ENHANCING DEVELOPMENT IN THE SAUDI RENEWABLE ENERGY SECTOR: A PROMISING STRATEGY FOR JOB CREATION AND ECONOMIC DIVERSIFICATION

A DISSERTATION IN
Economics
and
Social Science Consortium

Presented to the Faculty of the University of Missouri-Kansas City in partial fulfillment of the requirements for the degree DOCTOR OF PHILOSOPHY

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ENHANCING DEVELOPMENT IN THE SAUDI RENEWABLE ENERGY SECTOR: A PROMISING STRATEGY FOR JOB CREATION AND ECONOMIC DIVERSIFICATION

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ABSTRACT

Unemployment, a critical modern problem, has economic as well as social costs. While its economic cost can be illustrated through the loss of the value of labor, its social costs include divorce, addiction to illegal drugs, and decisions to drop out of school. This dissertation proposes investment in the Saudi renewable energy sector through the Saudi Job Guarantee Program (SJGP) to address the chronic Saudi unemployment issue. Following the establishment of a new theoretical framework based on structural/technological changes and ecological theories, in addition to the existing heterodox theory of unemployment, the research uses a Leontief Input-Output model to calculate job numbers and the new value generated by the investment of a certain amount of money in this sector. Increasing domestic energy consumption efficiency through the implementation of energy reforms, as well as accelerating progress in public services such as transportation and growth in the Saudi renewable energy sector, are prerequisites for reducing the domestic consumption of fossil fuels. Overall, the growth of the renewable energy sector, in particular, solar and wind energy, is a feasible strategy that Saudi Arabia can use to diversify its economy. The
dissertation also aims to provide solutions that address difficulties in the development of the renewable energy sector, such as Green Bond/Sukuk and public-private partnerships (PPPs). The vision of this research is to reveal methods for accomplishing four goals driving the Saudi economy to high levels of employment, stability, sustainability, and prosperity.
The faculty listed below, appointed by the Dean of the School of Graduate Studies, has examined the dissertation titled “Enhancing Development in the Saudi Renewable Energy Sector: A Promising Strategy for Job Creation and Economic Diversification” presented by Mohammed A. Al Yousif, candidate for the Doctor of Philosophy degree, and certify that it is worthy of acceptance.

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ACKNOWLEDGMENTS

I am very grateful to God for granting me the wisdom, health, and strength to complete my research. I would also like to express my sincere gratitude and thanks to my advisor and former professor, Dr. Forstater, for his continuous support of my Ph.D. study. Dr. Forstater was not only my teacher but also like my father, providing me with patience, motivation, and an immense amount of knowledge throughout the course of my Ph.D. work. I am certain that we will work together on research that focuses on our favorite topics: green jobs and investment in renewable energy. Dr. Forstater’s advice and guidance played a significant role in enabling me to research and write this dissertation. Whatever words I say are inadequate to thank him for what he has given me. I am also hugely appreciative of Professor James Sturgeon, Linwood Tauheed, Doug Bowles, and Jimmy Adegoke for serving as my committee members, and for their valuable comments, feedback, and suggestions.

The other factor that has helped me achieve this success is, without a doubt, my family. Words cannot express how grateful I am to my parents, brothers, and sisters. My parents have given me the love and energy necessary to continue my work on this research and to confront all the difficulties in my path. Whenever I talked with them, they encouraged me with kind words and supportive prayers. I am very thankful to all my brothers and sisters for their help and support as well; they have been on hand to help me during every stage of my personal and academic lives. I am also very much indebted to my wife and two children, Ahmed and Yaseen, who supported me in every possible way as I completed this work. My wife, especially, believed in me and my ability to write a good dissertation. She worked hard to make time and a comfort zone available for me to work on my research. She is a great
partner for me and is a very important part of my success. Thank God that I am fortunate to have a great family like mine.
CHAPTER 1
INTRODUCTION

Unemployment is not only an economic issue but a social issue linked to various social and political problems. The economic cost of unemployment is the loss of the value that labor surplus adds to the total domestic GDP (Kaboub, Forstater & Kelsay, 2015). Unemployment has various adverse effects on the social fabric. For example, studies have shown that the crime rate among unemployed citizens soars because crime represents an alternative to earning money (Darity, 1999; Kaboub et al., 2015). In addition, the social cost of unemployment includes divorce, addiction to illegal drugs, and decisions to drop out of school. Consequently, in most cases, a high level of unemployment leads to political instability due to expectations that jobless youth will protest against the existing political structure (Okafor, 2011).

Solving unemployment is a government responsibility and a prerequisite for economic stability. There is no evidence indicating that the private sector possesses the ability to address this issue without government intervention (Karimi, 2008). Hence, government intervention is essential because it guarantees jobs to those willing to work for a socioeconomically acceptable wage (i.e., a minimum wage). Various economists have explored the idea of a job guarantee (JG) and employment of last resort (ELR). These economists include Hyman P. Minsky (1986, 1992), who presented the idea of ELR. Various others have added elements to ELR, such as Mathew Forstater (1999a, 2002a, 2002b), Philip Harvey (1989), Jan Kregel (1991), William Mitchell (1998, 2001; Mitchell & Wray, 2005), L. Randall Wray (1998), and Fadhel Kaboub (2006; Kaboub et al., 2015). This dissertation
will discuss the theoretical framework of JG/ELR, including its difficulties and challenges, using Argentina and India as case studies.

The current dissertation proposes investment in the Saudi renewable energy sector as part of the Job Guarantee Program (JGP), representing a solution that addresses chronic unemployment among Saudis. In this connection, the Saudi government would enhance investment in the renewable energy sector to generate both direct and indirect jobs for unemployed youth. Direct jobs such as project development, construction, installation, and maintenance would be available in the renewable energy sector, while indirect jobs would be available in other manufacturing fields, services, and sectors, including banking and sectors involved in the supply of equipment, materials, and services. Also, new jobs (“induced jobs”) would be generated through expenditures on goods and services by employees of these new renewable energy sector projects. This new demand will lead to the expansion of local businesses and social activities such as groceries, hospitals, schools, and restaurants (Lehr, Nitsch, Kratzat, Lutz, & Edler, 2008). One aspect of the JGP is to provide the necessary training and education for its employees. Over time, the JGP’s employees would acquire a decent level of skills and experiences and would become more likely to obtain high-wage private sector jobs.

One tricky issue that repeatedly crops up is the fact that asking Saudi policymakers to invest in the renewable energy sector is a difficult task, for the Saudi oil reserves of 268 billion barrels of oil are the second largest in the world, following those of Venezuela (Nelson & Pierpont, 2013). However, two factors may encourage the Saudi government to shift investment toward the renewable energy sector. First is the government’s realization

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1 According to the U.S. Energy Information Administration (EIA) statistics report.
that the Saudi consumption of petroleum is the highest among other countries in the region. Saudi Arabia consumes, on average, three million barrels of oil and gas every day through transportation, power generation, air conditioning, and water desalination (Lahn & Stevens, 2011). Hence, it is logical to divert such a huge amount of domestic oil consumption to export by depending on the renewable energy sector domestically (Taher & Hajjar, 2014).

Furthermore, Saudi Arabia has significant financial reserves, with official reserve assets worth $529 billion according to the latest IMF figures. Saudi Arabia could use some of these financial resources to develop the domestic renewable energy sector and tap desert areas receiving the highest amount of sunlight throughout the year.

This research considers structural/technological changes and ecological economics as part of the existing heterodox theory of unemployment. It uses a Leontief Input-Output model to calculate job numbers and new value generated by investments of substantial amounts in the renewable energy sector. In this dissertation, the solution for Saudi unemployment stagnation is based fundamentally on the ELR theoretical framework. This research will examine the ability of the ELR theory to solve the problem of high unemployment among Saudi populations. The promotion of domestic Green Bond/Sukuk markets and public-private partnerships (PPPs) will be a strategy proposed for further development in the Saudi renewable energy sector. The vision of this research is to suggest methods of accomplishing four major goals driving the Saudi economy: a high level of employment, stability, sustainability, and prosperity.
CHAPTER 2
THE HIGH RATE OF UNEMPLOYMENT AMONG SAUDI CITIZENS AND OBSTACLES TO SAUDI ECONOMIC DIVERSIFICATION

Introduction

The primary objective of this dissertation is to study the complex economic problem of the high level of unemployment in Saudi Arabia. One fundamental question for this research is: “Does increasing investment in the Saudi renewable energy sector generate more jobs for Saudi citizens?” Chapter 4 of this dissertation estimates the number of new jobs that will result from new investment in the Saudi renewable energy sector through the Saudi Job Guarantee Program (SJGP). Briefly, this chapter is part of a comprehensive process that aims to find a suitable, enduring, and adequate solution for the high level of unemployment among Saudi citizens.

The modern Saudi economy suffers from many economic issues, such as a high unemployment rate among Saudi youth and less economic diversification. Various historical, social, and economic events have built the modern Saudi economy. This chapter addresses the early stages of Saudi Arabian development, specifically how King Abdulaziz brought about the Kingdom’s unity. This chapter also studies the development of the Saudi economy before/after oil discovery. This is followed by a review of the Saudi Arabian development plans from 1970 to 2015. Additionally, this chapter discusses the new National Transformation Program, NTP (2020) and Saudi Vision 2030, and explores various research papers that investigate the unemployment problem and governmental efforts to address it.
For convenience, this chapter has been divided into the following major sections: a brief history of Saudi Arabia, planning and development in Saudi Arabia, the Saudi Arabian economic structure, the population, the labor force, unemployment, and a conclusion.

**A Brief Overview of the Kingdom of Saudi Arabia**

The Arabian Peninsula is located in the southwestern part of the Asian continent. It comprises seven countries: Saudi Arabia, Qatar, Kuwait, Bahrain, Oman, the United Arab Emirates, and Yemen. With a unique location in the Arabian Peninsula, Saudi Arabia covers the most significant area: 829,995 square miles (2,149,690 square kilometers) of the total Arabian Peninsula, which itself is 1,250,000 square miles (3,237,500 square kilometers). Saudi Arabia is approximately three times the size of the state of Texas in the United States. Saudi Arabia’s geographical location is unique in that it has access to two seas: the Arabian Gulf and the Red Sea, which are its main gateways to Asia and Africa. It also has a unique spiritual position in the Islamic world, as the main Islamic holy lands, Mecca and Medina, are located there. Globally, Saudi Arabia is significant for two reasons: It is one of the primary suppliers of energy, and it has the world’s second-largest oil reserves, with 18% of the entire global oil reserves.

Before King Abdulaziz established the Kingdom of Saudi Arabia in 1932, the Arabian Peninsula was home to isolated tribes with sovereign territories. In most cases, these tribes had protracted feuds with each other because of the scarcity of natural resources—specifically, water and food—in the middle of the Arabian Desert (Luciani, 1990). The predominant majority of Arabic tribes adopted King Abdulaziz’s project, which brought unity and solidarity to these tribes and positioned them under a single flag/leader because they were weary of protracted and prolonged tribal wars and conflicts (Al-Rasheed, 2010;
Duri, 2012). In addition, the existence of the first and second Al Saud States (First Al Saud State [1744-1818] and Second Al Saud State [1824-1891]) was a significant impetus for King Abdulaziz to get his family states back from Ibn Rashid. In this regard, the loyalty that some major tribes had to the bin Saud family was a significant source of support for King Abdulaziz (Al-Rasheed, 2010). By 1932, King Abdulaziz had established complete authority over the entire land that today is known as the Kingdom of Saudi Arabia (KSA). He built the Kingdom of Saudi Arabia on the same fundamental values as those of the first and second Saudi states, establishing Islam as the religion and Sharia as the foundation of law. This ushered in a new era of progress and development in the Arabian Peninsula (Barakat, 1993; Dickson, 2015).

In terms of population, in 1932 the Saudi population was less than four million. Because 95% of the total Kingdom is desert, it lacked critical natural resources (food and water) at that time, and the poverty rate was very high. Regarding economic activities, there were three major occupations for Saudi citizens based on their geographical locations. On the eastern coast of Saudi Arabia, the primary economic activities were fishing, pearl diving, trading, and farming. In the middle of the nation, people were highly dependent on cattle rearing as the main source of their income. Citizens in the western region, which includes the two Muslim holy places, depended on trading and offering hospitality to pilgrims (Al-Rasheed, 2010; Al-Turaiqi, 2008).

During the pre-oil era, the Kingdom faced a financial crunch. King Abdulaziz had only three major sources of income: pilgrimage, funding from large merchant families, and British funds (Ramady, 2010). These sources of income were used to pay salaries to soldiers and government employees, and to cover other government expenditures. However, a
significant change in the history of Saudi Arabia took place in 1938, when Standard Oil of California (SOCAL) discovered oil there. This discovery caused dramatic shifts in the socio-economic and political development of Saudi Arabia (Al-Rasheed, 2010).

Following the discovery of oil, the Saudi socioeconomic structure witnessed rapid growth. Saudi Arabia took to this rapid development transformation scheme due to enormous pressure stemming from advanced countries’ efforts to return their economies to pre-WWII conditions (El Mallakh, 2015). Because Saudi Arabia faced a shortage of labor in terms of quantity and quality, the Saudi government had no choice but to seek foreign labor for new government development projects such as the construction of roads and schools, as well as other infrastructure development projects (Ramady, 2010). One result of this rapid transformation (i.e., the employment of millions of foreign laborers) was the creation of an imbalance between social and economic development.

The number of foreign laborers rapidly multiplied, reaching 11 million out of approximately 31 million residents by the end of 2017 (GSTAT, 2017). Saudi economic activity has relied heavily on low-skilled foreign laborers, particularly in the private sector. This is why the Saudi private sector is built on two foundations: cheap workers and cheap energy sources (gasoline and electricity). From 1940 until 1985, a significant majority of Saudis graduating from schools and colleges were employed in the public sector and by the major domestic oil companies. However, in the late 1980, the high unemployment rate among Saudi citizens became a major economic issue for two reasons: the public sector’s inability to generate more jobs for Saudi youth, and the private sector’s structural faults or
inability to employ Saudi job seekers. Additionally, Saudi Arabia’s fertility rate\(^2\) jumped by 5.0% between 1960 and 1990. Naturally, this increased in the number of Saudi youth, exacerbating the problem of unemployment among Saudis. This has created a critical economic issue due to the slow response of the government and other public sector organizations.

