Waldman claim, then, that distance is even smaller (Gibbons & Waldman, 2004).

Based on Gibbons and Waldman's logic, it becomes possible to understand that the range of occupations does not consist in a one- or two-dimensional continuum upon which we distinguish between vocations by means of the distance between them (Autor & Handel, 2013) as suggested by Shaw (1984). In actuality, the occupational spectrum is a multidimensional space defined by the multitude of the different tasks performed at every vector, each of which makes up a dimension that has a different requirement of human capital insofar as it is linked to a different type of human capital.[6]

3.4 From Human Capital to Occupational Characteristics

Developing this logic further, we can argue that the characteristics which used to be considered as restricted to one sector or to specific occupational categories are now recognized to have a wider value for several occupations, based on the intensity by which certain tasks need to be carried out. For example, knowledge of foreign languages as an asset of human capital has its field of application in the sector of tourism, as mentioned previously. Now, however, it assumes another dimension. The sector of tourism employs this type of human capital due to the high intensity of the task of written/oral communication with people of other ethnicities. However, this is not the only sector that manifests the need to carry out this task since the same need is also present in international sales, in commerce and journalism, and in diplomacy and state administration. Correspondingly, the above task is not the only one that utilizes this knowledge/skills since several occupations do likewise, at different intensities and qualities, such as, for instance, publishing and translators, or education and foreign language teachers, or study programs in the humanities and cultural research (ethnological and folklore studies, intercultural studies, etc.)

Finally, it is noteworthy in the context of the above literature that, despite the multiple models and varied approaches to the subject (Borjas,

[6] Therefore, the distance between two occupations is characterised by the differentiation of their n components/dimensions, where n represents the number of all possible tasks. Human capital requirements for each occupation are derived from this n-dimensional vector of tasks which represents the content of labor.

2015), the discussion of human capital is not a merely theoretical treatment but, on the contrary, a discussion empirically founded on research into workers' earnings, and it has important ramifications for proposals on economic policy or the management of corporations. More particularly, changes in these earnings, as in the various subcategories of the labor force—on the grounds of education (Acemoglu & Autor, 2010), experience (Kambourov & Manovskii, 2009; Neal, 1995; Shaw, 1984), or the field of entry into the workplace (Gibbons & Waldman, 2004)—show the changes in labor's productivity though they are also, to a large degree, based on the demand for various skills as Acemoglu and Autor (2010) succinctly note. In the present text, we are mainly concerned with highlighting the theoretical foundation of the various categories and conceptualizations of human capital employed in the literature. As noted, for a long period, a one-dimensional perception prevails in the approach to skills. According to it, the concept of human capital resembles more a polymorphous, malleable "capital" which is accumulated in one direction. By contrast, as noted by Shaw (1984) and even more emphatically by Gibbons and Waldman (2004), employees follow certain (career?) paths. Consequently, the matter of skills needs to be investigated along a more multidimensional direction. Even quite recent studies analyzing different categories of skills (with the help of O*NET which will be described in the next chapter) often opt for reducing them to a single dimension (low, middle, and high skilled) based on the level of education (Acemoglu & Autor, 2010). Using a framework based on occupational characteristics, a more multidimensional analysis becomes possible.

3.5 Structural Change, Development and Human Capital

It is generally accepted in economic thinking that an economy's development and growth are closely interwoven with its structural reform (Duernecker & Herrendorf, 2017; Giouli et al., 2021; Woldemichael & Shimeles, 2019). Kuznet argued that structural reform is one of the most basic parameters of economic growth and, moreover, that it may be correlated with a range of important socio-economic factors (Kuznet, 1973). Some of the factors Kuznet noted, among others, are the change from personal labor to partnership and the establishing of companies, urbanization, which goes together with the exiting of the labor force from the agricultural sector, and the family model. Almost half a century later, the process of development globally remains closely linked to the economies' structuring and Kuznet's insights are still relevant. For instance, today in Africa, the process of urbanization is the most conspicuous structural transformation, happening at such a fast rate that there is no time for cities to absorb the new labor force, develop properly, and create new places in the labor market (Collier, 2017). For countries of the Global North, too, the economies' structural transformation entails central issues related to labor such as productivity, working hours, racial discrimination (Borjas, 2015), and issues of gender parity (Ngai & Petrongolo, 2017).

Now, how can an economy's structuring be assessed, when it is primarily a qualitative feature? Further, how can the assessment of this qualitative feature be couched in quantitative terms, so that it becomes possible to track its change? As regards economic activity at the level of sectors, the most common measures are the following three: percentage of employment (in relation to overall employment), percentage of added value (in relation to the overall production), and levels of final consumption. Although fairly often in the literature, these three measures are considered of equal value and are treated as interchangeable, it must be noted that there are important differences between them (Herrendorf et al., 2014). To start with, the first two measures have to do with production while the third with consumption. They exhibit consistent deviations precisely because they refer to different measures. In the present context, the measures of greatest relevance are the ones to do with production, along with the special features that underpin each one. The approach based on employment percentage concerns the distribution of the labor force across the different sectors, yet, although it is the most appropriate measure for needs in labor force (and hence, indirectly, for human capital) it fails on its own to provide a full picture, since labor presents different features in each sector. One way of making up for this gap is using a second measure for the assessment of structural transformation, the percentage of added value, so that we can take into consideration how much each sector contributes to production. The discrepancies between the first measure (percentages of unemployment) and the second (percentages of added value) can explain the different characteristics of labor in terms of productivity for each sector.

From a macroscopic point of view, we may note the general characteristics of the development process. From such a perspective, the process of an economy's development and growth follows a course in which the focus of production shifts from sectors with low productivity to sectors with high productivity and, through this shift, the per capita Gross Domestic Product grows as the economy is restructured. The first economic sector in the course of this is the primary sector from which all the products derive and consequently people use them in their daily living. We might say that all civilizations derive from nature and its exploitation. Thus, an economy in its first stages of development is agricultural. Gradually, however, as it develops tools (capital), it becomes increasingly productive and frees up labor which can then turn to processing the product, thus gradually developing an industry wherein those tools are also produced. The last station along this route is the development of services, toward which the workers move as the overall production increases in combination with the complexity of the production structure.

The movement in the three basic sectors of every economy in terms of per capita GDP can clearly illustrate this (Duernecker & Herrendorf, 2021). It is easy to observe how percentages of employment in the agricultural sector diminish, since, as an economy develops, the labor force initially moves toward the secondary sector and, increasingly, toward the sector of service provision.

Yet this process does not take place automatically. In a microeconomically founded analytical framework, the above scheme appears logical and sufficient as an explanation for development and structural transformation. The labor force transits from sectors with lower productivity (and, so, returns) to sectors with higher productivity, due to its motives of maximization. Moreover, in a similar framework, differences in productivity lead to motives for the accumulation of human capital (Borjas, 2015). Things, however, are not quite that simple, since, although in many countries the difference between productivity in the agricultural and the other two sectors may be especially pronounced, this, on its own, does not suffice to lead to movements of the labor force that would amount to a structural transformation (Woldemichael & Shimeles, 2019). Previous conceptualizations of human capital can explain this deficiency, as human capital establishes and fosters this desirable movement of labor from agricultural production to the other sectors. Nevertheless, every industrial sector requires a different quality of human capital and this movement, especially, requires an increased quantity of human capital (in the sense of investments in knowledge and training). When someone is working in the agricultural sector with low levels of productivity, it is not required that they possess any high level of human capital; by contrast to working in industry and, even more so, in service provision, they need, as a rule, to possess a minimum quota of human capital. That quota is higher than in the past, especially today when a large part of the repetitive labor previously performed by unskilled workers is assigned to machines. This may explain the inability for structural transformation noted by Woldemichael and Shimeless (2019). Also, it may explain why the productivity of the agricultural sector assumes critical importance, as it allows for massive investments of human capital (Goldin, 2016) which, in turn, may make possible this structural economic transformation.

Within a macroscopic framework, with the differentiation of economies in the three roughly sketched economic sectors and the treatment of human capital as industry-specific, we have thus far shown the close mutual support between an economy's structuring and the human capital which it has accumulated.

Through the combined observation of the historical development of the percentages of employment and those of added value, we can form an initial picture of the requirements in human capital within a developing economy.[7] We observe that poor countries tend to have the largest part of their work force tied in agricultural production, although this is the least productive sector. Also, looking on the sector of service provision, we can see that its participation is significant even with low levels of development (it is responsible for at least 20% of the added value and 10% of employment), but, from a point onward, the extent of the participation of services in added value accelerates. We can also see that the industrial and service sectors, by contrast to agriculture, contribute to greater shares in GDP per capita than to employment. This is all the more the case in low-income environments, where the development process is conceivably still in the early stages.

At first glance, it would appear that during an economy's development, the same succession of qualitative changes occurs, although a certain caution is in order before accepting such a conclusion. We can observe that the quantitative and qualitative characteristics of various economies resemble one another, and a number of researches endorse similar conclusions. Despite, however, the similarity in the development of employment

[7] As mentioned previously, the difference between the ratios of employment and the ratios of the terms of added value, expresses the differences in labor productivity in each sector and, consequently, can comprise a macroeconomic index of the status of human capital in every sector.

and added value between countries, a range of data reside therein which diverge.

In economic theory, by contrast, it is expected that economies do not follow a similar course but, rather, that within the context of international commerce, they specialize in fields where they have the most returns (Krugman et al., 2014). So, although what has been mentioned thus far may indeed be the case for a closed economy,[8] when an economy develops in the context of open markets, a greater level of complexity needs to be sought. The experience of Europe's development shows that in open economies, although corresponding qualitative transformations may be occurring, there is a significant lateral diversity in those sectors where they actively engage, for every level of development (Herrendorf et al., 2014).

Consequently, economies do not develop in quite the simplistic way of the model previously described, and their structuring is not merely three-dimensional but rather multidimensional and highly complex. In reality, human capital plays a determinant role in supporting the structural transformation of economies as they develop and alter the overall structure of employment. Thus, in an economy, structural change is affected by change in the ratios of the different sectors (Duernecker & Herrendorf, 2017; Woldemichael & Shimeles, 2019) as well as by the internal shift in ratios within every general category (Haraguchi, 2016; Woldemichael & Shimeles, 2019).

In order to understand how a sector's internal structuring may differ, an example will suffice. Certainly, as previously stated, all economies have an agricultural production which, however, comprises different percentages of production per country and, also, it develops differently. To ascertain this, we might look at agricultural production in different countries. The data for such a comparison come from the Food and Agricultural Organization of the United Nations, through whose published data we can observe that important differences exist between food production in each country (FAOSTAT, 2019). For example, food production in Argentina for 2019 was primarily maize and soybeans, while in adjacent Brazil, these are in third and second place, as food production concentrates almost exclusively on sugarcane. Respectively, the USA produces mainly maize but also important quantities of milk or cows and soybeans,

[8] Considering, also, that there are more or less similar preferences within economies, leading them to develop along more or less common patterns.

Germany milk or cows, sugar beet and wheat, and France the same but in reverse order. Finally, India produces mainly sugarcane and rice paddy while China (which unlike the others, does not present intensive specializations) mainly produces rice, paddy, maze, and vegetables. It is thus obvious that even in food production, economies present differences in the characteristics of their structuring with some producing several products in common ratios, like China, while others specialize in one product like Brazil, or the Marshal Islands which produce exclusively coconuts. So, then, each country with its different climate produces different products. In all the food production data for 2019, it is not possible to find two countries with the same structuring even if we are looking at a very small subset of their production, i.e., food production. We find corresponding differentiations from country to country for every level of the economy, whether this is agricultural production, processing, and industry or the service provision sector.

These differentiations among countries lead to differing requirements in terms of human capital, as the labor force must work under different conditions to perform different tasks, interact with a wealth of technological equipment, and offer diverse products and services. In the next chapter, we will see how these differentiations of needs in human capital emerge out of the nature and characteristics of labor itself, and how it is possible to catalogue them.

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CHAPTER 4

Occupational Characteristics Analysis

Yorgos Pisinas

4.1 Introduction

We pointed out in the previous chapter (Chapter 3) that, depending on its field of application, the concept of human capital can be distinguished into different types. We saw that special significance in terms of these categories attaches to human capital that has to do with occupation. It was also shown how requirements for human capital are established in occupational tasks and how these can vary from one economy to the next while, despite shared general features in the development of their structuring, economies tend to evince differences in terms of the sectors they develop.

This chapter specifically presents how human capital requirements are affected by the economic structure, based on employment. Initially, in Sect. 4.2, some basic concepts on labor markets analysis are presented which are also necessary for any analysis on occupational information. Followingly, in Sect. 4.3, we delve deeper into the basic cohesive elements

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that can articulate human capital; the so-called occupational characteristics and their consequent competencies are presented. As this chapter shows, these characteristics can be derived from various databases, which are compiled by national or international authorities. Finally, in Sect. 4.4, the various forms of occupational characteristics are presented and grounded on occupational requirements and working activities. From the information in the aforementioned databases, and particularly O*NET, we are focusing on the core of knowledge, skills, and abilities, which pose the main occupational requirements (popularized as KSAs). Regarding these general categories, a coherent conceptual framework is formed which can distinguish the various concepts from each other, note their importance, but also show the strong mutual relations that they have and constitute a compact task-specific human capital theory. This innovative framework is of great preliminary importance in the attempt of an in-depth analysis of the role that human capital plays in economies.

4.2 Labor and Occupations

In relation to the discussion of the preceding chapter, current literature is paying increasing attention to the occupational characteristics which are shared by a group of kindred work positions and, therefore, comprise their defining characteristic vis a vis unrelated work positions (Shippmann et al., 2000). In that context, the need to improve measurement of work activities and skill requirements becomes increasingly evident (Tijdens et al., 2012) while, with time, there has been a substantial increase in the explanatory value of occupation in relation to earning differences (Acemoglu & Autor, 2010).

In this chapter, the analysis will be furthered of the structuring of economies and how it relates to human capital. Specifically, by contrast to the previous chapter where structuring was analyzed at an introductory level, here, we will probe the complexity of an economy's structuring at a particularly intensive level of analysis, which is the actual level of abstraction in research concerning developments in human capital terms (cf. Acemoglu & Autor, 2010; Giouli et al., 2021). We will thus see how, past the basic distinction into agricultural, industrial, and service provision, an economy is defined by contemporary research and economic policymakers by means of a range of occupational positions.

Before it becomes possible to describe in detail an economy's structuring in terms of occupational positions, a number of important concepts need to be understood about the job market and the information relating to occupations.

A position is defined as the sum of duties, activities, and elements which a single worker can undertake (Barros-Bailey, 2014). Each worker is employed in one position alone, which they cover. Hence, an economy has as many positions as it does employees. The description of that position, i.e., the information that pertains to it, concerns the role of the worker and the specific duties assigned by the employer. An example of a position is the work performed by worker X at the X company, for which they perform X duties. So, when someone is looking for a job, they are looking to be employed in a position, while when someone is looking to hire someone, they are looking to cover a position. In the job interview process, the information described concerns the position offered by the company.

A job concerns the work performed by a team or group of people who are doing related work. The concept of a job describes a sum of positions which are the same in their basic characteristics, within the context of a company (U.S. Department of Labor, 1991). So, although, in the context of a business, there may be many positions, these can be categorized into certain jobs. At a supermarket, for instance, though one finds many people working there, they can be categorized into cashiers, delicatessen and milk product dispensers, greengrocers, butchers, cleaners, storeroom keepers, truck drivers, delivery staff, etc. Likewise, the staff working at the company's main office could be grouped, adding new categories to the list. A job is a sum of occupational activities which are common in terms of the work performed and share common goals to such an extent that the organization (i.e., the company which provides employment) decides to name the workers by the same job title (Brannick et al., 2007).

The categorization relevant to our analysis is that of occupation. An occupation refers to a sum of jobs which are encountered in more than one company and which, in turn, involve a shared sum of work activities and tasks so that they have common methods and practices and, hence, share common characteristics (Barros-Bailey, 2014). The occupation then concerns a wider categorization than the job. For instance, cashiers serve customers, type in the codes, and expedite payments while butchers prepare the product in the form desired by the customer, chop, weigh, and package, irrespectively of whether they are working all together at a company, which supermarket they work at or if they work at some other type of store or, even, in other sectors.

At the level of abstraction we are concerned with, the information describing occupations essentially comprises information about the structuring of an economy. Respectively, information about jobs concerns the internal structuring of a business, while information about a position concerns the tasks of a specific employee.

With these basic distinctions in mind and maintaining the requisite level of abstraction, we can now examine the characteristics of occupations. In terms of human capital, these analyses are based on approaches dealing with the competence of the workers in an occupation (Shippmann et al., 2000). Employees' competency is treated through a number of concepts such as those of knowledge, skills, and abilities (also known as KSAs or KSAOs). These kinds of approaches comprise a large group which considers knowledge, skills, and abilities as three types of occupational competencies. Although these approaches often use different terms, e.g., the last category (abilities) is often referred to in the literature as attributes, or they ascribe new additional concepts derived from a common reference group (e.g., experience, work activities, education, teamwork criteria, etc.), they are governed by a common logic regarding the distinctions between basic types of skills and may thus be studied as a single trend in the literature. The common trait of such approaches is that, once they have differentiated between various occupations in the job market, they seek to analyze the characteristics of the occupations based on their internal features.

In all these approaches, a leading role is played by the O*NET (Occupational Information Network) which is a development of the DOT (Dictionary of Occupational Titles) occasioned by the scientific community's steadily increasing use (and corresponding criticism) of the latter (Handel, 2016). The O*NET is more inclusive in content; it has a more contemporary approach as regards the economy and is also consistently maintained.[1] DOT had been put together in 1939 as an instrument to support the aim of the American Employment Service to match people seeking employment with various jobs. It was subsequently republished and revised several times, with the latest edition out in 1991, and this was the initial base on which O*NET was built. Although the DOT was published with a different aim in mind, already by the twentieth century, it had become a valuable tool for social research, hence the need for a change in form so that it could better serve its new function but also, so as to resolve a number of issues due to the great distance from the DOT's initial compilation.[2] These types of databases were collected by combining several sources: employees, employers, special analysts, psychologists, etc., through a process of interviews, questionnaires, and the analysis of the results (Handel, 2016). Due to the great volume of the work required, these databases are issued by National Statistics Services and by the relevant state and international bodies responsible for matters of employment.

These tools of international statistics services (such as O*NET) are particularly important for studies of the labor force and educational policy. Yet, state and international initiatives of this kind entail contradictions which very few steps have been taken to resolve, apart from the case of Europe (Tijdens et al., 2012). O*NET's equivalent at the European level is ESCO (European Skills/Competencies, Qualifications and Occupations)[3] which operates under the European Commission and CEDEFOP, based in Thessaloniki.[4] According to ESCO, vocations are differentiated on the basis of tasks and the 13.485 skills/competencies (which do not fully follow O*NET's logic[5]) fall under:

- Attitudes and values
- Knowledge
- Language skills and knowledge
- Skills.

By contrast, O*NET's more developed database[6] provides more features for every occupation, such as:

- Tasks
- Technology skills and tools used (referring respectively to the use of software and equipment)
- Knowledge
- Skills
- Abilities
- Work activities
- Detailed work activities
- Work context (e.g., e-mail, telephone, exposure to weather conditions, being responsible for others' health or safety, etc.).

The KSAs classification technology is a useful tool in Human Resources Management (HRM) and has been widely used by various organizations in their hiring process. Also, from the very start, it has been a critical tool of analysis of the wider work environment, the job markets, educational policy, etc.

4.3 O*NET

In the context of this theoretical framework and following the above literature review, the contents and logic of O*NET[7] will be utilized, in order to analyze how an economy's productive and work structure affects its needs in knowledge, skills, abilities, and working activities.

*4.3.1 Some Basic Facts About O*NET*

O*NET is the main source of information regarding occupational features, the speedily evolving nature of work, and how this affects the labor force in the USA. In the project, a central role is taken up by the descriptions of almost 1.000 occupations (1016) covering the range of the American economy, and these are freely accessible to the public.

Every occupation requires a different combination of knowledge, skills, and abilities, since the work is performed through a wealth of activities and concerns a plethora of tasks. Information about occupations defines the sum total of the above characteristics through data collected by officers of labor or specialists in employment. In order to track changes, given the fluidity of the field of labor, O*NET is periodically revised.[8]

ONET contains 1.016 occupations, out of which 923 have data available on them, divided into 23 large groups and 93 small groups of 459 broader occupations. A single code is assigned to each title, on the basis of its place in the classification.

To make sure that all occupations are classified in the same manner by the appropriate staff, a series of rules are followed, the most important of which[9] are:

1. The classification covers all occupations for which work is performed with a view to a wage or profit, including work performed in family businesses by family members who are not directly remunerated. Work undertaken exclusively by volunteers is excluded. Every occupation corresponds to only one category at the lower level of classification.

2. Occupations are classified according to the work performed, skills, education, and requisite qualifications.
3. The overseers of vocational or technical employees usually have a common background with the workers whom they oversee and are thus classified in the same category. Respectively, team leaders, master craftsmen, and supervisors of production/sales/service provision who spend at least 20% of their time on tasks similar to the workers' are classified together with the staff they oversee. By contrast, directors of the first line and supervisors of production/sales/service provision who spend over 80% of their time on supervision are classified separately.
4. Trainees and interns are classified in common with the rest, but assistants are classified separately.
5. If a work activity has not been clearly classified under an occupation, it falls under the corresponding miscellany collected by small or large groups of professions, which are not independently classifiable.
6. Workers who can be classified under more than one occupations are listed in the one with the higher skill requirements, and if there is no difference in skills, they are classified where they spend the majority of their time.
7. Data collection and related services must classify workers to the highest degree of analysis, despite the fact that the various services may have different degrees of their aggregation.

Thus, searching in the general family of "Constructions and Mining,[10]" one may come across a range of titles such as, for instance (Table 4.1).

The first part indicates the general category in which an occupation belongs. For instance (Table 4.2).

The second part of the code shows the more specific category in which an occupation belongs, while the third completes the unique code which now describes an occupation. In the example in Table 4.1, we notice that the second part of the code may be common for specific kindred occupations within an occupational family group, such as the supervisors in the construction sector and in mining. This occurs because the second part of the code relates to the characteristics of each occupation, so that same second part may appear in corresponding professions from other sectors which belong to different family groups, and, as such, have a different first part in their code.

Table 4.1 Examples of titles from the sector of "constructions and mining"

Full Code	*Title*
47-1011.00	First-Line Supervisors of Construction Trades and Extraction Workers
47-1011.03	Solar Energy Installation Managers
47-2021.00	Brick masons and Block masons
47-2022.00	Stonemasons
47-2044.00	Tile and Stone Setters
47-2051.00	Helpers—Brick masons, Block masons, Stonemasons, and Tile and Marble Setters

Source https://www.onetonline.org/

Table 4.2 Examples of the first part of the code for various family groups of occupations

First part of code	Title of Occupation Family Groups
47-…	Construction and Extraction
29-…	Healthcare Practitioners and Technical
45-…	Farming, Fishing, and Forestry
53-…	Transportation and Material Moving

Source https://www.onetonline.org/

Based on the rules of codification, described above, O*NET is a catalog of all professions within an economy. For almost every recorded occupation, there is information which describes them thoroughly. In these descriptions are entered all the elements we mentioned previously, and in the next section, we analyze the role of some of those. For many of these elements, their significance for the particular occupation is laid out, in hierarchical order. These assessments are made by specialist analysts or through specially compiled questionnaires distributed to employees (Handel, 2016).

These features can describe analytically the structuring of an economy by thoroughly specifying the categories which obtain in the labor market. On the basis of these categories, the ratios of the labor force may be assessed as can the potential for development which may be present. Table 4.3 shows examples of titles with the second part of the code in common.[11]

Table 4.3 Examples of titles with the second part of the code in common

Full code	*Title*	*Family group of occupation*
47-1011.00	First-Line Supervisors of Construction Trades and Extraction Workers	(47) Construction and Mining
47-1011.03	Solar Energy Installations Managers	(47) Construction and Mining
11-1011.00	Chief Executives	(11) Administration
11-1011.03	Chief Sustainability Officers	(11) Administration
45-1011.00	First-Line Supervisors of Farming, Fishing, and Forestry Workers	(45) Farming, Fishing, Forestry

Source https://www.onetonline.org/

4.4 A Targeted Description of the Contents of O*NET[12]

Before moving on to looking at an example of the information about an occupation, it is worthwhile to consider the concepts we are about to encounter and the relationship between them.

As previously noted, in O*NET a series of data is found in accordance with which the characteristics of an occupation are described. Within the tightest possible framework, there are several features in respect of which the characteristics of an occupational position need to be described, while the distinction between them is not easy and that is also the case for the relationships between them. For instance, how are we to tell apart knowledge from skills and the latter from abilities? In the present subsection, we will attempt to distinguish between these categories while at the same time, establishing an overall framework for the characteristics relevant to an occupation.

In order to understand the relationship between occupation and human capital requirements (task-specific human capital) (Gibbons & Waldman, 2004)[13] let it be noted that the nucleus of an occupation, as was initially suggested, is the task. Indeed, as has been empirically shown, tasks have the highest explanatory value as regards the demand for human capital (Autor et al., 2003). The always specific multitude of laborers' tasks can be reduced to their working activities which can, therefore, describe the nucleus of the corresponding occupation. As Acemoglu and Autor (2010) note: "A task is a unit of work activity that produces output (goods and services)." We can reduce these tasks into working activities, occurring in a spectrum of occupations. From these, we extract the requisite competencies for every profession; hence, working activities comprise the base of the whole analysis.

Knowledge and skills comprise the fundamental features of worker requirements, i.e., of the cultivated or acquired characteristics of the employee that relate to work performance. Knowledge refers to the acquired data and principles in some field of information. By contrast, skills convey the processes of utilization and application of knowledge during the work process. Knowledge, then, constitutes the theoretical perception and understanding of a cognitive field. Its operations and the mechanisms relating to an object, just like the rules and laws that underpin it, have to do with the aspects an employee who is going to deal with that object is required to be conversant with. Skills, on the other hand, are the second element required of an employee and concern the ability to manage an object. In essence, they derive from knowledge, since they constitute its practical application by the employee who sets those mechanisms in motion, in order to attain the work goals. To look at an example, art theory and the history of its various movements, along with the history of aesthetics, among others, comprise a field of knowledge, that of the fine arts. Also, part of this knowledge is the sum total of the techniques that may be used to produce a work of art. Yet, their possession by someone does not automatically imply an ability on their part to apply them in order to produce a painting. For someone to succeed in having one of their works placed in an exhibition or even a museum, a high level of skill is required. On first approach, we could argue that knowledge is based on education while skills are built by the employee through experience. Education and experience are also, in turn, features of the worker requirements, as employers often ask their prospective employees for relevant work experience or certificates of qualification. The role of those, however, is indirect. As a work requirement, they have no independent value but are indicators of the existence of knowledge and skills (Spence, 1974).

Going one step further in understanding the relationship between skills and knowledge, we need to point out that the former are distinguished into basic and inter-operational skills. Basic skills facilitate the process of learning, while the latter concern skills which facilitate the performance of a work's activities. Hence, the relationship between training/experience and knowledge/skills is not one way but shows mutual and complex interdependence.

The knowledge and skills of workers are the categories of human capital to which reference is made most frequently. As stated, they refer to the workers' acquired traits vis a vis their object of work and, as such, they are those elements in respect of which it is possible to have accumulation through investments (Shultz, 1961) or through education (Goldin, 2016). Yet, the categories that comprise human capital are not restricted to these (Armstrong & Taylor, 2014; Coleman, 1988).

Worker characteristics are, in turn, of great importance for an occupation, in several ways. One central aspect of theirs refers to the workers' abilities which include the constant qualities of individuals that affect how they approach their tasks and, also, how they receive the requisite knowledge and skills. By contrast to work requirements which are a worker's acquired traits, these characteristics refer to the traits which we may say stem from their personality or constitute enduring aspects of their quality. Thus, in our previous example of the fine arts, theoretical knowledge and skillfulness constitute an artist's acquired traits, yet the ability for color differentiation is a permanent characteristic with other such being the ability to have original ideas or a steady hand so that it is possible to produce works possessing great detail.

In the context of workers' characteristics, secondary traits are work values and work style, as well as their preferences in relation to work environments (Dawis & Lofquist, 1984).

Finally, work activities comprise the nucleus of occupational requirements and characterize the occupation more than they do the workers. They are distinguished into generalized, intermediate, and detailed, on the basis of the span of occupations wherein they occur. Work activities relate directly to the specific work tasks that occur within the spectrum of an occupation. Important aspects of the occupational requirements are the organizational context and the work context. The surrounding conditions of the occupation are imprinted to a significant degree onto the workers' activities and, thus, affect in turn the work requirements. Whether, for example, someone performs a work alone or with a group or how such a group is organized changes the relevant work activities (Stevenes & Campion, 1994). At the same time, the environment of such work also plays a role; if, for instance, someone is working under dangerous conditions, then one needs sufficient knowledge for self-protection or needs to provide help to colleagues.

One last important note needed at this point, after all concepts have been delineated, concerns their nature. The tasks of an occupation are not made up of isolated elements but are constituted as the sums of those partial elements which are not mutually interchangeable among themselves (Autor & Handel, 2013). For example, builder-constructors need to be able to drive nails through wood, but no house can be built through nailing alone. The same is the case with occupational activities, which define the needs in terms of competencies as a whole.

A corresponding hypothesis needs to be made regarding the requirements of every occupational activity. As, to drive a nail, a steady hand and good short-distance vision are not enough, but one also needs the skill to control their hand while aiming and strike with the right amount of force and in the right direction, while, in terms of knowledge, they should know that the hammer's weight, the nail's sharpness, and the material's thickness are all relevant considerations. All these competencies are necessary at least up to a threshold level. Otherwise, all that one will succeed in doing will be to hurt themselves, scar the material at hand, or ruin their equipment (hammer and nails).

In the diagram below, we attempt a sketchy presentation of these categories, which may aid with the visualization and better understanding of the relevant concepts and their relationships (Fig. 4.1).

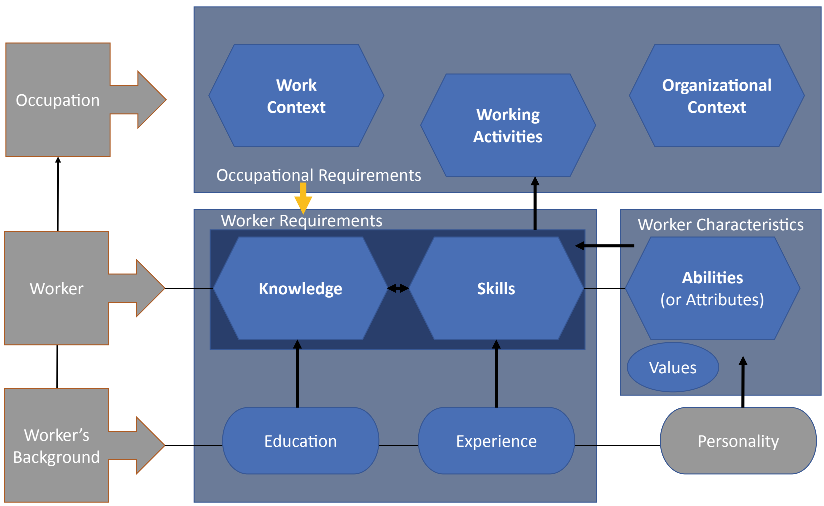

Fig. 4.1 Visual representation of the conceptual framework of occupational characteristics (*Source* Author's Illustration)

The diagram has three levels and can be read bi-directionally. At the very top, we have working conditions; in the middle, we see the worker's features; and finally, at the bottom part, we see the worker's background. When read from top to bottom, the diagram shows how the structuring of the economy shapes the necessary requirements of the occupations and how that is translated through the working activities into competency terms, that is to say, knowledge, skills, and abilities and, also, human capital terms. If, conversely, one reads from bottom to top, we are shown how an economy can shape its reservoir of human capital through its policies.

So, the downward scan determines the demand for various competencies and occupational characteristics. Alternatively, the upward scan determines their supply through public policies.[14] When these two motions are in contradiction, a misalignment of skills arises or a "skills mismatch" as is the term commonly used in the literature.[15] The greatest stake in avoiding this type of contradiction is for educational policy to manage to respond and readjust to the various changes occurring in the economy's structuring and, thus, to the dynamics of this downward demand for human capital.

Another matter worth discussing which arises from the above diagram has to do with how each employer treats human capital. The human capital managed by a business does not come under it since, unlike conventional capital, it does not fall in its ownership (Armstrong & Taylor, 2014). As represented in the diagram, a business is basically called to manage and define the nature and form of occupational activities, and the environment in which these will be performed (upper section of diagram); however, its workers are the ones who manage the human capital which the business is utilizing. Hence, a business is called on to locate the appropriate employees (in terms of human capital) as well as provide the necessary motives for the development of the aspects it requires (Armstrong & Taylor, 2014) even though it is the employees' demands and the educational policy that will ultimately determine the human capital on offer (and with a significant time delay at that). This complexity provides the field for a potential discrepancy whence a mismatch of skills may derive.

In terms of training and experience, businesses set certain traits as requirements in the course of selecting employees. For that reason, for O*NET, these make up aspects of the occupational requirements.[16] Yet, because they are marked by great differences in their formal aspects from one country to another (as each country institutes educational and professional qualifications) (Tijdens et al., 2012) at a general and theoretical level, they need to be grasped only in terms of their essential aspects (and not their typical form). Their basic essential aspect, as noted, is that they shape the sum total of the employees' knowledge and skills. In corresponding terms, it can be argued that education and experience play a determinant role on the employee's traits as well (abilities, values, etc.)[17] although at the level that interests us, a simpler understanding, such as the one outlined in the diagram about their contribution, is sufficient.

Lastly, a negative point is worth noting in relation to these catalogs, namely that, as the literature frequently notes, the utilization of O*NET by researchers is not all that easy. Difficulties arise often due to the close connection between various concepts and the indistinct boundaries between them.

One example of the conceptual proximity of different occupational characteristics is those characteristics linked to the written communication requirements in a profession, such as that of secretary. For O*NET, the requirements are[18]:

- In terms of knowledge:
  - The English language
- In terms of skills:
  - Writing
  - Reading—comprehension
- In terms of abilities:
  - Written comprehension
  - Written expression

Is it evident in relation to the above concepts that although, in the context of O*NET, they are clearly defined in theory, distinguishing between them is not always straightforward. This issue is present, too, in the utilization of the database by researchers (Acemoglu & Autor, 2010) as well as in the compiling of questionnaires for employees, which they are invited to fill out often without being able to clearly distinguish between the concepts about which they are being asked (Handel, 2016). This last consideration, in particular, gives rise in the literature to several questions of a methodological nature.

Annex

After the theoretical overview of O*NET's concepts, it is important to present the occupational information it provides so as to illustrate its material and possibilities. For example, let us look at a specific occupational position, one that has already been mentioned, secretaries and administrative assistants, apart from legal, medical, and executive administrative personnel.

43-6014.00—Secretaries and Administrative Assistants, Except Legal, Medical, and Executive[19]

Perform routine administrative functions such as drafting correspondence, scheduling appointments, organizing and maintaining paper and electronic files, or providing information to callers.

Sample of reported job titles:

Administrative Assistant (Admin Assistant), Administrative Clerk, Administrative Secretary (Admin Secretary), Administrative Specialist (Admin Specialist), Administrative Support Assistant (ASA), Administrative Technician, Department Secretary, Office Assistant, Secretary, Staff Assistant.

Tasks: (8/32, 32 Important, 20 Core)

See Table 4.4.

Table 4.4 Tasks of 43-6014.00

Importance	*Category*	*Task*
83/100	Core	Answer telephones and give information to callers, take messages or transfer calls to appropriate individuals
83/100	Core	Greet visitors or callers and handle their inquiries or direct them to the appropriate persons according to their needs
81/100	Core	Create, maintain and enter information into databases
81/100	Core	Use computers for various applications, such as database management or word processing

(continued)

Table 4.4 (continued)

Importance	*Category*	*Task*
77/100	Core	Operate office equipment, such as fax machines, copiers or phone systems and arrange for repairs when equipment malfunctions
74/100	Core	Set up and manage paper or electronic filing systems, recording information, updating paperwork or maintaining documents, such as attendance records, correspondence or other material
…(other core tasks)…		
81/100	Supplemental	Perform payroll functions, such as maintaining timekeeping information and processing and submitting payroll
79/100	Supplemental	Collect and deposit money into accounts, disburse funds from cash accounts to pay bills or invoices, keep records of collections and disbursements, and ensure accounts are balanced
…(other supplemental tasks)…		

Source https://www.onetonline.org/

Technology Skills: (4/45)

See Table 4.5.

Table 4.5 Technology skills of 43-6014.00

Accounting software	Fund accounting software; Intuit QuickBooks; Sage 50 Accounting; Tax software
Data base management system software	Apache Cassandra Hot technology; Apache Hive Hot technology; Apache Pig Hot technology; Apache Solr
Data base user interface and query software	Airtable; Blackboard software; Oracle software Hot technology; Yardi Hot technology
Enterprise resource planning ERP software	Microsoft Dynamics GP Hot technology; NetSuite ERP Hot technology; Oracle Hyperion Hot technology; Oracle JD Edwards EnterpriseOne
…(other technology skills)…	

Source https://www.onetonline.org/

Tools Used: (4/14)

See Table 4.6.

Table 4.6 Tools used by 43-6014.00

Laser fax machine	Dictation equipment
Laser fax machine	Laser facsimile machines
Mobile phones	
Notebook computers	Laptop computers
…(other tools used)…	

Source https://www.onetonline.org/

Knowledge: (8/33, 5 Important)

See Table 4.7.

Table 4.7 Knowledge of 43-6014.00

Imp	*Knowledge*	*Description*
88/100	Clerical	Knowledge of administrative and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms and other office procedures and terminology
82/100	English Language	Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition and grammar
71/100	Computers and Electronics	Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming
69/100	Customer and Personal Service	Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services and evaluation of customer satisfaction

(continued)

(continued)

Imp	*Knowledge*	*Description*
61/100	Administration and Management	Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods and coordination of people and resources
48/100	Mathematics	Knowledge of arithmetic, algebra, geometry, calculus, statistics and their applications
44/100	Communications and Media	Knowledge of media production, communication, and dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, and visual media
…(other non-important knowledge)…		
3/100	Physics	Knowledge and prediction of physical principles, laws, their interrelationships and applications to understanding fluid, material and atmospheric dynamics, and mechanical, electrical, atomic and sub- atomic structures and processes

Source https://www.onetonline.org/

Skills: (8/35, 11 Important)

See Table 4.8.

Table 4.8 Skills of 43-6014.00

Imp	*Skill*	*Description*
75/100	Active Listening	Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate and not interrupting at inappropriate times
75/100	Speaking	Talking to others to convey information effectively
72/100	Reading Comprehension	Understanding written sentences and paragraphs in work- related documents

(continued)

(continued)

Imp	*Skill*	*Description*
69/100	Writing	Communicating effectively in writing as appropriate for the needs of the audience
…(other important skills)…		
50/100	Judgment and Decision Making	Considering the relative costs and benefits of potential actions, to choose the most appropriate one
50/100	Social Perceptiveness	Being aware of others' reactions and understanding why they react as they do
47/100	Active Learning	Understanding the implications of new information for both current and future problem-solving and decision-making
47/100	Complex Problem Solving	Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions
…(other non-important skills)…		

Source https://www.onetonline.org/

Abilities: (4/52, 13 Important)

See Table 4.9.

Table 4.9 Abilities of 43-6014.00

Imp	*Ability*	*Description*
75/100	Oral Comprehension	The ability to listen to and understand information and ideas presented through spoken words and sentences
75/100	Oral Expression	The ability to communicate information and ideas in speaking so others will understand
75/100	Written Comprehension	The ability to read and understand information and ideas presented in writing
75/100	Written Expression	The ability to communicate information and ideas in writing so others will understand
72/100	Near Vision	The ability to see details at close range (within a few feet of the observer)
69/100	Speech Clarity	The ability to speak clearly so others can understand you
…(other important and non-important abilities)…		

Source https://www.onetonline.org/

Work Activities: (5/41, 17 Important)

See Table 4.10.

Table 4.10 Working activities of 43-6014.00

Imp	*Ability*	*Description*
85/100	Interacting With Computers	Using computers and computer systems (including hardware and software) to program and write software, set up functions, enter data or process information
79/100	Communicating with Supervisors, Peers or Subordinates	Providing information to supervisors, co-workers, and subordinates by telephone, in written form, including e-mail or in person
79/100	Getting Information	Observing, receiving and otherwise obtaining information from all relevant sources
77/100	Performing Administrative Activities	Performing day-to-day administrative tasks such as maintaining information files and processing paperwork
69/100	Establishing and Maintaining Interpersonal Relationships	Developing constructive and cooperative working relationships with others and maintaining them over time
…(other important and non-important working activities)…		

Source https://www.onetonline.org/

Detailed Work Activities: (5/35)

- Answer telephones to direct calls or provide information.
- Discuss account status or activity with customers or patrons.
- Greet customers, patrons, or visitors.
- Refer customers to appropriate personnel.
- Execute sales or other financial transactions.

Work Context: (4/57)

See Table 4.11.

Table 4.11 Work context of 43-6014.00

Work Context—Description	*Percentage of Top Responses*
Telephone—How often do you have telephone conversations in this job?	93/100 - > Every day
Contact With Others—How much does this job require the worker to be in contact with others (face-to-face, by telephone or otherwise) in order to perform it?	87/100 - > Constant contact with others 13/100 - > Contact with others most of the time
Electronic Mail—How often do you use electronic mail in this job?	93/100 - > Every day
Face-to-Face Discussions—How often do you have to have face-to-face discussions with individuals or teams in this job?	79/100 - > Every day 14/100 - > Once a week or more but not every day

Source https://www.onetonline.org/

Job Zone

See Table 4.12.

Table 4.12 Job zone of 43-6014.00

Title	*Job Zone Two: Some Preparation Needed*
Education	These occupations usually require a high school diploma
Related Experience	Some previous work-related skill, knowledge or experience is usually needed. For example, a teller would benefit from experience working directly with the public
Job Training	Employees in these occupations need anywhere from a few months to one year of working with experienced employees. A recognized apprenticeship program may be associated with these occupations
Job Zone Examples	These occupations often involve using your knowledge and skills to help others. Examples include orderlies, counter and rental clerks, customer service representatives, security guards, upholsterers and tellers
SVP Range	(4.0 to < 6.0)

Source https://www.onetonline.org/

Education

See Table 4.13.

Table 4.13 Education of 43-6014.00

Percentage of Respondents	*Education Level Required*
50/100	High school diploma or equivalent
22/100	Associate's degree
11/100	Bachelor's degree

Source https://www.onetonline.org/

Interests: (3/6, 2 Important)

See Table 4.14.

Table 4.14 Interests of 43-6014.00

Occupational Interest	*Interest*	*Description*
100/100	Conventional	Conventional occupations frequently involve following set procedures and routines. These occupations can include working with data and details more than with ideas. Usually there is a clear line of authority to follow
67/100	Enterprising	Enterprising occupations frequently involve starting up and carrying out projects. These occupations can involve leading people and making many decisions. Sometimes they require risk taking and often deal with business
33/100	Social	Social occupations frequently involve working with, communicating with and teaching people. These occupations often involve helping or providing service to others
…(and other non-important interest)…		

Source https://www.onetonline.org/

Work Styles: (3/16, 16 Important)

See Table 4.15.

Table 4.15 Work styles of 43-6014.00

Imp	*Work Style*	*Description*
90/100	Attention to Detail	Job requires being careful about detail and thorough in completing work tasks
88/100	Integrity	Job requires being honest and ethical
86/100	Cooperation	Job requires being pleasant with others on the job and displaying a good-natured, cooperative attitude
…(and other important work styles)…		

Source https://www.onetonline.org/

Work Values: (2/6, 2 Important)

See Table 4.16.

Table 4.16 Work values of 43-6014.00

Imp	*Work Value*	*Description*
67/100	Support	Occupations that satisfy this work value offer supportive management that stands behind employees. Corresponding needs are Company Policies, Supervision: Human Relations and Supervision: Technical
61/100	Relationships	Occupations that satisfy this work value allow employees to provide service to others and work with co-workers in a friendly non-competitive environment. Corresponding needs are Co-workers, Moral Values and Social Service
…(and other non-important work values)…		

Source https://www.onetonline.org/

Related Occupations: (All 9)

43-3011.00	Bill and Account Collectors
43-4031.00	Court, Municipal, and License Clerks
43-4081.00	Hotel, Motel and Resort Desk Clerks
43-4111.00	Interviewers, Except Eligibility and Loan
43-4121.00	Library Assistants, Clerical
43-4171.00	Receptionists and Information Clerks Bright Outlook
43-6011.00	Executive Secretaries and Executive Administrative Assistants
43-9041.00	Insurance Claims and Policy Processing Clerks
43-9061.00	Office Clerks, General

Notes

1. The records of O*NET's maintenance can be accessed here: https://www.onetcenter.org/dataUpdates.html.
2. The DOT had been criticized for placing undue emphasis on blue-collar and manual jobs, which the O*NET attempted to avoid, though not entirely successfully (Handel, 2016).
3. https://ec.europa.eu/esco/portal.
4. Yet another directory for Greece is the "Catalogue of Vocational Outlines" of the National Organization for the Certification of Qualifications and Vocational Orientation (ΕΟΠΠΕΠ). In this directory, 214 vocations/occupations and their characteristics are described, and their correspondence is listed with a range of other catalogued occupations used by the Greek state. It can be accessed here: https://www.eoppep.gr/index.php/el/structure-and-program-certification/workings/katalogos-ep.
5. There is no important methodological-theoretical contradiction between ESCO and O*NET, as can be seen in their list of definitions below. Still, O*NET's more developed framework allows for better theoretical underpinnings to the classification and its guiding principles. Characteristically, O*NET includes among its terms work values and work styles, although these are considered to be of secondary importance.
6. https://www.onetonline.org/.
7. https://www.onetcenter.org/content.html.
8. The latest revision, at the time these lines were written, was in 2019. https://www.onetcenter.org/taxonomy.html.
9. https://www.onetcodeconnector.org/oca/step2.
10. The total of 923 codes and titles with detailed data may be surveyed here: https://www.onetcenter.org/taxonomy/2019/data_coll.html.

11. Occupations with a second code 1011 are obviously not restricted to these, nor are they all administrative/supervisory. In this context, we merely wish to have their common characteristics noted. In a more thorough search of the database, a series of other examples may be located, such as "25-1011.00: Business Teachers, Postsecondary" or "19-1011.00: Animal Scientists" or "29-1011.00: Chiropractors" whose common characteristics, however, may not be as clear as those in the table.
12. https://www.onetcenter.org/content.html.
13. For the various approaches to human capital, see previous chapter (Chapter 3).
14. The concepts of upward and downward scan refer to the representation in the above figure and result from it.
15. In the present context, this would be more correctly described as competencies mismatch.
16. See Fig. 4.1.
17. As a case in point, in the structuralist educational approach, educational policy shapes traits of the trainee, such as their values and principles (González-Salamanca et al., 2020).
18. 43-6014.00—Secretaries and Administrative Assistants, Except Legal, Medical, and Executive: https://www.onetonline.org/link/summary/43-6014.00.
19. For reasons of brevity, we will not present the sum total of the information available but indicative data from each category, for the purposes of a general overview. The reason for the annex is not to provide in-depth understanding of the particular professions listed but, rather, an understanding of the nature of the information provided by O*NET.

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CHAPTER 5

Productive Structure, Technological Change and Requirements in Human Capital

Yorgos Pisinas

5.1 Introduction

In the previous chapters, human capital was introduced, analyzed and synthesized to the productive structure. It was shown how different structures translate into different shapes of demand for human capital. This chapter aims to approach theoretically how changes in the production structure in general, with technological change being a component, affect the requirements in terms of occupational characteristics and the required skills.