**Saudi Arabia Development Plans**

This section discusses the Saudi five-year development plans. King Faisal, the second in line after King Saud, founded these plans, whose principal purpose has been to drive the Saudi economy toward diversification, resilience, stability, and sustainability (Katanani, 1971). The Saudi development plans have two phases. The first phase is the five-year development plan, which had nine stages from 1970 to 2015. The second phase includes the National Transformation Plan (NTP 2020) and Vision 2030. The goal of this section is to review and assess the Saudi Arabian development stages, both actual and planned, up to 2030.\(^3\)

According to the Saudi Ministry of Economy and Planning (MEPsaudi), the primary goals of the First Development Plan (1970-1975) were to increase the education and skills of Saudi citizens as well as the resultant aggregate level of income. More precisely, the overall growth rate target at the end of the First Development Plan was set to be around 9.9% annually (4.6% for the agriculture sector and 14.0% for the manufacturing sector). The

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\(^2\) The fertility rate includes only Saudi citizens, while the growth rate of the total population includes both citizens and foreigners.

\(^3\) The Saudi Ministry of Economy and Planning archive is the main source of these five-year development plans. And statistical numbers got from different resources mainly GSTAT and SAMA.
budget set for the First Development Plan was around US $9.2 billion. This amount of money was to be spent on Saudi defense projects, education, transportation, and utilities. During the First Development Plan, Saudi Arabia’s growth rate was almost exactly what had been expected. It was around 10% on average during those five years, while the non-oil/private sector real GDP grew by 12.3% per year on average. Two major factors accounted for this high growth rate during the period from 1970 to 1975: a rapid expansion in oil production and an increase in oil prices from $1.30 in 1970 to $2.70, $9.75, and $10.75 in 1972, 1973, and 1975, respectively. The total oil revenues for those five years were around US $27 billion.

The significant amount of investment in oil projects like building refineries and boosting the oil infrastructure increased the demand for labor. During the First Development Plan, the Kingdom labor force (includes Saudis and Non-Saudis) grew from 1.3 million in 1970 to 1.6 million in 1975 at an approximate growth rate of 3.8% each year. Despite the growth rate of foreign workers was high at 4.2% from 1970 to 1975, Saudi workers’ contribution to the total Kingdom labor force was over 85%.

The Second Development Plan (1975-1980) had three goals: sustain a high rate of economic growth, reduce economic dependence on crude oil exports, and reinforce human resources development through education, training, and the stability of the social structure. In general, one of the most important purposes of the Second Development Plan was to increase Saudi citizens’ social prosperity and standard of living. That is why the Second Development Plan

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4 It is more convenient to continue using the U.S. dollar ($), as Saudi Arabia had not implemented a clear exchange rate system in 1970.
5 The non-oil-sector GDP of Saudi Arabia includes both the government sector and the private sector. For this research, we focus on the non-oil private sector GDP as an index for diversification.
6 For the oil price, we used the Brent price.
Plan contained a number of social benefits, including free medical services and education, especially vocational training. In terms of housing, the Saudi government established a loan program, in the form of marriage loans with zero interest rates for Saudi citizens. To reduce the cost of living, the Saudi government subsidized the prices of primary goods, services, and utilities such as water, electricity, and fuel. In addition, the Saudi government extended social security benefits to people with limited incomes. By the end of the Second Development Plan, for instance, the government had spent around 42% of the total budget, which was $142 billion, on the development of the Saudi foundation infrastructure, industry, and agriculture.

During the Second Development Plan, oil production increased to almost 8.5 million barrels per day (bpd), and the price of oil increased from $10.46 per barrel in 1975 to $37.42 at the end of 1980. During the Second Development Plan (1975-1980), the Saudi economic growth rate averaged 9.3%. The Saudi non-oil private sector had an astonishing growth rate of over 15%. The number of foreign workers inside Saudi Arabia was around 767,000 or 35% of total employment by the end of 1980. Saudi workers’ contribution to the total Kingdom labor force declined to around 65%, which amounted to 1,470,000 workers.

The Third Saudi Development Plan (1980-1985) had three goals. The first was to increase development in the non-oil sector. The second was to increase Saudi social participation in economic development, whether through business or jobs. The third was to enhance the public sector’s efficiency. However, the economic situation deteriorated during the Third Development Plan, as the price and quantity of oil exports experienced a downward trajectory. The price of oil was $34.23 per barrel at the beginning of the Third Development Plan (1981) and had decreased to $27.54 by the end of 1985. Also, Saudi oil production

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7 The big majority of these foreigner workers employed in the Saudi constriction sector.
dropped from 9.90 million bpd in 1980 to 3.17 million bpd by the end of 1985. This reduction in oil prices and quantities was the main reason for the slow growth rate, which was an average of 5.8% as compared to 9% during the years 1975-1979. The non-oil private sector average growth rate dropped to 6.2% as compared to 15%. All of these circumstances deviated the Saudi government from achieving the goals of the third plan of development.

The Fourth Development Plan (1985-1990) had two primary objectives: enhancing the efficiency of both the public and private sectors and encouraging development in the non-oil private sector. During this period, prices saw a significant increase, as did oil production. The oil price increased from $13.73 per barrel in 1985 to $20.82 per barrel in 1990. Oil production increased from 3.2 million bpd in 1985 to 6.4 million bpd in 1990. The economic activities that were boosted during this period of development included community welfare schemes, trade, and personal services. Moreover, the community and personal services sector witnessed approximately 790,000 new jobs, while the trade sector created more than 210,000 new jobs during 1985-1990. Because foreign workers dominated new jobs in the Saudi non-oil private sector, their participation in the total labor force ultimately increased to 59.8%, while the percentage of Saudi laborers witnessed a decline to 40.2% by the end of 1990. This period recorded an improvement in the living conditions and income of Saudi citizens due to an increase in the Saudi participation rate in the government and oil sector. This, in turn, increased demand for services and goods. Unfortunately, this new demand on the economy could not generate enough new jobs for Saudi youth in the non-oil Saudi private sector.8

8 Unfortunately, there is no official data for the rate of unemployment among Saudis in 1990, but I expected it should be no less than 8%.
During the beginning of the Fifth Development Plan (1990-1995), the overall real GDP growth rate exceeded 4.1%, boosted by an increase in oil production from 6.4 million bpd in 1990 to around 8 million bpd. The non-oil private sector grew rapidly, at a rate of 5.6%, due to massive government expenditures during the Gulf War (1991). However, this rapid growth did not generate more jobs for Saudis. The shortage of new jobs for Saudi citizens in the private sector was likely due to the significant amount of investments flowing to the construction and infrastructure sectors. In Saudi Arabia, low-skilled (productivity) and skilled foreign laborers dominated most construction and infrastructure activities. It is clear from this stage of the development plan that the problem of Saudi unemployment is a structural issue resulting from unplanned structural shifting to industrial society. By the end of 1995, the total number of employees was 6,867,700 (Saudi and Non-Saudi). However, the Saudi contribution rate to the total Kingdom labor force was still low, at 35%.  

During the Sixth Development Plan (1995-2000), the Kingdom focused on the social development of the educational system and the improvement of citizens’ income. However, rapid growth in the Saudi population was a major challenge to the achievement of these objectives. This rapid growth required a proportionate increase in the number of schools, the capacity of hospitals, and housing. Also, this situation required the creation of job opportunities for the increasing number of Saudi youth. The Sixth Development Plan also faced financial difficulties because of the budget deficit caused by the Arab Gulf War and deflation. Although the growth of real Saudi GDP during this period averaged around 2.0%, and that of the non-oil private sector was between 4.3% and 5.2% during the same period,  

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9 The total foreign laborers inside the Kingdom at the end of 1975 was no more 600 thousand. Note that this number has rapidly increased to around 5 million by the end of 1995 (less than 20 years).
and total employment grew at an annual rate of 2.3%. Total Saudi employment increased to 3.2 million, with an average annual growth rate of 3.3%. This increase in the level of Saudi participation in the total Kingdom labor force might have stemmed from the implementation of some of the Saudization programs, such as the Saudization banking sector. This growth in the total number of Saudi workers was not enough because the overall unemployment rate among Saudis was around 8.1%, while the unemployment rate among Saudi women was 15.8% at the end of 2000.

The general goals of the Seventh Development Plan (2000-2005) were to improve public services, such as education and health services, and achieve balanced development through all regions. The other important goal was human development. In addition, the Saudi government opened the door to the private sector to increase its participation in the development process. This plan of development also emphasized the development of the mineral resources sector for purposes of diversification. For the first time, this plan also mentioned its concern for environmental preservation and a decrease in pollution.

At the end of the Seventh Development Plan, the non-oil sector increased its contribution to the total Saudi real GDP, with the private sector participation more in total economic activity. The overall growth rate, on average, increased by 3.4% per annum during this period. The non-oil sector’s contribution to the total Saudi GDP increased from 71.7% in 1999 to 73.5% in 2004. The share of the private sector to the GDP rose from 52.4% to 54.6% by the end of 2004, with an annual growth rate of 4.3%. Government expenditures on human development witnessed the highest increase as compared to other development plans. It constituted a substantial share of 57.1% of total government expenditures. The foreign labor force’s contribution to the Kingdom labor force during this period had decreased from 62.5%
to 57.3% by the end of 2005. However, the unemployment rate among Saudis increased to around 11.5%, and the Saudi female unemployment rate was 25.4% at the end of 2005. Based on these two factors (Saudi contribution and unemployment rate), Saudi citizens’ (especially Saudi females’) rate of participation in the Kingdom’s labor force increased rapidly during this period.

The general objectives of the Eighth Development Plan (2005-2009) were to increase employment opportunities for citizens, improve the quality of life, and increase the rate of economic growth and educational development in terms of quantity and quality. The objectives for this development plan also included improvement in health and social services, the encouragement of scientific research and technology development, the implementation of more regulations to save water resources, and the protection of the environment. Under the Eighth Development Plan, overall real GDP growth was around 2.8%, while the non-oil private sector saw a significant growth rate of 9.5% over this period. The unemployment rate among Saudi citizens was around 10.5%, and the Saudi female unemployment rate was 25.4% at the end of 2009.

Finally, the objectives of the Ninth Development Plan (2010-2014) can be summarized as follows: the continuation of spending on human development, an increase in the standard of living and improvement in the quality of life for all citizens, the achievement of economic diversification, an increase in energy efficiency, and the encouragement of small and medium enterprises (SMEs). Overall, the Saudi real GDP growth during the Ninth Development Plan was around 5.4%, while the non-oil private sector had a significant growth rate of 7.2% over this period. The number of Saudi workers increased to 4.6 million at the end of 2013—a sharp increase over the 1.2 million total in 1970. However, the unemployment rate among
Saudi citizens was around 11.7%, while the Saudi female unemployment rate was 32.8% at the end of 2014.

Because the primary goal of the first phase (I) of Saudi development planning remained unachieved, the Saudi government decided to initiate the Second Development Plan phase (II), which includes the NTP (2020) and Vision 2030. It is clear that this new version of the development plan is more optimistic and promising. In effect, the Ministry of Economics and Planning has established the National Transformation Program NTP (2020) as the second phase of Saudi development planning; it could be considered the Tenth Development Plan (2015-2020). Overall, the focus will fall on enhancing the efficiency of the Saudi public sector, along with building unity among the various ministries. That is why 24 government ministries are directly involved in the NTP. The main goal of these shared tasks among ministries is to reduce the level of redundancy and increase the level of efficiency and supervision. The other benefit of having an enhanced level of cooperation among ministries is to increase the level of the capacity of the public sectors to handle major projects. Finally, Vision 2030 was designed to transform the Saudi economy into a robust and vigorous one. The main goals of Vision 2030 are to have a more efficient and participatory public sector, a more diversified economy, and a better quality of life for Saudi citizens. The primary challenge for the Saudi economy is to find the best strategy for achieving these initiatives with the fewest negative consequences on the social and economic fronts.

Briefly, from this summary, one can see that there were some issues with the Saudi development plans from 1970 to 2015. One problem was the absence of a final evaluation procedure for each of these plans, to allow for a thorough review and feedback. Discussing mistakes and problems is a very important aspect of any development plan, as it helps
prevent the same problems from occurring in the future. For example, during the Third Development Plan, Saudi Arabia pushed for growth in the agriculture sector as a form of diversification. However, the main source of fresh water in Saudi Arabia is water drawn from aquifer wells. That is why the Kingdom faced a freshwater availability issue following its substantial investment in agriculture. For example, in 1980, agriculture consumed 90% of fresh water. Such a massive investment in the agriculture sector, whose main achievement was the depletion of a scarce national resource, was not a good solution for diversification (Manama, 2016). Also, one fundamental goal of most of the Saudi five-year development plans was to build a more independent private sector with a significant contribution to the Saudi economy. Unfortunately, the Saudi private sector is still highly dependent on government spending, which is not in accordance with the aims of all these plans of development, initiated to develop a highly productive and independent Saudi private sector.

**Gross Domestic Product (GDP)**

This section explains the Saudi economic structure by discussing the Saudi Gross Domestic Product (GDP). The goal of this discussion is to show the extent to which the Saudi economy relies on the oil sector. The literature presents three approaches for calculating GDP: the income approach, expenditure approach, and production approach. The income approach is the total national income, which includes sales taxes, and the net foreign factor income. The expenditure approach is the value of purchases made by the final users. The production approach calculates the value added at each stage of production. The “value added” means the total sales minus the value of the intermediate inputs of the production process. The production approach contains more details to show the distribution of economic

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10 Real GDP
activities by producing sector, while the expenditure approach contains details that show the total value by type of final expenditure, including private sector and government investment (IP and IG), total consumption by the private sector and government (CP and CG), net business inventory accumulation (INV), and net exports (exports-imports, X-M).

Growth Domestic Product (GDP) is an acronym that economists regularly use. Non-economists may be unfamiliar with this concept. The first part of this section reviews the definitions of real and nominal GDP. The next section defines the differences between GDP and GNP. The third part will discuss, in detail, the methodology for calculating the GDP that the Saudi General Authority of Statistics (GSTAT) uses. The major objective is to evaluate the amount that the Saudi oil and non-oil sectors contribute to the total Saudi GDP. The Saudi non-oil sector includes the government sector and the private sector.

GDP calculates the level and the growth rate of economic activities. The Organization for Economic Co-operation and Development (OECD) defines GDP as expenditures on domestic finished goods and services plus net exports (i.e., exports minus imports). The International Monetary Fund (IMF) says that “GDP measures the monetary value of final goods and services—that is, those that are bought by the final user-produced in a country in a given period (say a quarter or a year)” (Callen, 2008, p. 1). GDP captures all market goods and services as well as non-market products such as defense or education/social services.

A significant difference exists between the concepts of GDP and GNP. The Gross National Product (GNP) is the total national production of the citizens and entities of a particular country, whether they happen to be inside the country or outside the country. By contrast, Gross Domestic Product (GDP) is the total national production that takes place within a certain country, whether it is produced by domestic or foreign entities. For instance,
if a certain U.S. national company has produced goods or services inside Saudi Arabia, its annual gross value added product would be added to the U.S. GNP total but would be counted as Saudi GDP. For evaluation of domestic economic activities, GNP does not necessarily reflect the actual growth rate of the domestic economy because it calculates the economic activities inside and outside the country. However, GDP accounts for all extensions in domestic products (goods and services) produced within the country during a year. A high GDP usually indicates strong economic growth and more job opportunities; the level of income is expected to increase, as will demand.

There are nominal GDP and real GDP. The nominal GDP reflects current prices (and current inflation) while the real GDP shows the real growth rate of physical activities, as it is adjusted for inflation.\(^{11}\) This is the reason why the nominal GDP value often appears higher than the real GDP except in the case of deflation or declining prices.

The current GSTAT methodology used to calculate the Saudi GDP is the “System of National Accounts (SNA) 1993.” Other Arabian countries have adopted SNA 1993, as have several developed and developing countries including Russia, China, and Denmark (SNA, 1993). Table 1 provides information about the GDP calculation methods and approaches that various countries use. However, SNA 1993 is an old methodology that does not calculate some essential economic sectors, such as small and medium enterprises (SMEs).

Table 1 explores the GDP methodologies used for different developed and developing countries, with three approaches: income, expenditure, and production. Developing and emerging countries use the SNA 1993 methodology to calculate their GDPs, but not all countries use these three approaches. The United States uses the NIPAs in addition to the

\(^{11}\) Real GDP = (nominal GDP/deflator) *100
SNA 1993 to calculate its GDP. The European System of Accounts 2010 is the GDP calculation methodology for most European countries. Canadian GDP is calculated using the Canadian System of National Accounts. Swaziland and Norway use the mixed methods of the European System of Accounts 2010 and SNA 2008. The countries do not necessarily use all three approaches. The Saudi Arabia General Authority of Statistics calculates its GDP using all three approaches, as do various other countries such as Norway, Turkey, the United Kingdom, and Morocco. For a researcher to understand the kind of information included in the GDP, that researcher should understand the GDP calculation methodology. For instance, if a researcher wants to compare two different GDPs of two different countries, he/she must be fully aware of these calculation methods to make a fairer judgment. Overall, GDP is an economic index for policymakers to evaluate their economic policies. GDP also presents useful information for foreign investors seeking to invest abroad.
Table 1

*GDP Methodologies Calculation*

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Income Approach</th>
<th>Expenditure Approach</th>
<th>Production Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saudi Arabia  System of National Accounts 1993 (SNA 1993)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Bahrain        System of National Accounts 1993 (SNA 1993)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Kuwait         System of National Accounts 1993 (SNA 1993)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Qatar          System of National Accounts 1993 (SNA 1993)</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Oman           System of National Accounts 1993 (SNA 1993)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>UAE            System of National Accounts 1993 (SNA 1993)</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Russia         System of National Accounts 1993 (SNA 1993)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>China          System of National Accounts 1993 (SNA 1993)</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Jordan         System of National Accounts 1993 (SNA 1993)</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Egypt          System of National Accounts 1993 (SNA 1993)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Morocco        System of National Accounts 1993 (SNA 1993)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Tunis          System of National Accounts 1968 (SNA 1968)</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>USA            System of National Accounts 1993 (SNA 1993) and European National Account 1995 and 2010 System of National Accounts 1993 (SNA 1993) and added more components to SNA 1993 to come up with the National Income and Product Accounts (NIPAs) for the U.S.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>UK             European System of Accounts 2010</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Turkey         European System of Accounts 1995</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Country</td>
<td>Methodology</td>
<td>Income Approach</td>
<td>Expenditure Approach</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Norway</td>
<td>European System of Accounts 2010 and System of National Accounts 2008 (SNA 2008)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>South Korea</td>
<td>System of National Accounts 2008 (SNA 2008)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>System of National Accounts 2008 (SNA 2008)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Canada</td>
<td>Canadian System of National Accounts</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Source: World Bank, 2018

**Saudi Arabia’s Real Gross Domestic Product (GDP)**

Over the past four decades, Saudi Arabia has experienced a rapid change in various economic and social sectors. The average growth rate of the Saudi real GDP was around 3.7% during the last six years (2011-2017), with a dramatic increase in the Saudi per capita GDP from about $1,433 in 1971 to about $21,057 by the end of 2017. Table 2 provides the average GDP growth rate in Saudi Arabia during the last five years, which was around 3.4%. Table 3 provides the economic activities and their contribution to the Saudi Arabian GDP. The share of the oil extraction and other mining sectors is still the highest, at 39.7%, as compared to that of the manufacturing sector (Petroleum Refining & Other), which is 12.2%. The share for electricity, gas, and water is 1.3%, while the share for construction is only 4.6%. The contribution of the non-oil sector, which includes the non-oil government sector and the private sector, is shown as no greater than 60% by the end of 2017 (GSTAT, 2017).

Table 2

**Saudi Arabia—Real GDP Growth Rate**

<table>
<thead>
<tr>
<th>Year (GDP)</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>5.4%</td>
<td>10.0%</td>
<td>5.4%</td>
<td>2.7%</td>
<td>3.6%</td>
<td>4.1%</td>
<td>1.4%</td>
<td>-0.9%</td>
</tr>
</tbody>
</table>

Source: General Authority for Statistics (GSTAT), 2018
Table 3

*The Contribution of Economic Activities to the Total Gross Domestic Product for 2017*

<table>
<thead>
<tr>
<th>Year/Industrial and Other Producers</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Mining and Quarrying (Crude Petroleum &amp; Natural Gas &amp; Other)</td>
<td>39.7%</td>
</tr>
<tr>
<td>2- Manufacturing (Petroleum Refining &amp; Other)</td>
<td>12.2%</td>
</tr>
<tr>
<td>3- Electricity, Gas, &amp; Water</td>
<td>1.3%</td>
</tr>
<tr>
<td>4- Construction</td>
<td>4.6%</td>
</tr>
<tr>
<td>5- Wholesale &amp; Retail Trade, Restaurants, &amp; Hotels</td>
<td>9.0%</td>
</tr>
<tr>
<td>6- Transport, Storage, &amp; Communication</td>
<td>6.0%</td>
</tr>
<tr>
<td>7- Finance, Insurance, &amp; Real Estate</td>
<td>9.7%</td>
</tr>
</tbody>
</table>

*Note. At producers’ values at constant prices (2010 = 100)*

Source: General Authority for Statistics (GSTAT), 2018

At the end of 2017, the total Saudi government revenue was SAR 691.5 billion ($184.4 billion). Despite a recent decrease in oil prices on the global level, this percentage of total oil revenue is still high: around 63%. This creates a clear picture of how much the Saudi Arabian economy depends on producing and exporting oil. The Saudi non-oil sector revenue was not more than SAR 180 billion at the end of 2017. Therefore, the non-oil sector represented no more than 36% of total Saudi revenue.

Saudi Arabia is a member of the Organization of Petroleum Exporting Countries (OPEC), which recommends the oil production quota for each OPEC country. Controlling oil’s contribution to the GDP is very difficult because the real oil GDP depends on oil production. For instance, the oil sector’s contribution to the Saudi GDP in 2018 is expected

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12 Except producers of government and personal, community, and social services.
to be high due to OPEC’s decision to increase oil supply by one million barrels per day to fill the gap in the oil market. Saudi Arabia is the most prolific member of OPEC, and its oil production is expected to increase by around 400,000 barrels per day. The quantity of oil production is an exogenous input to the economy. However, it is not the only issue. Although it increases real GDP growth, this increase in oil production will probably not create more jobs. Nor will it make a significant contribution to non-oil economic activities due to the fact that the oil sector depends largely on imported equipment. This reinforces the argument that researchers and policymakers must emphasize the growth of the non-oil sector (especially the private sector), which has a much greater impact on employment and economic activity, instead of focusing solely on the overall growth of Saudi Arabia’s GDP. Therefore, the Saudi National Transformation Plan (NTP 2020) and Vision 2030 are new plans of development for Saudi Arabia. These development plans aim to diversify the economy by increasing the contribution of the Saudi non-oil sector to the total Saudi GDP, thereby creating more jobs for Saudis, specifically in the Saudi private sector.

**Characteristics of the Saudi Arabian Labor Market**

**Population**

According to the last report by the General Authority of Statistics (GSTAT) (see Figure 1, GSTAT, 2017), Saudi Arabia experienced rapid population growth from 4 million in 1960 to 33.1 million by the end of 2017. Two major reasons could explain this growth. The first is that the fertility rate for Saudi families was around five percent, specifically, during the period between 1975 and 1992. Until recently, the fertility rate for Saudi Arabia was still higher than that of many developed and developing countries (see Table 4). The
second reason is the flow of foreign laborers, which could heighten population growth (Saudi and Non-Saudi) in the Kingdom of Saudi Arabia.

Table 4

Fertility Rate for Selected Countries, 2016

<table>
<thead>
<tr>
<th>Country</th>
<th>Fertility Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>1.8</td>
</tr>
<tr>
<td>Canada</td>
<td>1.6</td>
</tr>
<tr>
<td>Italy</td>
<td>1.4</td>
</tr>
<tr>
<td>Japan</td>
<td>1.4</td>
</tr>
<tr>
<td>USA</td>
<td>1.9</td>
</tr>
<tr>
<td>China</td>
<td>1.6</td>
</tr>
<tr>
<td>Bahrain</td>
<td>1.7</td>
</tr>
<tr>
<td>Saudi</td>
<td>2.9</td>
</tr>
<tr>
<td>World</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Source: Central Intelligence Agency, 2016; GSTAT, 2014

The Saudi population is expected to be around 39 million (both Saudi and Non-Saudi) by the end of 2030 (see Figure 1) (CIA, 2016; GSTAT, 2014). In this research, this prediction of the Saudi population stems from the fertility rate among Saudi families, which is expected to be around 2.4% during the period between 2018 and 2030. Also, the Saudi population prediction accounts for the fact that the growth rate of foreign laborers is expected to increase slowly due to the Saudization program. Policymakers must take this population projection seriously. Saudi youth will be required to have access to jobs, schools, services, healthcare, and utilities.
*GSTAT estimated this number based on the 2016 survey.

Figure 1. Population of Saudi Arabia during the period between 2010-2025.

Figure 2 classifies the distribution of population inside Saudi Arabia into four groups (newborn to 14 years, 15 to 39 years, 40 to 60 years, and 61 to 80 years). It is evident that the 15-to-39-year group is by far the largest, with over 45% of the total population. On the other hand, the portion of the population above 60 years is the smallest, at only five percent. Saudi Arabia should take advantage of—and responsibility for—this unique population distribution to tap into the talent and provide the required services, housing, school, college, and jobs for this new generation.
Structure of the Kingdom Labor Force

This section addresses the characteristics of the Kingdom labor force. It looks at the distribution of the labor force between Saudi and Non-Saudi workers, the foreign labor participation rate as compared to the total Kingdom labor force, and the distribution of employees between the government sector and the private sector. The last part of this section discusses the rate of unemployment among Saudi citizens.

The Kingdom labor force increased to 13.9 million in the first quarter of 2018 from 13.8 million in the fourth quarter of 2017. The foreign laborer participation rate was over 56% of the entire Kingdom labor force at the end of the first quarter of 2018. Although Saudi female workers’ participation in the private sector increased from 15.4% at the end of 2014 to 23% by the first quarter of 2018, Saudi female participation in the Kingdom labor force was no greater than 16% according to the latest GSTAT (2018) labor force survey.
Figure 3, one can see that youth aged between 25 and 39 showed a high level of density in the Kingdom labor force. From Figure 4, one can see that expatriate laborers in the Kingdom labor force dominated, with low-medium skilled showing an average of 80%.

Source: General Authority of Statistics (GSTAT), Q1, 2018.

Figure 3. Distribution of the Kingdom labor force by age (Saudi/Non-Saudi) (2017).

Source: General Authority of Statistics (GSTAT), Q1-2018

Figure 4. Saudi/Non-Saudi skills distribution in the Saudi labor market (Q1-2018).
Figure 5 shows the distribution of employees inside the Kingdom of Saudi Arabia between the private sector and the public sector. It also includes the division of Saudi and Non-Saudi laborers between these two sectors. Saudi laborers are employed mostly in the public sector, whereas the private sector employs mostly foreign laborers. As shown in Figure 5, the private sector employed more than 11.7 million people, while the public sector employed only 1.7 million by the end of 2017.

<table>
<thead>
<tr>
<th></th>
<th>Total Employed</th>
<th>Saudi National</th>
<th>Non-Saudi Nationals</th>
<th>Total Employed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.9</td>
<td>8.3</td>
<td>10.2</td>
</tr>
<tr>
<td>Source: General Authority of Statistics (GSTAT), 2018</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5. Employment distribution between the private sector and the public sector inside the Kingdom of Saudi Arabia (2017).

Figure 6 shows that the rate of unemployment among Saudi citizens was around 11.4% on average for the period from 1999 to 2017, and was around 28.8% on average among Saudi females for the same period. Because the number of older people who will be retiring is very low, as shown in Figure 3, it is important for Saudi Arabia to adopt a new,
effective economic policy to generate more jobs opportunities for new Saudi citizens entering the Saudi labor market. The two main reasons for this high level of unemployment among Saudi citizens are the high number of new graduates from colleges and universities (see Figure 2) and the government’s inability to employ new citizens.

![Unemployment rate among Saudi citizens (%)](image)

Source: General Authority of Statistics (GSTAT), 2018

*Figure 6. Unemployment rate among Saudi citizens (%)*

**Saudi Unemployment Literature Review**

The reality of endemic unemployment among Saudi youth is one of the most controversial topics for economists and government decision-makers in Saudi Arabia. The Saudi government knows that unemployment is a complex issue and requires serious in-depth study by economic researchers. It is also a structural problem that temporary solutions cannot address. Rather, it requires serious structural reform and long-term plans. These transformative plans could hurt some significant sectors of the Saudi economy, specifically the private sector. However, solving the problem of unemployment should guarantee the
economy’s stability and sustainability. This section studies the reasons for the high Saudi unemployment rate and governmental efforts to address this issue.