At first, in Sect. 5.2, the conceptual framework of occupational analysis and task-specific human capital (see Chapters 3 and 4) is employed to comprehend and reconstruct the approaches of the current literature on the issue of structural and occupational dynamics. Followingly, in Sect. 5.3, the effect of technological change is being theoretically

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presented, and it is supported why conceiving it as a mere skill-biased effect is wrong. In Sect. 5.4, the changes in occupational characteristics (and therefore in human capital needs) are analyzed. These changes are distinguished in two parts: the external change which concerns the difference in the labor markets and the internal change which occurs due to reconfigurations of the tasks employed in an occupation. The latter also includes any requirement shifts arising from changes in the organizational work environment. Both effects are analyzed in a macro-level to grasp current trends. Finally, in Sect. 5.5, we articulate the conclusions of our attempt to conceive and present the macro-trends of the effect in human capital requirements due to changes in the production structure. There we present that despite the observed mild upskill trend in the internal change, we find strong elements of polarization in the external change due to issues concerning both demand and supply forces.

5.2 Analyzing the Dynamics of Occupations and Human Capital Needs

Extensive reference is made in current literature to the changes in occupational characteristics starting at the turn of the twenty-first century. In addition to the task approach to human capital (Acemoglu & Autor, 2010; Autor, 2013; Autor & Handel, 2013), the references to the requisite skills for the twenty-first century fall in two categories which, despite differences, have a significant degree of overlap between them, as well as with the task approach.

The first category focuses on occupational traits and the consequent changes necessary in workers' skills (Ra et al., 2019; Walker & Lloyd-Walker, 2019). This approach, illustrated in Fig. 4.1 of the previous chapter, treats the worker's characteristics from top to bottom, that is, in terms of requirements in occupational tasks up to work competencies. Thus, employers' demand for occupational characteristics is explained, based on the work produced which these contribute to the economy.

The second category has as its point of departure the planning of occupational policy and contemporary educational possibilities (González-Salamanca et al., 2020; Winthrop et al., 2018) and, so, using the same Fig. (4.1), it treats workers' characteristics from bottom to top, i.e., from educational policies to workers' competencies. This perspective illustrates intervention into human capital and how it can create new conditions and new possibilities for production (Woldemichael & Shimeles, 2019).

Although there is now ample literature on issues to do with occupational characteristics, there seems to be missing a cohesive, theoretical overview of how the production and labor structure affect requirements for occupational characteristics and, specifically, the requirements for competencies[1] in the labor force (Autor & Handel, 2013; Tijdens et al., 2012). Overall, there are two relevant issues here. The first is theoretical, as the task-based approach has yet to come up with a clear map of the relationship between tasks and human capital (Tijdens et al., 2012). The second has to do with the deficit in measurements as the data available for studying occupation mostly use fairly blunt approaches to accumulated human capital (Autor & Handel, 2013) while information on occupational characteristics also presents a range of gaps (Autor & Handel, 2013; Handel, 2016).

Most of the research in the field is found in three related areas: predictions as to the development of occupations and the future of labor (Acemoglu & Autor, 2010; CEDEFOP, 2018; Khatiwada & Maceda Veloso, 2019), studies of the effect of new technological developments (4th industrial revolution) (Ra et al., 2019; Walker & Lloyd-Walker, 2019) and policies recommended for the attainment of goals or adjustments for the twenty-first century (González-Salamanca et al., 2020; Winthrop et al., 2018). According, then, to the prevalent goal-setting and methodology, a passing presentation is made of the relevant concepts (skills, occupational tasks, industrial sectors, etc.) and the emphasis quickly shifts onto research and scanning of the various research outcomes. The analytical deficit in the theoretical framework of the relationship between production structure and requirements in human capital is evident in the bibliography as, even the most pioneering works aiming to establish this relationship in terms of competencies, state that they are

[1] We use the term "competencies" to describe the various characteristics which are required of the worker for the performance of their tasks. As noted in the previous chapter, we distinguish them from "skills." Alternatively, the term KSAs is used in the literature, which is based on the three basic categories that comprise the competencies (Knowledge-Skills-Abilities) (Stevenes & Campion, 1994; Walker & Lloyd-Walker, 2019) although the term "competencies" is considered the most expedient (Shippmann et al., 2000). Even more frequent is the use of "skills" in the wide sense (Acemoglu & Autor, 2010, Autor, 2013, CEDEFOP, 2018) though we consider that this use complicates things and obscures the distinction between skills, knowledge, and abilities.

still operating at a first level and there is need for a more thorough theoretical infrastructure (Autor & Handel, 2013). In this work, we attempted to pay the necessary respect to the theoretical framework (see Chapter 4).

The cataloguing which is often utilized, though empirically very important and useful, needs to be accompanied by a cohesive theoretical background and not simply comprise a sum of entries, as O*NET aspires to do, whose internal reasoning was discussed in the previous chapter.

The aim of the present chapter is to avail itself of the fact that all three of the above approaches share the aim of analyzing a dynamic state of the production and labor structure and, based on the theoretical framework presented in the preceding chapter, to single out the effects which are observable on occupational characteristics due to developments in the production structure.

5.3 From Technological Change to Occupational Characteristics

Already from the framework elucidated in the preceding chapter, it can be roughly seen how a production structure effects the requirements in competencies.

As was argued there, occupational requirements (Work Context, Working Activities, Organizational Context) determine work requirements (Knowledge, Skills, Education/Experience requirements), as well as occupational characteristics (Abilities, Values) which align with the latter. If that is the case at the level of one occupation, then the aggregate of occupations can point to the work requirements of a production structure. To that end, cataloguing is utilized which allows such an aggregation and compiling of an economy's occupations and needs.

Thus, by mapping occupations and their content, it is possible to deduce the required occupational competencies. As noted: "The identification of what is done at work can be seen as a logical first step in identifying what skills are required for jobs now and into the future" (CEDEFOP, 2018).

Nevertheless, a mapping of this type is no more than a still photograph. In reality, the dynamics of the production structure affect occupational characteristics.[2] In essence, the role of labor and capital in production changes, even though their relationship in the canonical model of

[2] Besides, as noted in the previous chapter, the process of maintenance of the tools of classification is a demanding and ongoing task (Handel, 2016).

production appears stable (Autor, 2013). Technological change disturbs the distribution of tasks between labor and capital so that the labor-capital relationship is reordered within production, i.e., where these are complementary inflows and where they substitute one another.

Through this literature review, we are able to pick out these effects, analyze them inductively and classify them. At a first level, the bibliography on human capital talks about skill-biased technological change (Khatiwada & Maceda Veloso, 2019; World Bank, 2019). Yet, as a more thorough analysis of its characteristics shows, the abstract perception of technological change as skill-biased is incorrect. In reality, it, on the one hand, reinforces certain skills and, on the other, replaces others (Acemoglu & Autor, 2010; CEDEFOP, 2018). Specifically, technology is expected to reinforce requirements in high specializations but reduce requirements in middle-level specializations which are thought to follow certain routines (Autor et al., 2003). Consequently, the parameters reinforced by technological change may not assume a monotonous form in terms of the costs in human capital (Acemoglu & Autor, 2010). The particular form technological change is assuming nowadays leads to a polarization regarding the matter of competencies.[3] O*NET's detailed content allows us to more thoroughly differentiate the various characteristics of occupations and of labor.

Although technological change today appears to promote specialization, increasing the overall requirements in human capital, historically it did not always possess this aspect (CEDEFOP, 2018) nor is it possible to claim with certainty that it will maintain this function in the distant future. This has to do with the factors technological change reinforces at any given time. It is thus clear that technology does not necessarily make low-level specialization redundant nor does it necessarily complement high-specialization work, leading to a linear upgrade of skill-bias.

Acemoglu and Autor (2010) attempt a basic analysis of changes in occupational characteristics due to technological change, where they note that changes in tasks affect the demand for various skills. In turn, the

[3] This polarization is observable once we reduce the occupation to one dimension only and one axis with several intensities of specialization (mow, middle, high) and draw the corresponding requirements in human capital. Analysis through the various occupational catalogues (such as O*NET) may provide a more in-depth picture, as will be shown in the present chapter; nevertheless, such a type of deduction can be particularly helpful.

change in demand is mirrored in the wage differences between workers with differing degrees of skills, and in various categories (Acemoglu & Autor, 2010).

5.4 Productive Structure and Occupational Characteristics

Having given a rough outline of how technology affects occupational characteristics, we can now move to this chapter's main subject, understanding how changes in the productive structure impact on human capital requirements and the needs for occupational characteristics.

5.4.1 Labor Structure and the External Change of Occupational Characteristics

To start with, it is self-evident that changes in the distribution of labor impact directly on the needs for various competencies. One issue to be noted at the outset is the relationship between formal and informal economy. Only the formal market sector may manifest significant motives for rewarding human capital. Hence, the ratio of formal to informal economy exerts an important influence in terms of the competencies required and the development of demands for human capital (Asuyama, 2011). Although this issue is routinely disregarded in the bibliography, it is particularly important. This assumes quite a key role especially in the so-called developing economies, which are known to have extensive informal sectors. A related issue is that the cataloguing of occupations only relates to the formal sector of the economy. This presents an additional challenge in analysis which needs to be taken into consideration when attempting to run an analysis of countries where capitalism and the market economy are not particularly advanced. Further issues of occupational analysis are raised on the matter of gender studies and feminist economics, as most of the reproductive labor required by our societies remains hidden in the informal sector, within households or family networks (Dengler & Strung, 2018; Stevano et al., 2021). Therefore, it is impossible to analyze tasks in reproductive labor through the tools of national occupational databases.

Thus, putting aside the issue of under-the-table/unofficial work, changes in the work and occupational structure are expected to have a direct impact on work requirements and workers' characteristics.

Let us look at the main reasons contributing to changes in the work structure. One basic such is technological change (Acemoglu & Autor, 2010; CEDEFOP, 2018) which, along with the introduction of new possibilities, changes the work requirements of businesses. Consequently, new work sectors emerge, non-existent until recently, while old professions disappear. Certainly, these changes are not black and white. For instance, the introduction and significant upgrading in recent years of automatic corrections in word processing did not do away with professional text editors. Still, the need in man-hours for text editing has been significantly reduced.

Another reason leading to changes in work structure is demographic changes (CEDEFOP, 2018). A country/economy with a large population certainly has greater needs for various competencies than a country with a small population and, at the same time, has greater opportunities for specialization. Demographic reasons are related in yet another way with the transformation of the work structure that has to do with demand needs such as changes in the preferences of consumers. In the aging Europe, for example, it is anticipated that demand in ultimate goods and services will be affected, tending more to health services and a decline in the sectors of entertainment and recreation, apart from travel (CEDEFOP, 2018).

Lastly, yet another reason for changes in the work structure is international commerce. This has always been the case, but today, the phenomenon of offshoring is an important aspect of changes in work structure today (Acemoglu & Autor, 2010; Blinder, 2009). Offshoring is tied to the degree to which an occupation requires that its tasks be carried out in person (e.g., face to face or in situ) (Blinder, 2009). Thus, an occupation without these requirements is at risk of offshoring since the employer may decide to assign it to an overseas worker, with new technological viabilities nowadays rendering this risk very tangible. In view of the pandemic, also, there have been important recent developments in this respect with pervasive changes taking place in the form of work (Eurofound; 2020, IBM, 2020), particularly with the boosting of new forms such as work-from-a-distance (or telework) which affords new and enhanced possibilities of offshoring. At all events, the pandemic's impact is not clear, nor are its mid-range effect on work structure (Eurofound, 2020). It is nevertheless possible that it will play a clearly reinforcing role in that direction, as it does affect work conditions, technology and labor practices. One interesting point regarding offshoring is that it can apply to both mid-level occupations and highly specialized ones (Acemoglu & Autor, 2010). Two characteristic such cases are asynchronous service delivery and computer programming/coding, which constitute the main occupations performed offshore.

Consequently, a country's position in the global distribution of labor and global value chains assumes an important role in determining its future labor development (Krugman & Venables, 1995), and each economy is expected to develop different trends, despite the macro-similarity of changes in the production structure (Giouli et al., 2021). Moreover, on the same topic, an important role also seems to be played by social norms such as gender-based discrimination, as occupations largely performed by women are more susceptible to offshoring (Acemoglu & Autor, 2010).

Overall, in terms of the anticipated impact on labor structures, we might say that occupations of middle specialization are apt to have low rates of growth or even a drop in positions as both technological change and offshoring will affect them noticeably (Blinder, 2009; CEDEFOP, 2018; Giouli et al., 2021).

As regards the EU, all the above data are expected to usher in a state of polarization in human capital needs. The rate of positions in industry will be reduced, despite the increase of their product, and the basic source of economic growth is expected to reside in the service sector.

In services, the more vital occupations are considered administrative services and services of corporate support (such as legal, accounting and research) as well as a range of services centered on the consumer (commerce, food provision, art, entertainment and recreation). Moreover, before COVID-19, the air-transport industry was considered a particularly vital sector (CEDEFOP, 2018) though its development is now an open question since it has been severely impacted by the pandemic (OECD, 2020). In relation to public services, an increase was anticipated in the quota of health services and these have proven even more essential in the context of the pandemic, thus receiving a renewed boost. One last area considered critical is that of Research and Development, and innovation.

Regarding industry in general, its significance is expected to diminish although there, too, a number of vital sectors are emerging, especially in industrial products of high added value (CEDEFOP, 2018). The industry sector is the primary lever for polarization as this is where a major drop in employment is expected, in jobs of middle-level specialization.

By means of these assessments, one may draw conclusions about the future profile of competencies in terms of knowledge, skills and abilities.

Up to now, we have offered the general trends, at a high level of abstraction, using data primarily from the EU,[4] though it is not to be assumed that these changes are taking place in a similar manner in all countries. On the contrary, as the EU data make clear, despite the strength of the above trends, important differentiations between countries do exist (CEDEFOP, 2018).

The divergence between the existing profile and the one projected concerns the change of occupational characteristics which is based on changes in labor distribution; that is to say, it concerns the external change in occupational characteristics. Indeed, if we analyze this outcome further, we may discern three effects on occupational requirements (CEDEFOP, 2018) as well as on the way these impact on human capital requirements.

The *scale effect* concerns the change in human capital requirements due to the overall change in occupation. The *industry effect* has to do with changes in the various sectors of production. For instance, the change predicted in the boosting of the health sectors is expected to increase requirements in knowledge/skills that have to do with health. Finally, the *occupational effect* is the residue of the other two, having to do with changes in the distribution of labor due to the change in the distribution in the various occupations.[5] The occupational outcome is affected primarily by technological changes and the resultant restructuring taking place in the occupational mixes by means of which different products are produced. These three effects work additively in the overall external change of occupational characteristics.

One last possible change in the labor structure important enough to require distinct mention is the emergence and creation of new occupations. In essence, this change is part of the occupational effect because it comes about through technological change leading to the emergence of

[4] However, there does seem to be an overall agreement in the literature, at least on the general picture supported by data from the US (Autor & Handel, 2013) and Asia (Khatiwada & Maceda Veloso, 2019).

[5] It is important to note that the occupational effect is first derived in terms of occupation and has then to be translated into requirements in human capital. Otherwise, if it is derived directly in terms of competencies, the effect which we examine below will have been added as well, because of the change in the nature of the occupations. In this paragraph, we are only looking at the effect due to the change in distribution of the labor structure; thus, we consider the nature of labor to be stable (i.e., stable tasks).

new tasks and new working activities forming the core element of new occupations that break away from similar or related occupations (Tijdens et al., 2012).

It may be that emerging occupations do not have a wide application; however, as a rule, they have high requirements in competencies (Khatiwada & Maceda Veloso, 2019) and are particularly important for the economy's overall requirements in human capital. At the same time, the emerging occupations operate as forerunners for the future of economies as the technologies on which they are based, with time, will mature and become increasingly incorporated in the economies, and their occupational base will grow. One other issue related to the data on emerging occupations has to do with how detailed their registration is, given that they are frequently classed under roughly sketched groups (Khatiwada & Maceda Veloso, 2019) (in terms of value) while questions arise as to their specific duties, since these occupations are still fluid and in the process of formation.

In recent years, emerging occupations are located mainly in the sectors of communication and information technology, as well as in service provision, while, as one might expect, administrative sectors show a decline in vitality (Khatiwada & Maceda Veloso, 2019). In terms of competencies, this means that requirements are thus reinforced that have to do with abstract and non-automated activities such as, among others, the analysis and solving of complex problems, high specialization in various areas of science,[6] or interpersonal contact and communication. These appear with less frequency in sectors where working activities are more automated, such as administrative or clerical occupations.

In sum, we would say that the external change of occupational characteristics refers to the change of requirements in human capital (competencies) from one point in time to another, if the content of every occupation/work position remains stable in terms of tasks. It relates to changes in an economy's labor structure for reasons of demand, international commerce and technological change.

[6] Characteristically, it is mentioned that a large part of these occupations refers to jobs that relate to the hard sciences (STEM) where workers tend to have completed tertiary education.

5.4.2 *Technological Development and Internal Change of Occupational Characteristics*

By contrast to external change, the literature on the internal change of occupations is significantly more sparse. One main reason for the thinner bibliographical referencing on the subject is the high difficulty of approaching it. External change is founded on shifts in the labor market and, so, there is a significant wealth of information available, despite whatever weaknesses may exist. On the contrary, predictions as to the content of occupations are subject to much greater uncertainty while not being based on easily accessible information. Thus, the occupational research relies on tools which have weaknesses in terms of the internal change of occupational characteristics (Autor, 2013; Autor & Handel, 2013).

Up until now, we have examined how, once the different occupations have taken form, the distribution of labor among them for serving social needs affects the requirements in human capital and competencies. In the background of this analysis, two important questions still remain. How do the various tasks, which, as we saw in the previous chapter, form the nucleus of an occupation, aggregate into a new occupation? How are the various tasks distributed among the existing occupations in a dynamic manner? These dynamics have not been systematically investigated in relation to all the various occupations (Tijdens et al., 2012). These questions characterize the internal change of occupational characteristics.

It is considered that the current technological developments in robotization in Europe will not lead to a massive loss of employment positions. The current assumption/prediction is that workers in the sectors amenable to robotization will in all likelihood preserve their positions, though the total number of employees will drop as no more new work positions will be created (CEDEFOP, 2018). In this context, changes in the role of the remaining worker are the most likely scenario, in addition to other developments and agreements that may frame the transition such as remuneration changes, early retirements and retraining subsidies. This condition means that an analysis based on external occupational characteristics cannot provide a full picture of the changes underway, even if it does constitute an important first step.

As noted at the beginning of this chapter, the basic lever of change at the level of tasks has to do with the transfer of occupational tasks in relation to the capital (Autor, 2013).

Today, the form this technological transformation assumes has to do with the transfer of repetitive and codifiable work routines from workers to machines. This is important to note because the repetitiveness of a work routine is a necessary though not sufficient condition for capital to take it on. It needs to be pointed out that there are technological (as well as social) limits which make it impossible for all repetitive work routines to pass onto capital. As Autor mentions, the mopping of floors is by its nature repetitive yet, the current technological structure cannot take on these tasks (Autor, 2013), and within the sum of tasks this activity entails, there is at least one which is impossible to codify.[7] The principal hypothesis regarding this process is that the tasks more easily subject to substitution by capital fall within the range of middle specialization (Acemoglu & Autor, 2010). This may sound like a bold hypothesis, but it does have some empirical support; repetitive tasks exist not only in industry but in information management as well, i.e., administrative or clerical duties, which fall in the middle range of income distribution (CEDEFOP, 2018).

On the other hand, work routines that consist of non-repetitive tasks (i.e., tasks that continuously manifest genuine elements) are themselves both abstract and manual (Acemoglu & Autor, 2010). Analytic tasks are complementary to technology since problem solving tasks, and creative ones, too, rely heavily on the inflow of information and, as such, have high requirements in human capital. Correspondingly, there are non-repetitive tasks which require the ability to adjust to a situation, visual and linguistic recognition and human interaction. Such examples are driving inside city limits, meal preparation, gardening and landscaping, or, as previously mentioned, mopping floors. These are usually baseline occupations with requirements of most likely lower-level competencies and, hence, lower requirements in human capital.

It is thus evident that, regarding the internal change of occupational characteristics, a decline is observable in the need for competencies in tasks that involve repetition, resulting in a decline of requirements for human capital of middle intensity. Yet, it must be noted that it is by no

[7] Specifically, if someone wishes to guess at one possible point of difficulty, all one need do is picture the difficulty in identifying stains on a range of floors made of wood, marble or other materials with repetitive patterns of random striations, or, perhaps, mosaics. This task involves analytic competencies and critical thinking which computers do not possess, even to this rudimentary degree.

means necessary that this change leads to a fall in salaries in jobs of a middle level. As mentioned, an increase in the competitive advantage of the highly specialized workers vs. the middle specializations (due to technological change) may lead the former to take on more “middle-level” tasks resulting in an increase in productivity in these occupations (Autor, 2013). But this is not the only reason that a “contradictory” movement of this type may appear.

The eclipsing of repetitive routines is not the only change impacting work tasks. In reality, release from certain tasks affords the possibility for new tasks to emerge or for the tasks of an occupation to be redefined (Walker & Lloyd-Walker, 2019). Indeed, if that change takes place within an appropriate frame, this may remove possible difficulties or objections to the transformation of the occupation and lead to higher levels of motivation and satisfaction with the occupation. Such a possible move, where the technology-induced substitution of repetitive tasks is compensated by an increase in more analytic and creative tasks (which have a complementary relationship with capital, as inflows to production) leads objectively to higher requirements in competencies. But high tasks are not the only ones complementary (to capital) which can be highlighted through this process; the same goes for various manual tasks with low requirements.

Consequently, what the overall picture of the characteristics corresponding to each occupation will be after technological change is dependent on the degree to which each of the above effects will act. To what extent will the transferred tasks be replaced? To what degree will they be substituted by tasks of higher requirements? It is understood that each occupation will react differently to technological changes, while divergence between countries for similar occupations is also not inconceivable.

This makes a systematic analysis of the sum total of occupations particularly demanding and, up to the present time, unrealized (Tijdens et al., 2012). Especially within the existing framework, where the tools of analysis have yet to be formalized on the basis of tasks and each researcher makes use of different types of data (Autor, 2013), we dare say it is practically an impossibility.

Consequently, no serious assessment has been made to map of the internal changes of occupational characteristics. It is of interest that, even though the internal changes of occupational characteristics are harder to define and, usually, changes in the map of required competencies are attributed to changes in the labor structure[8] (CEDEFOP, 2018), they, too, are no less important for changes in requirements in human capital. Characteristically, in Germany from 1979 to 1999, change in the structure of tasks (which translates into competencies) is mainly attributed to changes inside the various occupations rather than to labor distribution (Autor, 2013).

Despite the difficulty, based on the literature, we are able to locate certain common characteristics for the changes regarding the first half of the twenty-first century, so as to draw certain basic general conclusions. To start with, already from the framework presented above, we can discern a slightly positive tendency to upgrade competencies (upskilling) as well as a further polarization, though the latter mustn't lead to erroneous policies nor must it be considered as a complete opposite to the former. The substitution of work in mid-level tasks and the movement toward higher requirements lead to higher requirements for higher competencies while, by contrast, the opposite movement leads to a reduction of requirements (of another sector in the labor structure). This, though, does not mean that middle tasks are going to disappear, nor that our societies ought to reduce requirements in middle-level (i.e., university) education, for a range of social and economic reasons (Autor, 2013; Brynin, 2002). Consequently, as regards internal change at an aggregate level, it is of importance that we focus on this upgrading.

Based on our discussion thus far on the internal change of occupational characteristics, a range of issues may already be highlighted, which accord with the literature on the subject. Firstly, as previously mentioned, the adaptation of the tasks of an occupation in the direction of analytic activities is per se an upgrading of competencies. The outcome of such a move is a required upgrading of human capital both in terms of the workers' knowledge and skills and of the ability to think critically or take initiatives (Walker & Lloyd-Walker, 2019). At the same time, due to the new distribution of tasks, workers need to cooperate with their capital (the machinery and programs) in the course of their work, in new terms.

[8] Or, they are treated under the assumption that professions remain relatively stable in terms of their internal characteristics. The use of cataloguing on a national scale resolves this to some degree, especially when it is regularly updated (particularly like O*NET) (Autor, 2013). However, not all catalogues are updated with the same regularity (Khatiwada & MacedaVeloso, 2019), while even regular updating resolves the issue to some degree only.

Thus, an important aspect of internal changes in occupational characteristics is the increased competencies of a technological nature (Walker & Lloyd-Walker, 2019). It follows that the importance of technological competencies will be assuming an increasingly central role in production. More specifically, for industry, the focus rests on competencies of three types (Taylor, 2015):

- Architectural Competencies, which entail the linking together of smaller elements for the building of larger systems.
- Planning Competencies, i.e., the invention of novel solutions, such as, for instance, the development of improvement programs.
- Analytic Competencies, i.e., the understanding of data, such as the application of analytics for the formulation of predictions.

Furthermore, the importance of various **creative competencies** (to do with entrepreneurship and intrapreneurship), such as the ability to be imaginative, passionate, insightful, flexible and accountable, is expected to be upgraded (Walker & Lloyd-Walker, 2019).

Finally, as was just noted in relation to occupational characteristics, flexibility is considered increasingly more important. Indeed, during the 4th industrial revolution when changes in the labor structure and in work tasks are accelerating, these characteristics are going to assume special prominence. Nevertheless, flexibility and adaptability are not sufficient as yet another type of competencies seems to be required, that of **learnability** (Ra et al., 2019; Walker & Lloyd-Walker, 2019). In order for workers to respond to their new tasks, they will need to be receptive to learning, and also unlearning, a range of skills and knowledge acquired through training and experience. And this will have to happen while the current cycle of program upgrades and changes is expected to accelerate (Walker & Lloyd-Walker, 2019) leading to higher requirements for continuous, lifelong training (Rae et al., 2019).

5.4.3 *The Organizational Framework of Occupations*

An important development to do with the nature of various occupations not noted so far concerns the work environment in the organizational sense. As noted in the previous chapter, the work environment affects the requirements in human capital (Stevenes & Campion, 1994). Communication and cooperation skills, skills for conflict resolution and so on are essential features that need to characterize not only a group coordinator but the group itself, even if to a lesser degree in the case of the latter.

Technological development and new communication possibilities are expected to significantly affect the work environment (CEDEFOP, 2018; Taylor, 2015; Walker & Lloyd-Walker, 2019).

A movement which on first sight appears contradictory is taking place regarding the organizational environment of work. Initially, workers' autonomy is expected to increase, both overall and within the frameworks described so far. Worker's possibilities for taking initiatives are expected to increase along with the trend for assigning work projects. Yet, although an agreement appears in the literature as to the strengthening of workers' autonomy (CEDEFOP, 2018; Walker & Lloyd-Walker, 2019), at the same time, a growing tendency is expected toward tighter collaborations and more numerous communications (Walker & Lloyd-Walker, 2019). These, in essence, both hold, to the degree that they are not two fully opposing movements, since a dilemma between autonomy/collaboration is particularly restrictive in describing the multiplicity of the organizational environment of production and work.

Based on these developments, a double movement is also expected as regards competencies. An increase is expected of the need for competencies which support entrepreneurship: the correct management of time (skill) and such abilities as taking initiative, accountability, self-discipline and knowledge of the limits of one's capacities. In parallel, an increase is also anticipated in requirements for competencies in communication and collaboration: i.e., in skills such as understanding the spoken word, active listening and abilities such as self-control, open mindedness but also knowledge of psychology, crisis management and communications theory, at least at some basic level.

At the same time, the increasing advancement of global economy, with greater connectivity and collaboration along global chains of value, also affects the organizational environment of work. We have already mentioned the increased trend of various occupations toward offshoring (Acemoglu & Autor, 2010; Blinder, 2009). This process of external change, however, has additional effects on occupational characteristics due to an internal effect. In this environment of international collaborations, a range of additional competencies are required (Walker &

Lloyd-Walker, 2019). Firstly, the abilities of an "open mind" and tolerance of diversity are going to feature more prominently in a multicultural workplace. Correspondingly, more important will be the knowledge of foreign languages but also cultural knowledge based on, among other things, people's language, history, religion and likewise with communication skills, speaking, writing in and understanding foreign languages and recognizing and respecting the different bodily expressions and stances of different cultures (see, for example, Yang, 2015, 2017).

Finally, the transition of communications from analog to digital encumbers workers with added requirements in knowledge and technological competencies.

5.5 Discussion to the Previous Analysis

Summing up with regard to changes in occupational characteristics, two categories have been gleaned. The first, which we named external change of occupational characteristics, refers to changes which are outside the occupations, i.e., to changes due to the redistribution of labor and the corresponding reconfiguring of the labor structure. Further analysis reveals three effects: the scale effect, which refers to the overall change in work availability; the sector effect, which refers to the distribution of work across the various sectors of the economy; and the occupational effect, which refers to the distribution among the different occupations in each sector.

The second category, which we defined as internal change in the occupational characteristics, refers to changes that occur due to the transformation itself of the occupations' nature due to the different distribution of tasks between capital and labor.

In terms of the content of the change occurring, we described its main characteristics as follows:

- In external change, strong elements appear of polarization in the required competencies, a swing toward the service sector, particularly health provision and tourism (in Europe administrative services also show signs of vitality) while an increasingly important phenomenon is that of offshoring which also contributes to the polarization of the required competencies.
- In internal change, we observe traits of a mild trend toward higher requirements in competencies of analysis and responsiveness to a non-repetitive set of factors, as well as significant prevalence of competencies in communication and social coexistence.

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PART II

Structural Relations and Structural Changes in the Greek Economy

CHAPTER 6

Sectoral Analysis of the Economic Activity of the Greek Economy, Input–Output Analysis

Svetoslav Danchev and Grigoris Pavlou

6.1 Introduction

The Greek economy, after 8 years of fiscal adjustment, was showing signs of stabilization, with prospects for a substantial recovery while having to maintain strict public finance targets. While it was still in the lookout for a new growth path, the outbreak of the pandemic in early 2020 upturned once more the outlook of the Greek economy.

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The restructuring of the production base of the Greek economy creates new conditions in the domestic labor market, while there are many external factors that may also affect employment in the Greek economy. Among the trends that are evolving in recent years internationally and affecting the international division of labor are protectionism, new digital technologies (Industry 4.0), but also wider social and environmental changes. In this context, the COVID-19 pandemic that broke out at the beginning of 2020 deeply affects all economic activity worldwide but also in Greece. The pandemic affects both supply and demand in almost all countries of the world, in such a way that the economic system is receiving strong shocks, with many sectors and occupations recording a rapid decline (food services, tourism, trade, etc.), while other sectors receive a temporary or permanent boost (pharmaceuticals, e-commerce, digital technologies, etc.). The Greek economy is expected to be affected by all these changes, while the challenges of digital transformation and climate change remain.

This chapter analyzes the current conditions in the labor market and presents the methodology for conducting projections for its future course. In particular, Sect. 6.2 outlines the effects of the economic cycle on total employment. The classifications of occupations and economic activities that are used to record and present employment data in Greece are shown in Sect. 6.3, while Sect. 6.4 examines various methodological approaches for recording employment. Section 6.5 examines the data on the sectoral dimension of employment in Greece the past decade, while Sect. 6.6 analyzes the structure and trends of employment per occupation groups. The methodological approach for estimating employment projections is introduced in Sect. 6.7. The chapter concludes with a more detailed exposition of the basic elements of the input–output analysis in Sect. 6.8 and the EURO method for projecting input–output tables in Sect. 6.9.

6.2 Macroeconomic Environment—Greece at a Crossroads of Significant Changes

The main growth driver in the years before the outbreak of the financial crisis in 2008 was private consumption (C). Public consumption (G) also had a positive contribution to growth, while investments (I) did not have a stable course in the period 2002–2008, as did exports (EX). During the same period, imports of goods and services (IM) had a negative impact on GDP change most of the years, as the strengthening of consumption, combined with the insufficient and non-competitive productive base, mainly fueled the increase in imports. Subsequently, the debt crisis in the period 2009–2010 led the Greek economy to the support mechanism, which aimed at ensuring debt refinancing, reduction of the twin deficits (in the General Government Balance and in the Current Account), and the improvement of competitiveness. The implementation of internal devaluation, with a reduction in public spending, an increase in taxes, and a restrictive income policy, aimed at achieving balances in the fiscal and external sectors, also through an increase in exports (Fig. 6.1).

After 2009, private consumption contributed negatively to the growth rate, as domestic demand declined. The impact of public consumption, as a tool of fiscal adjustment, was also negative. Investment fell sharply as a result of the sluggish demand, the climate of uncertainty, and lack of liquidity, while the decline in imports restrained to some extent the recession. Overall, in the period 2008–2013, GDP fell by ¼ of the level of 2007, while in the period 2014–2016, GDP change rates were close

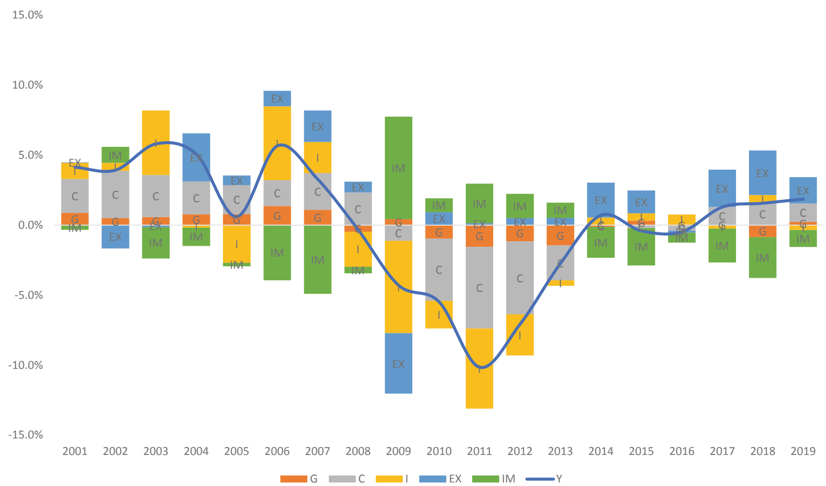

Fig. 6.1 Analysis of GDP components (*Source* Eurostat., National Accounts (GDP at constant prices using the expenditure method), G—Public Consumption, C—Private Consumption, I—Investments, EX—Exports of goods and services, IM—Imports of goods and services, Y—GDP)

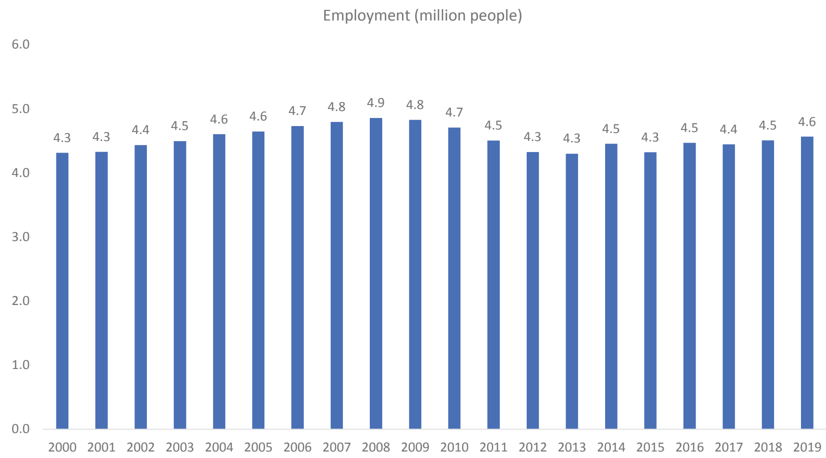

Fig. 6.2 Employment (*Source* Eurostat, National Accounts)

to 0%. In the years 2017–2019, GDP increased by 1.3%, 1.6%, and 1.9%, respectively, with an increase in exports and investments (mainly in 2017), while anemic but positive growth was also recorded in private consumption. Therefore, it seems that the production model is gradually changing, as cost competitiveness recovers as a result of the internal devaluation, while steps remain to improve structural competitiveness.

Employment was affected by the changes in GDP, with employment rising by 4.9 million by 2008, from 4.3 million in 2000. The economy entered a recession after 2008 causing a decline in employment, which approached 4.0 million people in 2013, a decrease of 0.9 million people compared to 2008. This large drop created very high unemployment rates, while it is estimated that it caused the flight of a significant part of human capital abroad (brain drain). In 2018–2019, employment increased by 1.4% and 1.2%, respectively (Fig. 6.2).

6.3 Categories of Occupations and Economic Activities (Sectors)

The main goal of the analysis is the study of employment in terms of occupations and sectors. Therefore, the categories of occupations and sectors should be explained.

The sectors of the economy are categorized using the classification NACE REV.2,[1] which has several hierarchical levels of analysis. The 1-digit level (Letters A–Y) corresponds to 21 broad sectors (sections), such as “Wholesale and Retail Trade” (G). At the 2-digit level, there are 88 sectors (divisions), such as 47 “Retail trade.” The classification is further divided into 3-digit (groups) and 4-digit (classes) levels, such as 47.1 “Retail sale in non-specialized stores” and 47.11 “Retail sale in non-specialized stores selling mainly food, beverages or tobacco.” For the needs of this and the next chapter, the analysis is performed at the 1-digit and 2-digit NACE Rev.2 levels (Table 6.1).

Respectively, the occupations are categorized according to the International Standard Classification of Occupations of 2008 (ISCO-08), with 4 levels of analysis (Table 6.2).

Therefore, the occupations too can be presented at different levels of analysis, i.e., at a very centralized level (Professionals, Technicians,

Table 6.1 Fields of economic activity (NACE REV.2 –2008), 1-digit level

A—Agriculture, forestry and fishing
B—Mining and quarrying
C—Manufacturing
D—Electricity, gas, steam and air conditioning supply
E—Water supply; sewerage, waste management and remediation activities
F—Construction
G—Wholesale and retail trade; repair of motor vehicles and motorcycles
H—Transportation and storage
I—Accommodation and food service activities
J—Information and communication
K—Financial and insurance activities
L—Real estate activities
M—Professional, scientific and technical activities
N—Administrative and support service activities
O—Public administration and defence; compulsory social security
P—Education
Q—Human health and social work activities
R—Arts, entertainment and recreation
S—Other service activities
T—Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
U—Activities of extraterritorial organisations and bodies

Source ELSTAT (Hellenic Statistical Authority)

Table 6.2 Occupation's categoreis, ISCO-08, 1-digit level

Code	*Description*
1	OC1—Managers
2	OC2—Professionals
3	OC3—Technicians and associate professionals
4	OC4—Clerical support workers
5	OC5—Service and sales workers
6	OC6—Skilled agricultural, forestry and fishery workers
7	OC7—Craft and related trades workers
8	OC8—Plant and machine operators and assemblers
9	OC9—Elementary occupations
0	OC0—Armed forces occupations

Source ELSTAT (Hellenic Statistical Authority missing)

etc.), at a less centralized level (Health Technicians, Construction Technicians, etc.), or at an even more detailed level (Doctors, Builders, etc.). For example, "Blacksmiths, Hammersmiths and Forging Press Workers," code "7221" in 4-digit ISCO, belong to the 3-digit category "Blacksmiths, Toolmakers and Related Trades Workers" with code "722," the 2-digit category "Metal, Machinery and Related Trades Workers" with code "72," and the 1-digit category 7 "Craft and related trades workers" (Table 6.3).

Here, the employment analysis is performed:

- Per occupation category, according to the standard classification of occupations of 2008 (ISCO-08), at 1-digit, 2-digit and 3-digit level, and

Table 6.3 Degree of analysis of professional categories (ISCO)

Degree of analysis	*Code*	*Description*
1-digit	7	Craft and related trades workers
2-digit	72	Metal, Machinery and Related Trades Workers
3-digit	722	Blacksmiths, Toolmakers and Related Trades Workers
4-digit	7221	Blacksmiths, Hammersmiths and Forging Press Workers

Source ELSTAT (Hellenic Statistical Authority)

- Per sector of economic activity, according to the statistical nomenclature of economic activities of 2008 (NACE REV.2-08) at 1-digit and 2-digit level.

6.4 Methodological Approaches for Recording Employment

Employment is recorded with different methodological approaches. The main ones are the Labor Force Survey (LFS), which is carried out with a questionnaire in households, the Structural Business Statistics (SBS) that collect data on the business sector from surveys in large companies and from administrative sources, and the National Accounts. The employment in the National Accounts is compiled by comparing and combining all the relevant available data sources of the country, making adjustments. These adjustments, integrating data from LFS and other sources, lead the employment of the National Accounts to be different from that of the LFS, as in the national accounts the employment data must be harmonized with other variables, such as production value and wages.

An additional issue concerns cross-border workers, which are not covered by the labor force survey, as it refers to resident households. Also, in the labor force survey, the employees with apprenticeship or internship status are not included, and neither are the employees with parental leave, while in contrast, they are included in the employment data of the National Accounts. Finally, in the labor force survey, age limits are set, which do not exist in the national accounts, without, however, this factor creating significant discrepancies.

For all the above reasons, the employment data differ between the two methods, yet both methods are useful, i.e., neither of them is superior. The employment of the National Accounts is considered more appropriate for the measurement of the employment levels, the trends in employment, and its composition by economic activity. LFS is more appropriate for measuring labor market participation (i.e., employment rates, workforce rates, employment and unemployment flows, etc.), demographic or social breakdowns (e.g., by age, gender, or educational level), and socio-demographic studies.

Due to the above, in the specific study both employment methodologies are used, as initially the employment is drawn based on the National Accounts data, in order to match them with the data of value added per sector, while at a second stage the data from the LFS is used with adjustments to examine the occupations categories.

6.5 Sectoral Employment Analysis

The analysis of employment per sector is of significant interest, as it presents which sectors are the largest employers in the Greek economy, but also the dynamics that are created in each sector. The following Table 6.4 shows in absolute terms the number of employees per sector of economic activity in 2019, their share in total employment, as well as the change in their share between 2008 and 2019, as categorized by NACE Rev.2.

The largest number of employees is recorded in the Wholesale and Retail Trade sector, with 17.2% of the workforce in terms of National Accounts included in the trade sectors, with a significant drop in its share since 2008. The Tourism sector (Accommodation and Food Services) presented significant resilience to the recession, creating new jobs and consolidating its participation in the Greek economy, resulting in it being ranked 2nd largest "employer" in the Greek economy with a share of 12.5% and an increase of 5.9 points of its share between the years 2008 and 2019.

It is followed by the sectors of Agriculture, Fishing and Forestry with 10.9% with a stable share since 2008, while the 4th place is taken by Public Administration, Defense and Compulsory Social Security, which absorbs a large part of the country's employment (397.5 thousand people), i.e., 8.7% of the total.

Education is 5th with a share of 8.0% and an increase since 2008, while Manufacturing comes 6th, with a significant drop in its share by 2.6 points since 2008. Note that many different activities are included in Manufacturing, with different developments in the period 2008–2019. Constructions present the largest drop in their share, by 3.7 points between 2008 and 2019, due to the significant decline in investment in construction and especially in housing after 2008 (Table 6.4).

In addition to the simple recording of employment per sector, important findings emerge if we add a comparison of the value added per sector. Figure 2.3 shows the share of each sector in value added and the corresponding share in employment (Fig. 6.3).

Table 6.4 Number of employees per 1-digit sector of economic activity (NACE REV.2), 2019

	Number of people 2019 (in thousands)	*Rank*	*Share (%)*	*Share Change 2008–2019 (percentage points)*
A—Agriculture, forestry and fishing	497.1	3	10.9	0.0
B—Mining and quarrying	10.0	20	0.2	0.0
C—Manufacturing	346.6	6	7.6	−2.6
D—Electricity, gas, steam and air conditioning supply	29.6	18	0.6	0.2
E—Water supply; sewerage, waste management and remediation activities	30.5	17	0.7	0.0
F—Construction	192.4	10	4.2	−3.7
G—Wholesale and retail trade; repair of motor vehicles and motorcycles	787.3	1	17.2	−3.1
H—Transportation and storage	249.5	9	5.5	0.9
I—Accommodation and food service activities	572.5	2	12.5	5.9
J—Information and communication	95.7	13	2.1	0.2
K—Financial and insurance activities	78.7	14	1.7	−0.6
L—Real estate activities	19.0	19	0.4	0.2
M—Professional, scientific and technical activities	264.6	8	5.8	0.9
N—Administrative and support service activities	137.5	11	3.0	0.8

(continued)

Table 6.4 (continued)

	Number of people 2019 (in thousands)	*Rank*	*Share (%)*	*Share Change 2008–2019 (percentage points)*
O—Public administration and defence; compulsory social security	397.5	4	8.7	−0.1
P—Education	364.2	5	8.0	1.4
Q—Human health and social work activities	266.6	7	5.8	1.0
R—Arts, entertainment and recreation	72.7	15	1.6	0.5
S—Other service activities	122.5	12	2.7	−1.2
T—Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	31.0	16	0.7	−0.8
U—Activities of extraterritorial organisations and bodies	0.0	21	0.0	0.0
Total	4.565		100.0	

Source ELSTAT (Hellenic Statistical Authority) National Accounts

Agriculture, Fishing and Stock Farming absorb 10.9% of employment, producing 4.4% of the total added value of the economy, as the activities are labor-intensive. By contrast, Industry without manufacturing and construction, i.e., Mining and Water and Energy Supply, employs 1.5% of the workforce, supplying 4.6% of the economy's value added, while in Manufacturing the share of employment is smaller (7.6%) than the share of value added (8.9%), as the Industry as a whole is a capital-intensive activity. In Construction, the share of employment (4.2%) is higher than the share of the sector in value added (1.4%). The Trade, Transport and Tourism sectors employ 1/3 of the workforce (33.2%), producing

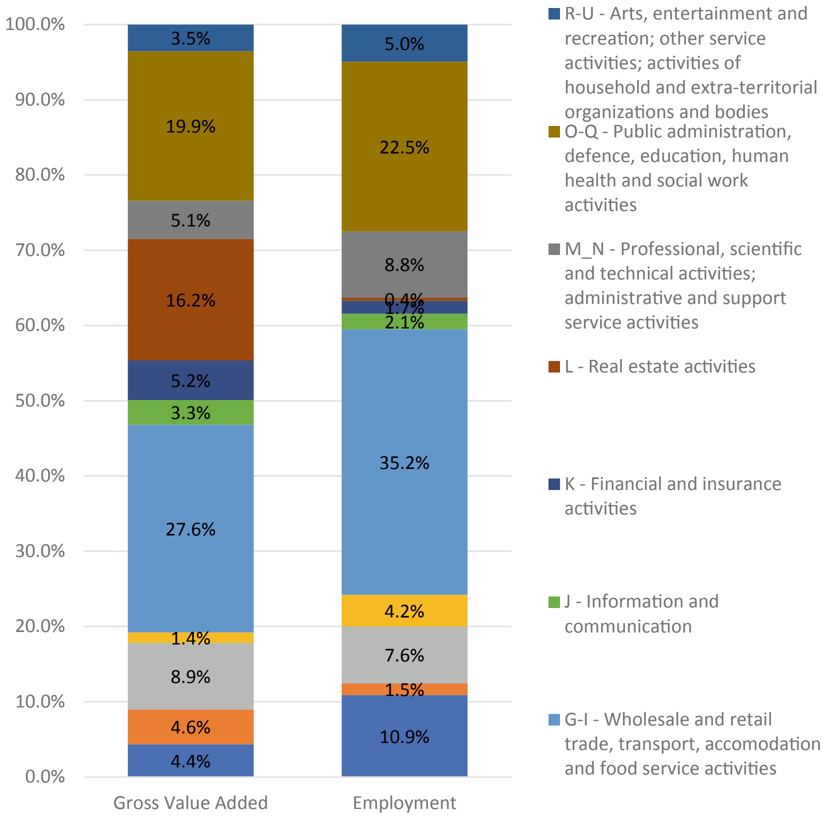

Fig. 6.3 Sector sharees in value added and employment (2019) (*Source* Eurostat, National Accounts)

¼ of the value added, indicating that these sectors are labor-intensive. In sectors with a strong presence of the public sector (Public Administration, Education, Health, etc.), the share of value added is equal to the share in employment, while in Professional, Technical and other activities the sector contributes more to employment (8.8%) than value added (5.1%).