Adam Smith has defined a rentier economy as an economic system that generates its income from the ownership of valuable natural resources such as land, gold, and oil (Beblawi & Luciani, 1987; Smith, 1940). This profit is not part of the labor surplus value, and laborers are not a significant part of this profit. This disconnect between surplus value and laborers may explain the association of high unemployment with rentier economies. The high level of unemployment is not the only issue that rentier economies face. The relevant literature also names other issues, such as less-independent policies, less economic diversification, unsustainable economies, corruption, and volatile social/political systems (Ali & Abdellatif, 2015; Gelb, Eifert, & Tallroth, 2002; Gylfason, 2001; Karl, 2004). Additionally, the rentier economic systems usually experience a shortage of locally trained workers (Elbadawi & Gelb, 2010; Elbadawi & Soto, 2012). The Saudi economic system is a rentier economy because a major portion of government income comes from the exportation of natural resources—chiefly oil and natural gas liquids (Amuzegar, 2001). However, the case is different for developed and other emerging economies, which generate their income from the exportation of domestic products and services (Manama, 2016).

Since the discovery of oil in 1938, the country has moved rapidly toward industrialization. This new economic development requires the building of major economic infrastructures such as housing, public buildings, roads, schools, and hospitals. However, the entire population of Saudi Arabia at that time was no more than four million, and most people were poorly educated. Meanwhile, the new economic situation requires well-qualified labor. The Saudi government had no a choice but to use foreign workers to establish the
Saudi development agendas (Al Shamhari, 2009). The Kingdom experienced a massive flow of expatriates. However, no protective plans were created to replace them with qualified and indigenous Saudi laborers (Alsulami, 2014). This has led to a significant increase in the number of expatriates, whose numbers reached more than 13.5 million at the end of 2017 (GSTAT, 2018). Unfortunately, a significant portion of foreign labor comprises poorly educated and low-skilled laborers, which encourages a proportionate wage reduction. Thus, highly educated Saudi laborers have difficulty finding jobs with salaries matching their skills and living standards. That is why Saudi Arabia is now witnessing a high unemployment rate among its citizens.

A significant number of Saudi job seekers prefer working for the government, because of the high wage in the public sector with fewer working hours and long vacation time (Fakeih, 2012). After 1981, however, the public sector could not absorb additional Saudi job seekers due to the precipitous decline in government oil revenues. Additionally, the Saudi private sector hesitated to employ Saudi citizens despite the fact that they were highly skilled and educated. The Saudi private sector preferred foreign workers. Also, Saudi employees frequently resigned from their companies so that they could work for companies offering higher positions and better salaries. By contrast, foreign workers could not move to other companies without written approval from their employers (Al-Dosary, 2006; Ramady, 2010). In addition, employers could not easily terminate Saudi laborers, who had the backing of the Saudi labor law (Fakeeh, 2009). Regrettably, many researchers and policymakers provided unreasonable solutions for the Saudi unemployment problem by ignoring the institutional flaws behind the high unemployment rate among Saudi citizens, which was around 12.9% by the end of the first quarter of 2018.
The current structure of the Kingdom labor force has some unique features. Saudi workers, overwhelmingly male, are employed mostly in the public sector. At the same time, foreign workers’ contribution to the total Kingdom labor force is around 54% of the total number employed inside Saudi Arabia in both the private and public sectors. Since 2000, the high level of unemployment among Saudis pushed the Saudi government to act immediately to address this issue. The first policy that the Saudi government implemented to reduce the high level of Saudi unemployment was the Saudization of taxi drivers. In September 2002, the Saudi government set a goal to complete this effort within six months. However, despite this move, foreign drivers still dominate the sector (Al Omarn, 2010; Al Sarhani, 2010). The lesson learned from the Saudization of taxi drivers is that Saudi youth regard blue-collar careers as less desirable. That is why a significant majority of foreign workers in Saudi Arabia are employed in blue-collar careers. Nevertheless, the Saudization program made a substantial achievement in the nationalization of professional careers such as administrators, accountants, and human resources specialists (Sadi & Al-Buraey, 2009; Alasmari, 2008).

In 2003, the Ministry of Labor (MoL) established the new face of the “Saudization” program. The MoL required all companies/industries working in the Saudi market, and having a percentage of Saudi employees less than 30% of total employees, to Saudize 5% per annum until they reached 30% (Looney, 2004; Madhi & Barrientos, 2003). In short, the government put more pressure on the private sector to employ Saudi laborers instead of foreign laborers. Again, the new Saudization program did not consider the significant factors preventing both sides—the private sector and Saudi jobseekers—from cooperating with the Saudization program. Consequently, the Saudization program failed to achieve the desired results (Al-Dosary & Rahman, 2005; Sadi & Henderson, 2010).
In late 2011, the MoL launched a new project called Nitaqat as an additional development phase of Saudization. Nitaqat is a classification system whose main goal is to classify Saudi companies based on the actual percentage of their current Saudi workforce. Nitaqat has four categories: Premium, Green, Yellow, and Red. Companies with a higher-than-required Saudization rate are placed in the Premium or Green categories (Fakeih, 2012). A company in this category—Green and Premium—would have prioritized access to government services such as the issuance of new foreign working permit visas. Additionally, the Saudi government instituted a new unemployment benefits program called Hafiz, which provides the Saudi unemployed with a monthly payment of SAR 2,000 ($533.33) and a new minimum wage of SAR 3,000 per month ($800). Finally, in 2013, in an attempt to reduce the number of foreign workers in the country, the government increased the fee for renewing expatriates’ work permits to SAR 2,400 ($640). It is clear that all these policies or acts on the part of the Saudi government have been unable to resolve the high unemployment rate among the Saudi labor, which at the end of the first quarter of 2018 was around 12.9%—still a very high percentage (GSTAT, 2018). The Saudi private sector by itself cannot address the existing issue of the high unemployment rate among Saudis. Moreover, it has become clear that the Saudi unemployment problem is not an issue of supply and demand in the Kingdom labor market, but of the Saudi economy’s structural fragility, which restricts its ability to provide jobs to its citizens.

This research refers to the Triangle of Full Saudi Employment (TFSE) policy. TFSE proposes three factors that will play an essential role in reducing the rate of Saudi unemployment. First, the Saudi government must act as the Employer of Last Resort (ELR) by providing jobs to Saudi jobseekers. Second, the Saudi government should adopt a long-
term strategy to drive the Saudi economy toward diversification. Third, the Saudi government should design a training program integrated with ELR jobs. Saudi Arabia must increase the productivity of Saudi laborers through training programs and capital investment. This would represent a major step forward in terms of increasing the Saudi economy’s competitiveness in the global market.

**Conclusion**

This chapter discusses the high unemployment rate among Saudi citizens. It has approached this problem following a review of the Saudi development stages during the period from 1970 to Saudi Vision 2030. The chapter has also reviewed the Kingdom’s history, for it is believed that the lessons learned from these historical phases could support additional thought and subsequent solutions. This research is designed to be different regarding research methodology and theories.

It has been found that the high unemployment rate among Saudi citizens is a more complicated problem than other Saudi economic issues. Saudi Arabia’s rapid transformation into an industrial economy led to a shortage of human capital. Hence, the Saudi government has invested a considerable amount of money into building human capital—most recently, the King Abdullah scholarship program in 2005.

Recently, it has been observed that over 45% of Saudi unemployed hold a bachelor’s degree or higher. Despite this high level of education, the private sector prefers low-skilled foreign laborers due to pecuniary issues (such as the fact that such workers receive low wages) and non-pecuniary issues (such as these workers’ loyalty and stability). It has been found that the Saudi private sector is mostly a supplier of goods and services to the Saudi public sector. Unfortunately, Saudi Arabia does not have a highly productive sector except
for the oil and petrochemical industries, which already have a high level of Saudization. Because the private sector’s main activities do not require highly educated and skilled employees, encouraging the private sector to employ all Saudi unemployed would be an inadequate solution to address the issue of Saudi Arabia’s high unemployment rate. This leads to the following chapters of this research, which will explore whether involvement in the production of goods and services besides oil and petrochemicals, such as renewables, could be a viable means by which the Saudi government could find a new source of income and create more jobs for Saudi jobseekers.
CHAPTER 3

THE THEORY OF UNEMPLOYMENT AS TWO-PRONGED:

ORTHODOX AND HETERO DOX ECONOMICS

Like my father, I believe that working people of all races share a vision. It is a vision of decent wages and working conditions, a vision of multiracial unity and mutual progress, a vision of hope and opportunity for all. It is a vision that the American labor movement and people of color have shared for generations, and it is the basis for a new coalition of conscience that will turn the struggles of today into the triumphs of tomorrow.

— Martin Luther King Jr., speaking at the District 65 Convention on September 6, 1962
(Martin Luther King, Jr. Center for Nonviolent Social Change, 1986, p. 12)

I do not believe we can repair the basic fabric of society until people who are willing to work have work. Work organizes life. It gives structure and discipline to life.

— President Bill Clinton
(Clinton, 1993, p. 26)

In [the] long run, the real choice is not jobs or environment. It’s both or neither.
(Foster, 2010)

There Are No Jobs on a Dead Planet.
(International Trade Union Confederation, 2015, p. 1)

Introduction

At the beginning of 2018, the Saudi economy was facing several major issues. The level of unemployment (especially among Saudi citizens) was high at 12.9%, and the Saudi economy was suffering from deflation (-0.9) and a negative economic growth rate of 0.86% (GSTAT, 2018). In these difficult circumstances, government intervention is required to prevent the Saudi economy from collapsing. However, in neoclassical economics, no room exists for government intervention (i.e., no fiscal policy), and economic forces will drive the economy back to the equilibrium after some periods. Neoclassical economics derives its economic theories from optimal mathematical models, in which are included a set of
hypothetical assumptions. The entire economy could be diagnosed based on the kind of relationship between their economic models and the agents inside these models. The individual agent’s reaction (behavior) in the neoclassical economic model could be estimated through these superior economic models (Snowdon & Vane, 2005). However, according to Mary Morgan (2012) in her *The World in the Model*, it is not possible to contain human behavior inside a mathematical model. That is why this dissertation is designed to study economics as a social science. It is based mostly on the theories of post-Keynesian economics (especially the Employment of Last Resort [ELR], and the Job Guarantee Program [JGP]), institutional economics, and ecological economics.

This research takes its economic position from Keynes and his followers, who called for government expenditure (i.e., fiscal policy) during an economic slump (Keynes, 1936). Increasing government spending will increase aggregate demand for domestic goods, services, and labor. This government spending will sustain investors’ expectations and move the Keynesian effective demand curve positively. The Keynesian effective demand curve (KED) must shift upward to generate more demand for capital and labor. The scope of Chapter 3 is to investigate theories of unemployment in orthodox and heterodox economics in detail. It builds a complementary bridge between the theory of ecological economics and the existing theories of ELR/JGP (Rezai & Stagl, 2016; Røpke, 2005). It also studies unemployment by discussing the properties of the production function and money. In addition, it highlights the theories of Employment of Last Resort (ELR) and the Job Guarantee Program (JGP). Chapter 4 attempts to solve the problem of the high level of unemployment among Saudi citizens through increased government investment in the renewable energy sector. In short, this chapter covers these topics: unemployment between
neoclassical and post-Keynesian economics, structural unemployment, technological unemployment, the economic business cycle, Employment of Last Resort (ELR) and the Job Guarantee Program (JGP), and the concluding argument.

**Unemployment in Neoclassical and Heterodox Economics**

This section explores the theory of unemployment in neoclassical and heterodox economics. These schools of economics maintain different interpretations of the problem of unemployment. The neoclassical economics of Alfred Marshall, Mill, Edgeworth, and Pigou adopt the theory of utility while the heterodox economics of Marx, Veblen, Keynes, and others adopt the theory of value. Under the theory of utility, all unemployment is voluntary in the long term. In the short term, involuntary unemployment could be possible because of a mismatch between the supply and demand curves in the labor market, which is the amount of time that laborers require to move from one job to another (Ranis, 1997). Voluntary unemployment exists so long as a continuous trade-off exists between the utility of wages and leisure time. An individual may choose to be voluntarily unemployed when the utility of leisure time is higher than the utility of earned wages. Overall, any intersection point between the supply and demand of labor is a new equilibrium point in the labor market.

Under the theory of utility, more utility must go through a production system, and having more utility means having access to more useful goods and services. Investors and laborers participate in the production system because it is the only way to generate utility. Investors and laborers participate in the production system to gain access to goods and services. In the long term, under the theory of utility, the production system is always running at full capacity, which means there is no room for involuntary unemployment. However, under the theory of value, it is not necessary to involve the production system in
the generation of more value. In the financial market, investors could generate more value (money) without involving the production system. The theory of value is a comprehensive framework that can account for intangible and tangible values. Under the theory of value in the existence of the financial market, the problem of unemployment is more complicated due to the very low elasticity between the demand for money and labor (Wray, 2015).

In addition, Keynes believed that neoclassical economics does not correctly define money. In neoclassical economics, money is simply a medium of exchange and a store of value (Snowden & Vane, 2006). In it, production is the only path toward generating more goods and services (utility) as \((C-M-C')\). Any increase in the number of initial goods and services \((C' > C)\) must go through the production sector. However, this is not a valid assumption under the recent monetary theory of production (MTP). The role of money is not just to serve as a store of value, but to serve as a capital asset (Townshend, 1937). In the monetary theory of production (MTP), it is possible to generate more money \((M')\) without involving the production process such as \((M-M')\) (Dillard, 1980; Wray, 2007). The Keynes’ effective demand accounts for a role of money that transcends a medium of exchange. The expectation for return on capital includes investment in the financial market (Pech & Milan, 2009). Investors usually compare different investment opportunities, which include investments in stock and bond markets. In other words, the production system is not the only path toward generating more money/value (Keynes, 1936, ch.12).

Another reason why people seek money is that it is one of the most important liquid assets. Investors use money to reduce risk and uncertainty. If investors are uncertain about the future, they will hold more money as a liquid asset to reduce their level of uncertainty. In reference to this situation, Keynes said, “people want the moon” (1936, p. 235). Investors’
level of uncertainty is never equal to zero. Under normal circumstances, it is very difficult to have full production capacity, including both laborers and capital. The financial market provides different kinds of financial products with a wide range of risks (Wray, 1991). Increased investment in the financial market means less investment in the production sector, causing less demand for labor and more involuntary unemployment. The act of increasing investments in the financial sector does not cause a notable increase in the demand for laborers. Overall, a strong relationship does not exist between the demand for money and laborers (Davidson, 1978; Minsky, 1992). As long as money has a negligible elasticity of production with laborers, an increase in the supply of money — printing money or more investment in the financial market — would not necessarily affect the other sector of production to generate more jobs (Keynes, 1936). Thus, the problem of unemployment should be more complicated under the monetary theory of production (MTP) for two reasons: Investors want to generate more money, and new investment is not necessarily flowing to the real production sector.

Furthermore, neoclassical economics adopts Say’s law, which holds that supply creates its own demand and that the aggregate supply curve (Z) equals the aggregate demand curve (D) (Z = D) at all times. Say said, “As each of us can only purchase the productions of others with his productions—as the value we can buy is equal to the value we can produce, the more men can produce, the more they will purchase” (Say, 1834, p. 103). Therefore, the curves Z and D must be on the same line. Keynes, in his book The General Theory of Employment, Interest, and Money (GT), rejects the neoclassical labor supply curve and accepts the existence of the labor demand curve for the sake of argument. Keynes rejects the neoclassical labor supply curve for two reasons: Laborers are not making daily comparisons
between real wage and the level of disutility, and laborers would not likely resign from their jobs because of a decrease in their real wage (Keynes, 1936). However, for Keynes, allocation of market forces cannot solve the problem of unemployment. During the Great Depression in the U.S., for instance, the unemployment rate was over 25%. It was not possible, Keynes argued, for all this unemployment to be voluntary, or for workers to have refused to accept lower real wages.

Keynes furnished a justification for Say’s law that says aggregate demand is the primary driver for economic growth. With any given technology, aggregate income depends on the volume of employment. More employment means more aggregate income, which would increase the level of spending that depends on the labor propensity of consumption (MPC for laborers) (Cuaresma, Kubala & Petrikova, 2016). Keynes’ effective demand function is the intersection of the aggregate supply price and the aggregate demand price of output. The aggregate demand price curve determines the number of workers required to produce a certain amount of output Y. The aggregate supply price determines the amount of expected profit that may be produced by employing a certain number of laborers. Therefore, if profits exceed investors’ expectations, these investors would be encouraged to increase investments. As a result, more laborers would be employed until the supply price curve equaled the demand price curve. Investors would keep hiring people as long as they had a good expectation of making a profit. For Keynes, in short, there are two kinds of effective demand curves: D1 and D2. The value of D2 depends on the level of investors’ expectations and spending. D1 is the consumption curve and is determined by aggregate employment and income. The number of laborers is determined by two important factors, N = F (MPC, D2), which are the marginal propensity to consume and investment spending. According to
Keynes, it is impossible to have the effective demand curve at full employment so long as the propensity of consumption (MPC) is less than 1 and the investors’ level of uncertainty are never equal to zero. In short, Keynes used a different methodology to strike a balance between aggregate supply and demand (Dillard, 1980; King & Plosser, 2001). In the case of the high level of unemployment, government intervention is necessary to push up the level of investors’ expectations, reduce investor uncertainty, and fill the existing dominant gap of the Keynesian effective demand. Thus, government investments, especially in high-risk and low-profit projects, are expected to increase the aggregate demand, gradually drive the economy to equilibrium, and develop the private sector. In addition, under the monetary theory of production (MTP), the full employment economy is a “special case” because the theory of marginal efficiency of capital (MEK) includes money. Also, investors’ process of evaluating any project should include the return on money (Keynes, 1936; Kregel, 1974; Wray, 1998).

In conclusion, the neoclassical school of economics makes no room for government intervention because it believes that market forces can resolve any market problem (Taylor, 1979, 1987). Keynes argued that when producers are pessimistic during an economic slowdown, workers lose both their jobs and income while the curve of aggregate demand slumps sharply. Therefore, government spending to stabilize the economic system and keep the effective demand at the level of full employment is required. Hence, government investment is not designed for pecuniary purposes and will not crowd out the private sector.

**Structural Unemployment**

Part one of this chapter looked at the problem of unemployment, discussing the continuous debates between Keynesian and neoclassical economics. This section studies structural unemployment, of which there are two types. The first is a skills mismatch between
demand and supply in the labor market. The second is when the production system of a particular economy replaces labor with machines. For instance, developed countries with a highly productive sector need fewer laborers to produce a massive amount of output. A study by the Organization for Economic Cooperation and Development concluded that, on average, employment growth in the industry has declined at annual rates close to one percent in various developed countries, such as the European Union, the United States, and Canada (OECD, 2018; OECD, International Monetary Fund, & World Bank Group, 2015). In conclusion, this section has two purposes. The first is to identify the dynamic change in the structure of production and investigate the problem of structural unemployment by studying the tradeoff between capital and laborers. Marx’s organic composition of capital and Leontief’s input-output model are different theoretical themes through which to study structural unemployment.

Marx studied the movement and change in the organic composition of capital (c/v) over time. He claimed that an increase in the organic composition of capital could affect the structure of labor, such as types of jobs, the level of unemployment, and wages. Leontief explained the structural unemployment through coefficients between the domestic production entities and the final demand sector.

Marx’s circular mode of production illustrates the mode of production as two departments: department I and department II. Department I produces the means of production (c1 + v1 + s1) while department II produces consumption goods and services (c2 + v2 + s2).

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Two conditions must be met under this simple reproduction system. The first is that department I must produce all the constant capital (i.e., the means of production) for both departments, such that $V_1 = c_1 + c_2$. The second condition says that the surplus in department II must equal the constant and variable capital in department I, $s_2 = c_1 + v_1$ (Fan-Hung, 1939). The equations for this system can be simplified as follows:

Department I: (produces the means of production [machines and equipment]):

$$c_1 + v_1 + s_1 = V_1 \quad \text{..........(1)},$$

Department II: (produces consumption goods and services):

$$c_2 + v_2 + s_2 = V_2 \quad \text{..........(2)},$$

Two conditions must hold to generate a self-reproduction dynamic for the system:

$$c_1 + c_2 = V_1 \quad \text{..................(3)},$$

$$c_1 + v_1 + c_2 + v_2 = V_2 \quad \text{......... (4),}$$

If we simplify this, it becomes $c_1 + v_1 = s_2$.

Any new expansion in department II in response to new government spending should carry over to department I. This expansion in department I would increase demand on the outputs of department II as well due to the new demand on goods and services from the new employees in department I. Moreover, government spending will drive up the domestic aggregate demand. Expansion in the entire production system is expected to take place gradually, which will mean the employment of more labor and capital. However, producers will likely meet this new demand by adding new machines to the production system, which means less labor is needed to produce this new output (shifting towards a high organic composition of capital). Additionally, the labor wage is not expected to increase at the same level as productivity, which means a depreciation in aggregate demand and an increased loss.
of jobs among laborers, who could be considered as ‘structure unemployment.’ In general, the new level of demand for laborers of new investment depends on the level of the organic composition of capital for a particular production system. If the purpose of increasing government spending is to generate jobs, this new spending should flow to the production sector with a low organic composition of capital.

In the Saudi case, the oil production sector is the dominant sector of production, accounting for almost 40% of the Saudi GDP. The Saudi oil production sector is highly capitalized, and its laborers are highly productive. In Marx’s term, the Saudi oil production sector has a high organic composition of capital, with most machines and equipment for the Saudi oil industries being imported. Hence, the level of competition in the global oil market is very high, which means the Saudi oil industry must keep increasing its productivity to maintain its share of oil exports with low cost. In addition, the Saudi private sector is highly dependent on low productivity, wage, and skilled foreign laborers. Thus, one could conclude that the Saudi economy suffers from less economic diversification and structural unemployment so long as the Saudi economy spends most of its investments in one sector of production (such as oil) and the Saudi private sector has easy access to cheap foreign workers. To solve the problem of Saudi structural unemployment, future government investments must flow into those production sectors that have a less organic composition of capital, such as the Saudi renewable energy sector. According to the literature, investment in the renewable energy sector is very promising and it could generate new jobs with a variety of skills and occupations. This will be discussed in Chapter 4 of this dissertation.

Because this research’s empirical work is based on Leontief’s input-output model, structural unemployment should be explained by studying the dynamic change in the
coefficients between the domestic production entities, which include all domestic production sectors (such as manufacturing, agriculture, oil, mining, and others) and final demand. For instance, part of the agriculture sector output will be an input to the agriculture sector and other domestic production sectors. The final demand sector will consume the rest of the agricultural production (Leontief, 1936). Leontief (I/O) coefficients define the kind of relationship between these different domestic entities. Leontief (I/O) coefficients create a map that includes the type of relationship between the different sectors of production in a specific economy. Leontief (I/O) coefficients are dynamic. Over time, these coefficients continuously change in association with changes in the structure of production to a form that is more capital intensive. For instance, the Saudi structure of production has changed to a highly advanced industrial economy and a high labor productivity. The other issue is all of these machines and equipment are imported from advanced industries. This new structure of production could explain the structural unemployment in Saudi Arabia among its citizens. Thus, the impact of these new investments in the oil sector is expected to be smaller because the Saudi oil sector labor multiplier is quite low. Today, moreover, the Saudi government aims to increase multipliers of the new oil sector investments by localizing supply chains for the oil industries.

The Leontief (I/O) model calculates the coefficients between the growth of any sector of production and demand on labor, which is an expansion in the production sector associated with an increase in the number of laborers. This increase in the number of laborers is highly dependent on the coefficients of labor for each sector of production. In addition, employing additional workers would increase the aggregate demand and indirectly increase demand for more goods and services in other sectors of production as a result of new demand
from new employees, who are essential aspects of the final demand sector. Additional expansion of the entire production system should require more laborers. In the case of recession, the high level of unemployment would stem from decreased investment spending and household consumption. Government spending as part of the final demand sector is necessary to push forward aggregate demand on the domestic level. Hence, it is clear that the government plays an essential role in stabilizing the economic system. As a result, an increase in government investments would increase income and the number of employees. An increase in aggregate income would encourage more investment spending and expansion in the production system.

Furthermore, the Saudi government could use Leontief (I/O) coefficients to build its new economic policies. Saudi Arabia has an economic problem, which is the high level of unemployment among its citizens. If the Saudi government decides to increase government spending to boost the economy and create more jobs for the unemployed, that spending should flow to production sectors that are highly labor-intensive, which means a sector of production that has a low organic composition of capital (c/v). For instance, it is assumed that the manufacturing sector must employ 200 new laborers to produce an extra one million SR value of manufactured products, whereas the oil sector must employ only 10 additional laborers to increase its production of oil by one million SR value of oil. Thus, the Saudi manufacturing sector has a high labor multiplier. To generate more jobs for Saudis, it would make sense for the government investment to flow mostly to the manufacturing sector. Meanwhile, the other sectors of production should indirectly experience some expansion as well because of the increasing government investment in the manufacturing sector, at a different level of expansion dependent on the coefficients between these sectors of
production and the Saudi manufacturing sector. As a whole, the economy will experience the direct generation of jobs in the manufacturing sector and the indirect generation of jobs in other sectors of production.

So far, the inefficient effect demand (KED) is the Keynesian (macroeconomic) explanation for unemployment, while a high level of organic composition of capital (c/v) is the structural (microeconomic) explanation for unemployment. Forstater said that we should have a “middle path,” which means the structural change should be considered along with Keynes’ effective demand (2007). The structural changes certainly have some influence in driving the KED curve. The middle path framework shall be between microeconomic analysis—the structure of production—and the macroeconomic analysis of Keynes’ effective demand curve. For instance, if we assume that the organic composition of capital (c/v) increased with a given output level, with this new organic composition of capital, fewer laborers are required to produce the same amount of output. While no expansion occurs in the other sectors of production, the level of unemployment is expected to increase and the aggregate income level decrease. There is an expected downward shifting in the Keynesian effective demand due to a change in the organic composition of production.

The literature contains some discussions about the differences between economic growth and structural changes (Doyle, 1997). Kuznets, in his 1973 paper, said that fundamental differences exist between economic growth and structural change (Kuznets, 1973). Economic growth is the amount of expansion in the domestic production of goods and services over time, usually a year, while structural change is the change in the composition of economic activities (organic composition of capital) (Feldman, McClain & Palmer, 1987). Structural change is an institutional change in local economic activities, such as moving from
an agriculture-labor intensive society to a capital-intensive-industrial society. Kuznets found a strong relationship between structural change (such as increases in labor productivity) and growth rate. Increasing labor productivity means boosting the growth rate (Kuznets & Murphy, 1966). However, if this increase in output is due to the increasing productivity of labor, it does not flow back into the economy as new investments in another sector of production or services. This development would create an expected negative impact on the labor market, as less labor could produce the same amount of output. For a country to be export-oriented, the efficiency of production and productivity of labor must increase because the level of competition in the global market is very high. The role of government is to enhance investment in a less productive sector that is less attractive to the private sector in order to reduce the negative impact of this new development on productivity. In short, the main problem is that this increase in labor productivity is not usually identically associated with an increase in labor wages, which causes a reduction in aggregate demand. Thus, government intervention to fill the income gap is essential for stability.

Pasinetti claimed that structural change is a continuous process (Syrquin, 2007). The question that should be discussed is: How can we avoid the adverse shocks of structural change, such as inflation and unemployment? One possibility is the flexible economy defined by Forstater (1999b). The flexible economy is an economic framework that requires less time to absorb any such shock (endogenous or exogenous). It can absorb structural unemployment due to the high rate of diversification and the presence of a strong government. For instance, if one sector of production must increase the productivity of production for the purpose of competition, the displaced laborers should have other opportunities for jobs in different sectors of production. The diversification of economic activity is an essential source of
stability and resilience. Diversification means that one sector of production does not have a monopoly over economic activities and that economic activities have a large variety of distributions. Hence, whenever an economic sector experiences a slowdown, other sectors experience boosts that absorb the decline in the first sector. If the economy has only one main sector of production, any slowdown in demand for labor in this sector would hardly affect the entire economy. Additionally, a strong government has a central role in supporting the economy during a crisis, maintaining the aggregate income by employing its citizens in the JGP and introducing a new sector of production, if necessary. The high level of economic diversification and the presence of a strong government are the main features of the flexible economy.

In fact, the current economic system is not a static system, and it is difficult to isolate any economy from the global economy in the 21st century. The global economy must be capable of adapting to these changes or challenges. The economic system must be capable of adopting changes in technologies, supplies of natural resources, consumer demand, labor demand, and other economic factors. Stability can also be defined as an economy’s ability to absorb an impact from inflationary pressures, sluggish growth, and stagnation with a high rate of unemployment. The resilient economy does not have excess supply and a high rate of unemployment but, rather, an ability to maintain full employment during a different stage of economic conditions (Forstater, 1999a).

Saudi Arabia is suffering from structural unemployment in two phases. The Saudi private sector is highly dependent on cheap, low-skilled labor. It is also dependent on oil production and the associated revenues. However, the Saudi oil production sector is well-developed and highly capital-intensive. The other Saudi sectors of production are poorly
developed. It is a rich country and most of its goods, foods, and services are imported. Recently, Saudi Arabia has witnessed an influx of highly educated and skilled citizens due to a baby boom that occurred several decades ago. Fewer jobs for them means that the Saudi unemployment problem is not one of supply but, rather, that job openings do not match the labor supply due to the lower salaries received by workers in low-productivity occupations. This means that there is a fragility in the Saudi Leontief (IO) coefficients such that any new investment within the Saudi economy has a very limited impact on domestic growth. One solution to this problem could be government investments in attractive projects, which would have a positive impact by creating a new demand for labor, breaking the stagnation of unemployment, and enhancing investment in a sector that offers a benefit for society, such as the renewable energy sector through the Saudi Job Guarantee Program (SJGP) (Forstater, 2005).