Looking deeper in the sectors, through their analysis at 2-digit level, can better highlight the sectoral changes that took place during the crisis period. The following Table 6.5 presents the number of employees and the relevant share per sector, showing the 20 sectors with the largest

Table 6.5 Number od employees per 2-digit sector of economic activity (NACE REV.2)—2019

NACE REV.2	*Description*	*Total 2019 (thousands)*	*Share 2019*	*Share Change 2008–2019 (points)*	
55–56	Accommodation and food service activities	572.5	12.5%	5.9	↑
85	Education	364.2	8.0%	1.4	↑
69–70	Legal and accounting activities—Activities of head offices; management consultancy activities	141.7	3.1%	1.0	↑
86	Human health activities	230.4	5.0%	0.9	↑
50	Water transport	63.2	1.4%	0.8	↑
52	Warehousing and support activities for transportation	51.0	1.1%	0.4	↑
80–82	Security and investigation, service and landscape, office administrative and support activities	85.0	1.9%	0.4	↑
62–63	Computer programming, consultancy, and information service activities	35.5	0.8%	0.3	↑
10	Food, beverage and tobacco industry	121.5	2.7%	0.3	↑
93	Sports activities and amusement and recreation activities	26.8	0.6%	0.3	↑
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	7.7	0.2%	–0.4	↓
45	Wholesale and retail trade and repair of motor vehicles and motorcycles	72.6	1.6%	–0.5	↓

(continued)

Table 6.5 (continued)

NACE REV.2	*Description*	*Total 2019 (thousands)*	*Share 2019*	*Share Change 2008–2019 (points)*	
31–32	Manufacture of furniture and other manufacturing	22.2	0.5%	−0.5	↓
47	Retail trade, except for trade of motor vehicles and motorcycles	484.3	10.6%	−0.5	↓
64	Financial services activities,, except insurance and pension funding	46.8	1.0%	−0.6	↓
13–15	Manufacture of textiles, wearing apparel, leather and related products	29.2	0.6%	−0.7	↓
97–98	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	31.0	0.7%	−0.8	↓
94	Activities of membership organisations	34.7	0.8%	−1.0	↓
46	Wholesale trade, except of motor vehicles and motorcycles	230.3	5.0%	−2.2	↓
41–43	Construction	192.4	4.2%	−3.7	↓

Source Eurostat, National Accounts

change (increase and decrease) of their share between the years 2008 and 2019.[2] The largest increase was recorded in Accommodation and Food Services, with an increase of 5.9 percentage points in the relevant share between 2008 and 2019, employing 572.5 thousand people, followed by Education with an increase of 1.4 points, but with a smaller number of employees (approximately 365 thousand). Legal and accounting activities strengthened their share by 1 point, corresponding to 3.1% of total employment, followed by Human Health Activities with a share increase of 0.9 points (Table 6.5).

As previously mentioned, the downturn in the Greek economy was accompanied by a dramatic decline in the construction sector, where all construction activity shrank rapidly. At the same time, the Wholesale Trade sector is shrinking, as are the Activities of Membership Organizations. The Textile and Clothing sector is also declining, having already lost much of its momentum in recent years due to changes that were created by the intensification of international competition and the expansion of the share of countries with lower labor costs (such as Bulgaria and China).

6.6 Analysis of Occupations

The data by occupation category come from the database of the Labor Force Survey (LFS) and not the National Accounts, while the data with the specific classification (ISCO-08) are available for the period 2011–2019. For 2019 (Fig. 1.4), the category of employees in the provision of services and sales workers holds the largest share among the occupations, with a percentage of 23.5%, i.e., about 1 in 4 employees in the Greek economy, followed by professionals with 19.2%, which includes categories such as doctors, physicists, chemists, accountants, and teachers. The shares of employees in the provision of services and professionals are increased compared to 2011, as between the years 2011 and 2019 the increase in the number of employees in these categories was more significant compared to the change in total employment.

Clerical support workers come third, with a share of 11.5% and an increase since 2011, followed by skilled agricultural, forestry, and fishery workers with 10.5%. Craft and related trade workers constitute 9.1% of the total workforce, with a significant drop since 2011, as in this category there are several professional categories belonging to the construction sector, which has declined rapidly. Technicians constitute 8.0% of the workforce, followed by elementary occupations and machine operators with 7.0% and 6.7%, respectively. Finally, managers constitute a small percentage of 2.9% of employees (Fig. 6.4).

Table 6.6, the 2-digit categories of occupations are analyzed, based on the ISCO classification, followed by the analysis of the 3-digit categories in the most numerous 2-digit categories, in order to highlight the categories that approach the concept of the profession. The most numerous professional category at 2-digit level is the sales workers (mainly in stores),

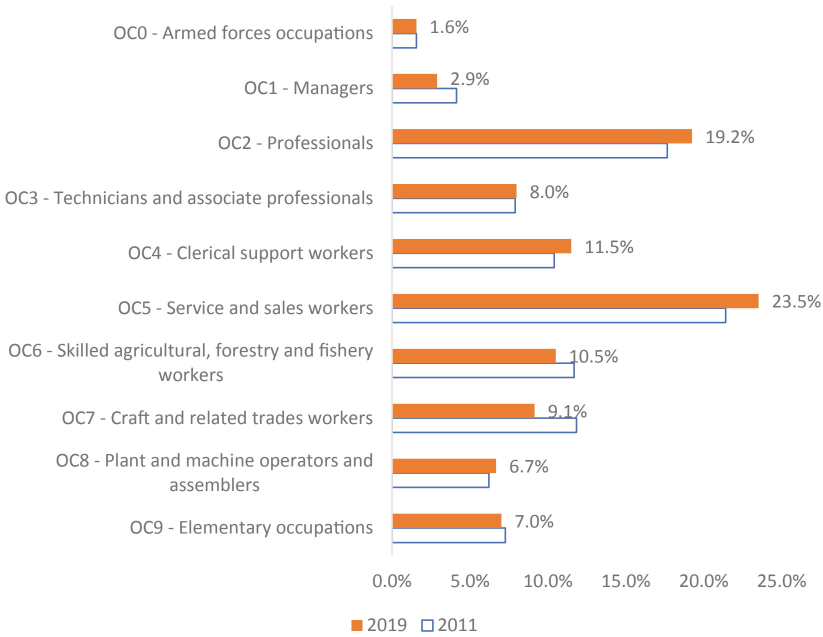

Fig. 6.4 Shares of occupations ISCO—2011, 2019 (*Source* ELSTAT (Hellenic Statistical Authority), Labor Force Survey)

with a share of 12.4% in the total employment (Table 6.7), followed by market-oriented skilled agricultural workers with 10.2%.

Employees in the provision of personal services account for 7.8% of total employment and mainly concern waiters and bartenders, who in 3-digit analysis constitute 75.4% of this category. Teachers are the 4th category, with a share of 6.6% in 2019, which mainly includes primary school and early childhood teachers and secondary school teachers. General and keyboard clerks consist 6.5% of the employees, with increase from 2011, followed by drivers and mobile plant operators, with a share of 5.1%. In the latter category, the most numerous subcategories are heavy truck and bus drivers, but also car, van, and motorcycle drivers.

Finally, tables with the correspondence of sectors and occupations are presented in the annex; that is, the number of employees per basic sector and per basic professional category is shown, while the shares of the

Table 6.6 Shares of occupations ISCO (2-digit analysis)—2011, 2019

	2011 (%)	*2019 (%)*
52 Sales workers	12.5	12.4
61 Market-oriented skilled agricultural workers	11.3	10.2
51 Personal service workers	6.2	7.8
23 Teaching professionals	6.6	6.6
41 General and keyboard clerks	4.9	6.5
83 Drivers and mobile plant operators	4.5	5.1
33 Business and administration associate professionals	3.0	3.5
26 Legal, social and cultural professionals	2.9	3.2
22 Health professionals	2.3	3.0
21 Science and engineering professionals	2.9	2.9
91 Cleaners and helpers	3.7	2.8
24 Business and administration professionals	2.6	2.8
71 Building and related trades workers, excluding electricians	4.5	2.6
42 Customer services clerks	2.2	2.6
54 Protective services workers	2.2	2.5
72 Metal, machinery and related trades workers	2.7	2.2
75 Food processing, wood working, garment and other craft and related trades workers	2.6	2.1
43 Numerical and material recording clerks	1.7	1.8
74 Electrical and electronic trades workers	1.7	1.8
32 Health associate professionals	1.9	1.8
93 Labourers in mining, construction, manufacturing and transport	1.7	1.7
0 Armed forces occupations	1.6	1.6
81 Stationary plant and machine operators	1.6	1.5
14 Hospitality, retail and other services managers	2.4	1.5
31 Science and engineering associate professionals	1.9	1.3
96 Συλλέκτες απορριμμάτων και άλλοι ανειδίκευτοι εργάτες	0.7	0.9
92 Agricultural, forestry and fishery labourers	0.7	0.9
34 Legal, social, cultural and related associate professionals	0.7	0.9
53 Personal care workers	0.5	0.8
13 Production and specialised services managers	0.9	0.8
25 Information and communications technology professionals	0.4	0.7
44 Other clerical support workers	1.5	0.7
94 Food preparation assistants	0.5	0.6
35 Information and communications technicians	0.4	0.5
12 Administrative and commercial managers	0.6	0.4
73 Handicraft and printing workers	0.4	0.4

(continued)

Table 6.6 (continued)

	2011 (%)	*2019 (%)*
62 Market-oriented skilled forestry, fishery and hunting workers	0.4	0.3
11 Chief executives, senior officials and legislators	0.1	0.1
82 Assemblers	0.1	0.1
95 Street and related sales and service workers	0.0	0.0

Source ELSTAT (Hellenic Statistical Authority). Labor Force Survey

professional categories per sector and the employees in each sector per occupation category follow.

6.7 Methodology for Making Employment Projections—Introduction

We estimated the employment by profession for the period 2019–2027 by projecting the evolution of the structure of the Greek economy in the future. In particular, based on macroeconomic forecasts, we estimated input–output tables of the Greek economy for the corresponding period (2019–2027). Then, assuming a stable percentage distribution of occupations per sector of economic activity, we estimated the evolution of employment per occupation and per sector by 2027 (Fig. 6.5). Examining the impact of macroeconomic developments on employment as well as on occupations at sector level, we detect, on the one hand, the occupations that show the greatest loss of employees due to the expected change in the structure of the economy and, on the other, the occupations and sectors that show a positive dynamic.

The projection of the input–output table (Petrakis, 1984, 1985) was performed using the EURO method of Eurostat (Eurostat, 2008). This method uses forecasts for the future course of GDP, for the components of final demand, and for value added per sector, in order to project an input–output table of a base year in a future period, through an iterative process. The latest available input–output table of the Greek economy is based on 2015 data.

The method was developed for Eurostat in order to avoid some disadvantages of alternative methods of projecting input–output tables, such as RAS, MODOP, the linear programming method, and the statistical

Table 6.7 3-digit professional categories in the most numerous professional categories in 2-digit analysis

2-digit ISCO	*3-digit ISCO*	*2019 (%)*
52 Sales workers	521 Street and market salespersons	4.0
	522 Shop salespersons	83.7
	523 Cashiers and ticket clerks	6.4
	524 Other sales workers	5.9
61 Market-oriented skilled agricultural workers	**611 Market gardeners and crop growers**	77.2
	612 Animal producers	13.2
	613 Mixed crop and animal producers	9.6
51 Personal service workers	511 Travel attendants, conductors and guides	2.7
	512 Cooks	18.3
	513 Waiters and bartenders	57.2
	514 Hairdressers, beauticians	14.6
	515 Building and housekeeping supervisors	4.9
	516 Other personal services workers	2.3
23 Teaching professionals	231 University and higher education teachers	7.2
	232 Vocational education teachers	2.8
	233 Secondary education teachers	30.3
	234 Primary school and early childhood teachers	35.9
	235 Other teaching professionals	23.8
41 General and keyboard clerks	**411 General office clerks**	77.6
	412 Secretaries (general)	18.9
	413 Keyboard operators	3.4
83 Drivers and mobile plant operators	831 Locomotive engine drivers	0.7
	832 Car, van and motorcycle drivers	38.3
	833 Heavy truck and bus drivers	47.3
	834 Mobile plant operators	10.6
	835 Ships' deck crews	3.1

Source ELSTAT (Hellenic Statistical Authority). Labor Force Survey

correction method (Dietzenbacher & Miller, 2009; Miller & Blair, 2009; Temurshoev et al., 2013). In particular, according to Eurostat, alternative methods may result in unreasonably high values for the production factors. An additional comparative advantage of the EURO method is that it is based on forecasts for GDP, final demand, and value added per sector, which are more widely available, compared to the forecasts

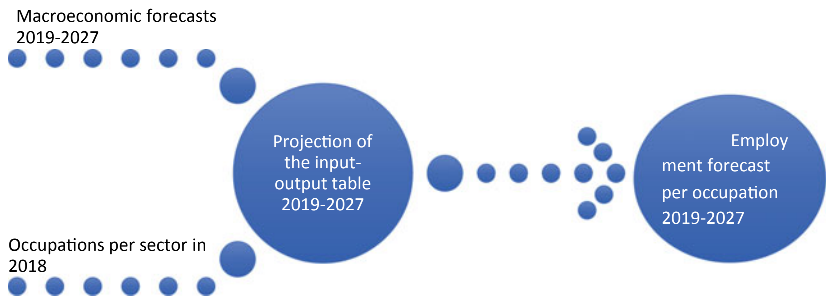

Fig. 6.5 Employment assessment elements per profession for the period 2013–2020 (*Source* Authors' own creation)

for total production and intermediate consumption needed for the other methods (Eurostat, 2008).

However, the iterative process of the EURO method does not necessarily lead to the termination of the estimation at the desired level of deviation from the external forecasts, which sometimes creates the need to adjust the external forecasts in order to find a solution. As in this chapter the interest is focused on employment and therefore on the domestic supply side, in case of non-termination of the repetitive process, it was chosen to adjust the forecasts of elements of the final demand, such as private and public consumption, as well as imports, without changing the forecasts for the evolution of GDP or value added per sector.

6.8 Basic Elements of the Input–Output Analysis

The input–output model is a general equilibrium model developed by W. Leontief in the 1940s, through which the cross-sector relations of an economic system can be analyzed. The analysis can take place either for the whole economy or at regional level (for the historical development of the model, see Tzouvelekas, 2003).

The basis of the analysis is the input–output table, which records the uses of goods and services produced in an economy over a period (usually over a year). This is a double entry table, in which all sectors of the economy appear twice, once as sellers and the second time as buyers. The economic system is broken down into 65 production sectors.[3] In the lines of the table, each sector appears as a producer of goods that cover intermediate and final demand, while in the columns of the table each sector appears as a buyer of goods and services, used in the production of its goods (Livas, 1994). If we assume that the economy is broken down into n economic sectors, then the input–output table takes the following form (Table 6.8).

In the 1st quadrant of the input–output table, we have the table of inter-sector transactions X (transactions matrix), with dimensions nxn, in which all the transactions between the sectors are recorded. The rows describe the intermediate demand, i.e., how the product of each sector is distributed to the remaining sectors (output), while the columns describe the intermediate supply, i.e., the products of the other sectors of the economy used to produce the product of each sector (input). The 2nd quadrant of the table, with dimensions nx5, depicts the data of the final demand of the produced goods, i.e., the share of the total output that corresponds to the following categories of final demand: private consumption (C), public consumption (G), fixed capital formation (K), stock changes (St), and exports (E). In the 3rd quadrant, with dimensions 6xn, the primary inputs to production are recorded, which constitute the elements of the value added of the production sectors. These are wages (W), profits (Pr), depreciation and rent (D), indirect taxes (T), subsidies received by each sector (S), and finally, imports of each sector

Table 6.8 Input–output

Inputs\outputs	*Intermediate demand*	*Final demand*	*Total demand*
Sectors	1 … … j … n	CGKStE	
1	X_{11}… … X_{1j} X_{1n}	C_1 G_1 K_1 St_1 E_1	$\mathbf{X_1}$
i	X_{i1}… … X_{ij} X_{in}	C_i G_i K_i St_i E_i	$\mathbf{X_i}$
n	X_{n1}… … X_{nj} X_{nn}	C_n G_n K_n St_n E_n	$\mathbf{X_n}$
W	W_1 … … W_j W_n	T_c T_g T_k T_{st} T_E	**W**
Pr	Pr_1 … … Pr_j Pr_n	$-S_c$ $-S_g$ $-S_k$ $-S_{st}$ $-S_E$	**Pr**
D	D_1 … … D_j D_n	Im_c Im_g Im_k Im_{st} Im_E	**D**
T	T_1 … … T_{jj} T_n		**T**
-S	$-S_1$ … … $-S_j$ $-S_n$		**−S**
Im	Im_1… … Im_j Im_n		**Im**
Total Production	$\mathbf{X_1}$ **… …** $\mathbf{X_j}$ $\mathbf{X_n}$	**C G K St E**	

Source Authors' own creation

(Im). Finally, the 4th quadrant includes the value of primary inputs corresponding to the elements of final demand (indirect taxes, subsidies, and imports).

6.8.1 *Table of Technological Coefficients*

From the table of inter-sector transactions X, the table of technological coefficients A can be calculated, which describes the relations between the inputs and the outputs of an economy. Specifically, the technological coefficients (the elements a_{ij} of Table A) determine the amounts of inputs required by the various production sectors of the economy in order to produce one unit of output of each sector. Therefore, the technological coefficients represent the production technology used. This is one of the most basic elements of the input–output analysis, as it shows that the change in the production of sector i can be realized only with a corresponding change in each of the required inputs of the sector.

Table A arises from the division of all the elements of the table of inter-sector transactions X with the total of the column in which every element belongs. Therefore, the standard element a_{ij} is calculated as:

$$a_{ij} = \frac{X_{ij}}{X_j}$$

where X_j is the total output of sector j, $i,\ j = 1,\ 2,\ ...,\ n$ and n is the number of sectors of the economy.

One of the most important advantages of the input–output analysis is that it enables the quantification of interdependence between the production sectors of the economy. The measure of interdependence is an indicator of vertical inter-sector production relations (backward linkages), which show the direct effects that the change by 1 unit of the final demand of sector j will have on the production of the related sectors. These indicators are given by the formula:

$$K_j = \sum_j a_{ij}$$

That is, the index of direct vertical interconnection of sector j is equal to the sum of the elements of the corresponding column of Table A of the technological coefficients. In addition to the input purchases of one sector from the others which are necessary to produce a unit of output and which are listed in Table A and constitute the direct effects on production due to an increase in the final demand, there are also indirect effects on production of almost all sectors.

In other words, there is a multiplicative process, through which the change in the final demand of a sector (in essence, an external shock to demand) has effects, both direct and indirect, on the total transactions of almost all sectors of the economy. This multiplicative effect, the determination of which is one of the central objectives of the input–output analysis, can be calculated using the so-called Leontief inverse matrix (also called multiplier or total requirements matrix).

6.8.2 Multipliers

If with X we represent the n-dimensional vector of sectoral production levels, with F the n-dimensional vector of sectoral levels of final demand, with A the n $\times$ n table of technological coefficients, and with I the n $\times$ n unit table, then we have:

$$X = AX + F \Rightarrow (I - A)X = F \Rightarrow X = (I - A)^{-1}F$$

where $(I - A)^{-1}$ is the Leontief inverse matrix. The elements of this inverse matrix are called coefficients of interdependence, denoted by b_{ij} and show what the overall results are in the economy after a 1-unit change in final demand. The sum of the columns of the inverse matrix:

$$R_j = \sum_j b_{ij}$$

gives the total vertical production interconnections. Therefore, the index R_j shows the vertical multiplier effects of changes in demand on the economy as a whole. The indirect effects are estimated from the difference:

$$R_j - K_j$$

Through the equation $X = (I - A)^{-1}F$, and assuming that the elements α_{ij} of the Table A of technological coefficients remain stable for the period under consideration, we can calculate the new vector of sectoral production levels, X', which is required to meet the new final demand F'.

6.8.3 Occupation Multipliers

The interdependence coefficients b_{ij} show the overall impact on the economy by a change in the final demand for a sector's product. The central importance of the Leontief inverse matrix in input–output analysis is shown by the fact that it is used to examine the overall impact on the economy due to a change in the demand for primary inputs (value added items), such as wages among others.

A distinction must be made between direct, indirect, and total effects (for a more detailed presentation, see Belegri-Roboli et al., 2010).

The *direct effects* show the amount by which the primary inputs of the sector will change if its production changes by one unit, and are given by the formula:

$$\text{direct}_i = \frac{w_i}{X_i},$$

where w_i is the examined magnitude.

The *overall effects* show the amount by which the examined magnitude of primary input should be increased to meet a unit increase in the final demand of sector j. They are given by the following formula:

$$\text{backward}^T = \text{direct}^T (I - A)^{-1},$$

where T symbolizes transposed table.

Finally, the *indirect effects*, which arise as the difference between total and direct effects, show the change due to the interconnections of the sector in question with the remaining sectors.

The calculation of multipliers for occupations is based on the following relations:

If we symbolize with $L_{i,k}$ the table whose random element $L_{m,n}$ gives the number of employees in sector m and occupation n, then:

$l_{k,i} = L^T_{i,k}\hat{X}^{-1}$, is the table of direct coefficients of occupations, while:

$$\Lambda_{k,i} = l_{k,i}(I - A)^{-1}$$

is the table of the total coefficients of occupations. Each element in Table L will therefore show which will be the total change in the number of employees in profession n of sector m, as a result of an increase by 1 unit in the final demand of the sector.

6.8.4 Inter-Temporal Stability of Table A

These tables are usually produced and published every five years because the data collection process for the construction of an input–output table, and therefore matrix A, is particularly time consuming and costly. A general rule adopted in the empirical bibliography is that these coefficients can be assumed to remain stable for a period of 5 years. However, input–output tables are published with a delay, which can be up to 3 years from the end of the reference year. Therefore, the use of input–output methods for future periods is faced with the problem that the technological coefficients have changed compared to the base year.

The technological coefficients of Table A change over time. This is due to the fact that production techniques change over time for a number of reasons, including:

- The very process of technological change,
- The change in relative prices, which is likely to lead to a substitution between inputs in the production process and, consequently, to a change in the production composition of the sectors, and
- The change in demand for the product of some sectors of the economy, which will affect the output of these sectors.

Especially for the Greek economy, which has gone through a prolonged period of economic recession, both the composition of the sectors of the economy and the production techniques are in the process of transformation. Therefore, it is necessary to update the table of technological coefficients, taking into account all the additional information on the evolution of the basic macroeconomic variables provided by the macro-econometric model, in order to assess the effects of the recession and the transformation of the growth model of the Greek economy both in the composition of the sectors and in the occupations and in the number of employees.

6.9 The EURO Method

In the first step of the iterative process of the EURO method, the data of the input–output table in terms of the intermediate and final demand for the forecast year are estimated. Specifically, the data for the base year are weighted with diagonal tables that contain forecasts for the rate of change of outputs and inputs:

$$T_2 = ZT_1$$

$$T_3 = T_1 S$$

$$T_4 = (T_2 + T_3)/2$$

where

T_1 = table with r × p dimensions with data on intermediate consumption and final demand for the base year,
T_2 = table with r × p dimensions with estimates for intermediate consumption and final demand for the forecast year, weighted with the rates of change of the outputs,
T_3 = table with r × p dimensions with estimates for intermediate consumption and final demand for the forecast year, weighted with the rates of change of inputs,
Z = diagonal table with dimensions r × r with the rates of change of the outputs,
S = diagonal table with p × p dimensions with the rates of change of inputs,
r = the number of sectors of economic activity + the number of rows of the input–output table for imports (1 in the present study), and
p = the number of sectors of economic activity + the number of items of final demand.

Initially, the rates of change of inputs and outputs correspond to the external forecasts for value added per sector, but then they differ so that the estimates for the rates of change in value added and the elements of final demand resulting from the model converge to external forecasts.

In the second step, the value added per sector for the forecast year is estimated:

$$\mathrm{T}_5 = vW$$

where

W = diagonal table (with p × p dimensions) with the rates of change of value added per sector of economic activity,
v = vector 1 × p with elements for value added per sector for the base year, and
T_5 = vector 1 × p with estimate for value added for the forecast year.

In the third step, Table T_4 and vector T_5 are linked to produce an input–output table F_1 for the forecast year, in which, however, there is no consistency in the sums of inputs and outputs.

Next, a balanced input–output table is estimated. First, the input coefficient Table A is evaluated on the basis of the inconsistent F_1 table previously constructed. The elements in Table A are as follows:

$$a_{ij} = x_{ij}/x_j$$

where

x_{ij} = intermediate consumption of goods (product or service) i from sector j,
x_j = total production value of sector j, and.
a_{ij} = input coefficient of domestically produced goods i in the production process of sector j.

The respective coefficients for imports and value added are similarly estimated:

$$b_j = m_j/x_j$$

$$c_j = v_j/x_j$$

where

m_j = imports of goods for the production needs of sector j,
v_j = value added of sector j,
b_j = import input coefficient in the production process of sector j, and
c_j = value added coefficient of sector j.

In the fifth step of the process, the total production value of the sector is estimated based on the final demand of the inconsistent input–output table F1 and the coefficients of Table A:

$$x = (I - A)^{-1} y$$

where

y = final demand vector,
I = unit table, and
x = vector with estimates of production value per sector.

In the sixth step, the inputs of the balanced input–output table are estimated:

$$T_6 = Bx$$

where,

B = table of input coefficients for domestic goods, imports and value added per sector, and
T_6 = table with inputs (domestic goods, imports, and value added) per sector.

.

In the seventh step, a balanced input–output table F_2 is constructed, combining the T_6 table with the vector y.

However, the estimated value added and final demand data in Table F_2 may deviate from the external forecasts. In order to achieve convergence with the forecasts, the rates of change of inputs and outputs are changed marginally (tables S and Z) and the steps of the process are repeated from the beginning.

Specifically, the divergence between the external projections and the results from the model is estimated:

$$e_j = d_j^p / d_j^m$$

where,

d_j^p = external forecast of value added per sector or final demand,
d_j^m = an estimate based on the model of value added per sector or final demand, and
e_j = divergence.

Then, the rates of change of inputs and outputs are modified based on the following adjustment functions:

$$z_{\mathrm{r}} = \begin{cases} z_{\mathrm{r}}^0 * \left(1 - \frac{[(1-e_{\mathrm{r}})*100]^c}{100}\right) & \text{for } e_{\mathrm{p}} < 1 \\ z_{\mathrm{r}}^0 * \left(1 + \frac{[(e_{\mathrm{r}}-1)*100]^c}{100}\right) & \text{otherwise} \end{cases}$$

$$s_{\mathrm{p}} = \begin{cases} s_{\mathrm{p}}^0 * \left(1 - \frac{[(1-e_{\mathrm{p}})*100]^c}{100}\right) & \text{for } e_{\mathrm{p}} < 1 \\ s_{\mathrm{p}}^0 * \left(1 + \frac{[(e_{\mathrm{p}}-1)*100]^c}{100}\right) & \text{otherwise} \end{cases}$$

where c = adjustment flexibility (in the present study it was set equal to 0.5).

The steps of the process are repeated until the difference between the model estimates and the external forecasts does not exceed an acceptable limit (e.g., 1%).

Annex

See Table 6.9, 6.10, 6.11, and 6.12.

Notes

1. NACE is derived from the French title "Nomenclature générale des Activités économiques dans les Communautés Européennes" (Statistical classification of economic activities in the European Communities).
2. The annex (Table 3.1) presents all the fields.
3. The double-digit sectors in the Statistical Classification of Economic Activities of ELSTAT (Hellenic Statistical Authority), which is based on NACE Rev. 2 of the EU (in turn based on ISIC Rev. 4 of the United Nations), are totally 88, but some of them are presented in the input–output tables as a total of two or three sectors together.

Table 6.9 Number of employees per 2-digit sector of ecnomic activity (NACE REV.2)—2019

NACE REV.2	*Total 2019 (thousands)*	*Share 2019*	*Share Change 2008–2019*	
I—Accommodation and food service activities	572.52	12.5%	5.92	↑
P—Education	364.15	8.0%	1.36	↑
M69–M70—Legal and accounting activities; activities of head offices; management consultancy activities	141.74	3.1%	0.96	↑
Q86—Human health activities	230.38	5.0%	0.89	↑
H50—Water transport	63.23	1.4%	0.80	↑
H52—Warehousing and support activities for transportation	51.03	1.1%	0.37	↑
N80–N82—Security and investigation, service and landscape, office administrative and support activities	84.95	1.9%	0.37	↑
J62–J63—Computer programming, consultancy, and information service activities	35.48	0.8%	0.34	↑
C10–C12—Manufacture of food products; beverages and tobacco products	121.49	2.7%	0.30	↑
R93—Sports activities and amusement and recreation activities	26.79	0.6%	0.28	↑
N78—Employment activities	17.6	0.4%	0.27	↑
L—Real estate activities	18.95	0.4%	0.22	↑
D—Electricity, gas, steam and air conditioning supply	29.6	0.6%	0.21	↑
R90–R92—Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities	45.89	1.0%	0.18	↑

(continued)

Table 6.9 (continued)

NACE REV.2	*Total 2019 (thousands)*	*Share 2019*	*Share Change 2008–2019*	
Q87–Q88—Residential care activities and social work activities without accommodation	36.24	0.8%	0.15	↑
M72—Scientific research and development	16.58	0.4%	0.11	↑
N79—Travel agency, tour operator and other reservation service and related activities	19.58	0.4%	0.09	↑
A02—Forestry and logging	9.22	0.2%	0.09	↑
C33—Repair and installation of machinery and equipment	16.48	0.4%	0.08	↑
N77—Rental and leasing activities	15.34	0.3%	0.05	↑
J61—Telecommunications	29.5	0.6%	0.04	↑
E37–E39—Sewerage, waste management, remediation activities	19.8	0.4%	0.02	↑
E36—Water collection, treatment and supply	10.67	0.2%	0.02	↑
M73—Advertising and market research	15.99	0.4%	0.00	↑
U—Activities of extraterritorial organisations and bodies	0	0.0%	0.00	↑
A03—Fishing and aquaculture	21.19	0.5%	−0.00	↓
K65—Insurance, reinsurance and pension funding, except compulsory social security	8.08	0.2%	−0.00	↓
C17—Manufacture of paper and paper products	8.55	0.2%	−0.01	↓
K66—Activities auxiliary to financial services and insurance activities	23.91	0.5%	−0.02	↓
B—Mining and quarrying	10.02	0.2%	−0.02	↓

(continued)

Table 6.9 (continued)

NACE REV.2	*Total 2019 (thousands)*	*Share 2019*	*Share Change 2008–2019*	
C27—Manufacture of electrical equipment	8.8	0.2%	−0.02	↓
C26—Manufacture of computer, electronic and optical products	3.86	0.1%	−0.02	↓
C20—Manufacture of chemicals and chemical products	11.98	0.3%	−0.03	↓
S96—Other personal service activities	76.22	1.7%	−0.03	↓
C19—Manufacture of coke and refined petroleum products	3.82	0.1%	−0.03	↓
H51—Air transport	3.86	0.1%	−0.04	↓
C22—Manufacture of rubber and plastic products	12.94	0.3%	−0.04	↓
C21—Manufacture of basic pharmaceutical products and pharmaceutical preparations	10.36	0.2%	−0.05	↓
C29—Manufacture of motor vehicles, trailers and semi-trailers	1.98	0.0%	−0.05	↓
J59–J60—Motion picture, video, television programme production; programming and broadcasting activities	17.33	0.4%	−0.05	↓
C30—Manufacture of other transport equipment	4.75	0.1%	−0.06	↓
M74–M75—Other professional, scientific and technical activities; veterinary activities	19.32	0.4%	−0.07	↓
M71—Architectural and engineering activities; technical testing and analysis	70.97	1.6%	−0.07	↓
J58—Publishing activities	13.35	0.3%	−0.08	↓
H53—Postal and courier activities	16.4	0.4%	−0.09	↓

(continued)

Table 6.9 (continued)

NACE REV.2	*Total 2019 (thousands)*	*Share 2019*	*Share Change 2008–2019*	
S95—Repair of computers and personal and household goods	11.6	0.3%	−0.10	↓
A01—Crop and animal production, hunting and related service activities	466.66	10.2%	−0.10	↓
O—Public administration and defence; compulsory social security	397.48	8.7%	−0.12	↓
H49—Land transport and transport via pipelines	114.97	2.5%	−0.15	↓
C24—Manufacture of basic metals	11.31	0.2%	−0.16	↓
C28—Manufacture of machinery and equipment n.e.c	10.67	0.2%	−0.18	↓
C18—Printing and reproduction of recorded media	10.57	0.2%	−0.18	↓
C25—Manufacture of fabricated metal products, except machinery and equipment	33.57	0.7%	−0.27	↓
C23—Manufacture of other non-metallic mineral products	16.41	0.4%	−0.30	↓
C16—Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	7.68	0.2%	−0.39	↓
G45—Wholesale and retail trade and repair of motor vehicles and motorcycles	72.6	1.6%	−0.45	↓
C31–C32—Manufacture of furniture; other manufacturing	22.19	0.5%	−0.47	↓
G47—Retail trade, except of motor vehicles and motorcycles	484.32	10.6%	−0.50	↓

(continued)

Table 6.9 (continued)

NACE REV.2	*Total 2019 (thousands)*	*Share 2019*	*Share Change 2008–2019*	
K64—Financial service activities, except insurance and pension funding	46.75	1.0%	−0.56	↓
C13-C15—Manufacture of textiles, wearing apparel, leather and related products	29.22	0.6%	−0.70	↓
T—Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	31.01	0.7%	−0.78	↓
S94—Activities of membership organisations	34.72	0.8%	−1.02	↓
G46—Wholesale trade, except of motor vehicles and motorcycles	230.34	5.0%	−2.15	↓
F—Construction	192.42	4.2%	−3.74	↓

Source ELSTAT (Hellenic Statistical Authority), Labor Force Surve

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Table 6.10 Employment per occupation and sector of economic activity in 2019

	OC1—Managers	*OC2—Professionals*	*OC3—Technicians and associate professionals*	*OC4—Clerical support workers*	*OC5—Service and sales workers*	*OC6—Skilled agricultural, forestry and fishery workers*
A—Agriculture, forestry and fishing	845	3.36	748	1.932	2.059	408.015
B—Mining and quarrying	-	340	418	534	344	
C—Manufacturing	14.03	28.818	24.784	35.534	29.202	405
D—Electricity, gas, steam and air conditioning supply	1.314	4.274	3.753	6.925	890	–
E—Water supply; sewerage, waste management and remediation activities	864	1.158	3.038	3.35	608	
F—Construction	31.582	33.048	19.847	72.223	432.127	–
G—Wholesale and retail trade; repair of motor vehicles and motorcycles	5.732	4.365	24.074	44.803	10.912	–
H—Transportation and storage	25.456	5.975	3.863	28.686	242.032	477
I—Accommodation and food service activities	5.903	39.49	15.746	27.565	5.966	–

	OC1—Managers	*OC2—Professionals*	*OC3—Technicians and associate professionals*	*OC4—Clerical support workers*	*OC5—Service and sales workers*	*OC6—Skilled agricultural, forestry and fishery workers*
J—Information and communication	2.734	12.283	39.607	26.959	1.546	–
K—Financial and insurance activities	203	897	2.509	1.427	–	–
L—Real estate activities	1.36	148.613	36.486	25.997	1.388	
M—Professional, scientific and technical activities	3.05	3.082	6.244	19.666	22.762	1.183
N—Administrative and support service activities	3.676	47.722	32.719	89.131	72.003	305
O—Public administration and defence; compulsory social security	5.869	268.093	7.886	14.457	10.439	–
P—Education	3.32	112.589	67.887	21.937	27.301	–
Q—Human health and social work activities	1.298	11.543	14.393	14.149	7.09	–
R—Arts, entertainment and recreation	1.932	14.164	3.401	5.757	45.338	–

(continued)

Table 6.10 (continued)

	OC1—Managers	*OC2—Professionals*	*OC3—Technicians and associate professionals*	*OC4—Clerical support workers*	*OC5—Service and sales workers*	*OC6—Skilled agricultural, forestry and fishery workers*
S—Other service activities	3.347	11.852	3.988	7.107	1.156	–
T—Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use		–	114	-	5.767	101
U—Activities of extraterritorial organisations and bodies	270	1.008	575	1.298	765	
Total	112.785	752.675	312.079	449.437	919.695	410.486

	OC7—Craft and related trades workers	*OC8—Plant and machine operators and assemblers*	*OC9—Elementary occupations*	*OC0—Armed forces occupations*	*Total*
A—Agriculture, forestry and fishing	1.444	1.123	34.099	–	453.624
B—Mining and quarrying	2.466	7.294	1.094		12.489

	OC7—Craft and related trades workers	*OC8—Plant and machine operators and assemblers*	*OC9—Elementary occupations*	*OC0—Armed forces occupations*	*Total*
C—Manufacturing	132.107	73.243	38.94		377.064
D—Electricity, gas, steam and air conditioning supply	8.296	2.117	2.029		29.6
E—Water supply; sewerage, waste management and remediation activities	2.077	4.746	17.274		33.114
F—Construction	62.532	22.351	18.179		691.888
G—Wholesale and retail trade; repair of motor vehicles and motorcycles	6.503	102.548	7.913		206.849
H—Transportation and storage	5.3	13.428	56.64		381.856
I—Accommodation and food service activities	6.876	217	400		102.162
J—Information and communication	74	139	862		84.205
K—Financial and insurance activities			-		5.036
L—Real estate activities	1.422	526	2.373		218.165

(continued)

Table 6.10 (continued)

	OC7—Craft and related trades workers	*OC8—Plant and machine operators and assemblers*	*OC9—Elementary occupations*	*OC0—Armed forces occupations*	*Total*
M—Professional, scientific and technical activities	1.522	6.758	26.668		90.936
N—Administrative and support service activities	14.157	8.028	12.698	61.055	341.493
O—Public administration and defence; compulsory social security	424	2.772	10.971	–	320.912
P—Education	3.766	2.519	9.075	–	248.395
Q—Human health and social work activities	1.154	124	3.965		53.716
R—Arts, entertainment and recreation	7.077	2.293	2.642		82.604
S—Other service activities	100.306	10.415	9.448	–	147.62

	OC7—Craft and related trades workers	*OC8—Plant and machine operators and assemblers*	*OC9—Elementary occupations*	*OC0—Armed forces occupations*	*Total*
T—Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	50	141	18.799		24.971
U—Activities of extraterritorial organisations and bodies	147	266			4.329
Total	357.699	261.049	274.07	61.055	3,911,030

Source ELSTAT (Hellenic Statistical Authority), Labor Force Surve

Table 6.11 Employment per profession and sector of economic activity in 2019 (vertical layout)

	OC1—Managers	*OC2—Professionals*	*OC3—Technicians and associate professionals*	*OC4—Clerical support workers*	*OC5—Service and sales workers*
A—Agriculture, forestry and fishing	0.7%	0.4%	0.2%	0.4%	0.2%
B—Mining and quarrying	0.0%	0.0%	0.1%	0.1%	0.0%
C—Manufacturing	12.4%	3.8%	7.9%	7.9%	3.2%
D—Electricity, gas, steam and air conditioning supply	1.2%	0.6%	1.2%	1.5%	0.1%
E—Water supply; sewerage, waste management and remediation activities	0.8%	0.2%	1.0%	0.7%	0.1%
F—Construction	28.0%	4.4%	6.4%	16.1%	47.0%
G—Wholesale and retail trade; repair of motor vehicles and motorcycles	5.1%	0.6%	7.7%	10.0%	1.2%
H—Transportation and storage	22.6%	0.8%	1.2%	6.4%	26.3%
I—Accommodation and food service activities	5.2%	5.2%	5.0%	6.1%	0.6%
J—Information and communication	2.4%	1.6%	12.7%	6.0%	0.2%

	OC1—Managers	*OC2—Professionals*	*OC3—Technicians and associate professionals*	*OC4—Clerical support workers*	*OC5—Service and sales workers*
K—Financial and insurance activities	0.2%	0.1%	0.8%	0.3%	0.0%
L—Real estate activities	1.2%	19.7%	11.7%	5.8%	0.2%
M—Professional, scientific and technical activities	2.7%	0.4%	2.0%	4.4%	2.5%
N—Administrative and support service activities	3.3%	6.3%	10.5%	19.8%	7.8%
O—Public administration and defence; compulsory social security	5.2%	35.6%	2.5%	3.2%	1.1%
P—Education	2.9%	15.0%	21.8%	4.9%	3.0%
Q—Human health and social work activities	1.2%	1.5%	4.6%	3.1%	0.8%
R—Arts, entertainment and recreation	1.7%	1.9%	1.1%	1.3%	4.9%
S—Other service activities	3.0%	1.6%	1.3%	1.6%	0.1%

(continued)

Table 6.11 (continued)

	OC1—Managers	*OC2—Professionals*	*OC3—Technicians and associate professionals*	*OC4—Clerical support workers*	*OC5—Service and sales workers*
T—Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0%	0.0%	0.0%	0.0%	0.6%
U—Activities of extraterritorial organisations and bodies	0.2%	0.1%	0.2%	0.3%	0.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

	OC6—Skilled agricultural, forestry and fishery workers	*OC7—Craft and related trades workers*	*OC8—Plant and machine operators and assemblers*	*OC9—Elementary occupations*	*OC0—Armed forces occupations*
A—Agriculture, forestry and fishing	99.4%	0.4%	0.4%	12.4%	0.0%
B—Mining and quarrying	0.0%	0.7%	2.8%	0.4%	0.0%
C—Manufacturing	0.1%	36.9%	28.1%	14.2%	0.0%

	OC6—Skilled agricultural, forestry and fishery workers	*OC7—Craft and related trades workers*	*OC8—Plant and machine operators and assemblers*	*OC9—Elementary occupations*	*OC0—Armed forces occupations*
D—Electricity, gas, steam and air conditioning supply	0.0%	2.3%	0.8%	0.7%	0.0%
E—Water supply; sewerage, waste management and remediation activities	0.0%	0.6%	1.8%	6.3%	0.0%
F—Construction	0.0%	17.5%	8.6%	6.6%	0.0%
G—Wholesale and retail trade; repair of motor vehicles and motorcycles	0.0%	1.8%	39.3%	2.9%	0.0%
H—Transportation and storage	0.1%	1.5%	5.1%	20.7%	0.0%
I—Accommodation and food service activities	0.0%	1.9%	0.1%	0.1%	0.0%
J—Information and communication	0.0%	0.0%	0.1%	0.3%	0.0%
K—Financial and insurance activities	0.0%	0.0%	0.0%	0.0%	0.0%
L—Real estate activities	0.0%	0.4%	0.2%	0.9%	0.0%

(continued)

Table 6.11 (continued)

	OC6—Skilled agricultural, forestry and fishery workers	*OC7—Craft and related trades workers*	*OC8—Plant and machine operators and assemblers*	*OC9—Elementary occupations*	*OC0—Armed forces occupations*
M—Professional, scientific and technical activities	0.3%	0.4%	2.6%	9.7%	0.0%
N—Administrative and support service activities	0.1%	4.0%	3.1%	4.6%	100.0%
O—Public administration and defence; compulsory social security	0.0%	0.1%	1.1%	4.0%	0.0%
P—Education	0.0%	1.1%	1.0%	3.3%	0.0%
Q—Human health and social work activities	0.0%	0.3%	0.0%	1.4%	0.0%
R—Arts, entertainment and recreation	0.0%	2.0%	0.9%	1.0%	0.0%
S—Other service activities	0.0%	28.0%	4.0%	3.4%	0.0%

	OC6—Skilled agricultural, forestry and fishery workers	*OC7—Craft and related trades workers*	*OC8—Plant and machine operators and assemblers*	*OC9—Elementary occupations*	*OC0—Armed forces occupations*
T—Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0%	0.0%	0.1%	6.9%	0.0%
U—Activities of extraterritorial organisations and bodies	0.0%	0.0%	0.1%	0.0%	0.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Source ELSTAT (Hellenic Statistical Authority), Labor Force Surve

Table 6.12 Employment per profession and sector of economic activity in 2019 (horizontal layout)

	OC1—Managers	*OC2—Professionals*	*OC3—Technicians and associate professionals*	*OC4—Clerical support workers*	*OC5—Service and sales workers*
A—Agriculture, forestry and fishing	0.2%	0.7%	0.2%	0.4%	0.5%
B—Mining and quarrying	0.0%	2.7%	3.3%	4.3%	2.8%
C—Manufacturing	3.7%	7.6%	6.6%	9.4%	7.7%
D—Electricity, gas, steam and air conditioning supply	4.4%	14.4%	12.7%	23.4%	3.0%
E—Water supply; sewerage, waste management and remediation activities	2.6%	3.5%	9.2%	10.1%	1.8%
F—Construction	4.6%	4.8%	2.9%	10.4%	62.5%
G—Wholesale and retail trade; repair of motor vehicles and motorcycles	2.8%	2.1%	11.6%	21.7%	5.3%
H—Transportation and storage	6.7%	1.6%	1.0%	7.5%	63.4%
I—Accommodation and food service activities	5.8%	38.7%	15.4%	27.0%	5.8%
J—Information and communication	3.2%	14.6%	47.0%	32.0%	1.8%

	OC1—Managers	*OC2—Professionals*	*OC3—Technicians and associate professionals*	*OC4—Clerical support workers*	*OC5—Service and sales workers*
K—Financial and insurance activities	4.0%	17.8%	49.8%	28.3%	0.0%
L—Real estate activities	0.6%	68.1%	16.7%	11.9%	0.6%
M—Professional, scientific and technical activities	3.4%	3.4%	6.9%	21.6%	25.0%
N—Administrative and support service activities	1.1%	14.0%	9.6%	26.1%	21.1%
O—Public administration and defence; compulsory social security	1.8%	83.5%	2.5%	4.5%	3.3%
P—Education	1.3%	45.3%	27.3%	8.8%	11.0%
Q—Human health and social work activities	2.4%	21.5%	26.8%	26.3%	13.2%
R—Arts, entertainment and recreation	2.3%	17.1%	4.1%	7.0%	54.9%
S—Other service activities	2.3%	8.0%	2.7%	4.8%	0.8%

(continued)

Table 6.12 (continued)

	OC1—Managers	*OC2—Professionals*	*OC3—Technicians and associate professionals*	*OC4—Clerical support workers*	*OC5—Service and sales workers*
T—Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0%	0.0%	0.5%	0.0%	23.1%
U—Activities of extraterritorial organisations and bodies	6.2%	23.3%	13.3%	30.0%	17.7%

	OC6—Skilled agricultural, forestry and fishery workers	*OC7—Craft and related trades workers*	*OC8—Plant and machine operators and assemblers*	*OC9—Elementary occupations*	*OC0—Armed forces occupations*	*Total*
A—Agriculture, forestry and fishing	89.9%	0.3%	0.2%	7.5%	0.0%	100.0%
B—Mining and quarrying	0.0%	19.7%	58.4%	8.8%	0.0%	100.0%
C—Manufacturing	0.1%	35.0%	19.4%	10.3%	0.0%	100.0%

	OC6—Skilled agricultural, forestry and fishery workers	*OC7—Craft and related trades workers*	*OC8—Plant and machine operators and assemblers*	*OC9—Elementary occupations*	*OC0—Armed forces occupations*	*Total*
D—Electricity, gas, steam and air conditioning supply	0.0%	28.0%	7.2%	6.9%	0.0%	100.0%
E—Water supply; sewerage, waste management and remediation activities	0.0%	6.3%	14.3%	52.2%	0.0%	100.0%
F—Construction	0.0%	9.0%	3.2%	2.6%	0.0%	100.0%
G—Wholesale and retail trade; repair of motor vehicles and motorcycles	0.0%	3.1%	49.6%	3.8%	0.0%	100.0%
H—Transportation and storage	0.1%	1.4%	3.5%	14.8%	0.0%	100.0%
I—Accommodation and food service activities	0.0%	6.7%	0.2%	0.4%	0.0%	100.0%
J—Information and communication	0.0%	0.1%	0.2%	1.0%	0.0%	100.0%
K—Financial and insurance activities	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
L—Real estate activities	0.0%	0.7%	0.2%	1.1%	0.0%	100.0%

(continued)

Table 6.12 (continued)

	OC6—Skilled agricultural, forestry and fishery workers	*OC7—Craft and related trades workers*	*OC8—Plant and machine operators and assemblers*	*OC9—Elementary occupations*	*OC0—Armed forces occupations*	*Total*
M—Professional, scientific and technical activities	1.3%	1.7%	7.4%	29.3%	0.0%	100.0%
N—Administrative and support service activities	0.1%	4.1%	2.4%	3.7%	17.9%	100.0%
O—Public administration and defence; compulsory social security	0.0%	0.1%	0.9%	3.4%	0.0%	100.0%
P—Education	0.0%	1.5%	1.0%	3.7%	0.0%	100.0%
Q—Human health and social work activities	0.0%	2.1%	0.2%	7.4%	0.0%	100.0%
R—Arts, entertainment and recreation	0.0%	8.6%	2.8%	3.2%	0.0%	100.0%
S—Other service activities	0.0%	67.9%	7.1%	6.4%	0.0%	100.0%
T—Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.4%	0.2%	0.6%	75.3%	0.0%	100.0%

	OC6—Skilled agricultural, forestry and fishery workers	*OC7—Craft and related trades workers*	*OC8—Plant and machine operators and assemblers*	*OC9—Elementary occupations*	*OC0—Armed forces occupations*	*Total*
U—Activities of extraterritorial organisations and bodies	0.0%	3.4%	6.2%	0.0%	0.0%	100.0%

Source ELSTAT (Hellenic Statistical Authority), Labor Force Surve

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CHAPTER 7

Estimation of the Medium-Term Demand for Occupations and Specialties in the Greek Economy Using the Input–Output Model

Svetoslav Danchev and Grigoris Pavlou

7.1 Introduction

This chapter presents employment projections of sectors and occupations in the Greek economy under two different scenarios: a base scenario and an optimistic (upside) scenario which has higher investment from the impact of reforms that are expected to be implemented in the Greek economy. Each scenario is linked to a different trajectory of GDP, but also

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of its components, namely consumption, exports and investment. In this chapter, we analyze the evolution of employment at the level of sectors and occupational categories separately for each scenario. Both scenarios reveal the first effects of the pandemic.