In summary, this research seeks to examine the problem of unemployment through macroeconomic and microeconomic perspectives—an examination that could provide additional information and details as well as a deeper understanding of the existing economic system.

**Technological Unemployment**

From the beginning of Great Britain’s industrial revolution, the issue of technological unemployment has invited serious consideration from economists. Two questions fall within the scope of this section: Does the Saudi economy suffer from technological unemployment? How can we create a balance between increasing labor productivity, high income, high Saudi employment, and effective demand? Technological unemployment is not the main reason for
the high rate of unemployment among Saudis. However, technological innovations may provide a solution to unemployment among the Saudi’s citizens.

Ricardo had a unique position on technological unemployment. In an added chapter, “On Machinery,” in his book On the Principles of Political Economy and Taxation (1891), Ricardo believed that technological innovation leads to persistent unemployment as long as workers displaced by technical progress cannot be employed elsewhere, as long as these new machines are not produced domestically. Nell’s theory of transformation growth says that if the new technological innovation (new machines) were domestically produced, this innovation would not cause unemployment because these fired laborers would move to the new production sector for new machines (Nell, 1992, 2009). In short, laborers would shift from one sector of production to another. On the other hand, an exogenous adoption of new technology involving all kinds of machines would increase the productivity of laborers, though fewer laborers would be required to create the same amount of output. This new adoption of new technology should crowd out laborers because no expansion is taking place in other domestic sectors of production that could hire these fired laborers.

Additionally, Ricardo and Nell identified a fundamental theoretical feature of the capitalist system, which is that no identical relationship exists between a change in productivity and the real wage. The new increase in labor productivity is not necessarily associated with an increase in the labor’s real wage. If labor’s real wage were associated with an increase in productivity, the aggregate income should increase with an increased demand for other domestic goods and services. This increase in demand would expand to other sectors of production, further increasing the demand for labor. However, a perfect
relationship is not necessary between productivity and wages, which creates the problem of technological unemployment under the capitalist economy.

Marx developed an explanation for the absence of an identical relationship between wage and productivity. The fundamental feature of the capitalist system is an accumulation of capital due to the replacement of laborers with machines (Marx, 1977). The assumption is that the capitalist class typically spends most of the surplus value generated from underpaid labor to purchase more capital (machines). To accumulate capital, the labor wage must be reduced, or at least not increased. Marx developed a concept that describes unpaid labor as a form of exploitation. Exploitation is associated with the level of social power, which is to pay laborers less than what they deserve (Elster, 1978). In addition, replacing labor with capital is expected to increase the level of unemployment “reserve army.” This high level of unemployment puts more pressure on the existing laborers to accept low wages. As a result, the capitalist class continues to reduce laborers’ wages until the wage level is equal to the level that is sufficient for the laborers to work again the next day. This is why technological unemployment is a result of the capitalist class’s inclination toward accumulating capital (Marx, 1977). A technological innovation increases labor productivity and surplus value for the capitalist class, which adds more machines to the system of production, thereby generating more unemployment and a lower wage.

Moreover, Veblen defined technological innovation as an institutional adjustment. Veblen believed that the problem is not in innovating new machines but, rather, in the group owning these new technologies. In *The Engineers and the Price System* (1918), and *Theory of Business Enterprise* (1935), Veblen discussed the dichotomy between industrial and business motives. Veblen made it very clear that people in business, with business motives,
misuse the machines for their purposes and cause the problem of unemployment. On the other hand, engineers and technicians represent industrial motives, and they want to use the machines to mass-produce goods for the community. Increasing laborers’ productivity, which is out of the capitalist class’s control, will create more to eat with less working time and a higher income. New machines are not the direct cause of unemployment so long as the capitalist class does not control it (Veblen, 1918/1965). Veblen’s dichotomy lends support to the thrust of this research—that engineers and technicians, part of the local community, should handle the diversification in Saudi Arabia through small and medium enterprises (SMEs). We must implement government regulations that encourage SMEs to handle these kinds of innovations. Second, the government must align the micro-behaviors of people in business with the macro-objectives of policymakers to strengthen the labor force, the environment, and the economy as a whole.

The literature presents an argument as to why Keynes did not discuss the issue of the technological/structure change that may cause unemployment in the long term. Keynesian followers argued that Keynes wrote GT during the American Great Depression. At that time, the situation was dire due to a shortage of spending and a problem with demand. Despite this fact, Keynes wrote an entire chapter about the long-term impacts, which is Chapter 12 of GT (Asimakopulos, 1991). In addition, the short-/long-term decision is highly dependent on the investor’s expectations. The short-term decision would depend on the short-term expectations of increasing production based on existing machines and equipment. The long-term decision to pump new investments into new industries would be easier to make depending on the short-term expectation. Overall, the expectation would be difficult to establish for the long term. No one can predict the future, especially in a modern dynamic
financial, economic system that is extremely unstable. Today’s employment level depends primarily on the decision based on short-/long-term expectations. A link exists between the short-/long-term expectation that today’s decisions are based on the conditions of today and expectations about tomorrow. The short-term expectation is highly dependent on the medium- and long-term expectation. The expectation of production is concerned with the amount of money a manufacturer can expect to receive for his “finished” goods and services. The level of job depends on these expectations, prospective costs, and sales proceeds.

Therefore, from the Keynesian perspective, the relationship between technological innovations and demand on employees has a positive side. The decision to invest in new technology (such as renewable technology) should not be based only on today’s expectation but also on the short-/long-term expectation. This means that more investment in sustainable technology would reduce investors’ level of uncertainty. Less uncertainty would mean higher expectations, which would lead to more investment and jobs. In short, Keynes believed that the problem of unemployment was more appropriate to discuss through the lens of the circumstances that drive decisions to invest in the real production sector. Keynes and his followers saw no present issue of technological unemployment. However, the problem of unemployment must be discussed with respect to investors’ expectation and aggregate demand.

So far, authors have differed in their viewpoints concerning the problem of structural/technological unemployment. For Saudi Arabia, the economic problem is the high level of unemployment associated with the high cost of living. So that Saudis can find jobs with acceptable incomes, the level of Saudi labor productivity must be increased through the adoption of new technology. In this situation, technological advances will generate new jobs.
for Saudi citizens in which technology and innovations are domestically developed. Saudi Arabia must utilize its universities and independent research centers to develop new technology domestically. In short, Saudi unemployment is structural unemployment that could be resolved through the adoption of a new domestic technological development base.

**Unemployment and the Economic Business Cycle**

The economic business cycle is the economic deviation from equilibrium (the full capacity of labor and capital). The questions that many economists have discussed are: “What are the main reasons for the economic business cycle?” and “How does the economic business cycle directly impact the level of unemployment?” The literature offers a variety of explanations for this. In neoclassical economics, economic deviation from the equilibrium could be only for the short term because of exogenous or endogenous factors (shocks) such as oil price shocks, natural disasters, financial crises, wars, political conflicts, and internal economic factors. Indeed, the economic forces should have the ability to drive the economy toward equilibrium in the long term. In the neoclassical system, this means that being in equilibrium is the normal situation for the economic system in the long term. Also, in such economic circumstances, there is no involuntary unemployment in the long term. However, involuntary unemployment exists in the short term due to a mismatch between supply and demand in the labor market. On the other hand, post-Keynesian economics explains the economic business cycle through the fluctuation of Keynes’ effective demand. Government (fiscal) spending/investment, which generates new income, demand, increase investors’ confidence, and investment opportunities, is essential for returning the economy to equilibrium/full employment in terms of labor and capital.
Keynes analyzed the fluctuation in the effective demand curve that accounts for uncertainty, duration, expectation, and the role of money. In the short term, the level of income, output, and employment are highly correlated with the level of aggregate demand (Keynes, 1936). For instance, if the aggregate demand has expanded for any reason, this expansion, Keynes claimed, directly influences the creation of more output, income, and employment. On the other hand, if the level of aggregate demand is low, the producers may be forced to employ fewer laborers and use fewer input materials. This means less demand for resources—both labor and capital. The reduction in employment and capital would directly impact the level of aggregate demand, including income, output, and employment. Fluctuation in the business cycle is significantly related to fluctuation in investors’ expectations (Keynes, 1936, chapters 2, 3, 20).

The Keynesian theory of business cycles has two spots: the expansion era (the top of the business cycle) and the recession/depression era (the bottom of the business cycle). Minsky’s theory that stability leads to instability is highly connected to Keynes’ analysis of business cycles (Minsky, 1992). Keynes and his followers explain the story of business cycles through continuous movement between expansion and slump. When business is expanding, investors have a high level of optimism. More investments enter the market. Investors, usually during the expansion era, move from low-risk investments to high-risk ones. Some investors may default, which is then followed by more defaults. Overall, fewer investments take place, leading to a decrease in jobs. The aggregate demand is reduced because of the reduction in consumption and investment (Minsky, 1992; Wray & Forstater, 2006).
Post-Keynesian and Ecological Economics

Since the industrial revolution in Western Europe in the middle of the 19th century, fossil fuels have been the primary sources of energy for most countries. Substantial increases in fossil fuel consumption would considerably pollute the environment and increase the possibility of a sharp global economic fluctuation, such as global warming. While fossil fuels do produce an enormous amount of energy, they also emit dangerous amounts of carbon dioxide into the atmosphere. This research paper proposes a new theoretical economic framework that achieves a consensus between ecological and economic theories and other co-discipline sciences, such as psychology, social science, and political science (Basiago, 1998; Rosser, 2001). In addition, post-Keynesian economics has unique features that allow this school of thought to deal with environmental issues. These features include a social rationale, path-dependent, historical time, and income effect. This research aims to find a solution to the problem of pollution and unemployment. This solution will provide a new, clean source of energy that promises to generate a new source of income and jobs.

Before taking a step toward this new economic framework, terminology regarding environmental and ecological economics must be defined. Environmental economics is more or less a field of knowledge that calculates the external costs of economic activities. The primary responsibility of environmental economics is to provide an alternative method of production that reduces the cost of externality (Holling, 1973, 2001). For environmental economics, saving the environment is not the primary concern; rather, the primary concern is to reduce the future cost of production due to global warming. Also, neoclassical economics cannot move forward to save the environment, as it will conflict with the principles of individuality, utility maximization, rationality, and real time. Also, the economic forces are
the main drivers toward a stable and optimal equilibrium for the economy. There is no need for an exogenous intervention entity such as government or the social fabric. On the other hand, post-Keynesian economics denied the mainstream static system and utilized the dynamic economic system, which is more capable of dealing with a change related to human behavior, an institutional change, and/or a change in the composition of production (Galbraith, 1997). For ecological economics, saving the environment is a fundamental factor. Growth is good, but it should not occur at the cost of losing the ecosystem’s beauty.

Because neoclassical economics is not designed to handle a complex social and environmental problem, ecological economics moved away and created its theoretical economic framework during the 1960s and 1970s (Ayres & Kneese, 1971; Ayres, Kneese, & d’Arge, 1970). Ecological economics has some unique features that do not exist in environmental economics (Røpke, 2004). Ecological economics could be classified as an interdisciplinary branch of knowledge with some influence over various sciences, such as social science, biological science, and political science (Ropke, 2004, 2005). It is also true that ecological economics rejects the theory of substitutions because natural resources have an intrinsic value that is interpreted differently. According to Rolston (2011), intrinsic value naturally exists in human beings, such as protecting life, health, and children (Rolston, 2011). Intrinsic value could be different among individuals, such as love, religion, and knowledge (Callicott, 1999). Bayram (2012) suggested that the value of saving the environment should instill in the younger generation through the education system. The goal of increasing environmental awareness involves not only boosting the awareness of cost and benefit but also making the value of saving the environment an intrinsic value, one that cannot be
measured regarding price. With this ideology, the new generation would be more interested in innovating green sources of energy (Bayram, 2012).

The second part of this section seeks to define how ecological economics engages with existing theories of economics. Individual rationality in mainstream economics is a utility maximization. Each individual has different characteristics, but all individuals seek to maximize their utilities under two conditions: asymmetric information and a high level of competition. As opposed to the individual rationality of neoclassical economics, post-Keynesian economics adopts the social rationality that an individual’s culture, religion habits, and other social values significantly influence that individual’s decisions. Social rationality is an essential concept in ecological economics, while its data gathering strategy is to watch other people’s behavior. Social rationality is also the constraint that society imposes on individual behaviors. If environmental issues are significant concerns of society, the individual’s behavior/decisions are more consistent with the environment. It is also true that some economists have defined social rationality as bounded rationality in which an individual’s behavior is consistent with the social contexts. For instance, an individual usually would not make a decision that could seem odd in his social circle. Social rationality could also be defined as a behavior of reducing certainty. This social/bounded rationality is an essential feature of the post-Keynesian era’s engagement with the theory of ecological economics (Holt, Pressman, & Spash, 2009). Thus, Post-Keynesian economics has a greater capability for solving ecology-related, economically complex issues (Holt et al., 2009). Also, the behavior of one investor may be affected by other investors’ acts, as bounded-rational decisions (Lavoie, 1992, 1994).
The kind of cooperation necessary to save the environment includes two phases. One phase is voluntary participation in saving the environment, such as participation in local activities that aim to educate people about environmental issues, or voluntarily using sources of energy that create less pollution. The second phase requires that the government assume a role by imposing regulations that could force people to reduce their consumption of contaminated products. Otherwise, some people may enjoy the beauty of nature as free riders. In an economic sense, Pressman explained the free-rider problem as a prisoner dilemma in that some players would receive rewards for doing nothing (2004). In the prisoner’s dilemma, there are two captured prisoners, each of whom is seeking to take advantage of the other. Both prisoners are put in different rooms. There are three expected scenarios; in each, both prisoners want to take advantage of each other and do not trust each other. Scenario (1) is that both prisoners refuse to confess to their crimes, thus inviting a protracted and expensive trial. Scenario (2) is that both prisoners confess, with each receiving moderate prison terms. The third scenario (3) is that each prisoner wishes to get away scot-free, without penalty. The decision is critical because they are separated from each other and want to take advantage of the other. Pressman argued that in the third scenario, one prisoner goes free while the other prisoner carries the consequences of the crime. In reality, some people enjoy clean air and a healthy environment without paying a penny, whereas other people pay for these things. This situation is not fair. Therefore, the government, as an authority, must be involved and impose regulations to ensure that everyone in society participates fairly in saving the environment.