This chapter is structured as follows: Sect. 7.2 presents a brief summary of the followed methodology. The expected evolution of the basic components of GDP, as drivers of the anticipated trends in the sectors of economic activity, until 2027 is outlined in Sect. 7.3. Section 7.4 presents the evolution of total employment in the two scenarios, based on the evolution of the GDP components. The employment projections per sector are analyzed at the level of sectors (1-digit and 2-digit NACE) in Sect. 7.5. Section 7.6 analyses the employment projections per occupation categories (1-digit, 2-digit and 3-digit ISCO). The chapter concludes with an analysis of the employment composition per sector and occupation categories in Sect. 7.7, while more detailed results are reported in the Appendix.

7.2 Brief Summary of the Methodology

The analysis carried out in this section utilizes the results of the forecasts of economic figures from the Global Economic Model of the organization Oxford Economics, while an input–output model of the Greek economy was used to examine the evolution of the interconnections between the economy's sectors. The projection of the demand for occupations until, 2027, was carried out with the following procedure:

- Basic developments in national-accounting figures, such as GDP,[1] consumption, investment and the trade balance, were captured through estimates by Oxford Economics—Global Economic Model
- The interconnections between the sectors of the economy were captured with the help of the input–output model. This particular model takes into account the fact that the sectors of the economy do not operate autonomously in the production system. For example, an increase in tourism affects positively the manufacture of food

[1] The national income identity of GDP is GDP = Private Consumption + Public Consumption + Investments + Exports—Imports.

and beverages, which supplies a significant part of its products to restaurants.

- In the third stage, the results of the above analyses in the economy and in the sectors were utilized in order to illustrate the changes that each occupational category will undergo until, 2027, due to the changes that are expected in economic activity.

Before presenting the results regarding the evolution of employment and occupations, some clarifications are necessary:

- In the individual assessments that took place, some sectors may show an increase or decrease in employment, but there is no corresponding development in their production. This stems from the possibility that the development of a sector is not combined with a proportional increase in employment (due to technological changes, etc.).
- At the level of occupational categories, the analysis uses the composition of categories based on the International Standard Classification of Occupations (ISCO−08), but it does not take into account the transformation of certain occupations due to technological or other factors.

7.3 Evolution of GDP Components

The development scenarios of the Greek economy have changed drastically, due to the impact of the COVID−19 pandemic on the economic activity. The rapid decline of GDP for, 2020, in many countries, including the Greek economy, is a safe assumption, while its subsequent course is uncertain, i.e., with respect to the speed of its recovery, the pandemic may leave its stamp in the economy.

In the base scenario, the growth rate of the economy is expected to reach −7.2% for, 2020, while in, 2021, the economy will recover quickly, presenting an average growth rate of 2.7% in the next period. By contrast, in the optimistic (upside) scenario, the contraction rate is expected to be lower in, 2020 (−4.9%), with a stronger recovery in, 2021, followed by an average rate of change of 3.7%, i.e., one point higher compared to the base scenario. At the end of the period under review, in, 2027, real GDP (2010 = 100) is expected to reach €225 billion in the base scenario (at 2010 levels), and €241 billion in the optimistic scenario, i.e., slightly higher from the levels of 2009. Including the period, 2020–2021, the average GDP growth rate for the base scenario is 2.0% and for the optimistic scenario 2.7% (Fig. 7.1).

All GDP components differ between the two scenarios, except for public consumption which is expected to evolve approximately the same in both scenarios. Investment is expected to contribute 0.2 points to GDP growth, while in the upside scenario, its contribution is doubled, to 0.4 points. Private consumption is expected to boost GDP growth by 1.2 points in the base scenario and by 1.5 points in the upside scenario. Exports will boost GDP growth in the base scenario by an average of 1.7% over the same period, while imports will subtract 0.7 points of GDP per year. Higher positive contribution of exports at 1.8 points and lower negative impact of imports at 0.5 points are expected in the upside scenario (Fig. 7.2).

The evolution of the components in each scenario, for the period, 2019–2027, is depicted in the following charts. In the base scenario, private consumption continues to have a positive contribution to GDP growth, as does public consumption, but to a much lesser extent after

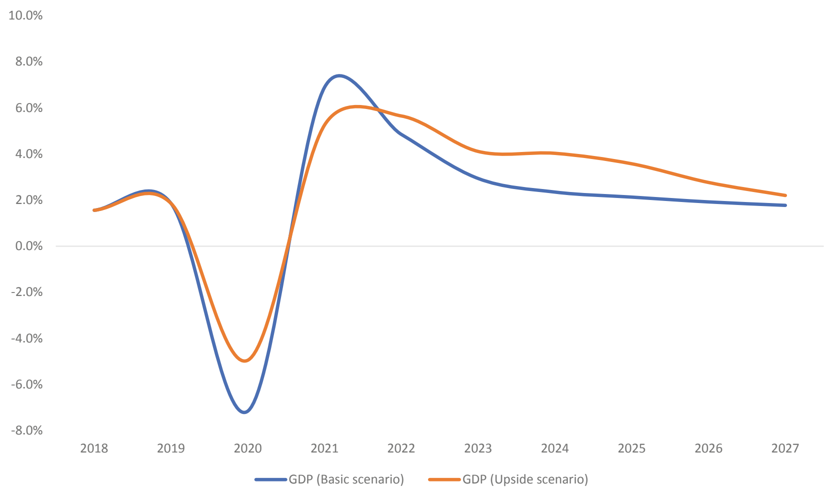

Fig. 7.1 GDP change rate 2018–2027 (*Source* Oxford Economics—Global Economic Model)

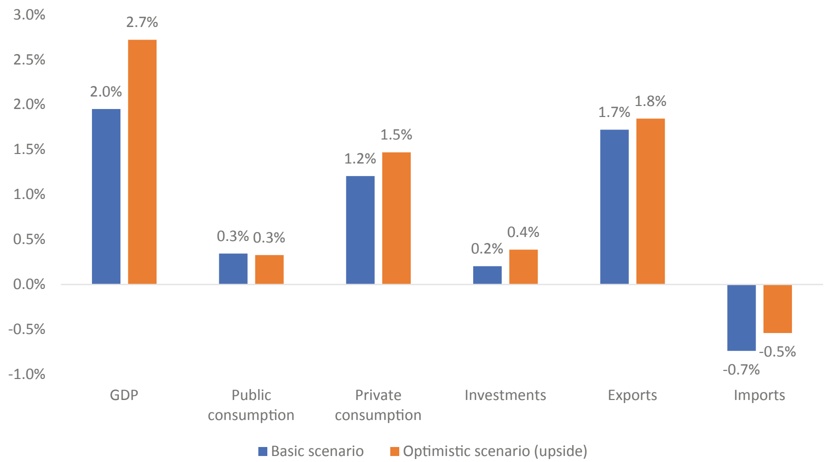

Fig. 7.2 Average contribution of GDP components (*Source* Oxford Economics—Global Economic Model)

2021. Investment will contribute to GDP after, 2021, following the fall of 2020. Finally, exports record a particularly positive contribution to GDP after, 2021, while after that the magnitude of their contribution to GDP slightly decreases (Fig. 7.3).

In the upside scenario, investment is estimated to grow significantly throughout the period under review, while, as it was previously analyzed, a significant increase is expected in private consumption most of the years (Fig. 7.4).

The above developments, in both scenarios, have different effects on the sectors of the economy, with implications on employment and in particular on the occupational categories. These changes are depicted in the following sections, where the evolution of employment is recorded per 1-digit and 2-digit NACE sectors, but also per 1-digit, 2-digit and 3-digit ISCO occupational categories.

7.4 Employment Projections

Employment is estimated to reach 4.7 million employees by the end of the period under review in, 2027, in the base scenario, with a steady growth after 2021. In the upside scenario, employment is approaching 4.8 million

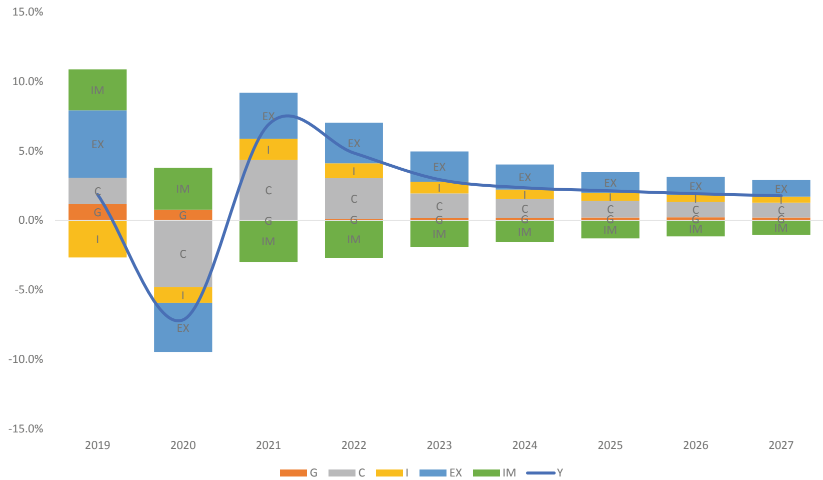

Fig. 7.3 Analysis of components of GDP 2019–2027, base scenario (*Source* Oxford Economics—Global Economic Model)

Fig. 7.4 Analysis of components of GDP 2019–2027, upside scenario (*Source* Oxford Economics—Global Economic Model)

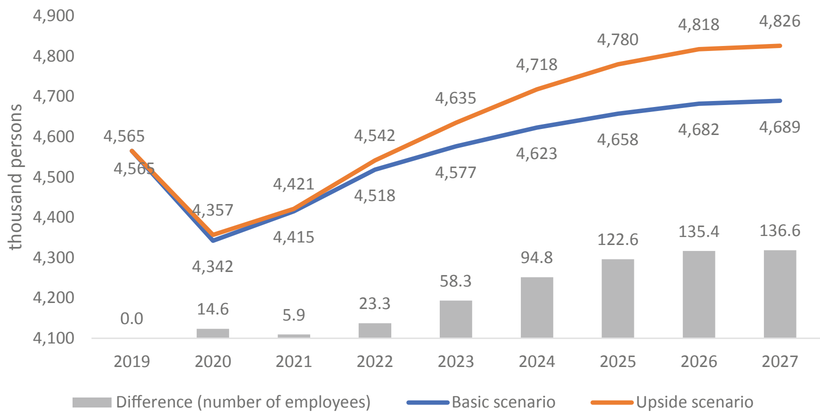

Fig. 7.5 Employement 2019–2027 (*Source* Oxford Economics—Global Economic Model)

in, 2027, reaching levels close to those of 2009. The reinforcement of employment in the upside scenario is expected to "add" 136.6 thousand additional jobs by, 2027, compared to the base scenario. The average annual rate of change in employment is 0.3% in the base scenario and 0.7% in the optimistic scenario, while from, 2021 to 2027, the rates are 1.0% and 1.5% respectively (Fig. 7.5).

7.5 Employment Projections per Sector

Employment is estimated to have different rates of change across the main sectors of the economy, resulting in a change in its sectoral composition.

Table 7.1 shows the evolution of the number of employees per 1-digit sector of economic activity. In the base scenario, employment in trade is expected to increase, with an average annual growth of 1.4%. Employment in the Information and Communication sector is estimated to expand by 1.3% on average by, 2027, followed by Professional, scientific and technical activities and Administrative and Support Activities with the same growth rate. Health Activities are expected to record an increase in employment of 1.1%, while despite the significant decline, in 2020, Accommodation and food service activities are expected to expand at an average rate of 1.0% by, 2027, and at a rate of 1.9% from 2021.

By contrast, employment is projected to decline in mining, electricity and water supply and in the sector of Agriculture, Forestry and Fishing, with an average decrease of 2.1, 1.4 and 1.3%, respectively, by 2027. This reduction can be related, either to the shift of the workforce to other sectors, or to the mechanization of processes and thus a reduction of labor intensity. Reduction of employment is also expected in the Construction sector by 0.7%, and in Real estate activities.

In the upside scenario (Table 7.2), Professional, scientific and technical activities are the sector with the strongest average annual growth, with 2.1% in the period, 2019–2027, which strengthens to 3.2% in the period 2021–2027. This development will shape the employment in the sector to 313 thousand employees.

The sector with the second highest average annual growth in the upside scenario (marginally lower compared to the Professional Activities) is Administrative and Support Activities with an average increase of 2.1% and trade with 2.0%. By contrast, the lowest growth rates are projected in the sector of Mining and quarrying, and Agriculture, Forestry and Fishing, with a negative average rate of—1.2%. Stagnation is expected in Manufacturing, while due to the fact that it includes many activities, with different trends, its dynamics will be reflected below in the analysis per 2-digit NACE sector.

The presentation of the development of employment at a more detailed sectoral level, i.e., per 2-digit NACE sectors, is estimated to reflect more clearly the dynamics in each activity, as sectors that may show opposite trends are not added up. For this reason, we discuss here the 2-digit NACE sectors with the largest and the smallest annual change between 2019 and 2027, while all sectors are presented in detail in the Appendix.

Significant growth, at an annual rate of 1.4% by, 2027, is expected to occur in Wholesale trade and trade of motor vehicles, while a corresponding expansion is expected in Publishing activities but also in Motion picture, video, television program production. Besides Retail trade, an increase is also expected in Legal and Accounting activities with an average annual growth rate of 1.3%, followed by Telecommunications.

By contrast, employment is projected to decrease in Mining, Waste management but also in the three subsectors of the Primary sector (Table 7.3).

In the optimistic (upside) scenario, the Legal and accounting activities—Head office activities—Management consulting activities show the largest increase at the 2-digit sectoral level with 2.2%, followed by

Table 7.1 Evolution of the number of employees per 1-digit sector of economic activity (NACE REV.2)—base scenario (thousand people)

NACE (1-digit)	*2019*	*2020*	*2021*	*2027*	*CAGR*[a] *2019–2027*	*Rank (CAGR)*
A—Agriculture, forestry and fishing	497.1	470.6	472.3	446.8	−1.3%	16
B—Mining and quarrying	10.0	9.3	9.4	8.4	−2.1%	19
C—Manufacturing	346.6	330.6	326.7	329.8	−0.6%	12
D—Electricity, gas, steam and air conditioning supply	29.6	28.8	27.0	26.4	−1.4%	18
E—Water supply; sewerage, waste management and remediation activities	30.5	29.4	28.5	27.2	−1.4%	17
F—Construction	192.4	182.5	176.0	181.9	−0.7%	15
G—Wholesale and retail trade; repair of motor vehicles and motorcycles	787.3	745.9	748.0	877.9	1.4%	1
H—Transportation and storage	249.5	220.9	227.4	237.1	−0.6%	13
I—Accommodation and food service activities	572.5	466.2	553.7	619.0	1.0%	6
J—Information and communication	95.7	95.6	95.1	105.9	1.3%	2
K—Financial and insurance activities	78.7	78.4	75.6	76.8	−0.3%	11
L—Real estate activities	19.0	18.6	18.6	18.0	−0.7%	14
M—Professional, scientific and technical activities	264.6	254.5	251.0	292.0	1.2%	3
N—Administrative and support service activities	137.5	129.0	129.8	151.2	1.2%	4
O—Public administration and defence; compulsory social security	397.5	411.5	410.2	389.7	−0.2%	10

(continued)

Table 7.1 (continued)

NACE (1-digit)	*2019*	*2020*	*2021*	*2027*	*CAGR[a] 2019–2027*	*Rank (CAGR)*
P—Education	364.2	362.8	362.6	385.5	0.7%	7
Q—Human health and social work activities	266.6	284.9	282.1	291.6	1.1%	5
R—Arts, entertainment and recreation	72.7	68.4	65.8	71.3	−0.2%	9
S—Other service activities & T—Activities of households as employers	153.6	154.5	155.5	152.8	−0.1%	8
Total	4,565.4	4,342.3	4,415.4	4,689.4	0.30%	

[a]Compound annual growth rate (the average annual growth rate)
Source Authors' own creation

Table 7.2 Evolution of the number of employees per 1-digit sector of economic activity (NACE REV.2)—upside scenario (thousand people)

NACE (1-digit)	*2019*	*2020*	*2021*	*2027*	*CAGR 2019–2027*	*Rank*
A—Agriculture, forestry and fishing	497.1	468.3	472.9	452.9	−1.2%	18
B—Mining and quarrying	10.0	9.7	9.6	9.1	−1.2%	19
C—Manufacturing	346.6	323.1	324.2	352.7	0.2%	11
D—Electricity, gas, steam and air conditioning supply	29.6	28.4	26.6	27.6	−0.9%	16
E—Water supply; sewerage, waste management and remediation activities	30.5	29.8	29.0	28.5	−0.8%	15
F—Construction	192.4	179.4	177.6	202.0	0.6%	7
G—Wholesale and retail trade; repair of motor vehicles and motorcycles	787.3	744.5	779.5	924.6	2.0%	3
H—Transportation and storage	249.5	231.7	238.7	242.5	−0.4%	14
I—Accommodation and food service activities	572.5	512.8	550.3	660.8	1.8%	4
J—Information and communication	95.7	92.9	91.0	101.3	0.7%	5
K—Financial and insurance activities	78.7	74.7	72.3	82.0	0.5%	8
L—Real estate activities	19.0	18.5	18.8	18.8	−0.1%	13
M—Professional, scientific and technical activitiesOccupation	264.6	258.9	260.0	313.6	2.1%	1
N—Administrative and support service activities	137.5	133.2	137.9	161.7	2.1%	2
O—Public administration and defence; compulsory social security	397.5	404.4	392.6	368.4	−0.9%	17

(continued)

Table 7.2 (continued)

NACE (1-digit)	*2019*	*2020*	*2021*	*2027*	*CAGR 2019–2027*	*Rank*
P—Education	364.2	363.7	348.4	364.2	0.0%	12
Q—Human health and social work activities	266.6	266.3	270.4	282.0	0.7%	6
R—Arts, entertainment and recreation	72.7	64.6	66.3	74.6	0.3%	10
S—Other service activities & T—Activities of households as employers;	153.6	152.1	155.0	158.6	0.4%	9
Total	4565.4	4356.9	4421.3	4826.0	0.70%	

Source Authors' own creation

Table 7.3 Evolution of employees per 2-digit sector of economic activity (NACE REV.2)—base scenario (thousand people)

Code	*Description*	*2019*	*2020*	*2021*	*2027*	*CAGR (2019–2027)*
Sectors with the biggest increase						
G46	Wholesale trade	230.3	219.5	218.4	258.0	1.40%
G45	Wholesale and retail trade and repair of motor vehicles and motorcycles	72.6	68.7	68.7	81.3	1.40%
J58	Publishing activities	13.4	13.3	13.1	14.9	1.40%
J59–J60	Motion picture, video, television programme production; programming and broadcasting activities	17.3	17.2	17.1	19.3	1.40%
G47	Retail trade	484.3	457.7	460.8	538.5	1.30%
M69–M70	Legal and accounting activities; activities of head offices; management consultancy activities	141.7	136.4	134.6	157.1	1.30%
J61	Telecommunications	29.5	29.9	29.6	32.6	1.30%
N79	Travel agency, tour operator and other reservation service and related activities	19.6	18.2	18.4	21.6	1.20%
J62–J63	Computer programming, consultancy, and information service activities	35.5	35.2	35.3	39.1	1.20%
N80–N82	Security and investigation, service and landscape, office administrative and support activities	85.0	79.9	80.2	93.5	1.20%
Sectors with the smallest increase or with reduction of employment						
H52	Warehousing and support activities for transportation	51.0	45.3	46.3	48.1	−0.70%

(continued)

Table 7.3 (continued)

Code	*Description*	*2019*	*2020*	*2021*	*2027*	*CAGR (2019–2027)*
C29	Manufacture of motor vehicles, trailers and semi-trailers	2.0	1.9	1.8	1.9	−0.70%
C30	Manufacture of other transport equipment	4.8	4.5	4.5	4.5	−0.80%
E36	Water collection, treatment and supply	10.7	10.4	10.1	9.7	−1.20%
A01	Crop and animal production, hunting and related activities	466.7	441.9	443.5	419.8	−1.30%
D35	Electricity, gas, steam and air conditioning supply	29.6	28.8	27.0	26.4	−1.40%
A02	Forestry and logging	9.2	8.7	8.7	8.2	−1.50%
A03	Fishing and aquaculture	21.2	19.9	20.1	18.8	−1.50%
E37–E39	Sewerage, waste management, remediation activities	19.8	19.1	18.4	17.5	−1.50%
B	Mining and quarrying	10.0	9.3	9.4	8.4	−2.10%

Source Authors' own creation

Wholesale trade and Other professional, scientific and technical activities. A characteristic element in the optimistic scenario is the expansion of employment in many scientific sectors. Reduction of employment in the optimistic scenario is recorded in Forestry, with greater intensity compared to the base scenario, followed by Mining (Table 7.4).

7.6 Employment Projections by Occupation

The sectoral analysis offers important conclusions regarding the development of employment, as it is directly related to the production volume in each sector. However, due to the variety of occupations that are integrated in each sector, it is of great interest to capture the trends between the occupational categories, as they are divided based on the ISCO classification.

The following table shows the results in the base scenario for the occupations in a 1-digit ISCO. In such a high-level analysis, there are no significant changes in the occupations, since employment as a whole is not expected to change significantly until 2027. In light this, Employees in the provision of services and sales workers show a relatively larger increase, 0.9%, until, 2027, followed by Managers and Professionals with an average increase of 0.7%. In line with the sectoral analysis, Skilled agricultural, forestry and fishery workers record a decrease of 1.3% and employment reaches approximately 411.5 thousand people in, 2027, compared to 456.4 thousand in 2019 (Table 7.5).

In the upside scenario, the largest average annual increase in employment is expected again in employees in the provision of services and sales workers, with a stronger increase of 1.4%, while an expansion compared to the base scenario is also expected in Managers. In the upside scenario, again the category of occupations operating in the primary sector is expected to decline by 2027 (Table 7.6).

Due to the large number of 2-digit ISCO categories, we analyze the occupational categories with most significant changes, while the annex at the end of the chapter captures all the occupations at the 2-digit level. The following table presents the top 10 occupations with the biggest change, positive and negative, in the base and in the upside scenario of economic development, per 2-digit ISCO.

At the top, with the highest expected annual increase are the Sales workers, with an average annual increase of 1.2%, followed by the Hospitality, retail and other services managers and Street and related sales and service workers with 1.1%. Health professionals are also expected to

Table 7.4 Evolution of the number of employees per 2-digit sector of economic activity (NACE REV.2)—upside scenario (thousand people)

Code	*Description*	*2019*	*2020*	*2021*	*2027*	*CAGR (2019–2027)*
Sectors with the biggest increase						
M69–M70	Legal and accounting activities; activities of head offices; management consultancy activities	141.7	138.8	139.5	169.1	2.20%
G46	Wholesale trade	230.3	219.1	227.6	272.0	2.10%
M74–M75	Other professional, scientific and technical activities; veterinary activities occupation	19.3	18.9	18.9	22.8	2.10%
N79	Travel agency, tour operator and other reservation service and related activities	19.6	18.8	19.6	23.1	2.10%
M71	Architectural and engineering activities; technical testing and analysis	71.0	69.4	69.9	83.6	2.10%
N80–N82	Security and investigation, service and landscape, office administrative and support activities	85.0	82.5	85.2	100.0	2.10%
N77	Rental and leasing activities	15.3	14.9	15.4	18.0	2.00%
G45	Wholesale and retail trade and repair of motor vehicles and motorcycles	72.6	68.6	71.6	85.1	2.00%
M73	Advertising and market research	16.0	15.7	15.6	18.7	2.00%
G47	Retail trade	484.3	456.8	480.2	567.5	2.00%
Sectors with the smallest increase or with reduction of employment						
J58	Publishing activities	13.4	12.9	12.6	12.7	−0.60%
H51	Air transport	3.9	3.7	3.8	3.7	−0.60%
E36	Water collection, treatment and supply	10.7	10.5	10.3	10.1	−0.70%

Code	*Description*	*2019*	*2020*	*2021*	*2027*	*CAGR (2019–2027)*
D35	Electricity, gas, steam and air conditioning supply	29.6	28.4	26.6	27.6	−0.90%
A03	Fishing and aquaculture	21.2	19.8	20.1	19.7	−0.90%
E37-E39	Sewerage, waste management, remediation activities	19.8	19.3	18.8	18.4	−0.90%
O84	Public administration and defense· compulsory social security	397.5	404.4	392.6	368.4	−0.90%
A01	Crop and animal production, hunting and related activities	466.7	439.8	444.1	426.0	−1.10%
B	Mining and quarrying	10.0	9.7	9.6	9.1	−1.20%
A02	Forestry and logging	9.2	8.7	8.7	7.3	−2.90%

Source Authors' own creation

Table 7.5 Evolution of the number of employees per 1-digit occupational categeory ISCO—base scenario (thousand people)

1digit ISCO	*2019*	*2020*	*2021*	*2027*	*CAGR 2019–2027*
OC1—Managers	136.4	126.2	131.0	144.6	0.70%
OC2—Professionals	917.3	903.5	906.1	970.8	0.70%
OC3—Technicians and associate professionals	343.6	338.3	338.0	355.8	0.40%
OC4—Clerical support workers	520.9	500.4	506.1	540.0	0.40%
OC5—Service and sales workers	1057.4	979.2	1023.0	1137.8	0.90%
OC6—Skilled agricultural, forestry and fishery workers	456.4	429.0	433.4	411.5	−1.30%
OC7—Craft and related trades workers	418.6	395.9	392.9	413.1	−0.20%
OC8—Plant and machine operators and assemblers	313.8	287.9	293.6	310.6	−0.10%
OC9—Elementary occupations	321.2	300.1	309.2	326.7	0.20%
OC0—Armed forces occupations	79.6	81.9	82.1	78.1	−0.20%
Total	4,565.4	4,342.3	4,415.4	4,689.0	0.30%

Source Authors' own creation

record an increase of 1.1%, while a corresponding increase is expected in Health associate professionals. By contrast, apart from the occupational categories of the Primary sector and the unskilled workers that will fall by, 2027, a fall is expected in Building and related trades workers and Stationary plant and machine operators (Table 7.7).

In the optimistic (upside) scenario, the occupational category of Sales workers remains in the first place, with an acceleration of the annual increase to 1.9%, followed by Hospitality, retail and other services managers with 1.8%. Street and related sales and service workers and Food Preparation Assistants will increase by 1.8 and 1.7% respectively, while a significant increase is expected in both Business and Administration professionals and Employees in the provision of personal services.

In the upside scenario, 4 categories will record a decline, namely the occupational categories of the primary sector, the unskilled workers and the employees in the provision of protection services. Meanwhile, the categories with a very small increase include Teachers, Garbage Collectors and other clerks (Table 7.8).

Table 7.6 Evolution of the number of employees per 1-digit occupational categeory ISCO—upside scenario (thousand people)

1-digit ISCO	*2019*	*2020*	*2021*	*2027*	*CAGR 2019–2027*
OC1—Managers	136.5	128.3	132.1	150.5	1.20%
OC2—Professionals	917.1	898.0	892.8	970.6	0.70%
OC3—Technicians and associate professionals	333.4	323.1	324.7	351.0	0.60%
OC4—Clerical support workers	513.3	494.2	499.7	544.0	0.70%
OC5—Service and sales workers	1063.6	1003.1	1043.1	1190.0	1.40%
OC6—Skilled agricultural, forestry and fishery workers	457.1	429.0	433.9	428.0	−0.80%
OC7—Craft and related trades workers	423.1	396.2	399.1	445.4	0.60%
OC8—Plant and machine operators and assemblers	318.2	297.6	304.3	328.3	0.40%
OC9—Elementary occupations	322.4	305.8	312.4	342.2	0.70%
OC0—Armed forces occupations	80.6	81.7	79.4	74.4	−1.00%
Total	4,565.4	4,356.9	4,421.3	4,824.3	0.70%

Source Authors' own creation

The 3-digit categories of occupations are 124, according to ISCO 2008. The deepening to 3-digit level of analysis can capture even better the prospects in specific occupational categories, however the number of employees in each category is clearly smaller compared to the 2-digit analysis and therefore the percentage change may concern smaller magnitudes.

Retail and wholesale trade managers are the category that comes on top, based on the annual growth of employment until, 2027, with an expansion of 1.4%, as they belong to the trade sector which is expected to increase in both scenarios. Several categories of sales workers occupy the top places, with the largest increase, until 2027, while the Veterinary technicians and assistants come third. Authors, journalists and linguists are also expected to increase yearly by 1.2% on average. By contrast, most of the declining occupational categories are related to the wider primary sector and mining (Table 7.9).

Table 7.7 2-digit occupational categeory of ISCO with the largest increase/decrease—base scenario (thousand people)

2-digit ISCO	*2019*	*2020*	*2021*	*2027*	*CAGR 2019–2027*
Occupations with the highest employment growth					
52 Sales workers	553.3	518.6	525.4	610.9	1.2%
14 Hospitality, retail and other services managers	77.6	69.2	74.1	84.9	1.1%
95 Street and related sales and service workers	2.5	2.3	2.3	2.7	1.1%
22 Health professionals	118.4	123.1	123.1	129.1	1.1%
32 Health associate professionals	77.0	80.6	80.4	83.5	1.0%
94 Food preparation assistants	27.5	22.5	26.6	29.7	0.9%
25 Information and communications technology professionals	28.6	28.1	28.1	30.7	0.9%
24 Business and administration professionals	147.4	141.8	141.8	157.0	0.8%
11 Chief executives, senior officials and legislators	6.2	6.0	6.1	6.6	0.8%
35 Information and communications technicians	27.7	27.0	27.1	29.4	0.8%
Occupations with the largest decrease in employment					
31 Science and engineering associate professionals	50.3	47.1	47.3	49.9	–0.1%
73 Handicraft and printing workers	21.4	20.3	20.2	21.1	–0.2%
96 Refuse workers and other elementary workers	37.4	35.7	35.9	36.6	–0.3%
82 Assemblers	3.3	3.1	3.1	3.2	–0.3%
75 Food processing, wood working, garment and other craft and related trades workers	90.2	85.2	85.3	87.6	–0.4%
81 Stationary plant and machine operators	63.2	60.0	59.9	60.7	–0.5%
71 Building and related trades workers, excluding electricians	131.9	124.4	121.9	126.7	–0.5%
92 Agricultural, forestry and fishery labourers	35.1	33.0	33.3	32.4	–1.0%
61 Market-oriented skilled agricultural workers	438.4	412.2	416.4	395.4	–1.3%
62 Market-oriented skilled forestry, fishery and hunting workers	18.0	16.8	17.0	16.0	–1.5%

Source Authors' own creation

Table 7.8 2-digit occupational categeory of ISCO with the largest increase/decrease—upside scenario (thousand people)

2-digit ISCO	*2019*	*2020*	*2021*	*2027*	*CAGR 2019–2027*
Occupations with the highest employment growth					
52 Sales workers	559.3	525.6	550.4	648.2	1.9%
14 Hospitality, retail and other services managers	77.7	72.0	75.8	89.5	1.8%
95 Street and related sales and service workers	2.4	2.2	2.3	2.7	1.8%
94 Food preparation assistants	27.7	24.8	26.5	31.6	1.7%
24 Business and administration professionals	149.0	143.5	144.9	165.6	1.3%
51 Personal service workers	338.5	312.2	328.6	375.6	1.3%
42 Customer services clerks	97.3	91.5	94.1	107.7	1.3%
43 Numerical and material recording clerks	90.9	86.5	88.4	100.2	1.2%
11 Chief executives, senior officials and legislators	6.3	6.1	6.2	6.9	1.0%
34 Legal, social, cultural and related associate professionals	27.3	26.7	26.7	29.7	1.0%
Occupations with the smaller increase or with decrease in employment					
31 Science and engineering associate professionals	51.0	48.4	48.8	52.6	0.4%
13 Production and specialised services managers	34.6	33.0	32.9	35.5	0.3%
81 Stationary plant and machine operators	64.1	60.2	60.5	65.4	0.2%
44 Other clerical support workers	31.2	30.1	30.4	31.8	0.2%
96 Refuse workers and other elementary workers	36.8	35.5	35.5	37.1	0.1%
23 Teaching professionals	274.1	272.7	261.6	273.6	0.0%
54 Protective services workers	129.5	129.2	127.8	128.3	−0.1%
92 Agricultural, forestry and fishery labourers	35.2	33.1	33.6	33.8	−0.5%
61 Market-oriented skilled agricultural workers	439.0	412.2	416.8	411.3	−0.8%
62 Market-oriented skilled forestry, fishery and hunting workers	18.1	16.8	17.0	16.7	−1.0%

Source Authors' own creation

Table 7.9 3-digit occupational categeory ISCO with the largest increase/decrease—base scenario (thousand people)

3-digit ISCO	*2019*	*2020*	*2021*	*2027*	*CAGR 2019–2027*
Occupations with the highest employment growth					
142 Retail and wholesale trade managers	39.2	37.0	37.2	43.8	1.4%
521 Street and market salespersons	20.8	19.5	19.8	23.1	1.3%
324 Veterinary technicians and assistants	1.3	1.3	1.3	1.5	1.3%
522 Shop salespersons	472.3	443.0	448.4	521.9	1.3%
524 Other sales workers	33.2	31.0	31.6	36.7	1.3%
264 Authors, journalists and linguists	24.1	23.6	23.6	26.5	1.2%
951 Street and related service workers	1.9	1.7	1.8	2.0	1.2%
225 Veterinarians	3.6	3.5	3.4	3.9	1.1%
224 Paramedical practitioners	1.3	1.4	1.4	1.4	1.1%
226 Other health professionals	41.4	42.1	42.2	45.3	1.1%
Occupations with the smaller increase or with decrease in employment					
711 Building frame and related trades workers	56.7	53.3	52.0	53.9	–0.6%
961 Refuse workers	17.0	16.5	16.2	15.7	–1.0%
921 Agricultural, forestry and fishery labourers	35.1	33.0	33.3	32.4	–1.0%
611 Market gardeners and crop growers	338.4	318.1	321.4	305.3	–1.3%
612 Animal producers	55.5	52.2	52.7	50.0	–1.3%
613 Mixed crop and animal producers	44.6	41.9	42.3	40.1	–1.3%
811 Mining and mineral processing plant operators	8.6	8.0	8.0	7.7	–1.3%
131 Production managers in agriculture, forestry and fisheries	0.1	0.1	0.1	0.1	–1.4%
621 Forestry	2.1	1.9	1.9	1.8	–1.4%
622 Forestry	16.0	14.9	15.1	14.2	–1.5%

Source Authors' own creation

In the upside scenario, the occupations of Wholesale and Retail trade occupy the top places based on the growth rate until, 2027, while by contrast, a contraction is expected mainly in the occupations of the primary sector (Table 7.10).

7.7 Composition Analysis

This section analyzes the shares of sectors and occupation categories, in the two different scenarios examined, at the end of the period under review (2027), together with their average rates of change. At the same time, the shares are compared between the upside and the base analysis scenario, in order to capture the differences that will arise, while the sectors and occupational categories are ranked according to the difference of shares that will occur at the end of the period.

The sectoral analysis of employment in a 1-digit NACE sector is analyzed in the following table. The first sector is trade as noted, since it incorporates 17.2% of total employment in 2019 and this share is expected to strengthen by, 2027, in both scenarios. In the upside scenario, the share is slightly higher by 0.5 points, as the rise in economic activity in this scenario will also expand the transactions in wholesale and retail trade.

A significant increase in the optimistic scenario is also expected in Accommodation and food service activities, which is the 2nd largest sector of the economy in terms of employment, with an average annual expansion of 1.8% in the upside scenario.

Third in the ranking comes the sector of Agriculture, with less than 10% of employment, a reduced share in both scenarios compared to 2019. In the upside scenario, Agriculture's share is expected to be slightly lower due to the change in the productive composition of the economy in other sectors.

By contrast, Manufacturing shows a reduced share in the upside scenario, which indicates that employment in other sectors will increase stronger (Tables 7.11 and 7.12).

At the level of occupational categories, the differences in shares at the 1-digit ISCO level are quite limited, due to the highly concentrated presentation in 9 categories. In any case, in an upside scenario the employees in the provision of services and sales workers are expected to be the occupational category with the strongest increase, with an increased share of 1.5 points in the upside versus 1.1 points in the base scenario.

Table 7.10 3-digit occupational categeory ISCO with the largest increase/decrease—upside scenario (thousand people)

3-digit ISCO	*2019*	*2020*	*2021*	*2027*	*CAGR 2019–2027*
Occupations with the highest employment growth					
142 Retail and wholesale trade managers	39.8	37.5	39.3	46.6	2.0%
521 Street and market salespersons	21.1	19.8	20.8	24.6	1.9%
522 Shop salespersons	477.7	449.1	470.3	554.1	1.9%
225 Veterinarians	3.6	3.5	3.6	4.2	1.9%
524 Other sales workers	33.7	31.6	33.1	39.0	1.8%
952 Street vendors (excluding food)	0.5	0.5	0.5	0.6	1.8%
324 Veterinary technicians and assistants	1.3	1.3	1.3	1.5	1.8%
343 Artistic, cultural and culinary associate professionals	14.9	14.3	14.5	17.1	1.8%
951 Street and related service workers	1.9	1.8	1.8	2.2	1.7%
141 Hotel and restaurant managers	28.8	25.7	27.6	33.1	1.7%
Occupations with the smaller increase or with decrease in employment					
961 Refuse workers	17.3	16.9	16.5	16.3	–0.7%
262 Librarians, archivists and curators	1.4	1.4	1.4	1.3	–0.8%
611 Market gardeners and crop growers	338.9	318.2	321.8	317.6	–0.8%
131 Production managers in agriculture, forestry and fisheries	0.1	0.1	0.1	0.1	–0.8%
612 Animal producers	55.6	52.1	52.7	52.0	–0.8%
613 Mixed crop and animal producers	44.6	41.9	42.3	41.7	–0.8%
335 Regulatory government associate professionals	15.7	15.9	15.5	14.6	–0.9%
111 Legislators and senior officials	1.4	1.5	1.4	1.3	–0.9%
621 Forestry	2.1	1.9	1.9	1.9	–1.0%
622 Fishery workers, hunters and trappers	16.0	14.9	15.1	14.8	–1.0%

Source Authors' own creation

Table 7.11 Shares of 1-digit sectors of economic acticity (NACE REV.2)—base and upside scenario

NACE (1-digit)	*Share 2027 (Base)*	*Share 2027 (Base)*	*CAGR 2019–2027 (Base)*	*Share 2027 (Upside)*	*CAGR 2019–2027 (Upside)*
A—Agriculture, forestry and fishing	10.9%	9.5%	−1.3%	9.4%	−1.2%
B—Mining and quarrying	0.2%	0.2%	−2.1%	0.2%	−1.2%
C—Manufacturing	7.6%	7.0%	−0.6%	7.3%	0.2%
D—Electricity, gas, steam and air conditioning supply	0.6%	0.6%	−1.4%	0.6%	−0.9%
E—Water supply; sewerage, waste management and remediation activities	0.7%	0.6%	−1.4%	0.6%	−0.8%
F—Construction	4.2%	3.9%	−0.7%	4.2%	0.6%
G—Wholesale and retail trade; repair of motor vehicles and motorcycles	17.2%	18.7%	1.4%	19.2%	2.0%
H—Transportation and storage	5.5%	5.1%	−0.6%	5.0%	−0.4%
I—Accommodation and food service activities	12.5%	13.2%	1.0%	13.7%	1.8%
J—Information and communication	2.1%	2.3%	1.3%	2.1%	0.7%

(continued)

Table 7.11 (continued)

NACE (1-digit)	*Share 2027 (Base)*	*Share 2027 (Base)*	*CAGR 2019–2027 (Base)*	*Share 2027 (Upside)*	*CAGR 2019–2027 (Upside)*
K—Financial and insurance activities	1.7%	1.6%	–0.3%	1.7%	0.5%
L—Real estate activities	0.4%	0.4%	–0.7%	0.4%	–0.1%
M—Professional, scientific and technical activities	5.8%	6.2%	1.2%	6.5%	2.1%
N—Administrative and support service activities	3.0%	3.2%	1.2%	3.4%	2.1%
O—Public administration and defence; compulsory social security	8.7%	8.3%	–0.2%	7.6%	–0.9%
P—Education	8.0%	8.2%	0.7%	7.5%	0.0%
Q—Human health and social work activities	5.8%	6.2%	1.1%	5.8%	0.7%
R—Arts, entertainment and recreation	1.6%	1.5%	–0.2%	1.5%	0.3%
S—Other service activities	3.4%	3.3%	–0.1%	3.3%	0.4%
Total	100.0%	100.0%	0.3%	100.0%	0.7%

Source Authors' own creation

Table 7.12 Share difference 2019–2027 of 1-digit sectors of economic activity (NACE REV.2)—base and upside scenario

NACE (1-digit)	*Base scenario*	*Upside scenario*
A—Agriculture, forestry and fishing	−1.4%	−1.5%
B—Mining and quarrying	0.0%	0.0%
C—Manufacturing	−0.6%	−0.3%
D—Electricity, gas, steam and air conditioning supply	−0.1%	−0.1%
E—Water supply; sewerage, waste management and remediation activities	−0.1%	−0.1%
F—Construction	−0.3%	0.0%
G—Wholesale and retail trade; repair of motor vehicles and motorcycles	1.5%	1.9%
H—Transportation and storage	−0.4%	−0.4%
I—Accommodation and food service activities	0.7%	1.2%
J—Information and communication	0.2%	0.0%
K—Financial and insurance activities	−0.1%	0.0%
L—Real estate activities	0.0%	0.0%
M—Professional, scientific and technical activities	0.4%	0.7%
N—Administrative and support service activities	0.2%	0.3%
O—Public administration and defence; compulsory social security	−0.4%	−1.1%
P—Education	0.2%	−0.4%
Q—Human health and social work activities	0.4%	0.0%
R—Arts, entertainment and recreation	−0.1%	0.0%
S—Other service activities & T—Activities of households as employers;	−0.1%	−0.1%

Source Authors' own creation

Table 7.13 Shares of 1-digit ISCO occupational categories—base and upside scenario

1-digit ISCO	*Share 2019*	*Share 2027 (Base)*	*CAGR 2019–2027 (Base)*	*Share 2027 (Upside)*	*CAGR 2019–2027 (Upside)*
OC1—Managers	3.0%	3.1%	0.7%	3.1%	1.2%
OC2—Professionals	20.1%	20.7%	0.7%	20.1%	0.7%
OC3—Technicians and associate professionals	7.5%	7.6%	0.4%	7.3%	0.6%
OC4—Clerical support workers	11.4%	11.5%	0.4%	11.3%	0.7%
OC5—Service and sales workers	23.2%	24.3%	0.9%	24.7%	1.4%
OC6—Skilled agricultural, forestry and fishery workers	10.0%	8.8%	−1.3%	8.9%	−0.8%
OC7—Craft and related trades workers	9.2%	8.8%	−0.2%	9.2%	0.6%
OC8—Plant and machine operators and assemblers	6.9%	6.6%	−0.1%	6.8%	0.4%
OC9—Elementary occupations	7.0%	7.0%	0.2%	7.1%	0.7%
OC0—Armed forces occupations	1.7%	1.7%	−0.2%	1.5%	−1.0%
Total	100.0%	100.0%	0.3%	100.0%	0.7%

Source Authors' own creation

Table 7.14 Share difference 2019–2027 1-digit ISCO occupational categories—base and upside scenario

1-digit ISCO	*Base scenario*	*Upside scenario*
OC1—Managers	0.1%	0.1%
OC2—Professionals	0.6%	0.0%
OC3—Technicians and associate professionals	0.1%	−0.3%
OC4—Clerical support workers	0.1%	−0.1%
OC5—Service and sales workers	1.1%	1.5%
OC6—Skilled agricultural, forestry and fishery workers	−1.2%	−1.1%
OC7—Craft and related trades workers	−0.4%	0.1%
OC8—Plant and machine operators and assemblers	−0.3%	−0.1%
OC9—Elementary occupations	−0.1%	0.1%
OC0—Armed forces occupations	−0.1%	−0.2%

Source Authors' own creation

Managers are expected to marginally increase their labor force participation, while by contrast skilled agricultural, forestry and fishery workers will record a lower share of 1.1 points in the upside scenario, due to reduced participation of the agricultural sector (Tables 7.13 and 7.14).

Annex

See Tables 7.15, 7.16, 7.17, 7.18, 7.19, 7.20, 7.21, 7.22, and 7.23.

Table 7.15 Employment (thousand people) per 2-digit NACE sector—base scenario

NACE (2-digits)	*2019*	*2020*	*2021*	*2022*	*2023*
A01—Crop and animal production, hunting and related service activities	466.7	441.9	443.5	442.5	433.5
A02—Forestry and logging	9.2	8.7	8.7	8.7	8.5
A03—Fishing and aquaculture	21.2	19.9	20.1	19.9	19.4
B—Mining and quarrying	10.0	9.3	9.4	9.3	9.1
C10-C12—Manufacture of food products; beverages and tobacco products	121.5	115.9	114.5	115.3	114.1
C13-C15—Manufacture of textiles, wearing apparel, leather and related products	29.2	27.9	27.3	27.5	27.5
C16—Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	7.7	7.3	7.3	7.3	7.5
C17—Manufacture of paper and paper products	8.6	8.2	8.0	8.1	8.3
C18—Printing and reproduction of recorded media	10.6	10.0	9.9	10.0	10.1
C19—Manufacture of coke and refined petroleum products	3.8	3.6	3.6	3.6	3.7
C20—Manufacture of chemicals and chemical products	12.0	11.4	11.3	11.5	11.5
C21—Manufacture of basic pharmaceutical products and pharmaceutical preparations	10.4	9.9	9.8	9.8	9.8
C22—Manufacture of rubber and plastic products	12.9	12.3	12.2	12.3	12.5
C23—Manufacture of other non-metallic mineral products	16.4	15.5	15.3	15.3	15.4
C24—Manufacture of basic metals	11.3	10.8	10.8	10.8	10.9
C25—Manufacture of fabricated metal products, except machinery and equipment	33.6	32.2	31.7	31.9	32.1
C26—Manufacture of computer, electronic and optical products	3.9	3.7	3.6	3.6	3.7
C27—Manufacture of electrical equipment	8.8	8.4	8.3	8.3	8.4
C28—Manufacture of machinery and equipment n.e.c	10.7	10.1	10.0	10.0	10.1
C29—Manufacture of motor vehicles, trailers and semi-trailers	2.0	1.9	1.8	1.9	1.9
C30—Manufacture of other transport equipment	4.8	4.5	4.5	4.5	4.5
C31_C32—Manufacture of furniture; other manufacturing	22.2	21.2	21.1	21.1	21.1

NACE (2-digits)	*2019*	*2020*	*2021*	*2022*	*2023*
C33—Repair and installation of machinery and equipment	16.5	15.7	15.6	15.6	15.8
D—Electricity, gas, steam and air conditioning supply	29.6	28.8	27.0	26.4	26.3
E36—Water collection, treatment and supply	10.7	10.4	10.1	10.1	9.9
E37–E39—Sewerage, waste management, remediation activities	19.8	19.1	18.4	18.5	18.2
F—Construction	192.4	182.5	176.0	177.6	178.3
G45—Wholesale and retail trade and repair of motor vehicles and motorcycles	72.6	68.7	68.7	72.7	75.0
G46—Wholesale trade, except of motor vehicles and motorcycles	230.3	219.5	218.4	231.1	238.7
G47—Retail trade, except of motor vehicles and motorcycles	484.3	457.7	460.8	484.7	501.8
H49—Land transport and transport via pipelines	115.0	101.4	104.7	108.9	111.3
H50—Water transport	63.2	56.1	57.7	59.7	60.7
H51—Air transport	3.9	3.5	3.6	3.7	3.8
H52—Warehousing and support activities for transportation	51.0	45.3	46.3	47.9	49.0
H53—Postal and courier activities	16.4	14.6	15.1	15.4	16.0
I—Accommodation and food service activities	572.5	466.2	553.7	588.9	604.7
J58—Publishing activities	13.4	13.3	13.1	13.8	14.1
J59–J60—Motion picture, video, television programme production; programming and broadcasting activities	17.3	17.2	17.1	17.9	18.2
J61—Telecommunications	29.5	29.9	29.6	30.3	31.0
J62–J63—Computer programming, consultancy, and information service activities	35.5	35.2	35.3	36.2	37.1
K64—Financial service activities, except insurance and pension funding	46.8	46.8	45.0	43.1	43.9
K65—Insurance, reinsurance and pension funding, except compulsory social security	8.1	8.0	7.7	7.4	7.4
K66—Activities auxiliary to financial services and insurance activities	23.9	23.6	22.8	21.9	22.1
L—Real estate activities	19.0	18.6	18.6	18.5	18.5
M69–M70—Legal and accounting activities; activities of head offices; management consultancy activities	141.7	136.4	134.6	138.9	143.9

(continued)

Table 7.15 (continued)

NACE (2-digits)	*2019*	*2020*	*2021*	*2022*	*2023*
M71—Architectural and engineering activities; technical testing and analysis	71.0	68.2	67.5	69.6	70.9
M72—Scientific research and development	16.6	15.9	15.6	16.1	16.7
M73—Advertising and market research	16.0	15.4	15.0	15.6	16.0
M74–M75—Other professional, scientific and technical activities; veterinary activities	19.3	18.6	18.3	18.9	19.4
N77—Rental and leasing activities	15.3	14.5	14.5	16.4	16.4
N78—Employment activities	17.6	16.4	16.6	19.0	19.2
N79—Travel agency, tour operator and other reservation service and related activities	19.6	18.2	18.4	20.2	20.6
N80–N82—Security and investigation, service and landscape, office administrative and support activities	85.0	79.9	80.2	90.4	91.8
O—Public administration and defence; compulsory social security	397.5	411.5	410.2	396.8	395.4
P—Education	364.2	362.8	362.6	363.4	369.8
Q86—Human health activities	230.4	246.0	244.2	242.9	245.9
Q87–Q88—Residential care activities and social work activities without accommodation	36.2	38.9	37.9	38.3	38.5
R90–R92—Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities	45.9	42.6	41.3	45.4	45.2
R93—Sports activities and amusement and recreation activities	26.8	25.8	24.5	26.5	26.5
S–T Other Service Activities & Activities of Households as Employers	153.6	154.5	155.5	156.7	155.3
S94—Activities of membership organisations	34.7	34.3	35.1	35.3	35.1
S95—Repair of computers and personal and household goods	11.6	11.6	11.7	11.9	11.7
S96—Other personal service activities	76.2	77.1	77.1	78.1	77.3
Total	4565	4342	4415	4518	4577

NACE (2-digits)	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
A01—Crop and animal production, hunting and related service activities	430.8	428.7	425.1	419.8	−1.3%
A02—Forestry and logging	8.4	8.4	8.2	8.2	−1.5%

NACE (2-digits)	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
A03—Fishing and aquaculture	19.4	19.1	18.9	18.8	−1.5%
B—Mining and quarrying	9.0	8.8	8.7	8.4	−2.1%
C5–C12—Manufacture of food products; beverages and tobacco products	114.8	115.7	115.3	114.8	−0.7%
C13–C15—Manufacture of textiles, wearing apparel, leather and related products	28.0	27.8	27.8	27.6	−0.7%
C16—Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	7.5	7.4	7.5	7.5	−0.3%
C17—Manufacture of paper and paper products	8.3	8.3	8.3	8.4	−0.3%
C18—Printing and reproduction of recorded media	10.1	10.0	10.0	10.0	−0.7%
C19—Manufacture of coke and refined petroleum products	3.8	3.8	3.8	3.8	0.0%
C20—Manufacture of chemicals and chemical products	11.6	11.5	11.5	11.4	−0.6%
C21—Manufacture of basic pharmaceutical products and pharmaceutical preparations	9.8	9.8	9.8	9.9	−0.6%
C22—Manufacture of rubber and plastic products	12.6	12.5	12.6	12.6	−0.4%
C23—Manufacture of other non-metallic mineral products	15.5	15.4	15.5	15.5	−0.7%
C24—Manufacture of basic metals	10.9	10.9	10.9	10.8	−0.6%
C25—Manufacture of fabricated metal products, except machinery and equipment	32.4	32.4	32.4	32.3	−0.5%
C26—Manufacture of computer, electronic and optical products	3.7	3.7	3.7	3.6	−0.7%
C27—Manufacture of electrical equipment	8.4	8.4	8.5	8.5	−0.4%
C28—Manufacture of machinery and equipment n.e.c	10.1	10.2	10.2	10.1	−0.7%

(continued)

Table 7.15 (continued)

NACE (2-digits)	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
C29—Manufacture of motor vehicles, trailers and semi-trailers	1.9	1.9	1.9	1.9	−0.7%
C30—Manufacture of other transport equipment	4.5	4.5	4.5	4.5	−0.8%
C31–C32—Manufacture of furniture; other manufacturing	21.3	21.4	21.5	21.2	−0.6%
C33—Repair and installation of machinery and equipment	15.6	15.7	15.6	15.6	−0.7%
D—Electricity, gas, steam and air conditioning supply	26.4	26.4	26.4	26.4	−1.4%
E36—Water collection, treatment and supply	9.9	9.8	9.9	9.7	−1.2%
E37–E39—Sewerage, waste management, remediation activities	18.0	17.9	17.6	17.5	−1.5%
F—Construction	179.2	180.5	181.5	181.9	−0.7%
G45—Wholesale and retail trade and repair of motor vehicles and motorcycles	77.3	78.7	80.1	81.3	1.4%
G46—Wholesale trade, except of motor vehicles and motorcycles	246.1	252.1	255.0	258.0	1.4%
G47—Retail trade, except of motor vehicles and motorcycles	514.3	523.2	534.6	538.5	1.3%
H49—Land transport and transport via pipelines	112.6	111.9	110.0	109.4	−0.6%
H50—Water transport	61.4	61.4	61.3	60.3	−0.6%
H51—Air transport	3.8	3.8	3.8	3.7	−0.4%
H52—Warehousing and support activities for transportation	49.4	49.1	48.6	48.1	−0.7%
H53—Postal and courier activities	16.0	16.1	15.7	15.5	−0.7%
I—Accommodation and food service activities	605.9	611.1	615.9	619.0	1.0%
J58—Publishing activities	14.2	14.4	14.7	14.9	1.4%
J59_J60—Motion picture, video, television programme production; programming and broadcasting activities	18.5	19.0	19.2	19.3	1.4%
J61—Telecommunications	31.7	32.3	32.5	32.6	1.3%

NACE (2-digits)	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
J62–J63—Computer programming, consultancy, and information service activities	37.8	38.2	38.8	39.1	1.2%
K64—Financial service activities, except insurance and pension funding	44.5	45.0	45.4	45.9	**−0.2%**
K65—Insurance, reinsurance and pension funding, except compulsory social security	7.6	7.7	7.8	7.8	−0.5%
K66—Activities auxiliary to financial services and insurance activities	22.6	22.9	23.1	23.1	−0.4%
L—Real estate activities	18.5	18.4	18.2	18.0	−0.7%
M69–M70—Legal and accounting activities; activities of head offices; management consultancy activities	148.0	151.9	154.7	157.1	1.3%
M71—Architectural and engineering activities; technical testing and analysis	73.4	75.0	76.5	78.1	1.2%
M72—Scientific research and development	17.1	17.5	17.9	18.2	1.2%
M73—Advertising and market research	16.5	17.0	17.2	17.5	1.1%
M74–M75—Other professional, scientific and technical activities; veterinary activities	20.1	20.5	21.0	21.2	1.2%
N77—Rental and leasing activities	16.7	16.8	16.9	16.9	1.2%
N78—Employment activities	19.3	19.2	19.3	19.3	1.1%
N79—Travel agency, tour operator and other reservation service and related activities	20.8	21.2	21.3	21.6	1.2%
N80–N82—Security and investigation, service and landscape, office administrative and support activities	92.5	92.5	93.2	93.5	1.2%

(continued)

Table 7.15 (continued)

NACE (2-digits)	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
O—Public administration and defence; compulsory social security	395.0	393.8	392.0	389.7	−0.2%
P—Education	376.0	380.5	383.6	385.5	0.7%
Q86—Human health activities	248.3	250.2	251.2	251.9	1.1%
Q87–Q88—Residential care activities and social work activities without accommodation	39.2	39.0	39.8	39.7	1.1%
R90–R92—Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities	45.2	45.0	44.9	44.8	−0.3%
R93—Sports activities and amusement and recreation activities	26.5	26.6	26.6	26.5	−0.1%
S–T Other Service Activities & Activities of Households as Employers	154.7	154.9	154.1	152.8	−0.1%
S94—Activities of membership organisations	35.1	35.1	35.0	34.8	0.0%
S95—Repair of computers and personal and household goods	11.7	11.5	11.5	11.4	−0.2%
S96—Other personal service activities	76.6	76.8	76.3	75.5	−0.1%
Total	4623	4658	4682	4689	0.3%

Source Authors' own creation

Table 7.16 Employment (thousand people) per 2-digit NACE sector—upside scenario

NACE (2-digits)	*2019*	*2020*	*2021*	*2022*	*2023*
A01—Crop and animal production, hunting and related service activities	466.7	439.8	444.1	435.6	435.5
A02—Forestry and logging	9.2	8.7	8.7	7.5	7.5
A03—Fishing and aquaculture	21.2	19.8	20.1	20.1	20.0
B—Mining and quarrying	10.0	9.7	9.6	9.6	9.6
C10–C12—Manufacture of food products; beverages and tobacco products	121.5	113.3	113.7	116.8	117.9
C13–C15—Manufacture of textiles, wearing apparel, leather and related products	29.2	27.3	27.1	27.5	28.1
C16—Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	7.7	7.1	7.2	7.3	7.6
C17—Manufacture of paper and paper products	8.6	8.0	8.0	8.2	8.6
C18—Printing and reproduction of recorded media	10.6	9.8	9.8	10.1	10.4
C19—Manufacture of coke and refined petroleum products	3.8	3.5	3.6	3.7	3.8
C20—Manufacture of chemicals and chemical products	12.0	11.2	11.3	11.6	11.9
C21—Manufacture of basic pharmaceutical products and pharmaceutical preparations	10.4	9.6	9.7	9.9	10.1
C22—Manufacture of rubber and plastic products	12.9	12.1	12.1	12.4	12.9
C23—Manufacture of other non-metallic mineral products	16.4	15.1	15.2	15.5	15.8
C24—Manufacture of basic metals	11.3	10.5	10.7	10.9	11.2
C25—Manufacture of fabricated metal products, except machinery and equipment	33.6	31.4	31.4	32.3	33.2
C26—Manufacture of computer, electronic and optical products	3.9	3.6	3.6	3.6	3.7
C27—Manufacture of electrical equipment	8.8	8.3	8.3	8.4	8.7
C28—Manufacture of machinery and equipment n.e.c	10.7	9.9	9.9	10.1	10.4
C29—Manufacture of motor vehicles, trailers and semi-trailers	2.0	1.8	1.8	1.9	1.9
C30—Manufacture of other transport equipment	4.8	4.4	4.5	4.5	4.6
C31–C32—Manufacture of furniture; other manufacturing	22.2	20.7	21.0	21.3	21.8
C33—Repair and installation of machinery and equipment	16.5	15.4	15.5	15.7	16.2
D—Electricity, gas, steam and air conditioning supply	29.6	28.4	26.6	26.6	26.8

(continued)

Table 7.16 (continued)

NACE (2-digits)	*2019*	*2020*	*2021*	*2022*	*2023*
E36—Water collection, treatment and supply	10.7	10.5	10.3	10.1	10.1
E37-E39—Sewerage, waste management, remediation activities	19.8	19.3	18.8	18.7	18.5
F—Construction	192.4	179.4	177.6	184.8	191.5
G45—Wholesale and retail trade and repair of motor vehicles and motorcycles	72.6	68.6	71.6	74.4	77.1
G46—Wholesale trade, except of motor vehicles and motorcycles	230.3	219.1	227.6	237.8	246.8
G47—Retail trade, except of motor vehicles and motorcycles	484.3	456.8	480.2	498.6	518.6
H49—Land transport and transport via pipelines	115.0	106.4	109.9	111.6	113.1
H50—Water transport	63.2	58.8	60.6	61.6	62.2
H51—Air transport	3.9	3.7	3.8	3.7	3.7
H52—Warehousing and support activities for transportation	51.0	47.5	48.6	49.7	50.4
H53—Postal and courier activities	16.4	15.3	15.9	15.9	16.3
I—Accommodation and food service activities	572.5	512.8	550.3	604.8	619.3
J58—Publishing activities	13.4	12.9	12.6	11.5	11.8
J59–J60—Motion picture, video, television programme production; programming and broadcasting activities	17.3	16.8	16.4	17.0	17.4
J61—Telecommunications	29.5	29.1	28.3	28.9	29.7
J62–J63—Computer programming, consultancy, and information service activities	35.5	34.2	33.8	34.4	35.5
K64—Financial service activities, except insurance and pension funding	46.8	44.6	43.1	44.0	45.5
K65—Insurance, reinsurance and pension funding, except compulsory social security	8.1	7.6	7.4	7.4	7.6
K66—Activities auxiliary to financial services and insurance activities	23.9	22.5	21.8	22.4	22.9
L—Real estate activities	19.0	18.5	18.8	18.9	19.1

NACE (2-digits)	*2019*	*2020*	*2021*	*2022*	*2023*
M69–M70—Legal and accounting activities; activities of head offices; management consultancy activities	141.7	138.8	139.5	144.4	150.9
M71—Architectural and engineering activities; technical testing and analysis	71.0	69.4	69.9	72.0	74.0
M72—Scientific research and development	16.6	16.1	16.2	16.5	17.3
M73—Advertising and market research	16.0	15.7	15.6	16.2	16.7
M74–M75—Other professional, scientific and technical activities; veterinary activities	19.3	18.9	18.9	19.6	20.3
N77—Rental and leasing activities	15.3	14.9	15.4	16.5	16.6
N78—Employment activities	17.6	16.9	17.7	19.0	19.5
N79—Travel agency, tour operator and other reservation service and related activities	19.6	18.8	19.6	20.3	21.0
N80–N82—Security and investigation, service and landscape, office administrative and support activities	85.0	82.5	85.2	91.0	93.6
O—Public administration and defence; compulsory social security	397.5	404.4	392.6	386.0	384.3
P—Education	364.2	363.7	348.4	352.6	358.7
Q86—Human health activities	230.4	229.9	234.1	235.3	238.8
Q87–Q88—Residential care activities and social work activities without accommodation	36.2	36.4	36.3	36.6	36.9
R90–R92—Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities	45.9	40.3	41.6	45.0	45.9

(continued)

Table 7.16 (continued)

NACE (2-digits)	*2019*	*2020*	*2021*	*2022*	*2023*
R93—Sports activities and amusement and recreation activities	26.8	24.4	24.7	26.2	26.8
S–T Other Service Activities & Activities of Households as Employers	153.6	152.1	155.0	157.2	158.5
S94—Activities of membership organisations	34.7	33.9	35.0	34.8	35.2
S95—Repair of computers and personal and household goods	11.6	11.5	11.7	11.8	11.8
S96—Other personal service activities	76.2	76.1	76.7	78.0	78.5
Total	4565	4357	4421	4542	4635

NACE (2-digits)	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
A01—Crop and animal production, hunting and related service activities	436.1	435.7	432.3	426.0	−1.1%
A02—Forestry and logging	7.4	7.5	7.3	7.3	−2.9%
A03—Fishing and aquaculture	20.2	20.0	19.8	19.7	−0.9%
B—Mining and quarrying	9.5	9.4	9.3	9.1	−1.2%
C10–C12—Manufacture of food products; beverages and tobacco products	120.4	122.9	123.3	123.0	0.2%
C13–C15—Manufacture of textiles, wearing apparel, leather and related products	29.0	29.2	29.4	29.2	0.0%
C16—Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	7.8	7.8	7.9	7.9	0.4%
C17—Manufacture of paper and paper products	8.6	8.8	8.8	9.0	0.6%
C18—Printing and reproduction of recorded media	10.5	10.6	10.7	10.7	0.1%
C19—Manufacture of coke and refined petroleum products	3.9	4.0	4.1	4.1	0.8%
C20—Manufacture of chemicals and chemical products	12.1	12.2	12.3	12.2	0.2%
C21—Manufacture of basic pharmaceutical products and pharmaceutical preparations	10.2	10.4	10.5	10.6	0.2%
C22—Manufacture of rubber and plastic products	13.1	13.3	13.4	13.4	0.5%
C23—Manufacture of other non-metallic mineral products	16.3	16.3	16.6	16.6	0.1%
C24—Manufacture of basic metals	11.3	11.5	11.6	11.5	0.3%

NACE (2-digits)	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
C25—Manufacture of fabricated metal products, except machinery and equipment	33.9	34.4	34.7	34.6	0.4%
C26—Manufacture of computer, electronic and optical products	3.8	3.8	3.8	3.8	−0.2%
C27—Manufacture of electrical equipment	8.8	9.0	9.0	9.1	0.5%
C28—Manufacture of machinery and equipment n.e.c	10.5	10.8	10.9	10.8	0.1%
C29—Manufacture of motor vehicles, trailers and semi-trailers	2.0	2.0	2.0	2.0	−0.1%
C30—Manufacture of other transport equipment	4.7	4.8	4.8	4.8	0.0%
C31–C32—Manufacture of furniture; other manufacturing	22.4	22.7	22.9	22.7	0.3%
C33—Repair and installation of machinery and equipment	16.3	16.6	16.6	16.7	0.1%
D—Electricity, gas, steam and air conditioning supply	27.1	27.3	27.5	27.6	−0.9%
E36—Water collection, treatment and supply	10.1	10.1	10.2	10.1	−0.7%
E37–E39—Sewerage, waste management, remediation activities	18.5	18.5	18.4	18.4	−0.9%
F—Construction	198.2	202.9	203.8	202.0	0.6%
G45—Wholesale and retail trade and repair of motor vehicles and motorcycles	79.8	81.7	83.6	85.1	2.0%
G46—Wholesale trade, except of motor vehicles and motorcycles	255.6	263.5	267.8	272.0	2.1%
G47—Retail trade, except of motor vehicles and motorcycles	534.0	546.5	561.3	567.5	2.0%
H49—Land transport and transport via pipelines	114.0	113.4	111.9	111.5	−0.4%
H50—Water transport	62.6	62.7	62.8	61.9	−0.3%
H51—Air transport	3.7	3.7	3.7	3.7	−0.6%
H52—Warehousing and support activities for transportation	50.6	50.4	50.0	49.6	−0.4%
H53—Postal and courier activities	16.3	16.3	16.0	15.9	−0.4%
I—Accommodation and food service activities	634.1	647.2	656.1	660.8	1.8%
J58—Publishing activities	12.0	12.2	12.6	12.7	−0.6%
J59–J60—Motion picture, video, television programme production; programming and broadcasting activities	17.8	18.3	18.6	18.8	1.0%

(continued)

Table 7.16 (continued)

NACE (2-digits)	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
J61—Telecommunications	30.5	31.2	31.5	31.8	0.9%
J62–J63—Computer programming, consultancy, and information service activities	36.4	36.9	37.6	38.0	0.9%
K64—Financial service activities, except insurance and pension funding	46.6	47.6	48.4	49.1	0.6%
K65—Insurance, reinsurance and pension funding, except compulsory social security	7.8	8.1	8.2	8.2	0.2%
K66—Activities auxiliary to financial services and insurance activities	23.7	24.3	24.7	24.8	0.4%
L—Real estate activities	19.1	19.1	19.0	18.8	−0.1%
M69–M70—Legal and accounting activities; activities of head offices; management consultancy activities	156.3	161.8	165.9	169.1	2.2%
M71—Architectural and engineering activities; technical testing and analysis	77.1	79.4	81.6	83.6	2.1%
M72—Scientific research and development	17.9	18.4	19.0	19.4	2.0%
M73—Advertising and market research	17.3	18.0	18.4	18.7	2.0%
M74–M75—Other professional, scientific and technical activities; veterinary activities	21.2	21.8	22.5	22.8	2.1%
N77—Rental and leasing activities	17.3	17.7	18.0	18.0	2.0%
N78—Employment activities	20.0	20.3	20.5	20.6	2.0%
N79—Travel agency, tour operator and other reservation service and related activities	21.5	22.3	22.7	23.1	2.1%
N80–N82—Security and investigation, service and landscape, office administrative and support activities	96.0	97.6	99.3	100.0	2.1%

NACE (2-digits)	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
O—Public administration and defence; compulsory social security	381.6	377.6	372.8	368.4	−0.9%
P—Education	362.6	364.6	364.9	364.2	0.0%
Q86—Human health activities	241.3	243.2	243.8	244.1	0.7%
Q87–Q88—Residential care activities and social work activities without accommodation	37.6	37.4	38.1	37.9	0.6%
R90–R92—Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities	46.6	46.9	46.9	46.9	0.3%
R93—Sports activities and amusement and recreation activities	27.3	27.6	27.8	27.7	0.4%
S–T Other Service Activities & Activities of Households as Employers	159.3	160.3	160.0	158.6	0.4%
S94—Activities of membership organisations	35.5	35.7	35.7	35.4	0.3%
S95—Repair of computers and personal and household goods	12.0	11.9	11.9	11.8	0.2%
S96—Other personal service activities	78.4	79.1	78.8	78.0	0.3%
Total	4718	478	4818	4826	0.7%

Source Authors' own creation

Table 7.17 Average annual rate of change of employment 2019–2027 per 2-digit NACE sector in both scenarios

NACE 2-digits	*Base scenario*	*Upside scenario*
A01—Crop and animal production, hunting and related service activities	−1.3%	−1.1%
A02—Forestry and logging	−1.5%	−2.9%
A03—Fishing and aquaculture	−1.5%	−0.9%
B—Mining and quarrying	−2.1%	−1.2%
C10–C12—Manufacture of food products; beverages and tobacco products	−0.7%	0.2%
C13-C15—Manufacture of textiles, wearing apparel, leather and related products	−0.7%	0.0%
C16—Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	−0.3%	0.4%
C17—Manufacture of paper and paper products	−0.3%	0.6%
C18—Printing and reproduction of recorded media	−0.7%	0.1%
C19—Manufacture of coke and refined petroleum products	0.0%	0.8%
C20—Manufacture of chemicals and chemical products	−0.6%	0.2%
C21—Manufacture of basic pharmaceutical products and pharmaceutical preparations	−0.6%	0.2%
C22—Manufacture of rubber and plastic products	−0.4%	0.5%
C23—Manufacture of other non-metallic mineral products	−0.7%	0.1%
C24—Manufacture of basic metals	−0.6%	0.3%
C25—Manufacture of fabricated metal products, except machinery and equipment	−0.5%	0.4%
C26—Manufacture of computer, electronic and optical products	−0.7%	−0.2%
C27—Manufacture of electrical equipment	−0.4%	0.5%
C28—Manufacture of machinery and equipment n.e.c	−0.7%	0.1%
C29—Manufacture of motor vehicles, trailers and semi-trailers	−0.7%	−0.1%
C30—Manufacture of other transport equipment	−0.8%	0.0%
C31–C32—Manufacture of furniture; other manufacturing	−0.6%	0.3%
C33—Repair and installation of machinery and equipment	−0.7%	0.1%
D—Electricity, gas, steam and air conditioning supply	−1.4%	−0.9%
E36—Water collection, treatment and supply	−1.2%	−0.7%

NACE 2-digits	*Base scenario*	*Upside scenario*
E37–E39—Sewerage, waste management, remediation activities	−1.5%	−0.9%
F—Construction	−0.7%	0.6%
G45—Wholesale and retail trade and repair of motor vehicles and motorcycles	1.4%	2.0%
G46—Wholesale trade, except of motor vehicles and motorcycles	1.4%	2.1%
G47—Retail trade, except of motor vehicles and motorcycles	1.3%	2.0%
H49—Land transport and transport via pipelines	−0.6%	−0.4%
H50—Water transport	−0.6%	−0.3%
H51—Air transport	−0.4%	−0.6%
H52—Warehousing and support activities for transportation	−0.7%	−0.4%
H53—Postal and courier activities	−0.7%	−0.4%
I—Accommodation and food service activities	1.0%	1.8%
J58—Publishing activities	1.4%	−0.6%
J59–J60—Motion picture, video, television programme production; programming and broadcasting activities	1.4%	1.0%
J61—Telecommunications	1.3%	0.9%
J62–J63—Computer programming, consultancy, and information service activities	1.2%	0.9%
K64—Financial service activities, except insurance and pension funding	−0.2%	0.6%
K65—Insurance, reinsurance and pension funding, except compulsory social security	−0.5%	0.2%
K66—Activities auxiliary to financial services and insurance activities	−0.4%	0.4%
L—Real estate activities	−0.7%	−0.1%
M69–M70—Legal and accounting activities; activities of head offices; management consultancy activities	1.3%	2.2%
M71—Architectural and engineering activities; technical testing and analysis	1.2%	2.1%
M72—Scientific research and development	1.2%	2.0%
M73—Advertising and market research	1.1%	2.0%
M74–M75—Other professional, scientific and technical activities; veterinary activities	1.2%	2.1%

(continued)

Table 7.17 (continued)

NACE 2-digits	*Base scenario*	*Upside scenario*
N77—Rental and leasing activities	1.2%	2.0%
N78—Employment activities	1.1%	2.0%
N79—Travel agency, tour operator and other reservation service and related activities	1.2%	2.1%
N80–N82—Security and investigation, service and landscape, office administrative and support activities	1.2%	2.1%
O—Public administration and defence; compulsory social security	−0.2%	−0.9%
P—Education	0.7%	0.0%
Q86—Human health activities	1.1%	0.7%
Q87–Q88—Residential care activities and social work activities without accommodation	1.1%	0.6%
R90-R92—Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities	−0.3%	0.3%
R93—Sports activities and amusement and recreation activities	−0.1%	0.4%
S–T Other Service Activities & Activities of Households as Employers	−0.1%	0.4%
S94—Activities of membership organisations	0.0%	0.3%
S95—Repair of computers and personal and household goods	−0.2%	0.2%
S96—Other personal service activities	−0.1%	0.3%
Total	0.3%	0.7%

Source Authors' own creation

Table 7.18 Employment (thousand people) per 2-digit ISCO category—base scenario

2-digit ISCO	*2019*	*2020*	*2021*	*2022*	*2023*
11 Chief executives, senior officials and legislators	6.2	6.0	6.1	6.2	6.4
12 Administrative and commercial managers	17.8	17.3	17.4	17.7	17.8
13 Production and specialised services managers	34.7	33.6	33.4	33.8	34.1
14 Hospitality, retail and other services managers	77.6	69.2	74.1	78.6	80.9
21 Science and engineering professionals	139.4	134.3	133.6	136.1	137.9
22 Health professionals	118.4	123.1	123.1	123.4	125.3
23 Teaching professionals	270.8	268.0	269.4	270.3	275.3
24 Business and administration professionals	147.4	141.8	141.8	145.4	148.7
25 Information and communications technology professionals	28.6	28.1	28.1	28.8	29.4
26 Legal, social and cultural professionals	212.7	208.2	210.1	213.8	216.1
31 Science and engineering associate professionals	50.3	47.1	47.3	48.3	49.0
32 Health associate professionals	77.0	80.6	80.4	80.4	81.4
33 Business and administration associate professionals	149.5	146.0	145.8	146.2	148.3
34 Legal, social, cultural and related associate professionals	39.1	37.6	37.4	38.8	39.2
35 Information and communications technicians	27.7	27.0	27.1	27.8	28.3
41 General and keyboard clerks	293.9	287.6	288.6	291.8	295.2
42 Customer services clerks	105.5	97.0	101.0	105.7	107.8
43 Numerical and material recording clerks	89.8	85.4	85.9	88.6	90.7
44 Other clerical support workers	31.8	30.3	30.7	31.3	31.8
51 Personal service workers	336.9	292.5	329.1	345.2	351.4
52 Sales workers	553.3	518.6	525.4	553.1	571.3
53 Personal care workers	36.5	37.8	37.5	37.9	38.1
54 Protective services workers	130.7	130.3	130.9	132.3	132.7
61 Market-oriented skilled agricultural workers	438.4	412.2	416.4	416.2	408.2
62 Market-oriented skilled forestry, fishery and hunting workers	18.0	16.8	17.0	16.9	16.5
71 Building and related trades workers, excluding electricians	131.9	124.4	121.9	123.4	124.2

(continued)

Table 7.18 (continued)

2-digit ISCO	*2019*	*2020*	*2021*	*2022*	*2023*
72 Metal, machinery and related trades workers	99.6	94.0	94.1	96.9	98.8
73 Handicraft and printing workers	21.4	20.3	20.2	20.5	20.8
74 Electrical and electronic trades workers	75.5	72.0	71.5	72.6	73.4
75 Food processing, wood working, garment and other craft and related trades workers	90.2	85.2	85.3	86.5	86.7
81 Stationary plant and machine operators	63.2	60.0	59.9	60.6	60.8
82 Assemblers	3.3	3.1	3.1	3.1	3.2
83 Drivers and mobile plant operators	247.3	224.7	230.7	239.3	244.0
91 Cleaners and helpers	136.6	129.3	133.8	140.3	141.8
92 Agricultural, forestry and fishery labourers	35.1	33.0	33.3	33.7	33.2
93 Labourers in mining, construction, manufacturing and transport	82.1	77.2	77.2	79.3	80.2
94 Food preparation assistants	27.5	22.5	26.6	28.3	29.0
95 Street and related sales and service workers	2.5	2.3	2.3	2.5	2.5
96 Refuse workers and other elementary workers	37.4	35.7	35.9	36.5	36.6
0 Armed forces occupations	79.6	81.9	82.1	79.5	79.3
Total	4565	4342	4415	4518	4577

2-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
11 Chief executives, senior officials and legislators	6.5	6.6	6.6	6.6	0.8%
12 Administrative and commercial managers	18.0	18.1	18.2	18.2	0.3%
13 Production and specialised services managers	34.4	34.6	34.7	34.7	0.0%
14 Hospitality, retail and other services managers	82.2	83.4	84.4	84.9	1.1%
21 Science and engineering professionals	140.4	142.2	143.7	144.8	0.5%
22 Health professionals	126.8	127.9	128.7	129.1	1.1%
23 Teaching professionals	279.8	283.1	285.5	286.9	0.7%

2-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
24 Business and administration professionals	151.7	154.1	155.8	157.0	0.8%
25 Information and communications technology professionals	29.9	30.1	30.5	30.7	0.9%
26 Legal, social and cultural professionals	218.3	220.4	221.8	222.2	0.6%
31 Science and engineering associate professionals	49.5	49.8	50.0	49.9	–0.1%
32 Health associate professionals	82.3	82.9	83.3	83.5	1.0%
33 Business and administration associate professionals	150.2	151.6	152.4	152.7	0.3%
34 Legal, social, cultural and related associate professionals	39.6	40.0	40.3	40.3	0.4%
35 Information and communications technicians	28.8	29.0	29.3	29.4	0.8%
41 General and keyboard clerks	298.4	300.4	301.5	301.8	0.3%
42 Customer services clerks	108.9	109.9	110.7	111.1	0.7%
43 Numerical and material recording clerks	92.4	93.7	94.6	95.1	0.7%
44 Other clerical support workers	32.0	32.1	32.0	32.0	0.1%
51 Personal service workers	351.5	354.0	355.5	356.1	0.7%
52 Sales workers	585.2	595.5	606.2	610.9	1.2%
53 Personal care workers	38.5	38.5	38.8	38.8	0.7%
54 Protective services workers	132.9	132.7	132.5	132.1	0.1%
61 Market-oriented skilled agricultural workers	405.6	403.7	400.4	395.4	–1.3%
62 Market-oriented skilled forestry, fishery and hunting workers	16.5	16.3	16.1	16.0	–1.5%
71 Building and related trades workers, excluding electricians	124.9	125.7	126.5	126.7	–0.5%
72 Metal, machinery and related trades workers	100.3	101.3	102.2	102.7	0.4%
73 Handicraft and printing workers	20.9	20.9	21.1	21.1	–0.2%
74 Electrical and electronic trades workers	74.0	74.5	75.0	75.1	–0.1%
75 Food processing, wood working, garment and other craft and related trades workers	87.6	87.8	88.0	87.6	–0.4%
81 Stationary plant and machine operators	60.9	61.0	60.9	60.7	–0.5%
82 Assemblers	3.2	3.2	3.2	3.2	–0.3%

(continued)

Table 7.18 (continued)

2-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
83 Drivers and mobile plant operators	247.0	247.7	246.9	246.7	0.0%
91 Cleaners and helpers	142.3	143.0	143.4	143.4	0.6%
92 Agricultural, forestry and fishery labourers	33.0	32.9	32.7	32.4	−1.0%
93 Labourers in mining, construction, manufacturing and transport	81.1	81.7	81.9	82.0	0.0%
94 Food preparation assistants	29.1	29.3	29.5	29.7	0.9%
95 Street and related sales and service workers	2.6	2.6	2.7	2.7	1.1%
96 Refuse workers and other elementary workers	36.7	36.7	36.7	36.6	−0.3%
0 Armed forces occupations	79.2	79.0	78.6	78.1	−0.2%
Total	4623	4658	4683	4689	0.30%

Source Authors' own creation

Table 7.19 Employment (thousand people) per 2-digit ISCO category—upside scenario

2-digit ISCO	*2019*	*2020*	*2021*	*2022*	*2023*
11 Chief executives, senior officials and legislators	6.3	6.1	6.2	6.3	6.5
12 Administrative and commercial managers	17.8	17.2	17.3	17.6	17.9
13 Production and specialised services managers	34.6	33.0	32.9	33.6	34.3
14 Hospitality, retail and other services managers	77.7	72.0	75.8	80.4	82.8
21 Science and engineering professionals	139.1	134.4	134.5	137.7	140.9
22 Health professionals	119.7	118.2	120.5	121.8	124.0
23 Teaching professionals	274.1	272.7	261.6	264.9	269.5
24 Business and administration professionals	149.0	143.5	144.9	149.0	153.6
25 Information and communications technology professionals	28.4	27.4	27.2	27.7	28.5
26 Legal, social and cultural professionals	206.8	201.7	204.0	207.8	212.3
31 Science and engineering associate professionals	51.0	48.4	48.8	49.8	50.8
32 Health associate professionals	78.0	77.1	78.5	79.2	80.4
33 Business and administration associate professionals	150.0	144.9	144.6	147.3	150.3
34 Legal, social, cultural and related associate professionals	27.3	26.7	26.7	27.4	28.0
35 Information and communications technicians	27.2	26.2	26.1	26.7	27.4
41 General and keyboard clerks	294.0	286.1	286.7	290.7	295.6
42 Customer services clerks	97.3	91.5	94.1	98.6	101.1
43 Numerical and material recording clerks	90.9	86.5	88.4	91.1	93.8
44 Other clerical support workers	31.2	30.1	30.4	30.8	31.4
51 Personal service workers	338.5	312.2	328.6	351.7	358.5
52 Sales workers	559.3	525.6	550.4	572.0	593.5
53 Personal care workers	36.3	36.1	36.3	36.8	37.3
54 Protective services workers	129.5	129.2	127.8	128.5	129.3
61 Market-oriented skilled agricultural workers	439.0	412.2	416.8	420.1	420.2
62 Market-oriented skilled forestry, fishery and hunting workers	18.1	16.8	17.0	17.1	17.0
71 Building and related trades workers, excluding electricians	133.1	124.1	123.7	128.0	132.2

(continued)

Table 7.19 (continued)

2-digit ISCO	*2019*	*2020*	*2021*	*2022*	*2023*
72 Metal, machinery and related trades workers	100.2	94.1	96.1	99.1	102.1
73 Handicraft and printing workers	21.7	20.3	20.5	21.0	21.6
74 Electrical and electronic trades workers	76.5	72.3	72.4	74.5	76.6
75 Food processing, wood working, garment and other craft and related trades workers	91.7	85.5	86.4	88.7	90.4
81 Stationary plant and machine operators	64.1	60.2	60.5	62.0	63.2
82 Assemblers	3.3	3.1	3.1	3.2	3.3
83 Drivers and mobile plant operators	250.8	234.2	240.6	248.0	253.0
91 Cleaners and helpers	137.6	132.6	135.7	141.6	144.2
92 Agricultural, forestry and fishery labourers	35.2	33.1	33.6	34.0	34.1
93 Labourers in mining, construction, manufacturing and transport	82.7	77.5	78.7	81.1	83.1
94 Food preparation assistants	27.7	24.8	26.5	29.0	29.7
95 Street and related sales and service workers	2.4	2.2	2.3	2.4	2.5
96 Refuse workers and other elementary workers	36.8	35.5	35.5	36.1	36.4
0 Armed forces occupations	80.6	81.7	79.4	77.9	77.6
Total	4565	4357	4421	4541	4635

2-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
11 Chief executives, senior officials and legislators	6.6	6.8	6.8	6.9	1.0%
12 Administrative and commercial managers	18.2	18.4	18.6	18.6	0.5%
13 Production and specialised services managers	34.9	35.3	35.5	35.5	0.3%
14 Hospitality, retail and other services managers	85.2	87.2	88.7	89.5	1.8%
21 Science and engineering professionals	144.7	147.6	149.7	151.1	1.0%
22 Health professionals	125.6	126.8	127.6	127.9	0.8%
23 Teaching professionals	272.4	273.8	274.1	273.6	0.0%
24 Business and administration professionals	157.7	161.4	163.9	165.6	1.3%

2-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
25 Information and communications technology professionals	29.1	29.5	30.0	30.2	0.8%
26 Legal, social and cultural professionals	216.0	219.3	221.5	222.2	0.9%
31 Science and engineering associate professionals	51.7	52.3	52.7	52.6	0.4%
32 Health associate professionals	81.4	82.1	82.5	82.5	0.7%
33 Business and administration associate professionals	153.1	155.4	156.7	157.2	0.6%
34 Legal, social, cultural and related associate professionals	28.6	29.1	29.5	29.7	1.0%
35 Information and communications technicians	28.0	28.4	28.8	29.0	0.8%
41 General and keyboard clerks	299.8	302.7	304.1	304.3	0.4%
42 Customer services clerks	103.5	105.5	106.9	107.7	1.3%
43 Numerical and material recording clerks	96.2	98.1	99.4	100.2	1.2%
44 Other clerical support workers	31.7	31.9	31.9	31.8	0.2%
51 Personal service workers	364.9	371.1	374.4	375.6	1.3%
52 Sales workers	611.4	626.3	640.9	648.2	1.9%
53 Personal care workers	37.7	37.8	38.1	38.0	0.5%
54 Protective services workers	129.6	129.5	129.0	128.3	–0.1%
61 Market-oriented skilled agricultural workers	420.8	420.5	417.3	411.3	–0.8%
62 Market-oriented skilled forestry, fishery and hunting workers	17.2	17.0	16.8	16.7	–1.0%
71 Building and related trades workers, excluding electricians	136.4	139.2	140.0	139.1	0.6%
72 Metal, machinery and related trades workers	104.6	106.6	108.0	108.8	1.0%
73 Handicraft and printing workers	22.0	22.3	22.6	22.6	0.5%
74 Electrical and electronic trades workers	78.5	79.8	80.5	80.3	0.6%
75 Food processing, wood working, garment and other craft and related trades workers	92.6	93.9	94.7	94.5	0.4%
81 Stationary plant and machine operators	64.3	65.1	65.4	65.4	0.2%
82 Assemblers	3.4	3.4	3.4	3.5	0.4%
83 Drivers and mobile plant operators	257.2	259.4	259.4	259.5	0.4%

(continued)

Table 7.19 (continued)

2-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
91 Cleaners and helpers	146.4	148.3	149.4	149.5	1.0%
92 Agricultural, forestry and fishery labourers	34.3	34.3	34.2	33.8	−0.5%
93 Labourers in mining, construction, manufacturing and transport	85.1	86.5	87.2	87.4	0.7%
94 Food preparation assistants	30.3	31.0	31.4	31.6	1.7%
95 Street and related sales and service workers	2.6	2.6	2.7	2.7	1.8%
96 Refuse workers and other elementary workers	36.8	37.1	37.2	37.1	0.1%
0 Armed forces occupations	77.0	76.2	75.3	74.4	−1.0%
Total	4718	478	4817	4824	0.7%

Source Authors' own creation

Table 7.20 Average annual rate of change of employment 2019–2027 per 2-digit ISCO categorey in the two scenarios

2-digit ISCO	*Base scenario*	*Upside scenario*
11 Chief executives, senior officials and legislators	0.8%	1.0%
12 Administrative and commercial managers	0.3%	0.5%
13 Production and specialised services managers	0.0%	0.3%
14 Hospitality, retail and other services managers	1.1%	1.8%
21 Science and engineering professionals	0.5%	1.0%
22 Health professionals	1.1%	0.8%
23 Teaching professionals	0.7%	0.0%
24 Business and administration professionals	0.8%	1.3%
25 Information and communications technology professionals	0.9%	0.8%
26 Legal, social and cultural professionals	0.6%	0.9%
31 Science and engineering associate professionals	−0.1%	0.4%
32 Health associate professionals	1.0%	0.7%
33 Business and administration associate professionals	0.3%	0.6%
34 Legal, social, cultural and related associate professionals	0.4%	1.0%
35 Information and communications technicians	0.8%	0.8%
41 General and keyboard clerks	0.3%	0.4%
42 Customer services clerks	0.7%	1.3%
43 Numerical and material recording clerks	0.7%	1.2%
44 Other clerical support workers	0.1%	0.2%
51 Personal service workers	0.7%	1.3%
52 Sales workers	1.2%	1.9%
53 Personal care workers	0.7%	0.5%
54 Protective services workers	0.1%	−0.1%
61 Market-oriented skilled agricultural workers	−1.3%	−0.8%
62 Market-oriented skilled forestry, fishery and hunting workers	−1.5%	−1.0%
71 Building and related trades workers, excluding electricians	−0.5%	0.6%

(continued)

Table 7.20 (continued)

2-digit ISCO	*Base scenario*	*Upside scenario*
72 Metal, machinery and related trades workers	0.4%	1.0%
73 Handicraft and printing workers	−0.2%	0.5%
74 Electrical and electronic trades workers	−0.1%	0.6%
75 Food processing, wood working, garment and other craft and related trades workers	−0.4%	0.4%
81 Stationary plant and machine operators	−0.5%	0.2%
82 Assemblers	−0.3%	0.4%
83 Drivers and mobile plant operators	0.0%	0.4%
91 Cleaners and helpers	0.6%	1.0%
92 Agricultural, forestry and fishery labourers	−1.0%	−0.5%
93 Labourers in mining, construction, manufacturing and transport	0.0%	0.7%
94 Food preparation assistants	0.9%	1.7%
95 Street and related sales and service workers	1.1%	1.8%
96 Refuse workers and other elementary workers	−0.3%	0.1%
0 Armed forces occupations	−0.2%	−1.0%
Total	0.3%	0.7%

Source Authors' own creation

Table 7.21 Employment (thousand people) per 3-digit ISCO category—base scenario

3-digit ISCO	*2019*	*2020*	*2021*	*2022*	*2023*
111 Legislators and senior officials	1.4	1.5	1.5	1.4	1.4
112 Managing directors and chief executives	4.8	4.6	4.6	4.8	4.9
121 Business services and administration managers	11.6	11.4	11.5	11.6	11.7
122 Sales, marketing and development managers	6.2	5.9	5.9	6.1	6.2
131 Production managers in agriculture, forestry and fisheries	0.1	0.1	0.1	0.1	0.1
132 Manufacturing, mining, construction, and distribution managers	17.0	15.9	15.8	16.0	16.2
133 Information and communications technology service managers	1.4	1.3	1.3	1.4	1.4
134 Professional services managers	16.3	16.2	16.2	16.2	16.4
141 Hotel and restaurant managers	28.4	22.9	27.5	29.2	30.0
142 Retail and wholesale trade managers	39.2	37.0	37.2	39.3	40.7
143 Other services managers	9.9	9.3	9.4	10.1	10.2
211 Physical and earth science professionals	7.9	7.6	7.5	7.7	7.8
212 Mathematicians, actuaries and statisticians	5.0	4.9	5.0	5.0	5.1
213 Life science professionals	17.5	17.1	17.1	17.5	17.7
214 Engineering professionals (excluding electrotechnology)	65.5	62.8	62.3	63.4	64.1
215 Electrotechnology engineers	13.4	12.9	12.8	13.1	13.3
216 Architects, planners, surveyors and designers	30.0	29.0	28.8	29.4	29.8
221 Medical doctors	56.7	59.9	59.8	59.5	60.3
222 Nursing and midwifery professionals	15.3	16.1	16.1	16.1	16.3
223 Traditional and complementary medicine professionals	0.1	0.1	0.1	0.1	0.1
224 Paramedical practitioners	1.3	1.4	1.4	1.4	1.4
225 Veterinarians	3.6	3.5	3.4	3.5	3.6
226 Other health professionals	41.4	42.1	42.2	42.8	43.6
231 University and higher education teachers	16.7	16.5	16.6	16.7	17.0
232 Vocational education teachers	10.5	10.4	10.5	10.5	10.7
233 Secondary education teachers	86.4	85.5	85.9	86.2	87.8

(continued)

Table 7.21 (continued)

3-digit ISCO	*2019*	*2020*	*2021*	*2022*	*2023*
234 Primary school and early childhood teachers	93.3	92.3	92.8	93.1	94.9
235 Other teaching professionals	63.9	63.2	63.6	63.8	64.9
241 Finance professionals	99.7	95.3	95.3	98.1	100.7
242 Administration professionals	23.7	23.4	23.4	23.4	23.7
243 Sales, marketing and public relations professionals	24.1	23.1	23.1	23.9	24.4
251 Software and applications developers and analysts	26.1	25.6	25.7	26.2	26.8
252 Database and network professionals	2.5	2.5	2.5	2.5	2.6
261 Legal professionals	61.4	59.4	59.1	60.3	62.1
262 Librarians, archivists and curators	1.5	1.5	1.5	1.5	1.5
263 Social and religious professionals	100.9	100.2	101.9	102.4	102.3
264 Authors, journalists and linguists	24.1	23.6	23.6	24.6	25.1
265 Creative and performing artists	24.8	23.4	24.0	25.0	25.1
311 Physical and engineering science technicians	24.3	23.2	23.0	23.4	23.7
312 Mining, manufacturing and construction supervisors	4.2	4.0	3.9	4.1	4.1
313 Process control technicians	3.2	3.0	3.0	3.0	3.1
314 Life science technicians and related associate professionals	3.1	3.0	3.0	3.1	3.1
315 Ship and aircraft controllers and technicians	15.5	13.9	14.3	14.8	15.0
321 Medical and pharmaceutical technicians	15.6	16.0	16.0	16.1	16.3
322 Nursing and midwifery associate professionals	43.3	45.8	45.7	45.5	46.1
323 Traditional and complementary medicine associate professionals	0.3	0.3	0.3	0.3	0.3
324 Veterinary technicians and assistants	1.3	1.3	1.3	1.3	1.4
325 Other health associate professionals	16.5	17.2	17.2	17.2	17.4
331 Financial and mathematical associate professionals	48.1	46.8	46.5	46.6	47.4
332 Sales and purchasing agents and brokers	29.3	28.3	27.9	27.7	28.2
333 Business services agents	13.7	12.9	13.0	13.5	13.7
334 Administrative and specialised secretaries	42.8	42.0	42.3	42.8	43.4