The other concept used by the post-Keynesian is path dependence. Path dependence means that an individual’s decision is directly and indirectly influenced by an accumulation
of historical events that have negative or positive impacts on the environment (David, 1985; Lavoie, 2005; Nelson, 2009). An example of path dependence is the Ford auto company’s purchase of Kansas City’s public transportation, with an aim to let the company default. Thus, modern Kansas City was built with a view toward having cars as the main source of transportation. Path dependence also has a positive face, such as in the city of Dubai, which has planned to have the cleanest energy source. Dubai’s facilities are designed to use clean sources of energy and be less dependent on conventional sources. Another example of the positive effects of path dependence is the government’s purchase of extra clean (solar, wind) electricity that households produce. This would encourage people to be more efficient in their use of electricity. Thus, path dependence can be used in either positive or negative ways. This dissertation aims to use path dependence in a positive sense.

The definition of uncertainty could be that it is not feasible to create the future from past experiences (Keynes, 1936). The best writer handling Keynes’ concept of uncertainty is Paul Davidson (1991a, 1996). It is hard to predict the future relying only on the past due to constant changes resulting from infrequent events (Loasby, 1976; Shackle, 1955, 1974). The world is non-ergodic unless both key parameters and structures are stable over time. Because of the existence of the non-ergodic system, the past is less likely to predict the future. Also, it can use people’s uncertainty in advantageous ways, such as by promoting investment in renewable energy as a factor that would reduce uncertainty and as a more stable and sustainable source of energy specifically for investors in oil countries. Investment in renewable energy would increase stability in these economies for two reasons. For example, many oil countries have a constraint on the quantity of oil they can produce. Reliance on oil as a main source of energy for domestic use would reduce the amount of oil available for
export. According to the last OPEC deal, Saudi Arabia’s quota of production is around 10 million bpd. On average, more than three million barrels of oil are consumed domestically to generate electricity and for desalination. Hence, only around seven million barrels of oil are available for export. Domestic Saudi consumption has deep links to population and economic growth. In the future, if the Saudi government does not increase energy efficiency or invest in renewable energy, domestic consumption of oil is expected to increase to more than 7.2 million bpd by 2030 (Gately, Al-Yousef & Al-Sheikh, 2012). These two factors explain the increasing uncertainty in the future of the Saudi economy. That is why the Saudi policymaker knows that Saudi Arabia must look for alternative sources of energy and income in the future.

The post-Keynesian historical time is different from neoclassical logical time. The ecological economics theories treat time as historical time. Robinson, Cattaneo, and El-Said (2001) and Kaldor (1940) discussed the fragility of neoclassical economics in terms of handling environmental issues due to ambiguity in the definitions of time. They believe that they do not have the correct definition of real time and that logical time is not the right way to define it. Logical time means that economic factors are simultaneously determined outside the limits of time and space. However, post-Keynesian economists adopt historical time, as people usually have planned for the present and the future (Holt, 2007; Holt & Setterfield, 1999). Hence, we could define time as a pipeline such that any event happening in the past could change in the future. Time is valuable because people require it to adapt or adjust to any economic policy (David, 1985). Historical time is associated more with the real world, such that any decision made in the past moves over to the future. For instance, if someone makes a spending decision, the calculation process for this decision includes the decision-
maker’s experience, the current situation, and the future expectation (Lavoie, 2005).

Historical time is an essential feature between post-Keynesian and ecological economics, as any economic decision is based on three factors: experience, present variables, and future expectation. These two schools of economics can calculate or project the future negative consequences of pollution. Hence, the decision to use methods of production that create less pollution reduces the risk of natural collapse in the future. Boulding (1966) argued that people must change their method of thinking and employ this advanced technology to produce a more sustainable source of inputs, such as generating energy from the sun.

Finally, neoclassical economics has no space for government intervention, and environmental issues are difficult to resolve through the private sector. However, in post-Keynesian economics, the government plays a significant role in addressing such issues. The government has two tasks: regulation and spending. First, the government should establish a regulation against the irresponsible use of fossil fuel. In addition, the government should start investing in the renewable energy sector, subsequently encouraging people to become involved in this drive and to eliminate their uncertainty. One suggestion of this dissertation is that the government could establish the renewable energy sector and sell projects to the private sector. This dissertation seeks to drive sustainability that is consistent with the environment, such as lowered carbon emissions, the renewable energy sector, and recycling.

**Employment of Last Resort (ELR) and the Job Guarantee Program (JGP)**

Building a consolidated theoretical foundation for the problem of unemployment under the modern capitalist system receives due consideration here. For Saudi Arabia, the problem of unemployment is a structural problem, one that contemporary solutions cannot resolve. The method of this research is to place in practice the Job Guarantee Program (JGP),
which is fundamentally built on the Employment of Last Resort (ELR) theory as a permanent solution to the problem of Saudi unemployment. While JGP programs have recorded some success in developed countries, the successful application of the JGP concept for developing and underdeveloped countries is still under investigation.

John Fagg Foster’s theory of institutional adjustment (1981) for solving the problem of involuntary unemployment in the capitalist system is one theoretical foundation of the ELR framework. Foster encouraged the public sector and society to address the issue of involuntary unemployment. Post-Keynesian economics (especially at the University of Missouri-Kansas City) introduced Minsky’s theory of the Employer of Last Resort (ELR) program, which shall be an extension of Fagg Foster’s concern. The primary goal of ELR is to employ an individual who is looking and willing to work in a minimum wage job but who cannot find one in the private sector. Also, the ELR program provides a training program (Bell, 2001; Forstater, 1999c, 2002a, 2002b, 2006; Minsky, 1986; Wray, 1998). This program is entirely sponsored and run by the public sector. Hence, government spending in the domestic public sector is essential for solving the problem of unemployment or any other economic issue (Keynes, 1936). The necessity of government intervention does not lessen when the economy is flourishing, though the role of government broadens through continued innovation via preventative economic measures.

Hyman Minsky (1986) proposed the idea of the Employment of Last Resort (ELR). The ELR has been developed by many scholars, such as Mitchell (1998) and Wray (1998). Later, Mosler built a connection between government finance and guaranteed employment (Mosler, 1997). The ELR framework was based on the primary characteristics of the monetary theory of production. The ELR simultaneously stabilizes the level of the Keynes
effective demand at full employment by resolving the lack of demand resulting from the change in investors’ expectations. In other words, even during a recession, ELR maintains the level of aggregate demand at the full employment level by absorbing those workers who are losing their jobs in the private sector. Stabilizing the level of effective demand will allow the economic system to recover more quickly by preventing a deep recession. Also, it can guarantee the stabilization of investment decisions and decrease volatility in the business cycle. Hence, ELR is not motivated by a need for pecuniary gain. ELR can achieve environmental sustainability by diverting government investments to the renewable energy sector.

Neoclassical economists criticize the use of fiscal policy to address unemployment, as they believe that government spending is a direct reason for inflation. Post-Keynesian economists, on the other hand, believe that so long as the government employs more workers in productive sectors, the aggregate supply will undoubtedly increase, which would prevent inflation. Government investment has two major benefits: increasing overall growth and stabilizing prices (Arestis & Sawyer, 2004). Even if inflation occurs, it would not be as bad as a high level of unemployment. That is why most post-Keynesian economists call for a fiscal policy such as Abba Lerner’s function finance (Bell, 2001; Forstater, 1999a, 2003b). Lerner’s theory has two principles. One is that the government has the ability to finance itself, and that fiscal policy is required to sustain the economy at full employment (Lerner, 1943). The main aim of the function finance policy is to keep economic activities at a high level and establish a full-employment economy. The primary purpose of Lerner’s function finance is to achieve three major goals: increasing aggregate demand, which leads to increased investment, which then leads to increased employment with low inflation. In
general, government spending flows to public sector services such as building roads and schools, the renewable energy sector, and recycling. It is correct to conclude that fiscal policy was a revolutionary Keynesian idea.

The Job Guarantee Program (JGP) is a national government program that provides jobs for people seeking employment at a uniform hourly wage, combined with a set of benefits such as a training and education program (Mitchell, 1998, 2001). The government provides the funding for these programs. These kinds of jobs could be in public services that are not attractive to the private sector, with wages determined by the government. Also, only the government is authorized to change the level of minimum wages. The other benefit of JGP is that it saves the monetary system from inflation and deflation. This is because, during the boom period of the business cycle, the JGP acts as a supplier of labor to the private sector. During the bust time, the JGP acts as the Employer of Last Resort and keeps incomes at the level of minimum wage. So long as JGP has a training program, the supply of skill and training labor will be high. Chapter 6 of this dissertation will discuss the JGP framework in details.

**Conclusion**

Climate change might cause the next economic crisis, but implementing a sustainable economic development policy is a significant challenge. This chapter maintains that investment in renewable energy will, directly and indirectly, help solve four problems (unemployment, instability, unsustainability, and pollution) for Saudi Arabia. Reframing the theory of Employment of Last Resort (ELR) for Saudi Arabia will contribute significantly to this thesis. Hence, the scope of ELR is broader than merely providing new jobs, as ELR builds a consensual theoretical framework through post-Keynesian and ecological
economics, finding a shared area between these two schools through common features of uncertainty, path dependence, social rationale, and historical time. This chapter concludes that any economic stability depends on the level of diversification and the role of the government. The ELR program is a tool that the government can use to stabilize the economy. The size of the ELR program is a countercyclical buffer against the economic business cycle, as the ELR program would be most effective during a recession and less prominent during economic booms, though it would always be operating.

The ELR framework is suited to developed and developing countries. Although many developing countries have fixed exchange rate systems, so long as the governments of these countries have sovereign currency issuers, they could still practice the framework of ELR. The reason for proposing investment in renewable energy is that the government must invest in sectors that would not crowd out the private sector. This is because the private sector is less willing to invest in risky projects such as renewables, though these projects are important to society and the economy as a whole.
CHAPTER 4

USING INPUT-OUTPUT ANALYSIS TO QUANTIFY THE NEW EMPLOYMENT AND VALUE ADDED BY INVESTMENT IN RENEWABLE ENERGY AS PART OF THE SAUDI JOB GUARANTEE PROGRAM (SJGP) WITH THREE EMPIRICAL SCENARIOS

Introduction

This research studies two substantial economic problems in Saudi Arabia: the high level of Saudi unemployment and reliance on a single source of income (oil revenues). In addition, the Saudi non-oil private sector depends on government spending, which is another critical problem for the Saudi economy. For instance, during an unexpected recent collapse in oil prices from $120 to $35 in the middle of 2014, government spending declined significantly in the following two years (2016-2017). As expected, the entire Saudi economic system could not stand independent of the government spending, and the Saudi government was forced to assume responsibility for saving its economy from collapse. Enhancing the independence of the Saudi non-oil private sector from government spending is one of the wisest paths for Saudi Arabia to take in resolving these economic fragilities. It must immediately adopt a new structural transformation plan, which can create an excellent opportunity for Saudis (both men and women) to play essential roles in the new Saudi transformation process (Perez, 1983).

By the end of the first quarter of 2018, the rate of unemployment had reached 12.9% (GSTAT, 2018). The question of interest in this chapter is: “Could rising investment in the Saudi renewable energy sector create more new jobs for Saudi unemployed?” This research studies the renewable energy sector’s ability to address the problem of Saudi unemployment.
This dissertation’s main contribution is to calculate the number of jobs generated by increasing investment in renewables. This research seeks to determine the amount of value added, as well as employment and output growth. Leontief’s input-output model (LIOM) is the mathematical tool that will be applied, for it can calculate the relationship between different sectors of production. Construction activities usually capture a significant portion of new jobs resulting from new investments in renewables (Ferroukhi, Khalid, Renner, & López-Peña, 2016). However, foreign laborers, who constituted around 90% of construction employment in 2016, occupy most construction industry jobs (GSTAT, 2017). The Saudi government must be conscious of this issue for two reasons: the need to restructure construction careers to make them more socially acceptable for Saudis and to increase the wages and productivity of Saudi laborers for these economic activities.

Based on various studies that investment in renewable energy is qualified to generate new jobs (Pestel, 2014), a limited number of existing studies calculates the number of new jobs that would be generated through investment in renewables in Saudi Arabia. The roadmap of this research can be summarized in two complementary steps. The first step is to calculate the output, labor, and value-added multipliers of government spending in renewables, using Leontief’s input-output model (Al-Hawwas, 2010; Chemingui & Lofgren, 2004; Haji, 1993). The second step is to build three different scenarios for the Saudi Job Guarantee Program (SJGP). These three scenarios are to invest SR100, SR150, and SR200 billion, respectively, in the Saudi renewable energy sector. The amount of investment was distributed over four years (2018-2022) to avoid inflationary pressures, reduce remittances, and control for possible leakages. Finally, this chapter will discuss the Leontief input-output
model (including the reasons for using the input-output model and its benefits), describe the data, present the Saudi Arabian input-output model, and interpret the results.

**Literature Review**

Various studies have investigated the economic, social, and environmental benefits of investment in renewables. According to the Environmental and Energy Study Institute (EESI) and the International Renewable Energy Agency (IRENA), increased investment in the renewable energy sector generates more new jobs than does increased investment in other sectors of production, specifically, the fossil fuel sector. For instance, the 2014 annual report issued by the Environmental and Energy Study Institute (EESI, 2014) said that there were more than 3.6 million new jobs in renewable energy worldwide in 2013 and 3.8 million in 2014. The International Renewable Energy Agency (IRENA) estimated that the number of jobs in the renewable energy sector (directly and indirectly) was 8.1 million by the end of 2016. Overall, the total number of renewable energy jobs worldwide has continued rising. The increase was recorded in Germany, China, Brazil, India, the United States, and Japan. The IRENA estimated that, by the end of 2016, there were more than 2.8 million jobs in the solar PV worldwide alone, especially in Japan and the United States. Despite the fact that the advanced Western countries were the dominant consumer of renewable energy, Asian countries are now among the leading essential renewables producers worldwide (Ferroukhi et al., 2016).