3-digit ISCO	*2019*	*2020*	*2021*	*2022*	*2023*
335 Regulatory government associate professionals	15.7	16.0	16.0	15.6	15.6
341 Legal, social and religious associate professionals	6.8	6.8	6.8	6.7	6.8
342 Sports and fitness workers	16.7	16.2	15.8	16.7	16.7
343 Artistic, cultural and culinary associate professionals	15.6	14.7	14.8	15.3	15.7
351 Information and communications technology operations and user support technicians	23.3	22.8	22.8	23.4	23.8
352 Telecommunications and broadcasting technicians	4.4	4.2	4.2	4.5	4.5
411 General office clerks	228.2	223.4	224.1	226.1	228.6
412 Secretaries (general)	56.6	55.4	55.7	56.7	57.4
413 Keyboard operators	9.1	8.8	8.8	9.1	9.3
421 Tellers, money collectors and related clerks	37.3	35.3	35.1	36.2	36.9
422 Client information workers	68.2	61.7	65.9	69.5	71.0
431 Numerical clerks	36.2	35.0	35.1	35.6	36.2
432 Material-recording and transport clerks	53.6	50.4	50.8	53.0	54.5
441 Other clerical support workers	31.8	30.3	30.7	31.3	31.8
511 Travel attendants, conductors and guides	8.5	7.7	7.9	8.3	8.4
512 Cooks	60.3	50.0	58.6	62.0	63.6
513 Waiters and bartenders	176.1	143.2	170.1	181.0	185.9
514 Hairdressers, beauticians	63.3	64.0	64.0	64.9	64.3
515 Building and housekeeping supervisors	18.7	17.6	18.5	19.0	19.1
516 Other personal services workers	9.9	10.0	10.0	10.1	10.1
521 Street and market salespersons	20.8	19.5	19.8	20.8	21.6
522 Shop salespersons	472.3	443.0	448.4	472.2	487.8
523 Cashiers and ticket clerks	27.0	25.1	25.6	26.7	27.6
524 Other sales workers	33.2	31.0	31.6	33.3	34.4
531 Child care workers and teachers' aides	21.2	21.8	21.6	21.9	22.0

(continued)

Table 7.21 (continued)

3-digit ISCO	*2019*	*2020*	*2021*	*2022*	*2023*
532 Personal care workers in health services	15.3	15.9	15.9	15.9	16.1
541 Protective services workers	130.7	130.3	130.9	132.3	132.7
611 Market gardeners and crop growers	338.4	318.1	321.4	321.3	315.2
612 Animal producers	55.5	52.2	52.7	52.6	51.6
613 Mixed crop and animal producers	44.6	41.9	42.3	42.3	41.4
621 Forestry	2.1	1.9	1.9	1.9	1.9
622 Fishery workers, hunters and trappers	16.0	14.9	15.1	15.0	14.6
711 Building frame and related trades workers	56.7	53.3	52.0	52.6	52.9
712 Building finishers and related trades workers	53.0	50.3	49.4	50.0	50.4
713 Painters, building structure cleaners and related trades workers	22.1	20.8	20.4	20.7	20.9
721 Sheet and structural metal workers, moulders and welders,	19.6	18.5	18.4	18.7	18.9
722 Blacksmiths, toolmakers and related trades workers	16.8	16.0	15.8	16.0	16.2
723 Machinery mechanics and repairers	63.2	59.5	59.8	62.2	63.7
731 Handicraft workers	9.8	9.3	9.3	9.4	9.5
732 Printing trades workers	11.6	11.0	10.9	11.1	11.3
741 Electrical equipment installers and repairers	61.6	58.4	57.9	58.7	59.2
742 Electronics and telecommunications installers and repairers	13.9	13.6	13.6	14.0	14.2
751 Food processing and related trades workers	49.6	46.5	46.9	47.8	47.9
752 Wood treaters, cabinet-makers and related trades workers	14.2	13.4	13.4	13.4	13.6
753 Garment and related trades workers	23.9	22.9	22.7	22.9	22.9
754 Other craft	2.4	2.4	2.4	2.3	2.3
811 Mining and mineral processing plant operators	8.6	8.0	8.0	8.0	7.9
812 Metal processing and finishing plant operators	2.4	2.3	2.3	2.3	2.3
813 Chemical and photographic products plant and machine operators	6.3	5.9	5.9	6.0	6.1
814 Rubber, plastic and paper products machine operators	10.4	9.9	9.8	9.9	10.1
815 Textile, fur and leather products machine operators	9.5	9.3	9.3	9.4	9.4

3-digit ISCO	*2019*	*2020*	*2021*	*2022*	*2023*
816 Food and related products machine operators	18.2	17.2	17.1	17.4	17.3
817 Wood processing and papermaking plant operators	2.9	2.8	2.7	2.8	2.8
818 Other stationary plant and machine operators	5.1	4.8	4.7	4.9	4.9
821 Assemblers	3.3	3.1	3.1	3.1	3.2
831 Locomotive engine drivers	0.3	0.3	0.3	0.3	0.3
832 Car, van and motorcycle drivers	97.3	86.3	90.7	94.5	96.6
833 Heavy truck and bus drivers	114.8	105.5	107.1	111.3	113.6
834 Mobile plant operators	29.8	28.1	27.9	28.4	28.6
835 Ships' deck crews	5.1	4.5	4.7	4.8	4.9
911 Domestic, hotel and office cleaners and helpers	128.5	121.6	126.0	132.1	133.4
912 Vehicle, window, laundry and other hand cleaning workers	8.1	7.7	7.8	8.3	8.4
921 Agricultural, forestry and fishery labourers	35.1	33.0	33.3	33.7	33.2
931 Mining and construction labourers	17.7	16.7	16.5	16.7	16.8
932 Manufacturing labourers	37.8	35.8	35.7	36.3	36.5
933 Transport and storage labourers	26.6	24.7	25.0	26.2	26.9
941 Food preparation assistants	27.5	22.5	26.6	28.3	29.0
951 Street and related service workers	1.9	1.7	1.8	1.9	1.9
952 Street vendors (excluding food)	0.6	0.6	0.6	0.6	0.6
961 Refuse workers	17.0	16.5	16.2	16.2	16.1
962 Other elementary workers	20.5	19.2	19.7	20.3	20.5
0 Armed forces occupations	79.6	81.9	82.1	79.5	79.3
Total	4565	4342	4415	4518	4577

3-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
111 Legislators and senior officials	1.4	1.4	1.4	1.4	–0.2%

(continued)

Table 7.21 (continued)

3-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
112 Managing directors and chief executives	5.1	5.1	5.2	5.2	1.1%
121 Business services and administration managers	11.8	11.8	11.8	11.8	0.2%
122 Sales, marketing and development managers	6.2	6.3	6.4	6.4	0.4%
131 Production managers in agriculture, forestry and fisheries	0.1	0.1	0.1	0.1	−1.4%
132 Manufacturing, mining, construction, and distribution managers	16.3	16.4	16.4	16.3	−0.5%
133 Information and communications technology service managers	1.4	1.4	1.4	1.4	0.8%
134 Professional services managers	16.6	16.7	16.8	16.9	0.4%
141 Hotel and restaurant managers	30.1	30.4	30.6	30.7	1.0%
142 Retail and wholesale trade managers	41.8	42.7	43.4	43.8	1.4%
143 Other services managers	10.3	10.3	10.4	10.4	0.5%
211 Physical and earth science professionals	7.9	8.0	8.1	8.1	0.4%
212 Mathematicians, actuaries and statisticians	5.1	5.1	5.2	5.2	0.3%
213 Life science professionals	18.0	18.2	18.3	18.4	0.6%
214 Engineering professionals (excluding electrotechnology)	65.3	66.1	66.9	67.4	0.4%
215 Electrotechnology engineers	13.6	13.8	14.0	14.1	0.6%
216 Architects, planners, surveyors and designers	30.5	30.9	31.3	31.6	0.7%
221 Medical doctors	60.8	61.3	61.5	61.7	1.1%
222 Nursing and midwifery professionals	16.4	16.5	16.6	16.6	1.1%
223 Traditional and complementary medicine professionals	0.1	0.1	0.1	0.1	0.9%
224 Paramedical practitioners	1.4	1.4	1.4	1.4	1.1%
225 Veterinarians	3.8	3.8	3.9	3.9	1.1%
226 Other health professionals	44.2	44.7	45.1	45.3	1.1%
231 University and higher education teachers	17.3	17.5	17.6	17.7	0.7%
232 Vocational education teachers	10.9	11.0	11.1	11.2	0.7%
233 Secondary education teachers	89.3	90.3	91.1	91.5	0.7%
234 Primary school and early childhood teachers	96.4	97.6	98.4	98.9	0.7%

3-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
235 Other teaching professionals	66.0	66.8	67.3	67.6	0.7%
241 Finance professionals	102.8	104.7	106.0	107.0	0.9%
242 Administration professionals	24.0	24.2	24.3	24.4	0.4%
243 Sales, marketing and public relations professionals	24.8	25.2	25.5	25.7	0.8%
251 Software and applications developers and analysts	27.2	27.5	27.8	27.9	0.9%
252 Database and network professionals	2.6	2.7	2.7	2.7	1.1%
261 Legal professionals	63.5	64.8	65.8	66.5	1.0%
262 Librarians, archivists and curators	1.5	1.5	1.5	1.5	0.0%
263 Social and religious professionals	102.7	102.9	102.9	102.4	0.2%
264 Authors, journalists and linguists	25.4	25.8	26.3	26.5	1.2%
265 Creative and performing artists	25.2	25.3	25.4	25.3	0.3%
311 Physical and engineering science technicians	24.0	24.2	24.4	24.5	0.1%
312 Mining, manufacturing and construction supervisors	4.1	4.1	4.2	4.2	−0.2%
313 Process control technicians	3.1	3.1	3.1	3.1	−0.2%
314 Life science technicians and related associate professionals	3.1	3.2	3.2	3.2	0.5%
315 Ship and aircraft controllers and technicians	15.2	15.2	15.1	14.9	−0.5%
321 Medical and pharmaceutical technicians	16.5	16.6	16.7	16.7	0.8%
322 Nursing and midwifery associate professionals	46.5	46.8	47.0	47.1	1.1%
323 Traditional and complementary medicine associate professionals	0.3	0.3	0.3	0.3	1.0%
324 Veterinary technicians and assistants	1.4	1.4	1.4	1.5	1.3%
325 Other health associate professionals	17.6	17.7	17.8	17.8	1.0%
331 Financial and mathematical associate professionals	48.2	48.8	49.2	49.6	0.4%
332 Sales and purchasing agents and brokers	28.8	29.2	29.4	29.5	0.1%
333 Business services agents	13.8	13.8	13.8	13.8	0.0%
334 Administrative and specialised secretaries	43.9	44.2	44.4	44.5	0.5%
335 Regulatory government associate professionals	15.6	15.6	15.5	15.4	−0.2%

(continued)

Table 7.21 (continued)

3-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
341 Legal, social and religious associate professionals	6.8	6.8	6.9	6.9	0.2%
342 Sports and fitness workers	16.7	16.8	16.8	16.7	0.0%
343 Artistic, cultural and culinary associate professionals	16.1	16.3	16.6	16.8	0.9%
351 Information and communications technology operations and user support technicians	24.2	24.4	24.6	24.7	0.7%
352 Telecommunications and broadcasting technicians	4.6	4.6	4.7	4.7	0.9%
411 General office clerks	230.9	232.4	233.1	233.2	0.3%
412 Secretaries (general)	58.0	58.5	58.8	58.9	0.5%
413 Keyboard operators	9.5	9.6	9.7	9.7	0.8%
421 Tellers, money collectors and related clerks	37.3	37.7	38.0	38.1	0.3%
422 Client information workers	71.6	72.3	72.7	73.0	0.9%
431 Numerical clerks	36.8	37.2	37.5	37.6	0.5%
432 Material-recording and transport clerks	55.7	56.6	57.1	57.5	0.9%
441 Other clerical support workers	32.0	32.1	32.0	32.0	0.1%
511 Travel attendants, conductors and guides	8.5	8.5	8.5	8.5	0.0%
512 Cooks	63.7	64.2	64.7	65.0	0.9%
513 Waiters and bartenders	186.2	187.8	189.3	190.2	1.0%
514 Hairdressers, beauticians	63.8	64.0	63.5	62.9	−0.1%
515 Building and housekeeping supervisors	19.2	19.2	19.3	19.2	0.3%
516 Other personal services workers	10.2	10.2	10.2	10.2	0.3%
521 Street and market salespersons	22.1	22.5	22.9	23.1	1.3%
522 Shop salespersons	499.7	508.6	517.8	521.9	1.3%
523 Cashiers and ticket clerks	28.1	28.6	29.0	29.2	1.0%
524 Other sales workers	35.2	35.8	36.4	36.7	1.3%
531 Child care workers and teachers' aides	22.2	22.2	22.4	22.3	0.6%
532 Personal care workers in health services	16.3	16.4	16.5	16.5	0.9%

3-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
541 Protective services workers	132.9	132.7	132.5	132.1	0.1%
611 Market gardeners and crop growers	313.2	311.7	309.2	305.3	–1.3%
612 Animal producers	51.3	51.0	50.6	50.0	–1.3%
613 Mixed crop and animal producers	41.2	41.0	40.6	40.1	–1.3%
621 Forestry	1.9	1.9	1.8	1.8	–1.4%
622 Fishery workers, hunters and trappers	14.7	14.4	14.3	14.2	–1.5%
711 Building frame and related trades workers	53.2	53.5	53.8	53.9	–0.6%
712 Building finishers and related trades workers	50.7	51.0	51.3	51.3	–0.4%
713 Painters, building structure cleaners and related trades workers	21.0	21.2	21.3	21.4	–0.4%
721 Sheet and structural metal workers, moulders and welders,	19.1	19.2	19.3	19.3	–0.2%
722 Blacksmiths, toolmakers and related trades workers	16.3	16.3	16.4	16.3	–0.4%
723 Machinery mechanics and repairers	65.0	65.8	66.5	67.0	0.7%
731 Handicraft workers	9.6	9.6	9.7	9.6	–0.3%
732 Printing trades workers	11.4	11.4	11.5	11.5	–0.1%
741 Electrical equipment installers and repairers	59.6	60.0	60.3	60.4	–0.2%
742 Electronics and telecommunications installers and repairers	14.4	14.5	14.6	14.7	0.7%
751 Food processing and related trades workers	48.3	48.8	48.9	48.8	–0.2%
752 Wood treaters, cabinet-makers and related trades workers	13.7	13.7	13.7	13.6	–0.5%
753 Garment and related trades workers	23.2	23.0	23.0	22.8	–0.6%
754 Other craft	2.3	2.3	2.3	2.3	–0.6%
811 Mining and mineral processing plant operators	7.9	7.8	7.8	7.7	–1.3%
812 Metal processing and finishing plant operators	2.3	2.3	2.3	2.3	–0.6%
813 Chemical and photographic products plant and machine operators	6.1	6.1	6.1	6.1	–0.3%
814 Rubber, plastic and paper products machine operators	10.1	10.1	10.1	10.1	–0.3%
815 Textile, fur and leather products machine operators	9.4	9.4	9.4	9.3	–0.2%
816 Food and related products machine operators	17.4	17.6	17.5	17.5	–0.5%

(continued)

Table 7.21 (continued)

3-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
817 Wood processing and papermaking plant operators	2.8	2.8	2.8	2.8	−0.3%
818 Other stationary plant and machine operators	4.9	4.9	4.9	4.9	−0.3%
821 Assemblers	3.2	3.2	3.2	3.2	−0.3%
831 Locomotive engine drivers	0.3	0.3	0.3	0.3	−0.6%
832 Car, van and motorcycle drivers	97.6	97.6	97.0	96.8	−0.1%
833 Heavy truck and bus drivers	115.3	115.9	115.6	115.7	0.1%
834 Mobile plant operators	28.8	28.9	29.0	29.0	−0.4%
835 Ships' deck crews	5.0	5.0	5.0	4.9	−0.5%
911 Domestic, hotel and office cleaners and helpers	133.8	134.4	134.8	134.8	0.6%
912 Vehicle, window, laundry and other hand cleaning workers	8.5	8.5	8.6	8.6	0.8%
921 Agricultural, forestry and fishery labourers	33.0	32.9	32.7	32.4	−1.0%
931 Mining and construction labourers	16.9	17.0	17.0	17.0	−0.5%
932 Manufacturing labourers	36.7	36.9	36.9	36.8	−0.3%
933 Transport and storage labourers	27.5	27.9	28.0	28.2	0.7%
941 Food preparation assistants	29.1	29.3	29.5	29.7	0.9%
951 Street and related service workers	2.0	2.0	2.0	2.0	1.2%
952 Street vendors (excluding food)	0.6	0.6	0.6	0.6	0.9%
961 Refuse workers	16.0	15.9	15.8	15.7	−1.0%
962 Other elementary workers	20.7	20.8	20.9	20.9	0.2%
0 Armed forces occupations	79.2	79.0	78.6	78.1	−0.2%
Total	4623	4658	4683	4689	0.3%

Source Authors' own creation

Table 7.22 Employment (thousand people) per 3-digit ISCO category—upside scenario

3-digit ISCO	*2019*	*2020*	*2021*	*2022*	*2023*
111 Legislators and senior officials	1.4	1.5	1.4	1.4	1.4
112 Managing directors and chief executives	4.9	4.6	4.8	4.9	5.1
121 Business services and administration managers	11.8	11.5	11.5	11.7	11.8
122 Sales, marketing and development managers	6.1	5.7	5.8	5.9	6.1
131 Production managers in agriculture, forestry and fisheries	0.1	0.1	0.1	0.1	0.1
132 Manufacturing, mining, construction, and distribution managers	17.3	16.0	16.1	16.6	17.0
133 Information and communications technology service managers	1.4	1.3	1.3	1.3	1.4
134 Professional services managers	15.9	15.6	15.3	15.6	15.8
141 Hotel and restaurant managers	28.8	25.7	27.6	30.3	31.0
142 Retail and wholesale trade managers	39.8	37.5	39.3	40.8	42.4
143 Other services managers	9.1	8.7	8.9	9.3	9.4
211 Physical and earth science professionals	8.0	7.7	7.7	7.9	8.1
212 Mathematicians, actuaries and statisticians	5.1	5.0	5.0	5.1	5.2
213 Life science professionals	17.2	16.8	16.9	17.2	17.5
214 Engineering professionals (excluding electrotechnology)	65.6	63.1	63.2	64.7	66.2
215 Electrotechnology engineers	13.4	12.9	12.9	13.2	13.5
216 Architects, planners, surveyors and designers	29.8	29.0	28.9	29.6	30.3
221 Medical doctors	57.4	57.0	58.0	58.4	59.2
222 Nursing and midwifery professionals	15.5	15.4	15.6	15.8	16.0
223 Traditional and complementary medicine professionals	0.1	0.1	0.1	0.1	0.1
224 Paramedical practitioners	1.3	1.3	1.3	1.3	1.4
225 Veterinarians	3.6	3.5	3.6	3.7	3.8
226 Other health professionals	41.8	40.8	41.9	42.6	43.6
231 University and higher education teachers	16.9	16.8	16.1	16.3	16.6
232 Vocational education teachers	10.7	10.6	10.2	10.3	10.5

(continued)

Table 7.22 (continued)

3-digit ISCO	*2019*	*2020*	*2021*	*2022*	*2023*
233 Secondary education teachers	87.5	87.0	83.4	84.5	86.0
234 Primary school and early childhood teachers	94.4	93.9	90.1	91.3	92.9
235 Other teaching professionals	64.7	64.3	61.7	62.5	63.6
241 Finance professionals	100.6	96.9	98.1	101.0	104.5
242 Administration professionals	24.0	23.4	23.2	23.5	23.9
243 Sales, marketing and public relations professionals	24.4	23.3	23.7	24.4	25.1
251 Software and applications developers and analysts	25.9	25.0	24.8	25.2	25.9
252 Database and network professionals	2.5	2.5	2.4	2.5	2.5
261 Legal professionals	61.9	60.7	60.7	62.2	64.5
262 Librarians, archivists and curators	1.4	1.4	1.4	1.3	1.3
263 Social and religious professionals	101.3	99.0	101.3	102.2	103.5
264 Authors, journalists and linguists	24.0	23.2	22.8	23.6	24.2
265 Creative and performing artists	18.2	17.5	17.9	18.4	18.7
311 Physical and engineering science technicians	24.7	23.5	23.5	24.1	24.6
312 Mining, manufacturing and construction supervisors	4.3	4.1	4.1	4.2	4.3
313 Process control technicians	3.2	3.1	3.0	3.1	3.2
314 Life science technicians and related associate professionals	3.1	3.0	3.1	3.1	3.1
315 Ship and aircraft controllers and technicians	15.7	14.7	15.1	15.4	15.5
321 Medical and pharmaceutical technicians	15.9	15.5	15.8	16.0	16.3
322 Nursing and midwifery associate professionals	43.8	43.5	44.3	44.6	45.2
323 Traditional and complementary medicine associate professionals	0.3	0.3	0.3	0.3	0.3
324 Veterinary technicians and assistants	1.3	1.3	1.3	1.4	1.4
325 Other health associate professionals	16.7	16.5	16.8	17.0	17.2
331 Financial and mathematical associate professionals	48.6	46.8	46.5	47.6	48.9
332 Sales and purchasing agents and brokers	29.2	27.5	27.3	28.1	28.8
333 Business services agents	13.6	13.0	13.3	13.6	13.8
334 Administrative and specialised secretaries	42.9	41.8	42.0	42.7	43.5
335 Regulatory government associate professionals	15.7	15.9	15.5	15.2	15.2

3-digit ISCO	*2019*	*2020*	*2021*	*2022*	*2023*
341 Legal, social and religious associate professionals	6.8	6.8	6.7	6.7	6.8
342 Sports and fitness workers	5.6	5.5	5.6	5.7	5.8
343 Artistic, cultural and culinary associate professionals	14.9	14.3	14.5	15.0	15.5
351 Information and communications technology operations and user support technicians	23.6	22.7	22.7	23.2	23.8
352 Telecommunications and broadcasting technicians	3.6	3.4	3.4	3.5	3.6
411 General office clerks	228.6	222.6	222.8	225.5	229.0
412 Secretaries (general)	56.2	54.7	55.1	56.1	57.1
413 Keyboard operators	9.1	8.7	8.9	9.2	9.4
421 Tellers, money collectors and related clerks	29.8	28.2	28.5	29.4	30.3
422 Client information workers	67.4	63.3	65.6	69.2	70.9
431 Numerical clerks	36.7	35.3	35.5	36.3	37.3
432 Material-recording and transport clerks	54.2	51.2	52.9	54.8	56.5
441 Other clerical support workers	31.2	30.1	30.4	30.8	31.4
511 Travel attendants, conductors and guides	8.4	7.9	8.1	8.3	8.5
512 Cooks	61.1	55.0	58.7	63.9	65.3
513 Waiters and bartenders	176.2	157.5	169.0	185.0	189.4
514 Hairdressers, beauticians	64.2	64.1	64.6	65.7	66.1
515 Building and housekeeping supervisors	18.5	17.7	18.2	18.8	19.1
516 Other personal services workers	10.0	10.0	9.8	10.0	10.1
521 Street and market salespersons	21.1	19.8	20.8	21.6	22.5
522 Shop salespersons	477.7	449.1	470.3	488.7	507.1
523 Cashiers and ticket clerks	26.8	25.1	26.2	27.2	28.2
524 Other sales workers	33.7	31.6	33.1	34.5	35.7
531 Child care workers and teachers' aides	20.8	20.7	20.7	21.1	21.3
532 Personal care workers in health services	15.5	15.4	15.6	15.8	16.0
541 Protective services workers	129.5	129.2	127.8	128.5	129.3
611 Market gardeners and crop growers	338.9	318.2	321.8	324.3	324.4
612 Animal producers	55.6	52.1	52.7	53.1	53.1

(continued)

Table 7.22 (continued)

3-digit ISCO	*2019*	*2020*	*2021*	*2022*	*2023*
613 Mixed crop and animal producers	44.6	41.9	42.3	42.7	42.7
621 Forestry	2.1	1.9	1.9	2.0	2.0
622 Fishery workers, hunters and trappers	16.0	14.9	15.1	15.1	15.0
711 Building frame and related trades workers	57.2	53.0	52.8	54.7	56.6
712 Building finishers and related trades workers	53.5	50.2	50.1	51.6	53.2
713 Painters, building structure cleaners and related trades workers	22.4	20.9	20.8	21.6	22.4
721 Sheet and structural metal workers, moulders and welders,	19.8	18.5	18.7	19.2	19.7
722 Blacksmiths, toolmakers and related trades workers	17.1	16.0	16.0	16.4	16.9
723 Machinery mechanics and repairers	63.3	59.6	61.4	63.5	65.4
731 Handicraft workers	10.0	9.3	9.4	9.6	9.9
732 Printing trades workers	11.7	11.0	11.0	11.3	11.7
741 Electrical equipment installers and repairers	62.4	58.7	58.8	60.6	62.3
742 Electronics and telecommunications installers and repairers	14.1	13.6	13.6	14.0	14.3
751 Food processing and related trades workers	50.5	46.9	47.7	49.2	50.0
752 Wood treaters, cabinet-makers and related trades workers	14.4	13.4	13.5	13.8	14.3
753 Garment and related trades workers	24.4	22.9	22.9	23.4	23.8
754 Other craft	2.4	2.3	2.3	2.3	2.3
811 Mining and mineral processing plant operators	8.7	8.2	8.2	8.3	8.4
812 Metal processing and finishing plant operators	2.4	2.3	2.3	2.3	2.4
813 Chemical and photographic products plant and machine operators	6.4	5.9	6.0	6.2	6.3
814 Rubber, plastic and paper products machine operators	10.6	9.8	9.9	10.2	10.5
815 Textile, fur and leather products machine operators	9.6	9.3	9.4	9.6	9.7
816 Food and related products machine operators	18.5	17.2	17.4	17.8	18.1
817 Wood processing and papermaking plant operators	3.0	2.8	2.8	2.8	2.9
818 Other stationary plant and machine operators	4.9	4.7	4.7	4.8	4.9
821 Assemblers	3.3	3.1	3.1	3.2	3.3
831 Locomotive engine drivers	0.3	0.3	0.3	0.3	0.3

3-digit ISCO	*2019*	*2020*	*2021*	*2022*	*2023*
832 Car, van and motorcycle drivers	98.6	91.4	94.7	98.1	99.8
833 Heavy truck and bus drivers	116.4	109.2	112.1	115.2	117.7
834 Mobile plant operators	30.2	28.5	28.5	29.4	30.1
835 Ships' deck crews	5.2	4.8	5.0	5.0	5.1
911 Domestic, hotel and office cleaners and helpers	129.4	124.7	127.6	133.1	135.5
912 Vehicle, window, laundry and other hand cleaning workers	8.2	7.9	8.1	8.4	8.6
921 Agricultural, forestry and fishery labourers	35.2	33.1	33.6	34.0	34.1
931 Mining and construction labourers	17.5	16.4	16.3	16.8	17.2
932 Manufacturing labourers	38.4	35.9	36.3	37.3	38.0
933 Transport and storage labourers	26.8	25.2	26.1	27.0	27.8
941 Food preparation assistants	27.7	24.8	26.5	29.0	29.7
951 Street and related service workers	1.9	1.8	1.8	1.9	2.0
952 Street vendors (excluding food)	0.5	0.5	0.5	0.5	0.5
961 Refuse workers	17.3	16.9	16.5	16.5	16.4
962 Other elementary workers	19.6	18.6	19.0	19.6	20.0
0 Armed forces occupations	80.6	81.7	79.4	77.9	77.6
Total	4565	4357	4421	4541	4635

3-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
111 Legislators and senior officials	1.4	1.4	1.4		−0.9%
112 Managing directors and chief executives	5.3	5.4	5.5	5.5	1.6%
121 Business services and administration managers	12.0	12.1	12.1	12.1	0.4%
122 Sales, marketing and development managers	6.2	6.3	6.4	6.5	0.8%
131 Production managers in agriculture, forestry and fisheries	0.1	0.1	0.1	0.1	−0.8%
132 Manufacturing, mining, construction, and distribution managers	17.4	17.7	17.8	17.7	0.3%

(continued)

Table 7.22 (continued)

3-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
133 Information and communications technology service managers	1.4	1.4	1.4	1.5	0.7%
134 Professional services managers	16.0	16.1	16.2	16.2	0.3%
141 Hotel and restaurant managers	31.7	32.4	32.8	33.1	1.7%
142 Retail and wholesale trade managers	43.8	45.0	46.0	46.6	2.0%
143 Other services managers	9.6	9.8	9.9	9.9	1.0%
211 Physical and earth science professionals	8.3	8.5	8.6	8.7	1.0%
212 Mathematicians, actuaries and statisticians	5.3	5.3	5.4	5.4	0.7%
213 Life science professionals	17.8	18.1	18.3	18.4	0.8%
214 Engineering professionals (excluding electrotechnology)	68.2	69.6	70.6	71.2	1.0%
215 Electrotechnology engineers	14.0	14.3	14.5	14.7	1.2%
216 Architects, planners, surveyors and designers	31.2	31.8	32.4	32.8	1.2%
221 Medical doctors	59.8	60.2	60.3	60.4	0.6%
222 Nursing and midwifery professionals	16.1	16.3	16.3	16.3	0.7%
223 Traditional and complementary medicine professionals	0.1	0.1	0.1	0.1	0.3%
224 Paramedical practitioners	1.4	1.4	1.4	1.4	0.7%
225 Veterinarians	3.9	4.1	4.2	4.2	1.9%
226 Other health professionals	44.3	44.8	45.3	45.5	1.1%
231 University and higher education teachers	16.8	16.9	16.9	16.9	0.0%
232 Vocational education teachers	10.6	10.7	10.7	10.6	0.0%
233 Secondary education teachers	86.9	87.4	87.4	87.3	0.0%
234 Primary school and early childhood teachers	93.9	94.4	94.5	94.3	0.0%
235 Other teaching professionals	64.2	64.6	64.6	64.5	0.0%
241 Finance professionals	107.6	110.4	112.3	113.7	1.5%
242 Administration professionals	24.3	24.6	24.8	24.8	0.4%
243 Sales, marketing and public relations professionals	25.8	26.4	26.8	27.1	1.3%
251 Software and applications developers and analysts	26.5	26.8	27.3	27.5	0.7%

3-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
252 Database and network professionals	2.6	2.6	2.7	2.7	0.9%
261 Legal professionals	66.4	68.2	69.6	70.6	1.6%
262 Librarians, archivists and curators	1.3	1.3	1.3	1.3	–0.8%
263 Social and religious professionals	104.6	105.3	105.5	105.0	0.5%
264 Authors, journalists and linguists	24.7	25.2	25.8	26.1	1.1%
265 Creative and performing artists	19.0	19.2	19.3	19.3	0.7%
311 Physical and engineering science technicians	25.2	25.7	25.9	26.0	0.7%
312 Mining, manufacturing and construction supervisors	4.4	4.5	4.5	4.5	0.7%
313 Process control technicians	3.2	3.3	3.3	3.3	0.3%
314 Life science technicians and related associate professionals	3.2	3.2	3.3	3.3	0.6%
315 Ship and aircraft controllers and technicians	15.6	15.6	15.6	15.4	–0.2%
321 Medical and pharmaceutical technicians	16.6	16.7	16.9	16.9	0.8%
322 Nursing and midwifery associate professionals	45.7	46.0	46.2	46.2	0.7%
323 Traditional and complementary medicine associate professionals	0.3	0.3	0.3	0.3	0.5%
324 Veterinary technicians and assistants	1.4	1.5	1.5	1.5	1.8%
325 Other health associate professionals	17.4	17.6	17.7	17.7	0.7%
331 Financial and mathematical associate professionals	50.0	51.1	51.7	52.2	0.9%
332 Sales and purchasing agents and brokers	29.8	30.5	30.9	31.1	0.8%
333 Business services agents	14.0	14.2	14.3	14.3	0.6%
334 Administrative and specialised secretaries	44.2	44.7	44.9	45.0	0.6%
335 Regulatory government associate professionals	15.1	15.0	14.8	14.6	–0.9%
341 Legal, social and religious associate professionals	6.8	6.8	6.8	6.8	–0.1%
342 Sports and fitness workers	5.8	5.8	5.8	5.8	0.4%
343 Artistic, cultural and culinary associate professionals	16.1	16.5	16.9	17.1	1.8%
351 Information and communications technology operations and user support technicians	24.3	24.6	24.9	25.1	0.8%

(continued)

Table 7.22 (continued)

3-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
352 Telecommunications and broadcasting technicians	3.7	3.8	3.8	3.9	1.1%
411 General office clerks	232.1	234.1	235.0	235.0	0.3%
412 Secretaries (general)	58.1	58.8	59.1	59.2	0.6%
413 Keyboard operators	9.7	9.8	10.0	10.1	1.2%
421 Tellers, money collectors and related clerks	31.0	31.6	32.1	32.4	1.0%
422 Client information workers	72.4	73.9	74.8	75.3	1.4%
431 Numerical clerks	38.1	38.7	39.1	39.4	0.9%
432 Material-recording and transport clerks	58.1	59.4	60.3	60.8	1.4%
441 Other clerical support workers	31.7	31.9	31.9	31.8	0.2%
511 Travel attendants, conductors and guides	8.6	8.6	8.6	8.6	0.3%
512 Cooks	66.8	68.1	69.0	69.4	1.6%
513 Waiters and bartenders	193.9	197.9	200.6	202.0	1.7%
514 Hairdressers, beauticians	66.1	66.7	66.4	65.8	0.3%
515 Building and housekeeping supervisors	19.4	19.5	19.6	19.6	0.7%
516 Other personal services workers	10.2	10.2	10.2	10.2	0.2%
521 Street and market salespersons	23.1	23.7	24.3	24.6	1.9%
522 Shop salespersons	522.5	535.4	547.9	554.1	1.9%
523 Cashiers and ticket clerks	28.9	29.5	30.2	30.5	1.6%
524 Other sales workers	36.8	37.7	38.6	39.0	1.8%
531 Child care workers and teachers' aides	21.5	21.6	21.7	21.6	0.5%
532 Personal care workers in health services	16.2	16.3	16.4	16.3	0.6%
541 Protective services workers	129.6	129.5	129.0	128.3	−0.1%
611 Market gardeners and crop growers	324.9	324.7	322.2	317.6	−0.8%
612 Animal producers	53.2	53.2	52.7	52.0	−0.8%
613 Mixed crop and animal producers	42.7	42.7	42.3	41.7	−0.8%
621 Forestry	2.0	2.0	1.9	1.9	−1.0%
622 Fishery workers, hunters and trappers	15.2	15.0	14.9	14.8	−1.0%

3-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
711 Building frame and related trades workers	58.5	59.8	60.1	59.7	0.5%
712 Building finishers and related trades workers	54.7	55.8	56.1	55.8	0.5%
713 Painters, building structure cleaners and related trades workers	23.1	23.6	23.8	23.7	0.7%
721 Sheet and structural metal workers, moulders and welders,	20.2	20.5	20.7	20.8	0.6%
722 Blacksmiths, toolmakers and related trades workers	17.3	17.6	17.7	17.7	0.4%
723 Machinery mechanics and repairers	67.2	68.5	69.6	70.3	1.3%
731 Handicraft workers	10.1	10.2	10.4	10.4	0.5%
732 Printing trades workers	11.9	12.1	12.2	12.3	0.6%
741 Electrical equipment installers and repairers	63.9	65.0	65.5	65.3	0.6%
742 Electronics and telecommunications installers and repairers	14.6	14.8	15.0	15.1	0.9%
751 Food processing and related trades workers	51.1	52.2	52.6	52.7	0.5%
752 Wood treaters, cabinet-makers and related trades workers	14.6	14.8	14.9	14.9	0.4%
753 Garment and related trades workers	24.5	24.6	24.8	24.6	0.1%
754 Other craft	2.4	2.4	2.4	2.3	−0.4%
811 Mining and mineral processing plant operators	8.5	8.5	8.5	8.4	−0.5%
812 Metal processing and finishing plant operators	2.4	2.5	2.5	2.5	0.2%
813 Chemical and photographic products plant and machine operators	6.5	6.6	6.6	6.6	0.5%
814 Rubber, plastic and paper products machine operators	10.7	10.8	10.9	10.9	0.4%
815 Textile, fur and leather products machine operators	9.8	9.9	9.9	9.9	0.3%
816 Food and related products machine operators	18.4	18.8	18.9	18.9	0.3%
817 Wood processing and papermaking plant operators	3.0	3.0	3.0	3.1	0.4%
818 Other stationary plant and machine operators	5.0	5.0	5.1	5.1	0.4%
821 Assemblers	3.4	3.4	3.4	3.5	0.4%

(continued)

Table 7.22 (continued)

3-digit ISCO	*2024*	*2025*	*2026*	*2027*	*CAGR 2019–2027*
831 Locomotive engine drivers	0.3	0.3	0.3	0.3	0.2%
832 Car, van and motorcycle drivers	101.2	101.6	101.4	101.3	0.3%
833 Heavy truck and bus drivers	119.7	121.0	121.2	121.5	0.5%
834 Mobile plant operators	30.8	31.3	31.4	31.3	0.4%
835 Ships' deck crews	5.1	5.2	5.2	5.1	−0.2%
911 Domestic, hotel and office cleaners and helpers	137.5	139.3	140.4	140.4	1.0%
912 Vehicle, window, laundry and other hand cleaning workers	8.8	9.0	9.1	9.1	1.3%
921 Agricultural, forestry and fishery labourers	34.3	34.3	34.2	33.8	−0.5%
931 Mining and construction labourers	17.7	18.0	18.1	18.0	0.4%
932 Manufacturing labourers	38.8	39.4	39.6	39.7	0.4%
933 Transport and storage labourers	28.6	29.2	29.5	29.7	1.3%
941 Food preparation assistants	30.3	31.0	31.4	31.6	1.7%
951 Street and related service workers	2.1	2.1	2.1	2.2	1.7%
952 Street vendors (excluding food)	0.5	0.5	0.6	0.6	1.8%
961 Refuse workers	16.4	16.4	16.3	16.3	−0.7%
962 Other elementary workers	20.4	20.7	20.8	20.9	0.8%
0 Armed forces occupations	77.0	76.2	75.3	74.4	−1.0%
Total	4718	4 78	4817	4824	0.70%

Source Authors' own creation

Table 7.23 Average annual rate of change of employment 2019–2027 per 3-digit ISCO categorey in the two scenarios

3-digit ISCO	*Base scenario*	*Upside scenario*
111 Legislators and senior officials	−0.2%	−0.9%
112 Managing directors and chief executives	1.1%	1.6%
121 Business services and administration managers	0.2%	0.4%
122 Sales, marketing and development managers	0.4%	0.8%
131 Production managers in agriculture, forestry and fisheries	−1.4%	−0.8%
132 Manufacturing, mining, construction, and distribution managers	−0.5%	0.3%
133 Information and communications technology service managers	0.8%	0.7%
134 Professional services managers	0.4%	0.3%
141 Hotel and restaurant managers	1.0%	1.7%
142 Retail and wholesale trade managers	1.4%	2.0%
143 Other services managers	0.5%	1.0%
211 Physical and earth science professionals	0.4%	1.0%
212 Mathematicians, actuaries and statisticians	0.3%	0.7%
213 Life science professionals	0.6%	0.8%
214 Engineering professionals (excluding electrotechnology)	0.4%	1.0%
215 Electrotechnology engineers	0.6%	1.2%
216 Architects, planners, surveyors and designers	0.7%	1.2%
221 Medical doctors	1.1%	0.6%
222 Nursing and midwifery professionals	1.1%	0.7%
223 Traditional and complementary medicine professionals	0.9%	0.3%
224 Paramedical practitioners	1.1%	0.7%
225 Veterinarians	1.1%	1.9%
226 Other health professionals	1.1%	1.1%
231 University and higher education teachers	0.7%	0.0%
232 Vocational education teachers	0.7%	0.0%
233 Secondary education teachers	0.7%	0.0%

(continued)

Table 7.23 (continued)

3-digit ISCO	*Base scenario*	*Upside scenario*
234 Primary school and early childhood teachers	0.7%	0.0%
235 Other teaching professionals	0.7%	0.0%
241 Finance professionals	0.9%	1.5%
242 Administration professionals	0.4%	0.4%
243 Sales, marketing and public relations professionals	0.8%	1.3%
251 Software and applications developers and analysts	0.9%	0.7%
252 Database and network professionals	1.1%	0.9%
261 Legal professionals	1.0%	1.6%
262 Librarians, archivists and curators	0.0%	–0.8%
263 Social and religious professionals	0.2%	0.5%
264 Authors, journalists and linguists	1.2%	1.1%
265 Creative and performing artists	0.3%	0.7%
311 Physical and engineering science technicians	0.1%	0.7%
312 Mining, manufacturing and construction supervisors	–0.2%	0.7%
313 Process control technicians	–0.2%	0.3%
314 Life science technicians and related associate professionals	0.5%	0.6%
315 Ship and aircraft controllers and technicians	–0.5%	–0.2%
321 Medical and pharmaceutical technicians	0.8%	0.8%
322 Nursing and midwifery associate professionals	1.1%	0.7%
323 Traditional and complementary medicine associate professionals	1.0%	0.5%
324 Veterinary technicians and assistants	1.3%	1.8%
325 Other health associate professionals	1.0%	0.7%
331 Financial and mathematical associate professionals	0.4%	0.9%
332 Sales and purchasing agents and brokers	0.1%	0.8%
333 Business services agents	0.0%	0.6%
334 Administrative and specialised secretaries	0.5%	0.6%

3-digit ISCO	*Base scenario*	*Upside scenario*
335 Regulatory government associate professionals	−0.2%	−0.9%
341 Legal, social and religious associate professionals	0.2%	−0.1%
342 Sports and fitness workers	0.0%	0.4%
343 Artistic, cultural and culinary associate professionals	0.9%	1.8%
351 Information and communications technology operations and user support technicians	0.7%	0.8%
352 Telecommunications and broadcasting technicians	0.9%	1.1%
411 General office clerks	0.3%	0.3%
412 Secretaries (general)	0.5%	0.6%
413 Keyboard operators	0.8%	1.2%
421 Tellers, money collectors and related clerks	0.3%	1.0%
422 Client information workers	0.9%	1.4%
431 Numerical clerks	0.5%	0.9%
432 Material-recording and transport clerks	0.9%	1.4%
441 Other clerical support workers	0.1%	0.2%
511 Travel attendants, conductors and guides	0.0%	0.3%
512 Cooks	0.9%	1.6%
513 Waiters and bartenders	1.0%	1.7%
514 Hairdressers, beauticians	−0.1%	0.3%
515 Building and housekeeping supervisors	0.3%	0.7%
516 Other personal services workers	0.3%	0.2%
521 Street and market salespersons	1.3%	1.9%
522 Shop salespersons	1.3%	1.9%
523 Cashiers and ticket clerks	1.0%	1.6%
524 Other sales workers	1.3%	1.8%
531 Child care workers and teachers’ aides	0.6%	0.5%
532 Personal care workers in health services	0.9%	0.6%

(continued)

Table 7.23 (continued)

3-digit ISCO	*Base scenario*	*Upside scenario*
541 Protective services workers	0.1%	−0.1%
611 Market gardeners and crop growers	−1.3%	−0.8%
612 Animal producers	−1.3%	−0.8%
613 Mixed crop and animal producers	−1.3%	−0.8%
621 Forestry	−1.4%	−1.0%
622 Fishery workers, hunters and trappers	−1.5%	−1.0%
711 Building frame and related trades workers	−0.6%	0.5%
712 Building finishers and related trades workers	−0.4%	0.5%
713 Painters, building structure cleaners and related trades workers	−0.4%	0.7%
721 Sheet and structural metal workers, moulders and welders,	−0.2%	0.6%
722 Blacksmiths, toolmakers and related trades workers	−0.4%	0.4%
723 Machinery mechanics and repairers	0.7%	1.3%
731 Handicraft workers	−0.3%	0.5%
732 Printing trades workers	−0.1%	0.6%
741 Electrical equipment installers and repairers	−0.2%	0.6%
742 Electronics and telecommunications installers and repairers	0.7%	0.9%
751 Food processing and related trades workers	−0.2%	0.5%
752 Wood treaters, cabinet-makers and related trades workers	−0.5%	0.4%
753 Garment and related trades workers	−0.6%	0.1%
754 Other craft	−0.6%	−0.4%
811 Mining and mineral processing plant operators	−1.3%	−0.5%
812 Metal processing and finishing plant operators	−0.6%	0.2%
813 Chemical and photographic products plant and machine operators	−0.3%	0.5%
814 Rubber, plastic and paper products machine operators	−0.3%	0.4%
815 Textile, fur and leather products machine operators	−0.2%	0.3%
816 Food and related products machine operators	−0.5%	0.3%

3-digit ISCO	*Base scenario*	*Upside scenario*
817 Wood processing and papermaking plant operators	−0.3%	0.4%
818 Other stationary plant and machine operators	−0.3%	0.4%
821 Assemblers	−0.3%	0.4%
831 Locomotive engine drivers	−0.6%	0.2%
832 Car, van and motorcycle drivers	−0.1%	0.3%
833 Heavy truck and bus drivers	0.1%	0.5%
834 Mobile plant operators	−0.4%	0.4%
835 Ships' deck crews	−0.5%	−0.2%
911 Domestic, hotel and office cleaners and helpers	0.6%	1.0%
912 Vehicle, window, laundry and other hand cleaning workers	0.8%	1.3%
921 Agricultural, forestry and fishery labourers	−1.0%	−0.5%
931 Mining and construction labourers	−0.5%	0.4%
932 Manufacturing labourers	−0.3%	0.4%
933 Transport and storage labourers	0.7%	1.3%
941 Food preparation assistants	0.9%	1.7%
951 Street and related service workers	1.2%	1.7%
952 Street vendors (excluding food)	0.9%	1.8%
961 Refuse workers	−1.0%	−0.7%
962 Other elementary workers	0.2%	0.8%
0 Armed forces occupations	−0.2%	−1.0%
Total	0.3%	0.7%

Source Authors' own creation

PART III

Analysis of Human Capital Requirements in Greece

CHAPTER 8

Restructuring the Greek Labor Market During the Last Two Economic Crises

Anna-Maria Kanzola

8.1 Introduction

The labor market is a volatile environment that supports economic activity though, it is directly affected by shifts in economic activity through the channels of labor supply and labor demand. These shifts are observable due to the changes in the relative demand for the occupations. Thus, the changes observed within these two channels can provide important information about the requirements within the labor market.

This chapter concentrates on the educational requirements for the Greek labor market from 2010 to 2025 and is structured as follows: Sect. 8.2 analyzes the effects of the two major crises (2008, 2020) on the labor market about the 4th Industrial Revolution. Specifically, concerns a theoretical review of the conditions affecting the labor market and a presentation of data on the shits of professions. In Sect. 8.3, the need for

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reskilling and upskilling is analyzed. Finally, in Sect. 8.4, there is a discussion regarding policy proposals for training and lifelong education of the workforce.

8.2 Economic Crises (2008, 2020) and Their Impact on the Labor Market

Economic crises are historical periods of economic turmoil that affect statistical variables such as growth rate but also affect the expectations of individuals and investors. This observation is important because economics relies on the analysis of expectations that relate to the map of individuals' utility curves. Utility hierarchy influences the action of individuals as it concerns trade-offs due to the comparative analysis between two goods. Thus, as human capital is perceived as an investment (Becker, 1964, 1975) changes in the economy and in the expectations affect decisions that concern it.

8.2.1 Conditions Impacting the Labor Market

The effects of economic crises are visible locally and globally by the reorganization of the labor market demand and supply for the occupations whose relative importance is changing as a response to the circumstances. A key feature of the effects of financial crises such as that of, 2010, is the increase in unemployment due to lack of available jobs positions as well as the difficulty of matching the (few) job positions with the characteristics (knowledge, skills and abilities) of the workforce. After all, the crisis of 2010 coincided with the technological change in light of the 4th Industrial Revolution (Schwab, 2016).[1]

Technological change has been associated with the polarization phenomenon (Autor et al., 2006) in which, employment concentration is observed in high-skilled and low-skilled professions leading to marginalization of the middle-skilled professions. The main explanation

[1] The impact of technological change is located on both the supply and demand sides (Schwab, 2016). On the supply side, the introduction of new technologies generates new ways of production and assistance as well as new conditions of competition between companies. Thus, quick adaptation is the key to corporate market dominance. On the demand side, the change in consumer preferences leads companies to adjust their products and services accordingly.

for this phenomenon in developed countries is related to the routinization hypothesis where the middle-skilled jobs contain working activities that can be integrated into a routine context and are easily replaced by information and communication technologies (ICTs) (Das & Hilgenstock, 2018). However, the future of some middle-skilled jobs is not in jeopardy, as qualities such as critical thinking and problem solving are not easily replaced by technological machines (Autor, 2015).[2]

In the canonical model of Acemoglu and Autor (2010), where there are only two types of work (high-skilled and low-skilled) technology has a positive effect (factor augmenting) in the direction of increasing productivity either in the category of high-skilled or in the category of low-skilled workers, taking place indirectly and not directly as a way of substituting skills. The elasticity of substitution for each type of work operates either supplementary (to increase the number of low-skilled workers) or substitutable (to increase the number of high-skilled workers by replacing the low-skilled workers).

Technology is expected to play an important role in the coming decades favoring economic growth. After all, one of the ways to deal with the Greek financial crisis of, 2010, concerned the implementation of structural reforms that promoted technological transformation as a key driver of the economy (Bank of Greece, 2018). The COVID-19 pandemic coincided with this stage of transition and at the same time, it has led to significant differentiations internationally in the labor market and in its structure due to lock-downs to protect public health.

For the past twenty years, the internet was expected to change the working conditions for many professions, mainly related to the provision of services (such as telecommunications) as their execution would be carried out remotely, but resulting consequently, in more working hours as teleworking is likely to replace leisure with production (Autor, 2001). The COVID-19 pandemic highlighted the importance of teleworking—wherever it was possible—as it was instrumental in supporting the economy through the ICTs. Of course, this led to an internationally increased demand for teleworking to maintain existing job positions and also create new employment opportunities (Bank of Greece, 2020).

[2] The possibility of automating a task is related to whether computer capital can replace human capital in both routine tasks and non-routine tasks (Blien et al., 2021; Frey & Osborne, 2017).

The adaptation for the countries to the new circumstances concerned two key features. Firstly, whether the labor market and the economy in general were familiar with teleworking and ICTs, and secondly, whether the production structure of each economy contained occupations that could be carried out remotely. Remote activities that mainly operate by the use of the internet concern the alteration of how the provision of services is taking place, but also concern the alteration of how employees acquire qualifications since the internet reduces the cost of lifelong learning (Autor, 2001).

In conclusion, currently, the labor market is affected by two phenomena that fully interact with each other; technological change and the COVID-19 pandemic consequences (Kanzola, 2021). Although the 4th Industrial Revolution was preceded, the COVID-19 pandemic had a catalytic effect on the need for technological transformation due to the sudden stop of economic activity and the adaptation of teleworking. Thus, an endogenous shock (technological change) and an exogenous shock (COVID-19) led to a common component in favor of technological transformation. This perhaps is a positive coincidence given that the shock in the production structure is mitigated by the common direction taken by the two crises. The validity of the last hypothesis is to be confirmed or rejected in the future depending on the developments.

8.2.2 Evidence on Labor Market's Shifts

The factors described above are globally observed, but the intensity and duration of economic crises vary according to each country's characteristics. For this reason, to draw specific conclusions one must focus on the statistical observations regarding employment worldwide, and in our case in Greece.

The financial crisis of, 2010, had both positive and negative impacts on the professions and sectors of economic activity, which in most cases operated compensatory. Worldwide from, 2013 to 2017, employees in real estate and marketing specialists were benefited while, professions concerning building construction and engineering were negatively impacted in terms of labor demand (WEF, 2018).

The sectors of health, information, energy, technology, and finance experienced an increased demand for software engineers (Alekseeva et al., 2021; WEF, 2018). This observation is in line with the broader developments related to the 4th Industrial Revolution. In the same sectors, the demand for professions such as administrative assistants and project managers decreased (WEF, 2018). Accordingly, in the sector of services provision, the professions that favored were relevant to marketing and software engineering, while the sales and administration professions experienced a negative demand (WEF, 2018).

In Greece, from 2011 to 2019, the occupations that experienced increased labor demand concerned the provision of personal services, general duty services with computer and ICTs knowledge, health professionals, administrative employees and carriers, and operators of mobile equipment (Giouli et al., 2021). For the same period, building constructors, skilled farmers, stock farmers, cleaners and assistants, catering workers, clerks, metal sellers, and craftsmen experienced reduced labor demand (Giouli et al., 2021).

It is, thus, observed that both internationally and in Greece, the labor demand shifts have been in the direction of technological transformation and digital skills enhancement, especially in favor of artificial intelligence (AI) skills regarding administration and management professions. This labor market trend was associated with a highly digitally skilled workforce and it was already present from 2017 to 2018 when middle-skilled professions such as computer operators, secretaries, typists, file clerks, machine operators, telecommunications employees, and postal workers faced the greatest risk of automation (WEF, 2020).

Such pressures will continue to exist in these professions due to the COVID-19 crisis, as teleworking led to a further increase in the demand for digitally skilled professions internationally (WEF, 2020). The adaptation of the labor market in teleworking was smoother in countries characterized by a high percentage of digital literacy and previous experience in remote employment such as the Scandinavian countries, while in Greece even with COVID-19 conditions teleworking remained at low levels (Bank of Greece, 2020).

Although teleworking is not something new, the consequences of such a shift in the production structure will concern the labor market even after the pandemic. Teleworking can either positively or negatively affect employee productivity depending on the working activities of each occupation. Benefits concern the flexibility from working at home that increases worker satisfaction and the reduction of the operating costs of companies about infrastructure (OECD, 2020). On the other hand, productivity can be negatively affected as interpersonal contact disappears, the monitoring of employees could be challenging, the remote work environment may not be appropriate and also, worker satisfaction may be diminished due to the ongoing interaction between personal and professional life (OECD, 2020).

In the post-COVID-19 era, teleworking is expected to increase compared to pre-pandemic levels (Bank of Greece, 2020). Before the COVID-19 pandemic, the concentration of teleworkers mainly concerned knowledge-driven professions and the self-employed (Sostero et al., 2020). This trend is expected to intensify as in an international level, favored technologies under the COVID-19 pandemic regarded cloud computing, data analysis, robots, encryption, and cyber security (WEF, 2020). Thus, if the teleworking phenomenon is intensive, it may lead to the replacement of humans by machines, as it catalyzes the adoption of new technologies.

In Greece from 2019 to 2020 in terms of employment shifts, the workers who experienced negative pressure concerned of professionals in the sector of services provision, hospitality, and tourism such as clerks, cashiers, accountants, technicians, and related professions, market-oriented growers, caterers, assistants in food preparation, and cleaners and helpers in households, hotels, and offices (Giouli et al., 2021). On the contrary, professionals in administration, engineers, beauticians, professionals in finance and mathematics, professionals in the health sector, professionals in construction, and transporters experienced increased labor demand (Giouli et al., 2021).

In conclusion, in the labor market of the near future, digital literacy will be crucial due to the acceleration of the 4th Industrial Revolution by the adaptation of the labor market to teleworking practices. Thus, some of the existing occupations and job positions will lag while new ones will emerge. In the context of the transformation of the production structure and the mitigation of social costs, reskilling and upskilling of the workforce is more than required.

8.3 Reskilling and Upskilling of the Workforce

Skill shortages refer to the situation when the labor supply measured in skills cannot meet the labor demand's requirements. On the contrary, skill surpluses occur when the labor supply measured in skills exceeds the labor demand's requirements. Of course, both skill shortages and skill surpluses lead to a non-optimal equilibrium known as skill-mismatch of the workforce with the existing job positions. For the purpose to identify skill shortages and skill surpluses in the economy, indices have been developed using different variables depending on their structure.[3]

Technological advancements stimulate labor demand in the direction of staffing the existing new job positions under the shifts in the production structure. This process concerns professions directly affected by the demand for new technologies. Accordingly, the products and services provided will relate to the green economy in the context of sustainable integration, and with derivative professions of the 4th Industrial Revolution. Thus, these developments concern three questions (Giouli et al., 2021):

1. Where do skill shortages occur?
2. Which sectors of economic activity are facing skills shortages?
3. To what extent do the qualifications of the employees correspond to the job requirements in the tasks they are called to perform?

The answer to these questions will lead us to form the profile of knowledge and skill requirements for the coming years.

The OECD skill indices for Greece provide important information for the shortages and surpluses in skills, abilities, and knowledge requirements for the workforce. Specifically, in terms of skills and abilities in Greece, there are shortages, greater than the average of the countries, in the areas of communication and speech, justification, perception, persuasion, service orientation, and digital skills[4] (OECD, 2018). On the contrary, surpluses in skills and abilities relate to qualities such as adaptability, problem solving, time management, utilization, and repair of equipment to be used (OECD, 2018).

[3] For example, OECD indices (Skill Needs Indicators) measure the degree of deficit (positive values) and the degree of surplus (negative values), on a scale from -1 to $+1$, for a range of dimensions such as skills, abilities, and knowledge (OECD, 2018). Thus, 1 corresponds to the largest shortage observed among the 31 countries for the dimensions of skills while the opposite corresponds to the negative value.

[4] Of particular interest about digital skills is the digital economy and society index (DESI), a complex index that summarizes Europe's digital performance and monitors the evolution of European Union's (EU) Member States in digital competitiveness. For both 2018 and 2019, Greece ranked in the last positions among the EU Member States (DESI, 2018, 2019).

Regarding the knowledge content of the Greek labor market, there are shortages in humanities (such as psychology, anthropology, law), in positive sciences (chemistry, biology, food technology), in management sciences (clerical, administration and management, personnel and human resources management) but also in fields related to communication and the media (OECD, 2018). Knowledge surpluses are observed in the various fields of engineering (engineering, mechanics, building construction) (OECD, 2018).

For 2018, skill-mismatch of job positions with the workforce accounted for 44%, of which 24% were overqualified while 20% were underqualified (OECD, 2018). The sectors of economic activity in which we observe the greatest skill shortages in Greece concern the primary sector (agriculture, stock farming, and fishing), the sciences and arts, the sectors of services provision, and especially regarding health, technology, and communications, and public administration (OECD, 2018). Let be noted that the aforementioned sectors are the ones characterized by the highest population concentration of employees in Greece for 2018 (Kanzola, 2021).

On the contrary, the sectors with overqualified employees were construction, catering services, services in general, and sales (OECD, 2018). Once again, occupations in the sectors of services provision and construction are the ones characterized by the highest population concentration of employees for, 2018, in Greece (Kanzola, 2021).

An important conclusion can be drawn. In both cases, we refer to sectors of economic activity with economic development prospects. Thus, it is crucial to ensure that they operate effectively. In general, asymmetries in skills at the microeconomic level refer to the non-matching of an employee with their profession, while at the macroeconomic level are linked to structural unemployment (Brunello & Wruuck, 2019).

Sectoral analysis for skill-mismatch can lead to the exact kind of knowledge requirements for the support of the production structure (Kanzola, 2021). In Greece for the, 2018, production structure, 43% of the knowledge requirements accounted for low-level mathematics, customer and personal service, clerical support, engineering knowledge, and sales and marketing (Kanzola, 2021). Of course, in every sector of economic activity corresponding knowledge-specific items may not always coincide with the above knowledge items but they are necessary for the performance of the working activities and they are relatively important per sector (Kanzola, 2021).

Globally, skill requirements for the coming years are estimated to be mainly related to functional literacy, critical thinking and problem solving, digital literacy, collaboration, administration, self-control and stress management, and to a smaller extent with physical condition (WEF, 2020). Though, within the sectors of economic activity, we can locate different specific skills that concern the nature of the professions and their corresponding sector. Thus, it is not expected that the same requirements for skills and knowledge items will prevail in all sectors.

In the coming years, the use of technology will be extensive thus, the job positions will be technology-intensive, while the functional knowledge (writing, basic math, reading) will be ancillary to the use of technology. However, as the pace of specialization of the workforce and processes increases, the required creativity that stimulates entrepreneurship is undermined (Giouli et al., 2021) and at the same time, the intergenerational quality of knowledge and therefore future prosperity may be degraded.

In conclusion, labor demand shifts for specific types of skills and knowledge items will result in corresponding labor supply shifts. Employment movements toward the new (or modified) occupations will take place in three ways: (a) job transitions, (b) job pivots, and (c) job families. Job transitions concern transferring current skills, knowledge, and activities to a new occupation. Job pivots refer to transferring employees away from their previous activity to completely new occupations. Job families refer to by switching between professions with a common background in skills.

For the reskilling and the upskilling of the workforce the COVID-19 pandemic, the 4th Industrial Revolution, as well as the growth opportunities associated with the green economy, should be taken into account. However, in this direction, apart from the asymmetries in the skills of the workforce, the lack of investments, and the wider institutional framework and cultural background, also play an important role.

8.4 Policy Implications

Policymaking to address skill asymmetries concerns three interrelated events. Firstly, the aforementioned requirements in skills, abilities, and knowledge. Secondly, the fact that different skills and knowledge requirements attribute to new or differentiated occupations and therefore, new working activities. Thus, the transition process from one production structure to another is of particular importance as an erratic transition process involves high social costs. Thirdly, the fact that the post-COVID-19 era will be characterized by high growth rates and therefore higher demand for labor.

The above analysis regarding the requirements in skills, abilities, and knowledge items points out the necessity of educational policies for the improvement of productivity (Kanzola, 2021). As circumstances call to the direction of technological transformation, we are led to a skill-based technological change which favors skilled labor over unskilled labor with serious effects on income distribution and inequalities (Violante, 2008).

Education could make a decisive contribution to the smooth transition from one production structure to another, given that skills development takes place under basic education and training, and other education (Brunello & Wruuck, 2019; ESI, 2018). Thus, the creation of favorable institutions that provide education and training in the context of lifelong learning is extremely important for the smooth transition to the new era (Bulman, 2020). At the same time, especially in light of the rapid developments due to the COVID-19 crisis, lifelong learning structures are ideal because they are efficient and with low operating costs (Giouli et al., 2021).

Beyond general macroeconomic policies related to education and reskilling and upskilling, policymakers need to keep in mind that individuals face a personal choice of cost-benefit analysis to invest in human capital (Becker, 1964, 1975) and therefore in reskilling and upskilling. That being, the potential benefits must exceed the (financial and opportunity) cost.

In addition, complementary to the enhancement of educational structures that promote lifelong learning, policies should address other institutional issues related to the circumstances of the new era. In a constantly technologically evolving world, these issues refer to the creation of an institutional framework that protects privacy and intellectual property as well as personal and employee rights in the context of the industrial organization[5] to ensure the proper operation of the economic system.

[5] For example, in the context of industrial organization, the institutional framework should address issues such as the employees' assessment in the new forms of work such as telework, etc. (Bank of Greece, 2020).

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CHAPTER 9

The European Experience in Lifelong Learning and the Restructuring of the Economy

Pantelis C. Kostis and Kyriaki I. Kafka

9.1 Introduction

Learning is different from teaching and as noted by Illeris (2016) it concerns the mental processes that will lead to permanent changes or results as well as the interactive processes that develop between individuals or a person with learning material and his social environment and that lead again to changing behaviors, attitudes and skills.

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There are three forms of learning that can take place during a person's lifetime. These are formal learning, non-formal learning and informal learning. The first and most widespread of these three forms, formal learning, takes place within the formal education system (primary, secondary and tertiary education) and is addressed to specific ages depending on the level of education, while depending on the level of education is mandatory. Non-formal learning takes place in any space (workplaces, institutions of social activities, institutions of formal education), is not mandatory and is a conscious and voluntary choice of the individual. Informal learning takes place throughout the life of the individual in any space and through it the individual forms attitudes, choices, knowledge and behaviors while his consciousness can be affected (Lionarakis, 2013).

Lifelong learning includes all learning and educational activities, of any type, content or level, that take place in the context of any form of learning and in which individuals of all ages and educational levels participate, in a technical phase of their biological and social cycle. It is based on the assumption of the continuity of the learning path (Karalis, 2010). The goals of lifelong learning are to promote employment and the active participation of citizens so that human capital stays alert throughout its life by continuously improving its quality with significant expectations for its outputs in the production process (Allert et al., 2004).

Today's education systems focus on the development of cognitive skills, however non-cognitive skills that cultivate an individual's ability to work with others and solve problems are becoming increasingly important. Current education systems are also "time constrained" in a way that may not make them suitable for current or future job markets. In other words, they impose narrow career and experience decisions at a young age. The distinction between formal education and the labor market needs to be bridged, as learning, research and development (R&D), knowledge sharing, retraining and innovation take place simultaneously throughout the life cycle, regardless of work and education level. Lifelong learning programs also offer a second chance to those leaving the formal education system. Research results (Kugler et al., 2016) show that vocational training and formal education are complementary investments and that there are teaching implications for family members, especially among those seeking distance education with a high basic level of education.

With the current developments associated with the advent of the 4th Industrial Revolution, combined with the great challenges associated with the aftermath of the, 2008, financial crisis, the COVID-19 pandemic crisis and a number of other global trends that take place, it is now necessary to train the workforce. The term "education" means the further education of the individual, i.e., beyond the limits set by the basic educational system. Obviously, training is closely linked to the individual's freedom and free will to develop his or her abilities and skills. It mainly concerns people who are mature, settled and usually older, while the decision for training is mostly conscious.

The present chapter firstly (Sect. 9.2) presents the effects of lifelong learning on societies and economies. Then (Sect. 9.3), lifelong learning in Europe is presented, as well as (Sect. 9.4) lifelong learning in the new Era of digitalization and the 4th Industrial revolution. Finally, in Sect. 9.5 the role of skilling and reskilling for the necessary restructuring of economies is presented.

9.2 The Effects of Lifelong Learning on the Societies and the Economies

Theoretical approaches about the importance of lifelong learning have varied considerably over the last decades. During the 1970s, lifelong learning was the answer to the changing socio-political conditions of the period (Boshier, 1998). However, until the mid-1980s, lifelong learning was not considered to be linked to the labor market and economic progress. Therefore, lifelong learning programs were initially linked to the individual's personal development (Rogers, 2002), while they were unaware that through these programs the trainee's professional skills are developed at the same time. The role of lifelong learning began to be increasingly understood after the 1980s, when—on the occasion of the foundations laid for the theory of human capital and investment in it (Becker, 1974)—the societies began to realize the benefits of all forms of learning.

However, the importance of lifelong learning has changed over the years and from the social dimension the burden has shifted to the needs of the economic field. Thus there is highlighted the need to upgrade the knowledge and skills of human capital in an ever-changing economic environment. The connection to the labor market is perhaps the main reason why so much value is attached to lifelong learning (Nuissl, 2001).

In an ever-changing and highly competitive labor market, lifelong learning is a key factor in both individuals' personal development and overall economic development. Differences between countries in GDP per capita generally reflect differences in labor productivity (McGowan & Andrews, 2015). In turn, these labor productivity gaps are largely a function of differences in the productivity ratio and the concentration of human capital that a country has at its disposal. While human reserves have increased, highly educated workers have significantly increased labor productivity over the past 50 years (Braconier et al., 2014; Fernald & Jones, 2014). At the same time, the growing economic importance of knowledge is expected to increase the return on investment in skills, thus enhancing the further increase in income inequalities within countries in the coming decades (Braconier et al., 2014). In this context, the ability of economies to effectively develop existing human capital reserves and strengthen the capacity of the population through lifelong learning will be of greater importance in combating the slowdown in growth and the increase in inequalities. Cedefop (2011) shows that initial vocational education and training are positively associated with many social outcomes: those who have completed vocational education and training report significantly higher levels of citizen participation, self-esteem, job satisfaction and satisfaction about their economic status.

In an evolving world, lifelong learning can contribute to the efficiency of the education system and create benefits for the economy and society (Kim & Moore, 2005; Marengo & Marengo, 2005; Moravec et al., 2015; Mothibi, 2015; Trubina & Braines, 2016). Kuppens et al. (2015) point out that higher levels of education are associated with a wide range of positive outcomes: better health and well-being, higher social trust, greater interest on politics, lower political cynicism and less hostile attitude toward immigrants.

At the state level, lifelong learning contributes to the development of democracy (Hoskins & Mascherini, 2008) and the creation of a culture of conscientious citizenship and to the establishment of structural reforms. At the same time, lifelong learning helps to redistribute resources in an economy. Lifelong learning can also be an important source of motivation and well-being in the workplace, as satisfied employees are more productive, collaborate more effectively and display higher levels of creativity and innovation (FinALE, 2018), while at the same time lifelong learning leads to lower health costs, improvement social relations and salary increases (NIACE, 2012).

The most important benefits of enhancing lifelong learning are related to obtaining a higher income, finding better jobs, higher individual and social well-being and health, greater social inclusion and participation in voluntary activities, greater capacity for innovation and higher competitiveness. Lifelong learning contributes to the development of new skills in key areas such as digital transformation, leadership and management of change. This is not only a vital source of competitive advantage, but it is essential for the long-term viability and survival of the company.

Lifelong learning becomes vital for both society and the economy and for economic policymakers, businesses and individuals, as skills and occupations evolve over time (Marengo & Marengo, 2005; OECD, 2013; Trubina & Braines, 2016). It is reported to have several positive effects on adult learners and society, leading to poverty reduction and reduced domestic violence (Hammond, 2002; Jarvis, 2006; Miller & Mullins, 2002; van der Veen & Preece, 2005) and leads to a better quality of life, greater self-confidence and self-efficacy (Kubzansky et al., 1999; Vega Dienstmaier et al., 1999). It can also be a lifelong resource for older people to achieve a good quality of life during aging (Meeks & Murrell, 2001). Lifelong learning, in addition to focusing on enhancing personal and career life, simultaneously promotes thinking, self-expression and action, and facilitates positive and profound changes in the quality of life of those involved (Hudson, 1999). The acquisition of knowledge and skills through continuing education improves the efficiency and effectiveness of individuals, while giving them the necessary supplies for a successful professional career.

In addition, quality of life and self-efficacy also have a major impact on the learning process and outcome. Studies show that students with poor health perceptions have a higher risk of low academic achievement or drop out of school (Huurre et al., 2006; Lasheras et al., 2001). Therefore, lifelong learning, quality of life and self-efficacy are significantly related to each other.

Enhancing the importance of lifelong learning can also be rooted in the close family circle, since if, for example, a family member shows zeal for his or her continuing education, there will be an impact on other family members, especially in the newer ones. The range of potential benefits is very wide, and often includes, among many other things, better family well-being because of higher self-fulfillment of the trainee family member, improved health due to higher awareness and prevention, higher earnings and career choices, and greater ability supporting other family members by transmitting the benefits of their learning, knowledge and experiences. Learners often become role models for other family and community members who then follow their own learning paths.

In addition to the economic benefits associated with higher levels of skills and education, numerous studies (Cutler & Lleras-Muney, 2012; Grossman, 2006) have shown that education is closely related to health and well-being (Kempter et al., 2011; Spasojevic, 2010; Van Kippersluis et al., 2011). Field (2009) reports the positive effect of education on health, especially mental disorders, while Lochner (2011) reports improved health-related behaviors. Hammond and Feinstein (2005) and Jenkins (2011) find significant benefits from participating in learning to increase participants' self-confidence and perceived well-being. Some studies focus on reducing mortality (Albouy & Lequien, 2009; Clark & Royer, 2013; Van Kippersluis et al., 2011), while others focus on the positive effect of self-perceived health, the reduction of long-term health problems (Kempter et al., 2011) or health-related behaviors, such as reducing smoking (Conti et al., 2010).

At the same time, lifelong learning and more generally, the increase in educational attainment and continuing education appear to reduce crime (Hjalmarsson et al., 2011; Lochner & Moretti, 2004; Sabates, 2008). Machin et al. (2011) find that an annual increase in people continuing their education reduces the conviction rate for property-related crimes. According to Buonanno and Leonida (2006), a 10% increase in continuing education rates leads to a 4% reduction in property crime and a 3% reduction in overall crime. Groot and Maassen van der Brink (2010) showed that the number of years of education significantly reduces theft and violence, but at the same time increases tax fraud offenses.

9.3 Lifelong Learning in Europe

The European Union in its text on lifelong learning "The Goals, Architecture and Means of Lifelong Learning" (Gass, 1996), where 1966 was also designated as the "European Year of Lifelong Learning", proposes the economic dimension over the social dimension for the objectives of lifelong learning stating that:

a. The economic dimension includes investing in human resources, promoting employment in an era of structural change and making the company a key partner in the learning society.

b. The social dimension refers to the removal of the traditional division of life (education, work and pension), to equal opportunities and to the provision of educational opportunities of multiple forms.

At the Summit on Fair Employment and Growth in Europe on November 17, 2017, the European Parliament, the Council and the European Commission proclaimed the European pillar of social rights. One of its 20 main principles refers to education, training and lifelong learning: every person has the right to high-quality and inclusive education, training and lifelong learning to acquire and maintain skills that will enable him to participate fully in society and to successfully manage changes in the labor market. The European Commission points out that most children entering primary education today are likely to end up working in new forms of employment that do not yet exist, and that large-scale investment in skills and a general review of education systems and lifelong learning systems will be required.

Thus, it is essential that the European education area will be able to respond to the functioning of European democracies, to changes in European labor markets, to demographic changes, to changes resulting from climate change and to the limits of natural resources, in combination with economic and social inequalities, supporting digital, business skills, other skills (science, technology, engineering, math), cybersecurity and artificial intelligence skills and metacognitive skills, such as those related to citizenship. To this end, tools should be developed to enhance the basic skills of young people as part of national lifelong learning strategies. The European Commission (2020) also supports Member States in implementing tools for teaching staff, such as open mass online courses, self-assessment tools, networks and e-learning platforms.

According to the results of a study by Cedefop (2017a, 2017b) on a sample of 35,645 people regarding their opinion on vocational education and training (VET), most EU citizens agree that people in vocational education learn skills required of employers (in their country) (86%), while only 9% disagree. Two out of three respondents (67%) agree with the proposal "vocational training allows you to find a job quickly after obtaining additional qualifications or a diploma", while 26% disagree. About three out of five respondents (61%) agree that "vocational training leads to well-paid jobs", while a similar percentage (60%) agree that "vocational training leads to jobs that are considered very high". In both statements, about one in three respondents disagree (32 and 33% respectively). Overall, these findings confirm the generally positive picture of vocational training throughout the EU, especially in terms of acquiring relevant vocational skills, but also in finding work, increasing job earnings and recognition.

Focusing on the contribution of vocational training to the acquisition of relevant vocational skills, there is a divergence of views in the various EU-27 countries. The European Commission also emphasizes the importance of VET in addressing the needs of employers and in addressing skills shortages (European Commission, 2012). At least three quarters of respondents in each country agree with the statement that “VET provides skills that are useful to employers”. In several countries, at least nine out of 10 respondents agree with the statement: Finland (96%), Cyprus (94%), Austria (94%), Malta (92%), Germany, Greece, Sweden (all three countries with 91%), Ireland and Slovakia (both countries with 90%).

Regarding the opinion of EU citizens for the role of VET in society, they consider that it brings positive benefits. Focusing on respondents whose upper secondary education was mainly vocational, more than four out of five agree that VET strengthens their country’s economy (86%) and plays an important role in reducing unemployment (83%). Also, four out of five agree (80%) that VET helps to address social inclusion.

However, it seems that the EU-27 failed to meet the target set under the strategic framework for European cooperation and training (ET 2020 Working Group) according to which, at European level, an average of at least 15% of adults should participate in lifelong learning by 2020. The latest results from the European Union (EU) labor force survey show that in, 2020, the participation rate in the EU-27 stood at 9.2% and 10% in Euro area (Fig. 9.1).

9.4 Lifelong Learning in the New Era

In the modern digitized era of the 4th Industrial Revolution, new technologies will create new jobs and replace existing ones. It is estimated that almost half of the jobs in developed economies are particularly vulnerable to being replaced by new, digital technologies within the next decade or two (Frey & Osborne, 2017). For workers to be able to cope with the growing dynamics of the labor market, they need to acquire greater mobility in jobs, occupations and industries. The relative importance of their skills for a particular job will decrease, while the skills immediately

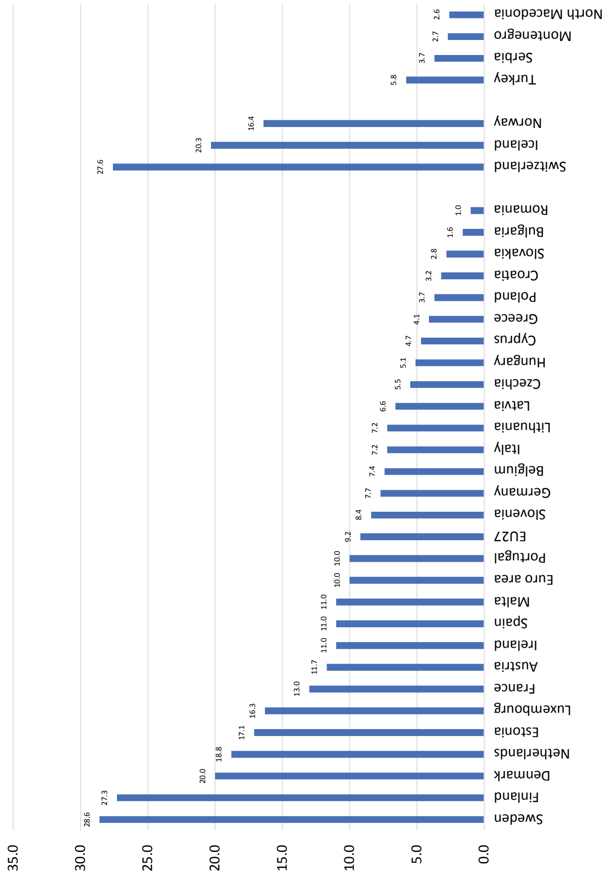

Fig. 9.1 Participation rate in education and training (last 4 weeks) by sex and age (*Source* Eurostat [trng_lfse_01])

applicable to the new occupation will increase. To maintain workers' jobs and strengthen their resilience to technological change, more and more workers must be constantly updated and trained and adapt their skills to the new demands of the times, to improve their mobility in positions, professions and industries.

Therefore, technological change will accelerate further in the digital age. This will require an even greater need for a workforce that can respond more flexibly to an ever-changing demand for labor. Jobs in less developed countries may face even greater challenges. Digital technologies will also create many new jobs, in different occupations or industries, while requiring different skills from current jobs (Autor, 2015; Brynjolfsson & McAfee, 2011).

Adult education policies developed in the age of computerization should refocus on the challenges of the new Era. The policy has responded to the ever-changing demands of computer-age skills, with an emphasis on lifelong learning (ILO, 2010; OECD, 2003, 2005, 2010, 2015; UNESCO, 2009, 2016). Lifelong learning has also been recognized as an important goal of the United Nations Sustainable Development Goals, however many of the policies implemented fail to target those workers who need more education and training and provide practical skills needed for the job rather than general, non-cognitive and digital skills required for occupational mobility (OECD, 2016). They focus mainly on training skills in specific occupations or specializing in specific industries that enhance employee productivity in their current jobs, but place very little emphasis on general skills that enhance employee mobility in jobs, occupations or industries. In other words, this process can be described as static, avoiding adding dynamic features that will make the professional course of human resources more flexible and secure. Therefore, training these general skills will help employees to adapt flexibly to technological change. It will increase their mobility in jobs, occupations and industries, thus increasing their opportunities for permanent employment, even if the company in which they work, or the industry is facing problems.

As many new skills are difficult to codify, theoretical, non-cognitive and digital skills enable employees to complement—rather than compete with—new technologies (Autor et al., 2003; Deming, 2015). Theoretical skills are intellectual skills that determine the ability to learn, evaluate and take initiative. They enable employees to better understand and critically reflect on why they are doing what they are doing, to solve creative problems that are not routine, and to acquire new knowledge or problem-solving skills that accompany new technologies. Higher competencies in these skills will also enhance employee mobility in jobs, occupations or industries (Poletaev & Robinson, 2008; Geel & Backes-Gellner, 2011).

Non-cognitive skills are the characteristic patterns of values and behaviors that determine an individual's attitude toward learning and initiative. Non-cognitive skills, also called "soft" skills, include basic "employability" skills such as accuracy, reliability, responsibility, integrity, honesty and the work discipline that is important for all jobs, especially for those with low cognitive skills requirements (Lerman, 2013; OECD, 2015; Van de Werfhorst, 2014). Employers undoubtedly value these skills even more than basic cognitive skills such as reading or writing (Lerman, 2013). Values, behaviors and attitudes that are a prerequisite for learning, problem solving and creativity, such as curiosity, open-minded people, determination, self-confidence and self-motivation. These non-cognitive skills facilitate the accumulation of theoretical skills by enhancing the willingness to learn (Almlund et al., 2011; Kautz et al., 2014). Therefore, deficits in non-cognitive skills often go hand in hand with lower cognitive skills and lower creativity (Cunha et al., 2010; Sternberg, 2006; Whitmore Schanzenbach et al., 2016).

Moreover, social (interpersonal) skills such as the ability to communicate or work in teams are important in many ways. On the one hand, the ability to direct, coordinate and motivate colleagues are a valuable managerial skill that complements theoretical skills. On the other hand, caring for the well-being of others is a valuable skill in a variety of services, including health services and society. In any case, social skills will be difficult to replace by technology soon. Digital skills are cognitive skills that are specific to the use of digital technologies and working in digital environments.

9.5 Lifelong Learning and Economic Restructuring Through Skilling and Reskilling

Neoclassical economic models suggest that a one-time increase in human capital stock leads to a one-time increase in productivity, while endogenous models suggest that the same one-time increase in human capital can lead to a permanent increase in labor productivity and growth. In the short run, both models produce similar results, but in the long run endogenous models result in significantly higher returns on investment in human capital (Wilson & Briscoe, 2004). Regardless of the specific models adopted, there is strong evidence that lifelong learning increases productivity and higher levels of growth. If education is measured by the skills acquired, the education of a population is closely linked to the long-term growth rate of a nation. However, if the years of education are used as an approximate variable for education, there is a much weaker relationship with economic growth (Woessmann, 2014).

At EU level, this requires a continuous focus on mutual learning and cooperation in education and training policies in the Member States. Regardless of the models adopted, the macroeconomic benefits of education are undeniable: for example, Woessmann (2014) reports that an increase in educational achievement of 50 PISA points translates into a 1% higher growth rate in the long run. If the EU managed to upgrade learning processes by 25 PISA credits, this would result in a profit of € 35 million.

It is understood that economic policymakers need a clear picture not only of how labor markets and economies are changing, but also of the extent to which their citizens are being equipped with the skills needed in the twenty-first century. People with low professional skills face a much higher risk of financial disadvantage, a higher chance of being found unemployed and poor quality of health compared to a highly trained workforce.

Skills can change a person's life by favoring their economic and social development, contributing to the improvement of well-being and promoting their social inclusion (OECD, 2013). Without the right skills, people will be marginalized in society, technological progress will not translate into economic growth, and businesses and countries will not be able to compete in an increasingly complex global environment.

As the demand for workforce with information analysis and communication skills increases and as technology permeates all aspects of life, people with poor writing and arithmetic skills are more likely to face the problem of unemployment. Lack of IT skills limits adults' access to many basic services, better paying jobs and access to further education and training, which is vital to developing and maintaining skills in working life.

Enhancing the skills of adults through lifelong learning and e-learning methods could be the springboard to tackle social exclusion and help integrate into the labor market (Cedefop, 2016).

The link between skills and prosperity applies not only at the individual level but also at the country level. Countries with low skills are lagging in terms of competitiveness as the global economy tends to become increasingly dependent on a skilled workforce (OECD, 2013). At the same time, skills inequality is related to income inequality. The way skills are distributed to the population has a significant impact on how wealth is distributed in society.

Investments in skills could be captured by increasing labor productivity, reducing the cost of hiring more skilled workers, saving production downtime due to a lack of qualified staff, providing training opportunities and internal dissemination of knowledge. These are probably the main reasons why companies are involved in training (Hogarth et al., 2012; Pfeiffer et al., 2009). Riley and Robinson (2011) identify significant positive effects of human capital on corporate profitability. Lebedinski and Vandenberghe (2013) show that university graduates are 23% more productive than secondary school graduates and 42% more than primary school graduates. Higher education and continuing education equip people with skills and abilities that enable them to be more productive. It also equips people with the knowledge and skills that enable them to create and adopt new ideas that promote innovation and technological progress (Woessmann, 2014).

However, one of the most frustrating aspects of evaluations of voluntary training is that employees who needed training are usually less willing to participate (Caliendo et al., 2016; OECD, 2016; Schwerdt et al., 2012). This is probably due to insufficient information, to the limited existence of non-cognitive skills that make it difficult to perceive the benefits of voluntary lifelong learning, class reasons, belief in determining their course in external factors such as fate or fate and not their own action (Caliendo et al., 2016). Furthermore, we should not forget that education in lifelong learning programs cannot be an obligation and awareness of the benefits of trainees from attending training programs should be increased (Barr & Turner, 2017).

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CHAPTER 10

Labor Market Analysis Based on the Knowledge, Skills, Abilities and Working Activities of Employees in the Present and Future Production Structure of 2027

Panagiotis E. Petrakis

10.1 Introduction

The purpose of this chapter is to analyze the knowledge requirements for production transformation in the aftermath of the 2010–2020 Greek economic crisis.

More precisely, the chapter analyzes the production structure of the Greek economy as reflected in the sectors of economic activity in 2018,

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based on their employment which has an equivalent in the occupations that exist. Based on this analysis of occupations, it is possible to identify the knowledge requirements that the Greek economy had in 2018 based on its employment structure.

This structure has the characteristics of the period after the crisis of 2011–2015 which was particularly severe for the country. Then, based on the available methodology and projecting the corresponding picture of employment and occupations for 2027, a new map of knowledge requirements for the new production structure can be identified, which is estimated to emerge in 2027.

Thus, the differences between the two productive structures can be identified, and any deficits that may arise can be predicted. The results of this analysis are of particular value for the design of formal, non-formal and informal education policy in order to facilitate the operation of the production model, to serve and possibly influence the restructuring of the production model.

This chapter presents the estimated developments for the economic and labor structure of the Greek economy. The structure of the chapter is the following: Sect. 10.2 analyzes the relation between human capital, growth and transformation. Section 10.3 presents the contemporary labor market and the crisis of 2008 and 2020. Section 10.4 analyzes the employment and occupations of the Greek Production System 2018 and 2027. The chapter concludes with the analysis about the production system requirements on human capital concerning terms of working activities, knowledge, skills and abilities requirements, Sect. 10.5. Finally, in Sect. 10.6 a discussion on the analysis of the chapter is realized.

10.2 Human Capital, Growth and Transformation

"Human capital" today is mainly defined as the abilities and skills of people and productive wealth that is integrated into work, knowledge and skills (World Bank, 2019). The theory of human capital, however, does not focus only on education (formal or non-formal) and the accumulation of skills but is also concerned with public health which affects individuals and their productivity, which is an input to economic output, although mainly when talk about the development of human capital (expenditures for education or training) we usually refer to the acquisition and increase of the number of people who have skills, knowledge and experience that are critical for the economic development of a country (Adelakun, 2011).

Although the beginnings of the theory of human capital originate from the Classical Political Economy, the theory of human capital was developed in the second half of the twentieth century within the framework which was related to the developmental patterns and logics of this century (see Chapter 2). At the same time, through this research process, growth and human capital were correlated to such an extent that models were created that explain the dynamics of growth mainly based on the historical evolution of human capital (Galor & Weil, 2000), or other endogenous models in which human capital plays a key role (Romer, 1990).

However, at the same time, the theory of human capital was further developed and transformed to be in line with the new development thinking of the twenty-first century that seeks multidimensional sustainable development (Bochańczyk & Pęciak, 2015), both in economic, social and environmental terms (UN, 2020).

Sustainable development depends on sustainable governance. Therefore, the robustness of an economy's development depends on the structures that support it, setting the framework and providing the environment in which economic actors pursue their goals (Petrakis, 2020a). The effectiveness and culture of these institutions largely determine the resilience of themselves to adapt to new situations but also the resilience of the economy and the country in general (Petrakis, 2020b). In this context, modern economic theory communicates with a number of other social sciences and relies on conceptual loans from related fields to analyze concepts and behaviors (such examples may be economic behavior, animal spirits and the psychological dimension of the economies) (Petrakis, 2020a, 2020b).

Furthermore, human capital theory has been refined in terms of the content and conceptualization of the concept of human capital. After the original general theory of human capital, in which all knowledge had a productive effect on workers, theories of differentiated human capital were developed (see Chapter 3). This process, called modern human capital theory, which is utilized in the present chapter is based on the tasks of the work (Autor, 2013; Autor & Handel, 2013) and distinguishes a number of categories of human capital that support these tasks in different ways (see Chapter 4).

The present chapter specifies the various differentiated characteristics that are required based on the structure of the Greek economy and its productive and working structure for the coming years. The combination of short-term and long-term shocks and changes that affect the requirements in the basic categories of human capital are about to be studied: Working Activities, Knowledge, Skills and Abilities.

To be able to do this, the analysis starts estimating the labor structure, both at a basic general level and specifically for the years 2018–2027 in order to extract the changes in employment characteristics for the future.

10.3 The Contemporary Labor Market and the Crisis of 2008 and 2020

The modern international labor market environment is radically different from the one in the second half of the last century. The main long-term trends concern technological change, deindustrialization and the emergence of knowledge-based services (CIPD, 2013), making the importance of human capital ever greater in modern economies. Technology and the consequent globalization have a direct impact on work as they open new channels and transform business models. The importance of education is significantly higher. A wider field of knowledge for communication, cooperation, problem solving and learning is required (Buta, 2015; CIPD, 2013). While new forms of education are emerging to meet these new requirements, such as retraining, lifelong learning, asynchronous education and so on.

An element of the 4th Industrial Revolution is the wealth of emerging technologies that is expected to bring radical change in the economies of the twenty-first century. AI, Big data, blockchain, 3D printing, 5G networks and augmented reality are just some of the technologies that are expected to revolutionize work (Kim, 2019). An important new element is the acceleration of developments, the more frequent and intense changes in work, which makes research like this one especially necessary in today's environment, with the aim of predicting and preparing for the changes that are taking place.

Apart from these long-term forces, the labor markets in the world, and the Greek economy, are also affected by the short-term disturbances of the economies. The most important disorder for the 2020s is that of the COVID-19 pandemic. The 2020 crisis is a simultaneous supply and demand shock that has shaken economies. These short-term shocks interact with, amplify, or delay long-term trends. Typically, due to the pandemic and the following economic difficulties, investments in cutting-edge technologies or energy changes have been significantly affected

(Mulvaney et al., 2020), while at the same time, pandemic disturbance can be a long-term accelerator of energy changes. In general, it is estimated that the pandemic crisis pushed 83% of companies to remote work, while at the same time 84% accelerated the digitization process and 50% the automation process (WEF, 2020). This creates new conditions in the labor market where long-term (like the 4th Industrial Revolution) and short-term forces (such as COVID in particular) are intertwined.

This situation is not unprecedented for Greece, as in the previous crisis, similar phenomena had coexisted at the same time. The effects of technological change, now called the 4th Industrial Revolution, were already visible before 2010. Simultaneously, globalization is a phenomenon that pervades the entire twenty-first century. Consequently, the financial crisis of 2007–2008 and the ensuing Greek and European crisis of 2010 coexisted with the effects of the technological changes that occurred.

The extremely interesting element of that period is that the structural changes in the economies of the Eurozone and Greece are not extremely significant (see Table 10.1). This is a conclusion worth keeping. The same conclusion seems to apply to the 2020 crisis as assessed given the estimated changes until 2025 based on the expected changes.

At the same time, however, developments in the labor market in the long run are expected to be particularly significant (Kim, 2019; WEF, 2018, 2020). As you estimate that the work environment is changing rapidly, as a result of which the demands on human capital are also changing. In particular, the workforce of the future should be more flexible and easily adaptable to a complex and non-linear environment. Although the time spent by humans and machines to accomplish their tasks is not expected to change significantly, the work structure will undergo significant changes.

More precisely, the effects of the economic crises are visible through the reorganizations that take place in the labor market as the relative weight of various occupations varies as shown in the recruitment tables both at the level of global economy and in the case of Greece.

The biggest negative impact of the crisis of 2008 mainly concerned the occupations of Administrative Assistants, but also those of Electrical Technicians, Mechanical Technician, Environment Health Safety Managers, Accountants, Managers of Engineering, Civil Engineering, Manager of Construction, Electrical Engineers and Construction Workers (WEF, 2018).

Table 10.1 Percentage participation of each sector in the total Gross Value Added (2010–2025)

Eurozone	*2010 (%)*	*2017 (%)*	*2018 (%)*	*2019 (%)*	*Difference 2010–2019 (%)*	*2020 (%)*	*2021 (%)*	*2022 (%)*	*2023 (%)*	*2024 (%)*	*2025 (%)*	*Difference 2019–2025 (%)*
Gross value added in agriculture and forestry, real, LCU	1.6	1.6	1.6	1.5	−0.1	1.6	1.5	1.5	1.5	1.5	1.5	0.0
Gross value added in arts, entertainment and recreation, real	1.3	1.3	1.3	1.3	0.0	1.2	1.3	1.3	1.3	1.3	1.3	0.0
Gross value added in communications, real	3.9	4.7	4.9	5.0	1.1	5.3	5.2	5.3	5.3	5.4	5.4	0.4
Gross value added in construction, real	5.7	4.8	4.9	5.0	−0.7	4.9	5.0	5.0	5.0	5.1	5.1	0.1
Gross value added in distribution services, real	10.4	10.9	11.0	11.0	0.7	11.0	10.9	11.1	11.1	11.2	11.2	0.2
Gross value added in electricity, gas, steam & air-cond. supply	2.0	1.8	1.7	1.7	−0.3	1.7	1.7	1.7	1.7	1.6	1.7	0.0

Eurozone	*2010* (%)	*2017* (%)	*2018* (%)	*2019* (%)	*Difference 2010–2019* (%)	*2020* (%)	*2021* (%)	*2022* (%)	*2023* (%)	*2024* (%)	*2025* (%)	*Difference 2019–2025* (%)
Gross value added in extraction, real	0.4	0.3	0.3	0.3	−0.1	0.3	0.3	0.2	0.2	0.2	0.2	−0.1
Gross value added in financial services, real	5.3	4.7	4.6	4.7	−0.6	5.0	4.8	4.8	4.8	4.8	4.8	0.1
Gross value added in health, real	7.3	7.4	7.3	7.3	0.0	7.6	7.7	7.5	7.5	7.4	7.4	0.1
Gross value added in hotels and catering, real	2.9	2.5	2.9	2.9	0.1	2.0	2.7	2.8	2.9	2.9	2.9	0.0
Gross value added in manufacturing, real, LCU	15.7	16.9	16.9	16.6	0.9	16.0	16.2	16.2	16.1	16.1	16.1	−0.5
Gross value added in other services, real	3.7	3.4	3.4	3.4	−0.3	3.2	3.3	3.3	3.3	3.3	3.3	−0.1
Gross value added in professional services, real	6.3	6.6	6.6	6.6	0.4	6.8	6.7	6.8	6.8	6.8	6.8	0.2

(continued)

Table 10.1 (continued)

Eurozone	*2010 (%)*	*2017 (%)*	*2018 (%)*	*2019 (%)*	*Difference 2010–2019 (%)*	*2020 (%)*	*2021 (%)*	*2022 (%)*	*2023 (%)*	*2024 (%)*	*2025 (%)*	*Difference 2019–2025 (%)*
Gross value added in real estate, real	11.2	11.1	11.1	11.1	−0.1	11.8	11.2	11.1	11.1	11.0	11.0	−0.1
GVA in transport services and storage, real	5.0	4.7	4.7	4.7	−0.3	4.4	4.6	4.6	4.7	4.7	4.7	0.0
Gross value added in water supply, waste management	1.0	0.9	0.9	0.9	0.0	0.9	0.9	0.9	0.9	0.9	0.9	−0.1
Gross value added in administrative and support services	4.3	4.7	4.8	4.8	0.5	4.7	4.8	4.8	4.9	4.9	5.0	0.1
Gross value added in public administration	7.0	6.4	6.4	6.4	−0.6	6.9	6.7	6.5	6.4	6.4	6.3	−0.1
Gross value added in education	5.0	4.7	4.6	4.6	−0.4	4.6	4.6	4.5	4.5	4.4	4.4	−0.2
Total	100.0	100.0	100.0	100.0	–	100.0	100.0	100.0	100.0	100.0	100.0	–

Greece	*2010 (%)*	*2017 (%)*	*2018 (%)*	*2019 (%)*	*Difference 2010–2019 (%)*	*2020 (%)*	*2021 (%)*	*2022 (%)*	*2023 (%)*	*2024 (%)*	*2025 (%)*	*Difference 2019–2025 (%)*
Gross value added in agriculture and forestry, real, LCU	3.2	4.3	4.4	4.3	1.0	4.2	4.3	4.2	4.1	4.1	4.1	−0.2
Gross value added in arts, entertainment and recreation, real	1.3	1.3	1.3	1.4	0.1	1.2	1.2	1.3	1.3	1.3	1.3	0.0
Gross value added in communications, real	3.8	3.0	3.0	3.0	−0.8	3.1	3.0	3.0	3.0	3.0	3.0	0.1
Gross value added in construction, real	4.4	3.1	3.3	3.6	−0.8	3.6	3.7	3.8	3.9	4.0	4.2	0.5
Gross value added in distribution services, real	12.5	8.9	9.0	9.2	−3.4	9.0	9.1	9.3	9.4	9.4	9.4	0.2
Gross value added in electricity, gas, steam & air-cond. supply	1.4	1.4	1.4	1.3	−0.1	1.4	1.3	1.3	1.3%	1.3	1.3	0.0
Gross value added in extraction, real	0.4	0.3	0.3	0.3	−0.1	0.3	0.3	0.3	0.3	0.3	0.3	0.0

(continued)

Table 10.1 (continued)

Greece	*2010 (%)*	*2017 (%)*	*2018 (%)*	*2019 (%)*	*Difference 2010–2019 (%)*	*2020 (%)*	*2021 (%)*	*2022 (%)*	*2023 (%)*	*2024 (%)*	*2025 (%)*	*Difference 2019–2025 (%)*
Gross value added in financial services, real	4.8	3.9	3.5	3.2	−1.6	3.2	3.2	3.2	3.2	3.2	3.2	0.0
Gross value added in health, real	5.7	4.2	4.2	4.2	−1.6	4.5	4.5	4.4	4.3	4.2	4.1	−0.1
Gross value added in hotels and catering, real	4.9	6.9	7.1	7.3	2.5	5.4	6.2	7.1	7.2	7.4	7.5	0.2
Gross value added in manufacturing, real, LCU	8.1	8.5	8.5	8.5	0.4	8.8	8.6	8.5	8.5	8.6	8.6	0.2
Gross value added in other services, real	3.9	4.1	4.1	4.2	0.3	4.0	4.0	4.1	4.1	4.1	4.1	−0.1
Gross value added in professional services, real	3.7	3.0	3.1	3.2	−0.5	3.2	3.1	3.2	3.2	3.2	3.2	0.1
Gross value added in real estate, real	16.6	20.9	20.6	20.5	3.9	21.6	20.8	20.7	20.7	20.8	20.9	0.5
GVA in transport services and storage, real	7.0	6.0	6.2	6.3	−0.7	5.5	6.0	6.1	6.1	6.1	5.9	−0.4

Greece	*2010 (%)*	*2017 (%)*	*2018 (%)*	*2019 (%)*	*Difference 2010–2019 (%)*	*2020 (%)*	*2021 (%)*	*2022 (%)*	*2023 (%)*	*2024 (%)*	*2025 (%)*	*Difference 2019–2025 (%)*
Gross value added in water supply, waste management	1.1	1.4	1.4	1.3	0.2	1.3	1.3	1.3	1.3	1.3	1.2	−0.1
Gross value added in administrative and support services	1.6	1.7	1.7	1.8	0.2	1.7	1.8	1.8	1.8	1.8	1.8	0.0
Gross value added in public administration	9.9	11.1	10.9	10.8	0.9	11.9	11.7	10.9	10.5	10.3	10.1	−0.6
Gross value added in education	5.8	6.0	6.0	5.9	0.1	6.1	6.1	5.8	5.7	5.7	5.6	−0.2
Total	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	

Source Oxford Economics—Global Economic Model

At the same time, however, a number of other occupations were favored, such as Real Estate employees, of which Agents showed significant positive change, as well as Marketing Specialists, Software Engineers, Human Resources Specialists, Civil Engineers, Account Managers and Sales Executives (WEF, 2018).

In this context, it is particularly important that, in order to avoid the negative consequences of technological change accompanied by human capital deficits, mass unemployment, or increased inequality, institutions and companies strengthen the existing workforce through upskilling and reskilling, but also to provide incentives for employees and the unemployed to take part in such actions. Today, companies take such initiatives but unfortunately this is limited to a close circle of their employees, who already have high education and high value returns. In order for economies to be able to meet the demands, investment in human capital must be further strengthened.

A similar observation can be made for the Greek economy in terms of changes in employment. The observed differences in the period 2011–2019 are recorded in Table 10.2.

The biggest negative change concerns the construction and finishing technicians of buildings, with the exception of electricians. They are followed by skilled farmers and stockbreeders, cleaners and assistants, managers of hotels, restaurants, retail and wholesale businesses and other services, other (non-specialist) clerks, metalworkers, machinery and craftsmen and related occupations, craftsmen and related occupations, food, wood processing, clothing and related occupations.

On the other hand, personal service providers, general staff and keyboard operators, health professionals, business and administration assistants, transport drivers and mobile operators, security service providers, in the provision of personal care, customer service staff and professionals in the field of information and communication technologies, were increased.

As mentioned above, the crises of 2010 and 2020 each have their own special characteristics (financial crisis and pandemic COVID-19, respectively). Especially for the first one, there is an extensive literature, in terms of its various conditions, but also its results. The debt crisis of 2009–2010 is largely related to the particular timeless weaknesses of the Greek Economy (Hatzis, 2018; Petrakis, 2020a; Tsoulfidis & Zouboulakis, 2016). The 2020 crisis, on the other hand, is a historically unprecedented for a simultaneous shock in both supply and demand (Eichenbaum et al.,

Table 10.2 Changes in employment in the Greek Economy: 2011–2019

	Difference 2011–2019 in thousands of people
Construction and finishing technicians of buildings, excluding electricians	–79,770
Specialized farmers and stockbreeders, professionals	–58,047
Cleaners and assistants	–39,429
Managers of hotels, restaurants, retail and wholesale businesses and other services	–38,753
Other office workers	–35,702
Positive science and engineering technicians	–25,247
Metal, machine and related craftsmen practicing related professions	–23,949
Sellers	–23,347
Food processing technicians, woodworking, clothing and related professions	–19,831
Professionals in the field of information and communication technologies	9,871
Customer service employees	10,082
Employed in the provision of individual care	10,764
Employed in the provision of protection services	10,869
Vehicle drivers and mobile equipment operators	16,342
Assistants for Business and Administration Professionals	16,766
Health professionals	24,106
General staff and machine operators with keyboards	53,031
Employed in the provision of personal services	54,101

Source Labor Force Survey—EL.STAT

2020; Martín Fuentes & Moder, 2021). At the same time, these two crises of the twenty-first century share the common element of appearance in a time of sharp changes in technology due to the 4th Industrial Revolution and the implications that this has for the work structure.

If we isolate the effects on the labor market from the change of technology with the peak of automation during the first crisis in the second decade of the twenty-first century, we observe that the changes of labor were in the following form.

The most pressured employee occupations in developed countries were Computer Operators (~70% reduction), Executive Secretaries and Executive Administrative Assistants (~62% reduction), World Processors and Typists (~61% reduction), Switchboard Operators—including Answering Service (~55% reduction), Machine Feeders (~53% reduction), Telemarketers (~53% reduction), File Clerks (~53% reduction), Postal Service employees (~49% reduction), Data Entry Keyers (~45% reduction), Bill and Account Collectors (~39% reduction), and general management (Ding & Saenz Molina, 2020; WEF, 2020). The reason why all these changes have taken place has to do with the nature of the job in that occupations, which is a means of specialization requirements, while following specific work patterns that can be recorded in code. These are, therefore, routine tasks that can be automated and replaced by capital (Acemoglu & Autor, 2010, Autor, 2013).

In the current crisis, since technology is constantly changing over the last decade and disruptions due to COVID-19 seem to have amplified it precisely because of its nature (WEF, 2020), the current changes in the labor market at the level of roles and occupations are mainly of a technological nature although they certainly should not be considered to be of a purely technological nature. The WEF (2020) survey for the Future of Jobs presents the occupations that show the most variability, which presents the 20 occupations with the largest increase and the corresponding 20 occupations with the largest decrease in demand for 2020, essentially under the short-term pressure of COVID-19. The ones that show the strongest upward demand in the labor market are Data Analysts and Scientist, AI and Machine Learning Specialists, Big Data Specialists, Digital Marketing and Strategy Specialists, Process Automation Specialists, Business Development Professionals, Digital Transformation Specialists, Information Security Analysts, Software and Applications Developers, Internet of Things Specialists, Project Managers and other related occupations.

In contrast, the occupations with the most intense downward trends are in order of intensity: Data Entry Clerks, Administrative and Executive Secretaries, Accounting, Bookkeeping and Payroll Clerks, Accountants and Auditors, Assembly and Factory Workers, Business Services and Administration Managers, Client Information and Customer Service Workers, General and Operations Managers, Mechanics and Machinery Repairers, Material-Recording and Stock-Keeping Clerks and a number of other occupations (WEF, 2020).

10.4 Analysis of Employment and Occupations of the Greek Production System 2018 and 2027

The starting point of the analysis of this chapter is the available analysis of the relationship between employment and occupations that exists for the Greek economy in 2018. This analysis has been produced based on the processing of data of the Hellenic Statistical Service Labor Force Survey[1] This work categorizes in single-digit codes of the sectors of economic activity in Greece all the occupations that are active in them. The occupations have a three-digit analysis in their codes, so that their study can be made even more thorough. Thus, all employees who are registered in a two-digit code (sector) are divided into all the occupations that are active in this sector during the three-digit analysis. Of course, there are occupations that are active in more than one sector, but their double registration would be a problem. In this case the employees in such an occupation are divided into the various sectors in which the occupation is employed based on the density with which the occupations meet in each sector so that the total number of employees in the sectors remains stable, i.e., the total number of 2018.

The one described is the 1st step of the analysis that follows (more details can be found on the Annex at the end of this chapter).

The 2nd step comes from the combination of the forecasts of the Oxford Economics Global Economic Model for the year 2027 and the analysis of Inputs–Outputs of the Greek economy (see Chapter 7).

Before presenting the results regarding the development of employment and occupations, some clarifications are necessary:

1. In the assessments made, some sectors may show an increase or decrease in employment, but there is no corresponding development in their production. This stems from the possibility that the development of a sector is not combined with a proportional increase in employment (due to technological changes, etc.).
2. At the level of occupations, the analysis is based on the structure of the categories based on the Statistical Classification of Occupations (STEP-08), which is compiled under the responsibility of the Hellenic Statistical Authority and is related to the international

[1] I would like to thank Dr. Angelos Efstratoglou for sharing his “Research on the relationship between employment and occupations,” INE/GSEE 2020 (mimeo).

ISCO-08. An issue that holds using this type of cataloging is that it underestimates the evolution of certain occupations due to technological or other factors that affect the nature of each job (see Chapter 5). Therefore, the present chapter mainly concerns the external change in the characteristics of employment.

In the baseline scenario, the growth rate of the economy is expected to reach 7.2% for 2020, due to the external shocks of the pandemic. However, in 2021 the economy is expected to recover quickly, showing an average growth rate of 2.7% in the period immediately following the crisis. Including the period 2020–2021, the average GDP growth rate is 2.0%. In a more optimistic scenario, which incorporates any positive impact from the reforms, the growth rate you estimate could be up to 2.7%.

Employment is estimated that in the baseline scenario will be 4.7 million employees up to 2027, with a continuous increase after 2021. In the most optimistic scenario, employment may approach up to 4.8 million in 2027, in levels close to those of 2009. The increase in employment in the optimistic scenario is expected to "add" 136.6 thousand additional employees by 2027 compared to the baseline scenario. The average annual rate of change in employment is 0.3% in the baseline scenario and 0.7% in the most optimistic scenario, while from 2021 to 2027, the rates are 1.0 and 1.5%, respectively.

However, between the main sectors of the economy, it is estimated that different rates of change in employment will be observed, resulting in the change of the relevant shares and the change of the productive structure of the economy.

The following table shows the evolution of the number of employees per 1-digit sector of economic activity, as divided by the main economic sectors of the economy. Analytically, employment in trade is expected to increase, with an average annual increase of 1.4%. The Information and Communication sector is estimated to expand in terms of employment by 1.3% on average by 2027, followed by the same increase in Professional, Scientific and Technical Activities, as well as Administrative and Support Activities. As for the Health sector, it is expected to record an increase in employment by 1.1%. Finally, Tourism activities (Accommodation and Catering) despite the significant decline in 2020, accommodation and catering is expected to expand at an average rate of 1.0% by 2027 and at a rate of 1.9% from 2021.

On the other hand, negative rates of change in employment are found in mining (Mining and Quarrying sector), Electricity and Water Supply and utilities, as well as in Agriculture, Forestry and Fisheries, with an average decrease of 2.1, 1.4 and 1.3%, respectively, by 2027 (see Table 10.3). This reduction can be associated, either with the shift of labor to other sectors, i.e., the restructuring of the employment structure, or with the mechanization of processes and therefore a reduction in the labor rate. Finally, a decrease in employment is expected in the Real Estate Management occupations and in the Construction sector by 0.7%.

Based on the results of the analysis of Chapter 7 the estimation of employment per sector of activity in a single-digit analysis for 2027 is derived. Then, based on the rates of employment by sector and occupations as obtained in Step 1, i.e., with the labor distribution that existed in 2018, there is a reduction to a three-digit analysis and the employees in each sector of activity are calculated corresponding by occupation for 2027. Therefore, the internal structure of the sectors and the distribution of workers in occupations are assumed to be constant.

This is how the 2nd Step of the analysis is formed which contains the estimation of the number of employees (employment) per sector of activity in double-digit analysis (sectors) and three-digit analysis (occupations) in the year 2027.

To proceed to the 3rd Step we get the results of the analysis of Chapter 7 from which the employment per occupation in a three-digit analysis for 2027 is obtained. Then, based on the coefficients obtained in step 1, the employees in each occupation are calculated proportional by sector of activity for 2027 assuming that the relationship between two-digit and three-digit analysis of occupations remains the same as was in 2018.

Essentially both steps, step 2 and step 3, refer to the same content, i.e., the distribution of workers in sectors and occupations in the year 2027 (but they are not quantitatively identical). The first has been calculated based on the assessment of the evolution of employment by sector and the third based on the assessment of the evolution of occupations, both of which result from the analysis of inputs–outputs of the Greek economy. In both cases the hypothesis that the relationship between single-digit and three-digit classification of occupations remains stable as in 2018 is used.

Table 10.3 Evolution of employees per 1-digit branch of economic activity (STAKOD 2008)—Basic Scenario, (thousand people)

NACE (1 digit)	*2019*	*2020*	*2021*	*2027*	*Average yearly change 2019–2027 (%)*	*Classification based on average yearly change 2019–2027*
Agriculture, hunting, forestry and fishing	497,1	470,6	472,3	446,8	**−1.3**	**16**
Mining and quarrying	10,0	9,3	9,4	8,4	**−2.1**	**19**
Manufacturing	346,6	330,6	326,7	329,8	**−0.6**	**12**
Electricity, gas supply	29,6	28,8	27,0	26,4	**−1.4**	**18**
Water supply	30,5	29,4	28,5	27,2	**−1.4**	**17**
Construction	192,4	182,5	176,0	181,9	**−0.7**	**15**
Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	787,3	745,9	748,0	877,9	**1.4**	**1**
Transport and storage	249,5	220,9	227,4	237,1	**−0.6**	**13**
Transport, storage and communication	572,5	466,2	553,7	619,0	**1.0**	**6**
Media and Communication	95,7	95,6	95,1	105,9	**1.3**	**2**
Financial intermediation	78,7	78,4	75,6	76,8	**−0.3**	**11**
Real estate, renting and business activities	19,0	18,6	18,6	18,0	**−0.7**	**14**

NACE (1 digit)	*2019*	*2020*	*2021*	*2027*	*Average yearly change 2019–2027 (%)*	*Classification based on average yearly change 2019–2027*
Professional, Scientific and Technical Activities	264,6	254,5	251,0	292,0	**1.2**	**3**
Administrative activities	137,5	129,0	129,8	151,2	**1.2**	**4**
Public administration and defense; compulsory social security	397,5	411,5	410,2	389,7	**–0.2**	**10**
Education	364,2	362,8	362,6	385,5	**0.7**	7
Health and social work	266,6	284,9	282,1	291,6	**1.1**	**5**
Arts	72,7	68,4	65,8	71,3	**–0.2**	**9**
Other community, social and personal service activities	153,6	154,5	155,5	152,8	**–0.1**	**8**
Total	4.565,4	4.342,3	4.415,4	4.689,4	0.3	

Source Labor Force Survey—EL.STAT

The 4th step and last step of the methodology is to construct the employment relationship in the sectors of the economy and in the occupations that exist in the sectors as the average of the content of steps 2 and 3 to get the consideration of the two approaches.

10.5 Analysis of the Production System Requirements on Human Capital

In this section, all the changes previously presented are presented based on the production structure and the employment structure for the Greek economy into an analysis of the requirements in terms of human capital.

In order for such an analysis to take place, a set of information is required regarding each occupation, the Working Activities undertaken by its employees to complete it, as well as the set of Knowledge, Skills and Abilities that they need for this to happen. This critical role in this analysis is undertaken by the well-known database O*NET On Line which offers a set of information on the labor market and employment characteristics (Handel, 2016) (see Annex A at the end of the chapter). Through this cataloging of occupations, we can draw a hierarchical list of different characteristics that are of great interest based on the importance they have for each occupational category.

So, for example, in terms of knowledge requirements, there are 33 required items for the analysis of all occupations based on O*NET database. That is, the total required knowledge has been divided into items that cover individual areas such as mathematics, food production knowledge, economics and accounting, etc.

At the same time, for each occupation there is a Ranking of Importance (RBI) (see Annex B at the end of the chapter) importance hierarchy for each Knowledge Item and therefore they can be ranked based on the importance they receive in it. The 3 most important items are selected, which configure the basic profile of the occupation for each feature through the 3 basic items.

However, depending on the sector—field of occupation, we add an additional knowledge, which we consider to characterize the sector, which is defined based on the subjective judgment of the analyst. Therefore, all occupations have a fixed triad of characteristics and an additional characteristic that varies depending on which sector the occupation appears in.

With this method of establishing a basic professional profile and the recognition of an industry characteristic, we can analyze the requirements of the work structure in terms of human capital.

To give an example, having compiled these profiles, we know how many items of knowledge professionals are required to have, of a category, e.g., working in the field of "sales and marketing" in all sectors of economic activity, then the product of the number of employees of this occupation in each sector on the four items (3 basic and 1 sector) of their profiles, can give the density of knowledge items used by the whole economy for the cognitive support of "sales and marketing".

This analysis can be done for 2018 and 2027 and of course requires significant computational assistance.[2]

10.5.1 Analysis in Terms of Working Activities Requirements

With this method, we export all the work activities required by the production structure, as presented in the previous section, both in absolute terms and in percentage. This analysis is done in two time points, for the production structure of 2018 as well as for the estimation of the production structure for 2027. Having now the information for each moment, we can compare it to see the evolution of the activities that entails over time the restructuring of the employment structure during the 3rd decade of the twenty-first century.

We observe (Table 10.4) that a significant part of the activities is stable, such as Repairing and Maintaining Electrical Equipment (−0.014%), Interacting with Computers (+0.004%), Resolving Conflict or Negotiating with Others (−0.003%) and so on. This is an expected development as it would be particularly strange to anticipate an overall radical restructuring of work activities. In any case, the activities we mentioned are the main features of a wide range of tasks and we would not expect them to show drastic changes.

At the same time, some activities are emerging which are expected to upgrade their importance in the coming years. Such activities are

[2] The analysis and processing of the data were done using Excel. Initially, a routine was developed in Visual Basic with which the occupations—sectors were assigned to the sector items. From the resulting table were created the corresponding cumulative tables per item. Finally, with the use of formulas and appropriate formatting, the final reference tables were presented.

Table 10.4 Comparison of requirements in Working Activities 2027 in relation to 2018

item title	*item*	*2027 Employees*	*2027 Percentage (%)*	*2018 Employees*	*2018 Percentage (%)*	*Difference in percentages (%)*	*Difference in employees***
Performing For People or Working With Public	w30	1734662	**9,956%**	1382788	9,595%	0,361%	6270
Handling and Moving Objects	w17	1477196	8,479	1289992	8,951	−0,472	−6978
Communicating With Persons Outside Organization	w5	1469207	**8,433**	1166917	8,097	0,336	4932
Getting Information Needed to Do the Job	w15	1443181	**8,283**	1139986	7,910	0,373	5386
Operating Vehicles or Equipment	w27	1125139	6,458	1035897	7,188	−0,730	−8213
Performing General Physical Activities	w31	1103482	6,334	996385	6,914	−0,580	−6402
Controlling Machines and Processes	w6	795395	4,565	752281	5,220	−0,655	−5207
Communicating With Other Workers	w4	717473	**4,118**	565528	3,924	0,194	1391

item title	*item*	*2027 Employees*	*2027 Percentage (%)*	*2018 Employees*	*2018 Percentage (%)*	*Difference in percentages (%)*	*Difference in employees***
Selling or Influencing Others	w38	668184	**3,835**	521058	3,615	0,220	1467
Identifying Objects, Actions and Events	w18	588171	**3,376**	436771	3,031	0,345	2030
Processing Information	w32	587504	**3,372**	413867	2,872	0,500	2939
Teaching Others	w40	575715	3,304	504509	3,501	−0,196	−1130
Repairing and Maintaining Mechanical Equipment	w35	450173	**2,584**	370158	2,568	0,015	69
Establishing and Maintaining Relationships	w12	422783	2,427	366969	2,546	−0,120	−507
Monitoring and Controlling Resources	w26	421790	**2,421**	336758	2,337	0,084	355
Documenting or Recording Information	w10	411350	**2,361**	308612	2,141	0,220	903
Analyzing Data or Information	w1	396874	**2,278**	312353	2,167	0,111	438

(continued)

Table 10.4 (continued)

item title	*item*	*2027 Employees*	*2027 Percentage (%)*	*2018 Employees*	*2018 Percentage (%)*	*Difference in percentages (%)*	*Difference in employees***
Performing Administrative Activities	w29	358362	**2,057**	275793	1,914	0,143	513
Providing Consultation and Advice to Others	w33	345760	**1,985**	269944	1,873	0,111	385
Monitor Processes, Material or Surroundings	w25	304239	1,746	286746	1,990	–0,243	–741
Making Decisions and Solving Problems	w24	258685	1,485	214893	1,491	–0,006	–17
Interpreting Meaning of Information to Others	w22	174624	1,002	153517	1,065	–0,063	–110
Updating and Using Job-Relevant Knowledge	w42	174102	0,999	146906	1,019	–0,020	–35
Developing Objectives and Strategies	w9	158722	**0,911**	127549	0,885	0,026	41
Judging Qualities of Things, Services or People	w23	144576	**0,830**	118956	0,825	0,004	6
Interacting With Computers	w21	142213	**0,816**	117091	0,812	0,004	5

item title	*item*	*2027 Employees*	*2027 Percentage (%)*	*2018 Employees*	*2018 Percentage (%)*	*Difference in percentages (%)*	*Difference in employees***
Resolving Conflict or Negotiating with Others	w36	131742	0,756	109416	0,759	−0,003	−5
Inspecting Equipment, Structures or Material	w20	115743	0,664	100462	0,697	−0,033	−38
Thinking Creatively	w41	96476	**0,554**	62425	0,433	0,121	116
Evaluating Information Against Standards	w14	96437	0,554	87448	0,607	−0,053	−52
Assisting and Caring for Others	w2	86917	0,499	78223	0,543	−0,044	−39
Organizing, Planning and Prioritizing	w28	84626	0,486	80102	0,556	−0,070	−60
Repairing and Maintaining Electrical Equipment	w34	73332	0,421	62621	0,435	−0,014	−10
Guiding, Directing and Motivating Subordinates	w16	68488	**0,393**	47058	0,327	0,067	45
Estimating Needed Characteristics	w13	65016	0,373	57930	0,402	−0,029	−19

(continued)

Table 10.4 (continued)

item title	*item*	*2027 Employees*	*2027 Percentage (%)*	*2018 Employees*	*2018 Percentage (%)*	*Difference in percentages (%)*	*Difference in employees***
Implementing Ideas or Programs	w19	49574	0,285	42569	0,295	−0,011	−6
Staffing Organizational Units	w39	37515	**0,215**	24697	0,171	0,044	16
Scheduling Work and Activities	w37	25667	**0,147**	17128	0,119	0,028	7
Coordinating Work and Activities of Others	w7	23448	**0,135**	13339	0,093	0,042	9
Drafting and Specifying Technical Devices	w11	14103	0,081	12595	0,087	−0,006	−1
Coaching and Developing Others	w3	4177	0,024	3657	0,025	−0,001	−1

Source Own calculations based on data from the Hellenic Statistical Authority and the analysis in Chapter 7 based on the methodology presented in this chapter

Getting Information Needed to Do the Job (+0.373%), Performing for People or Working with Public (+0.361%), Communicating with Persons outside the Organization (+0.336%) and Identifying Objects, Actions and Events (+0.345%). We observe that these activities are tasks that are performed in a complex or flexible environment and are therefore difficult to routine and translate into code. Therefore, our findings are in line with the international literature on long-term trends and developments in the labor market, especially in terms of capital and labor substitution and complementarity (Acemoglu & Autor, 2010, Autor, 2013, Tijdens et al., 2012).

Finally, a number of activities, such as Handling and Moving Objects (−0.472%), Operating Vehicles or Equipment (−0.730%), Controlling Machines and Processes (−0.655%) or Performing General Physical Activities (−0.580%), show declining trends. The common feature of these activities is not so much their physical dimension as that they occur in a more or less stable context, and that they require an average level of specialization and can therefore be replaced by capital (Autor et al., 2003).

The presentation of developments in employment characteristics with Working Activities is not done by chance as they are the central element of Occupational Requirements. Essentially, Working Activities are the high level of abstraction analysis of work tasks in each occupation.

With the above illustration we have a first general picture of the tasks and activities which are estimated that will be called to execute the productive structure of the Greek economy in 2027.

All other changes in terms of human capital must be based on changes in Working Activities and Occupational requirements in general. These result in both Working Requirements (Knowledge and Skills) and the required Worker Characteristics (Abilities) (see Chapter 4). For this very reason, we choose to start presenting the developments in the characteristics of employment by the Working Activities.

Already from the changes in Working Activities we can expect developments regarding the required human capital. Less material and machinery management requirements, increased situation management and communication requirements.

10.5.2 *Analysis in Terms of Knowledge Requirements*

Based on the method presented above we can also export the changes in terms of knowledge.

In relation to changes in Working Activities, we observe that a significant share of the most important cognitive requirements remain constant. However, the elements that articulate the overall knowledge requirements for the work structure seem to be more volatile than Working Activities. Generally knowledge such as English Language (−0.004%), Building and Construction (−0.007%), or Communications and Media (−0.01%) are predicted to have the same importance for the work structure in 2027 as in 2018.

At the same time, a number of fields of knowledge such as Mathematics (+0.142%), Customer and Personal Service (+0.377%), Sales and Marketing (0.403%), Administration and Management (+0.475%) are expected to be strengthened.

Knowledge such as Mechanical (−0.583%), Engineering and Technology (−0.335%), Biology (−0.842%), Chemistry (0.503%) are expected to have a decreasing importance for the working structure. This shows a clear trend for less demanding knowledge of STEM scientific fields (other than mathematics) for the job structure. These findings are in line with other research that shows the declining importance of these fields for the Greek economy, as well as a surplus in such knowledge (WEF, 2018, see also Chapter 8).

The findings in Table 10.5, regarding the changes in knowledge requirements between 2027 and 2018, are in line with the changes in the core element of Working activities, mainly to the extent that there is an increase in knowledge requirements related to interpersonal communication, and situation management and people treatment.

10.5.3 *Analysis in Terms of Skills Requirements*

Respectively, following the same methodology, we can analyze the changes in terms of Skills. Skills are the second key element of Working Requirements, and therefore, we should expect an agreement of the relative changes to a large extent. Again there is an increasing trend of skills related to communication tasks, while there is a declining trend in the importance of skills related to the management of tools and processes.

Table 10.5 Comparison of Knowledge 2027 statistical characteristics in relation to 2018

item title	*item*	*2027 Employees*	*2027 Percentage (%)*	*2018 Employees*	*2018 Percentage (%)*	*Difference in percentages (%)*	*Difference in employees***
Mathematics	k20	1890020	**10.881**	1541004	10.738	0.142	2693
Customer and Personal Service	k8	1689936	**9.729**	1342052	9.352	0.377	6370
Clerical	k5	1361391	7.838	1148886	8.006	−0.168	−2293
Sales and Marketing	k29	1329801	**7.656**	1040750	7.252	0.403	5362
Mechanical	k21	1208403	6.957	1082050	7.540	−0.583	−7050
Administration and Management	k1	886525	**5.104**	664260	4.629	0.475	4210
English Language	k13	858363	4.942	709687	4.945	−0.004	−33
Engineering and Technology	k12	735975	4.237	656154	4.572	−0.335	−2469
Biology	k2	712803	4.104	709717	4.946	−0.842	−6002
Education and Training	k11	647379	3.727	567336	3.953	−0.226	−1467
Chemistry	k4	553565	3.187	529495	3.690	−0.503	−2784
Transportation	k33	545030	**3.138**	426945	2.975	0.163	886
Food Production	k15	507638	2.922	476755	3.322	−0.400	−2030
Economics and Accounting	k10	494702	**2.848**	378473	2.637	0.211	1042
Production and Processing	k26	479694	2.762	439980	3.066	−0.304	−1461
Computers and Electronics	k7	434153	**2.499**	351856	2.452	0.048	206
Geography	k17	430940	**2.481**	286582	1.997	0.484	2085

(continued)

Table 10.5 (continued)

item title	*item*	*2027 Employees*	*2027 Percentage (%)*	*2018 Employees*	*2018 Percentage (%)*	*Difference in percentages (%)*	*Difference in employees***
Public Safety and Security	k28	419444	**2.415**	332248	2.315	0.099	417
Personnel and Human Resources	k23	299922	**1.727**	234643	1.635	0.092	274
Medicine and Dentistry	k22	277310	1.596	236618	1.649	−0.052	−146
Therapy and Counseling	k32	252507	**1.454**	206610	1.440	0.014	35
Design	k9	241260	**1.389**	187403	1.306	0.083	200
Law, Government and Jurisprudence	k19	199062	**1.146**	156325	1.089	0.057	112
Building and Construction	k3	188480	**1.085**	154741	1.078	0.007	12
Psychology	k27	137619	0.792	119961	0.836	−0.044	−61
History and Archeology	k18	132581	**0.763**	62323	0.434	0.329	436
Sociology and Anthropology	k30	114969	**0.662**	39843	0.278	0.384	441
Telecommunications	k31	105371	0.607	91262	0.636	−0.029	−31
Communications and Media	k6	77518	**0.446**	62588	0.436	0.010	7
Fine Arts	k14	61116	**0.352**	34940	0.243	0.108	66
Physics	k25	51590	0.297	45900	0.320	−0.023	−12
Foreign Language	k16	45084	**0.260**	33086	0.231	0.029	13

Source Own calculations based on data from the Hellenic Statistical Authority and the analysis in Chapter 7 based on the methodology presented in this chapter

Based on Table 10.5 skills that seem to maintain a constant importance for the Greek economy in the coming years are: Evaluation (−0.005%) and Perception (−0.006%), Systems, Evaluation of Ideas (+0.035%), Operations Analysis (0.0095) and Management of Material Resources (0%).

Opposite examples of skills that are estimated to be of enhanced importance for the future are Information Organization (+0.625%) and Gathering (+0.490%), as well as various communication skills, like Active Listening (+0.325%), Speaking (+0.179%), Writing (+0.238%) and Reading Comprehension (+0.201%). Service Orientation (+0.325%) is also expected to have an upgraded significance (Table 10.6).

On the contrary. Skills related to the management and supervision of processes and tools are expected to be of less importance for the work structure. It is estimated that Equipment Selection will show significant negative changes (−0.71%) in terms of its role as a skill, as well as Operation and Control (−0.988%) and Equipment Maintenance (−0.462%).

10.5.4 Analysis in Terms of Abilities Requirements

The last category of human capital that is examined in the present research is Abilities, which are inherent characteristics of the employee that assist and facilitate the execution of specific tasks. Table 10.7 has been extracted using the corresponding method with the previous ones and presents the estimated changes in requirements in terms of abilities from 2027 to 2018.

It is important to note that again we observe changes that are in agreement with both the international literature and the changes in terms of Working Activities.

Typically, an enhanced role is expected for communication-related abilities like Oral Expression (+0.523%), Oral Comprehension (+0.232%), Speech Clarity (+0.140%) and Written Comprehension (+0.140%). The same hold for abilities related to flexibility and complex situation management like Information Ordering (+0.293%) and Category Flexibility (+0.346%).

At the same time, a number of abilities related to simple physical tasks seem to be losing their importance, like Dynamic Strength (+0.669%), Trunk Strength (+0.483%), Manual Dexterity (0.173%) and Extent Flexibility (+1.009%).

Table 10.6 Comparison of statistical characteristics of Skills 2027 in relation to 2018

Item title	*item*	*2027 Employees*	*2027 Percentage (%)*	*2018 Employees*	*2018 Percentage (%)*	*Difference in percentages (%)*	*Difference in employees***
Speaking	s38	1700482	**9.787**	1379353	9.609	0.179	3035
Service Orientation	s35	1585450	**9.125**	1262658	8.796	0.329	5221
Active Listening	s2	1371533	**7.894**	1086508	7.569	0.325	4460
Equipment Selection	s6	1141723	6.571	1045206	7.281	−0.710	−8104
Reading Comprehension	s32	1085209	**6.246**	867712	6.045	0.201	2185
Operation and Control	s25	1084695	6.243	1038085	7.231	−0.988	−10,721
Equipment Maintenance	s5	743912	4.282	680955	4.744	−0.462	−3437
Social Perceptiveness	s36	712723	**4.102**	563421	3.925	0.177	1263
Repairing	s33	663272	3.817	616611	4.295	−0.478	−3170
Information Organization	s14	660127	**3.799**	455690	3.174	0.625	4125
Writing	s47	557907	**3.211**	426852	2.973	0.238	1325
Installation	s15	552702	3.181	480717	3.349	−0.168	−927
Learning Strategies	s18	512859	2.952	443361	3.088	−0.137	−702
Information Gathering	s13	499923	**2.877**	342663	2.387	0.490	2451
Mathematics	s22	459805	2.646	386578	2.693	−0.047	−214
Product Inspection	s30	376694	2.168	333583	2.324	−0.156	−587
Critical Thinking	s4	373772	**2.151**	295836	2.061	0.090	338
Coordination	s3	366468	**2.109**	286239	1.994	0.115	422
Judgment and Decision Making	s17	363514	**2.092**	296294	2.064	0.028	102
Instructing	s16	301538	1.736	267790	1.865	−0.130	−392
Science	s34	235018	1.353	198220	1.381	−0.028	−67
Problem Identification	s29	222424	1.280	202229	1.409	−0.129	−286
Management of Personnel Resources	s21	207030	**1.192**	144551	1.007	0.185	382

Item title	*item*	*2027 Employees*	*2027 Percentage (%)*	*2018 Employees*	*2018 Percentage (%)*	*Difference in percentages (%)*	*Difference in employees***
Monitoring	s23	193740	1.115	164817	1.148	−0.033	−65
Operation Monitoring	s26	191916	1.105	174149	1.213	−0.109	−209
Management of Financial Resources	s19	163859	**0.943**	121491	0.846	0.097	158
Persuasion	s28	156489	0.901	130038	0.906	−0.005	−9
Troubleshooting	s45	154956	**0.892**	126134	0.879	0.013	20
Synthesis/Reorganization	s39	146085	**0.841**	61553	0.429	0.412	601
Implementation Planning	s12	99986	0.575	82794	0.577	−0.001	−2
Negotiation	s24	99116	**0.570**	77869	0.542	0.028	27
Identification of Key Causes	s9	91436	**0.526**	74487	0.519	0.007	6
Programming	s31	61344	0.353	56886	0.396	−0.043	−27
Idea Generation	s8	59855	**0.344**	47878	0.334	0.011	6
Active Learning	s1	41295	**0.238**	32279	0.225	0.013	5
Testing	s43	37755	0.217	33945	0.236	−0.019	−8
Management of Material Resources	s20	28833	0.166	23827	0.166	0.000	−1
Operations Analysis	s27	22365	**0.129**	17242	0.120	0.009	1
Idea Evaluation	s7	20689	**0.119**	12135	0.085	0.035	7
Time Management	s44	19201	**0.111**	10038	0.070	0.041	7
Systems Evaluation	s40	3190	**0.018**	1896	0.013	0.005	0
Systems Perception	s41	1841	0.011	2360	0.016	−0.006	−1
Solution Appraisal	s37	1841	0.011	2360	0.016	−0.006	−1

Source Own calculations based on data from the Hellenic Statistical Authority and the analysis in Chapter 7 based on the methodology presented in this chapter

Table 10.7 Comparison of statistical characteristics of Abilities 2027 in relation to 2018

item title	*item*	*2027 Employees*	*2027 Percentage (%)*	*2018 Employees*	*2018 Percentage (%)*	*Difference in percentages (%)*	*Difference in employees***
Oral Expression	a29	2459325	**14.118**	1959515	13.594	0.523	12,865
Oral Comprehension	a28	1550027	**8.898**	1249117	8.666	0.232	3594
Speech Clarity	a40	1332753	**7.651**	1082597	7.511	0.140	1864
Written Comprehension	a51	900838	**5.171**	734734	5.097	0.074	665
Information Ordering	a20	833547	**4.785**	647439	4.492	0.293	2444
Manual Dexterity	a21	812496	4.664	697155	4.837	–0.173	–1402
Memorization	a23	779674	**4.476**	626832	4.349	0.127	989
Extent Flexibility	a10	667560	3.832	697733	4.841	–1.009	–6733
Deductive Reasoning	a5	664948	**3.817**	547333	3.797	0.020	132
Number Facility	a27	617910	**3.547**	496213	3.443	0.105	645
Written Expression	a52	577183	**3.313**	476986	3.309	0.004	23
Dynamic Strength	a8	510347	2.930	518778	3.599	–0.669	–3417
Inductive Reasoning	a19	508821	**2.921**	350639	2.433	0.488	2484
Arm-Hand Steadiness	a1	461601	2.650	395241	2.742	–0.092	–426
Trunk Strength	a47	440135	2.527	433767	3.009	–0.483	–2125
Reaction Time	a35	402761	**2.312**	302610	2.099	0.213	856
Problem Sensitivity	a33	396635	2.277	342808	2.378	–0.101	–403
Control Precision	a4	385865	2.215	352279	2.444	–0.229	–884

item title	*item*	*2027 Employees*	*2027 Percentage (%)*	*2018 Employees*	*2018 Percentage (%)*	*Difference in percentages (%)*	*Difference in employees***
Near Vision	a25	350276	**2.011**	285483	1.981	0.030	105
Static Strength	a45	348574	**2.001**	282413	1.959	0.042	145
Category Flexibility	a3	299278	**1.718**	197805	1.372	0.346	1034
Mathematical Reasoning	a22	235778	**1.353**	184026	1.277	0.077	180
Spatial Orientation	a39	217370	**1.248**	168894	1.172	0.076	165
Speed of Limb Movement	a43	197190	1.132	171078	1.187	−0.055	−109
Originality	a30	189634	1.089	156966	1.089	0.000	−1
Wrist-Finger Speed	a50	163374	**0.938**	124187	0.862	0.076	124
Finger Dexterity	a12	162947	**0.935**	123478	0.857	0.079	128
Fluency of Ideas	a14	149215	**0.857**	120781	0.838	0.019	27
Dynamic Flexibility	a7	114015	**0.654**	87145	0.605	0.050	56
Far Vision	a11	113491	0.651	95714	0.664	−0.013	−15
Multilimb Coordination	a24	90634	**0.520**	74015	0.513	0.007	6
Visual Color Discrimination	a48	88422	0.508	86056	0.597	−0.089	−80
Hearing Sensitivity	a18	72573	0.417	60234	0.418	−0.001	−1
Selective Attention	a37	66036	0.379	54798	0.380	−0.001	−1
Visualization	a49	57291	**0.329**	38549	0.267	0.061	35
Stamina	a44	42348	0.243	35507	0.246	−0.003	−2
Rate Control	a34	37751	0.217	32761	0.227	−0.011	−4

(continued)

Table 10.7 (continued)

item title	*item*	*2027 Employees*	*2027 Percentage (%)*	*2018 Employees*	*2018 Percentage (%)*	*Difference in percentages (%)*	*Difference in employees***
Gross Body Equilibrium	a17	35029	0.201	34395	0.239	−0.038	−14
Explosive Strength	a9	30926	**0.178**	23868	0.166	0.012	3
Glare Sensitivity	a15	17730	0.102	20485	0.142	−0.040	−8
Depth Perception	a6	17041	0.098	14157	0.098	0.000	−1
Flexibility of Closure	a13	12346	**0.071**	6145	0.043	0.028	3
Gross Body Coordination	a16	8558	0.049	7110	0.049	0.000	−1
Peripheral Vision	a32	3267	**0.019**	2512	0.017	0.001	0
Auditory Attention	a2	2755	**0.016**	2062	0.014	0.002	0

Source Own calculations based on data from the Hellenic Statistical Authority and the analysis in Chapter 7 based on the methodology presented in this chapter

Finally, a wide range of key abilities, such as Fluency of Ideas (+0.019%), Originality (+0.0%) and Selective Attention (−0.001%), is going to keep its importance constant.

10.6 Discussion to the Previous Analysis

In this chapter, we briefly presented the estimated developments for the economic and labor structure of the Greek economy. In order to complete this assessment, we took into account both the change in the sectoral structure and the professional change in the economy.

Then we tried to make estimates for the evolution of the cumulative characteristics of employment in general. We translated the above estimated changes in the work structure in terms of Working Activities and the required human capital in terms (Knowledge, Skills and Abilities). We have noticed that our predictions are both internally consistent with each other and that they are in line with the international literature which addresses the issue of the labor market in the future.

Consequently, the developments in the Greek economy follow the changes of the rest of the developed countries. However, the observed changes are not radical as they do not show high intensity. This is related both to the particular characteristics of the Greek economy and its productive structure as presented in this chapter, as well as to a number of other macroeconomic characteristics, such as the low quality of institutions and the low preparation for the digital transformation and the low technological adaptability of the economy (Petrakis, 2020a). In any case, the Greek economy is following the developments of the West, even if this is a weakness.

Changes in the work activities in which the country's workforce is expected to be involved in the coming years affect all human capital requirements. We expect less work related to the management of materials and machinery and upgraded response to complex situations and contact needs with people. These developments translate into Knowledge, Skills and Abilities as Knowledge such as Science and machine management skills are expected to be less important, but the requirements for communication, administration and management or customer and personal service are to be increased.

The above provisions are particularly important for the establishment of a training program which will be able to prevent any skill gaps, but also to assist the forthcoming changes in the work structure. An education policy that will include both the basic education structure and the large institutions of the country (i.e., secondary-tertiary education), but also much more flexible such as lifelong learning, retraining, Upskilling and reskilling schemes (Giouli et al., 2021). It is of particular importance to reduce the frictions of the transition of the work structure based on (re) training of people who are within the work structure and the unemployed and future workers as well aiming to a continuous existence and supply of the required human capital characteristics, but also the maintenance of social cohesion, the reduction of inequality and the achievement of intergenerational justice; elements which are all necessary for the sustainable development (UN, 2020) of the Greek economy.

Annex

A. The Data of O*Net

Each profession is composed of 4 components based on the platform Dictionary of Occupational Titles (DOT) and O'NET on Line. The DOT and O'NET online databases developed by the United States Department of Labor. These databases were developed by labor market analysts who mapped thousands of workplaces to record the different types of work and what they include. Access to DOT is via the link https://occupationalinfo.org/. The four components are analyzed as follows:

Work Activities: is a systematic and deliberate action that requires different and complementary skills. A work activity involves different people working together in an organized way, in a common idea or project, to turn them into a specific result.

Knowledge: is an organized portfolio consisting of principles and truths, commonly accepted data that apply to various areas of life. According to Cedefop (2008), knowledge is the result of the assimilation of information acquired through learning.

Skills: defines the ability of an individual to apply knowledge and know-how in such a way as to be able to complete his tasks and solve problems (Cedefop, 2008). According to O*NET, the term skill also refers to those skills developed that facilitate learning and the faster acquisition of knowledge.

Abilities: refers to what we are capable of and can do when we make the maximum effort. For example, we may be able to solve mathematical equations, write perfect texts, disassemble a machine or persuade others to form an idea of something specific.

Each analytical profession has a unique six-digit code which follows the coding given by DOT (Dictionary of Occupational Titles) and O*NET Online (Occupational Information Network) in the occupations included and described by these databases (e.g., 4224—Hotel Receptionists -> 238,367,038—Hotel front desk clerk).

The Dictionary of Occupational Titles was developed by the United States Department of Labor and has helped employers, government officials, and HR professionals identify more than 13,000 different jobs. It was created by Job Analysts who visited and observed thousands of work environments in order to record the different types of work and the elements involved in their execution. DOT gradually evolved into the state-of-the-art online information platform: Occupational Information Network—O*NET developed by the United States Department of Labor, Employment and Training (USDOL/ETA) and first launched in 1998. The O*NET online platform is the most important source of information on employment and occupation in the United States and provides the most up-to-date data on understanding the changing nature of work and its impact on the workforce.

For a list of Working Activities—Knowledge—Skills—Abilities based on DOT and O'NET see O'NET Database.

B. Ranking by Importance Index (RBI)

An indicator that characterizes every knowledge, skill, ability, work activity and marks the degree of importance that each such element has in the execution of an Analytical Occupation. All Analytical Occupations contain a range of Work Activities, Knowledge, Skills and Abilities. These elements are found mostly in all occupations while what differs is the RBI (Ranking by Importance) index. The RBI index takes values from 1 to 100.

The most critical work activities, knowledge, skills and abilities from those that compose an Analytical Occupation are at the top with the RBI index approaching 100. The RBI that approaches the value of 1 marks the work activities, knowledge, skills and abilities of the Analytical Occupation that is of lesser importance for the performance of the occupation. These are the components of the Analytical Occupation (WA, A, S, K) that are not considered prerequisites for the performance of the occupation or are found less frequently in its practice.

Therefore, each Analytical Occupation corresponds to a unique outline of Work Activities, Knowledge, Abilities and Skills as the RBI for each component of the Analytical Occupation differs depending on the importance it has for the execution of each Analytical Occupation.

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