One of the main hypotheses of this research is that an investment in the renewable energy sector is a viable strategy for not only saving the world from pollution but also generating jobs and boosting economic growth (Kammen, Kapadia & Fripp, 2004). The first part of this section covers studies that support the subject of this thesis. Juan Carlos Ciscar
Martinez (1998) wrote a paper, “Quantification of the Socio-Economic Effects of Renewable Energy Technologies in Southern Mediterranean Countries: An Input-Output Evaluation.” The paper supports this dissertation for two reasons: the research methodology is the I-O model, and this study proposes investment in renewable energy as a new strategy for generating jobs. The aforementioned paper estimated the expected impact of investment in renewables such as wind, biomass, and PV electricity on employment, imports, and added value in southern Mediterranean countries such as Turkey, Tunisia, and Morocco. Using the input-output model for each country, the study found that the wind and biomass projects create at least 90 jobs per year for every million dollars invested. However, it also found that PV rural electrification projects create approximately 45 new jobs per year for every million dollars. The reason why PV generates fewer new jobs in these countries is that the electrical parts (such as PV panels and electrical cycles) are not produced domestically, and this kind of technology is too expensive, accounting for 47% of the total project cost. Hence, the number of new jobs generated by investment in PV and wind is less than the number of new jobs for other renewable energy methods due to the significant amount of money used to purchase imported goods. This study also found that a significant portion of jobs in PV and wind projects are mainly in the service and construction sectors in the countries included in this study. Also, this study shows that many researchers agree that Leontief’s input-output model is a beneficial tool for policymakers and energy planners.

According to a July 2014 study by the Center for European Economic Research entitled “Employment Effects of Green Energy Policies.” The main questions for this study are: “Does a switch in energy policy toward more renewable sources create or destroy jobs in the industrial countries?”, and “Does the renewable energy sector have the ability to adopt
these laborers, who will lose their jobs in the fossil fuel sector as a result of these policies?” (Pestel, 2014) This study found that investment in renewable energy creates new jobs in different economic activities such as infrastructure, construction, and services. It also increases the demand for labor in the research and development sectors and boosts new demand in various other sectors such as installation and maintenance. Moreover, most European countries have plans to place more restrictions on the use of fossil fuel energy. This type of policy could place more pressure on the oil companies, whose business activities might record a decline, thereby crowding out some laborers. However, this study found that in many European countries, laborers have already been shifting from the fossil fuel sector to the renewable energy sector. While the rate of replacement is still less than one, it could be more than one if we count the number of jobs indirectly generated by new investment in renewables. Also, this research found that the input-output model has a greater ability to capture the flow of goods and services between different sectors of production. The purpose of calculating this new expansion in the production system is to estimate the new increase in demand for goods, services, and labor resulting from the expansion of investment in the renewable energy sector. This study asserted that the input-output model is one of the best methods for calculating the growth rate resulting from increased investment in renewables.

This research is built on the basis that renewable energy (RE) and energy efficiency (EE) are two sides of the same coin. One strategy is to increase the cost of fossil fuel use domestically by imposing taxes on the use of highly polluting sources of energy, as many European countries have done. These taxes on fossil fuel would encourage people to use energy more efficiently. The argument is that if people can change their behavior and use energy more efficiently, society as a whole can shift its energy sources toward more
expensive ones, such as renewables. The second step is to make renewable energy part of the social movement toward a cleaner and sustainable source of energy. Adopting a new lifestyle and ensuring the availability of the required infrastructure are essential for encouraging investors to invest in renewables.

A paper by Thilanka M. Sooriyaarachchi, Tsai, El Khatib, Farid, and Mezher, entitled “Job Creation Potentials and Skill Requirements in PV, CSP, Wind, Water-to-Energy, and Energy Efficiency Value Chains” (2015) studied socio-economic developments resulting from investment in renewable energy (RE) technologies. This article’s scope was to show renewables’ ability to generate jobs in Germany, the United States, and the Middle East. It used a different methodology to study jobs and skills in renewables and energy efficiency (EE): a value chains methodology. A value chain contains a number of economic activities involved in the production processes of industries or manufacturers that create valuable products and services for the market (Porter, 2011). This method is beneficial for tracking the requirements of new jobs and skills through a different set of activities, which are directly/indirectly related to the renewable energy sector.

Because the sample of this study included advanced and developing countries, it is essential to consider the fact that developing countries do not manufacture the advanced technology of renewables. Therefore, the level of skills and type of occupations required by new jobs in renewables are different for developed and developing countries. If jobs are created in the value chain of the production of renewable energy technology, new high-skilled occupations will be generated in addition to other kinds of non-professional occupations. For developing and less developing countries, which usually import technology,
the new jobs resulting from increased investment in renewables will be distributed among such sectors as construction, operation, and maintenance.

In addition, this paper stated that the introduction of new jobs incited a new demand among renewable energy laborers for local goods and services such as grocery stores, schools, restaurants, etc. Because of this new investment in renewables, other sectors of business will acquire many indirect jobs due to an increased demand for goods and services. The total number of jobs generated as a result of increased investment in the renewable energy sector includes all direct, indirect, and induced new jobs, according to this paper and IRENA. Other research papers mention two types of renewable energy jobs: permanent and temporary. Permanent jobs usually emerge in the manufacturing and research areas, while construction and installation provide temporary jobs (Sooriyaarachchi et al., 2015). However, the demand for energy is associated with continuous GDP growth. As long as economic growth exists, there will be a renewed demand for energy, and more construction and installation work will be required. In short, this research believes that this sector does not offer temporary jobs.

In general, the International Renewable Energy Agency (IRENA) classifies renewable jobs into three types of employment: direct, indirect, and induced. Direct employment refers to those activities associated with renewable energy, e.g., economic activities such as the project development, construction, installation, and maintenance of RE power plants. The second type of jobs is indirect jobs. These are generated by the kinds of economic activities that supply goods and services for renewables, such as manufacturing, the supply chain that provides raw materials and services, and the financial sector. Induced employment refers to the kinds of new jobs created as a result of increased demand among
new direct and indirect employees for local goods and services such as grocery stores, local school systems, and restaurants (Dvořák, Martinát, Van der Horst, Frantál, & Turečková, 2017). According to a study by Sastresa, Usón, Bribián, and Scarpellini (2010), entitled “Local Impact of Renewables on Employment: Assessment Methodology and Case Study,” categories in renewable energy jobs are:

1- Research and development,
2- Product manufacturing and distribution,
3- Project development,
4- Construction and installation,
5- Operation and Maintenance (O&M).

This study claimed that the renewable energy sector provides a wide range of occupations, namely, engineering, technician jobs, marketing, retail, administration, and customer service. Thus far, the renewable energy jobs have included a variety of occupations, from very low-skilled to highly skilled advanced labor in different sectors of production. Table 5 provides information for the number of jobs in the renewable energy sector with a classification of the type of technology and country during the period between 2014 and 2015.
Table 5

Employment Numbers in the Renewable Energy Sector

<table>
<thead>
<tr>
<th>Country</th>
<th>Type of RE</th>
<th>Employment Number</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>Solar PV</td>
<td>1.6 million jobs</td>
<td>2014</td>
</tr>
<tr>
<td>China</td>
<td>Solar heating/cooling</td>
<td>600,000 jobs</td>
<td>2014</td>
</tr>
<tr>
<td>China</td>
<td>Wind power</td>
<td>502,400 jobs</td>
<td>2014</td>
</tr>
<tr>
<td>Brazil</td>
<td>Renewable energy</td>
<td>934,000 jobs</td>
<td>2015</td>
</tr>
<tr>
<td>Brazil</td>
<td>Liquid biofuels</td>
<td>845,000 jobs</td>
<td>2015</td>
</tr>
<tr>
<td>Brazil</td>
<td>Solar heating/cooling</td>
<td>36,000 jobs</td>
<td>2015</td>
</tr>
<tr>
<td>Brazil</td>
<td>Small hydropower</td>
<td>12,000 jobs</td>
<td>2015</td>
</tr>
<tr>
<td>India</td>
<td>Total renewable energy sector</td>
<td>934,000 jobs</td>
<td>2015</td>
</tr>
<tr>
<td>India</td>
<td>Solar PV</td>
<td>125,000 jobs</td>
<td>2015</td>
</tr>
<tr>
<td>India</td>
<td>Biogas</td>
<td>85,000 jobs</td>
<td>2015</td>
</tr>
<tr>
<td>India</td>
<td>Solar heating/cooling</td>
<td>75,000 jobs</td>
<td>2015</td>
</tr>
<tr>
<td>India</td>
<td>Biomass</td>
<td>58,000 jobs</td>
<td>2015</td>
</tr>
<tr>
<td>Germany</td>
<td>Total number in RE</td>
<td>437,000 jobs</td>
<td>2015</td>
</tr>
<tr>
<td>Germany</td>
<td>Wind power</td>
<td>138,000 jobs</td>
<td>2015</td>
</tr>
<tr>
<td>Germany</td>
<td>Solar PV</td>
<td>56,000 jobs</td>
<td>2015</td>
</tr>
<tr>
<td>Germany</td>
<td>Biomass</td>
<td>52,000 jobs</td>
<td>2015</td>
</tr>
</tbody>
</table>

Source: Ferroukhi et al., 2016

Renewable energy technology is still new compared to other conventional sources of energy. One challenge confronting investment in renewables is that this sector requires significant spending on research and development, due to the renewable energy sector is still less efficient than the fossil fuel energy sector. Meanwhile, some European countries have imposed taxes on the use of fossil fuels as a means of increasing the cost of fossil fuel energy and thereby eliminating the gap in cost between renewable energy and fossil fuel. These taxes—or part of them could be used to fund the renewable energy research sector in the form of scholarships for researchers in renewables. This research firmly believe that the future of renewables as alternative sources of energy is highly promising because the annual
growth rate of renewables is over 5% worldwide (Sooriyaarachchi et al., 2015). Renewable technology has a broad range of diversification, including such uses as solar photovoltaic cells, liquid biofuels, wind power, solar heating/cooling, solid biomass, biogas, hydropower, geothermal energy, and Concentrated Solar Power. This technological diversification can result in the employment of a significant number of highly educated and skilled laborers. It is essential to note, also, that there are fewer geographical constraints for investment in renewables, as most cases are not constrained by location. For instance, oil refineries must be near oil wells, sea coasts, and big cities to decrease transportation costs. This research used the Leontief input-output model (LIOM) to calculate the amount of net income, the value added, and the new jobs generated by new investments in the renewable energy sector inside Saudi Arabia.

**Historical Aspects of Input-Output Models**

The history of the input-output model goes back to the 18th century when Francois Quesnay tried to establish a connection between two social classes: the productive class (landowners, farmers, and rural workers) and the business class (merchants). Quesnay wrote about the relationships between the outputs and expenditures of farmers, landowners, and manufacturers in his book *Tableau Economique* (Barna, 1975; Quesnay, 1894). Moreover, Walras founded the first theoretical approach of the input-output model in 1874, though his book was not translated into English until 1985 (Ten Raa, 2010). Walras designed the first mathematical model of the interrelationship between different entities of production, but his theory was not examined empirically (Walras, 1954/2013, lesson 20). Leontief’s contribution to the Walras theory was the addition of the empirical work (Davar, 2000). Both Walras and
Leontief endeavored to calculate the coefficients of the production process (Bjerkholt & Kurz, 2006; Kurz & Salvadori, 2000; Miller & Blair, 2009).

In the 19th century, Marx developed the two-department model, which comprised two departments of production. The circulation model analyzes the interrelationship between these two sectors of production (Marx, 1894/1967). Marx explained that the capitalist system works with two departments of production. The first department (I) produces machines (raw materials) while the second department (II) produces the consumption of goods and services. The relationship between these two sectors can be explained as the outputs of department (I) machines becoming input for department (II), which is their use in the production of goods and services. These goods and services are then consumed by laborers in both departments (I) and (II). Marx’s two-department model may have influenced Leontief’s input-output model, for both theories seek to find the relationship between different sectors of production, which was the main contribution of the Leontief model.

Wassily Leontief (1906–1999) was considered the father of the input-output approach and earned the Nobel Prize in Economics for his article “Quantitative Input and Output Relations in the Economic System of the United States” (1936). His two previous papers were “Die Wirtschaft als Kreislauf” (“The Economy as a Circular Flow”) (Leontief, 1928/1991) and “Quantitative Input-Output Relations in the Economic System of the United States” (Leontief, 1936). These two papers are considered to have formed a new branch of quantitative economics (Rose & Miernyk, 1989, p. 220). Leontief said, “Input-Output analysis is a practical extension of the classical theory of general interdependence which views the whole economy of a region as a single system and sets out to describe and interpret its operation regarding directly observable basic structural relationships” (Leontief, 1987,
The input-output model is a quantitative microeconomic method that traces economic activities as a process of interrelations between different sectors of production and the final demand entities (Murray, 2010; Rodrigues, Lorena, Costa, Ribeiro, & Ferrão, 2016). During a press conference after he won the Nobel Prize in 1973, Leontief offered an example of input-output analysis: “When you make bread, you need eggs, flour, and milk. Moreover, if you want more bread, you must use more eggs. There are cooking recipes for all the industries in the economy.” In fact, an input-output model studies the circulation of inputs of raw materials (or services) and the output of finished or semi-finished goods (or services) between different sectors of production and the final demand sector (Christ, 1955; Kronenberg, 2012). Leontief’s input-output model is a unique method that builds interrelationships among different local/global sectors of production. The input-output model calculates the structural coefficient of each sector of production in the quantitative term (Líšková, 2015).

The Leontief model tracks the flow of goods and services in the whole economy under study. For instance, sector A receives some inputs from A, B, and C. On the other hand, sector A sends some of its outputs to other sectors of production A, B, and C. Overall, there are two primary objectives for using Leontief’s model. These are calculating the tradeoff coefficient between different domestic entities of production and the final demand (government, investors, household consumption, trade) (Miller, 1998). These calculations are intended to help us estimate the amount of expansion in the whole economic system as a result of increased investment in renewables. According to Miller and Blair (2009), Leontief’s input-output model can simulate the forward and backward connections between the domestic production sectors and the final demand sectors. Thus, the input-output model
would be a static system if separated from the domestic production sector or the final demand sector (Miller & Blair, 2009). The study by Guo and Planting (2000) analyzed U.S. economic structural change through the periods between 1947-1977 and 1978-1996, calculating the coefficients of various sectors of production. This study investigated the existing influence (directly/indirectly) of the changes in the production sectors’ coefficient on the change in the U.S. economic structure. This study concluded that the structure change of the U.S. economy during the period 1947-1996 had a low level of interdependencies on domestic industries because of a general lowering of the coefficients. The entire economic system was more dependent on imported goods and services, and the role of non-manufacturing industries significantly increased (Guo & Planting, 2000). In addition, the Leontief model can be used to simulate government policy. For instance, if the government removes taxes from industries that use renewable energy as a supplemental source of energy, demand will increase for renewable items and cause further expansion of the renewable production sector. Over time, this policy can drive the economic structure of this country toward one that is more environmentally friendly.

The input-output model measures the whole economic system, but in some cases, the entire economic system is divided into different regions. The additional advantage of a regional input-output model is having a calculation of spillover effects among different regions with each other (Sargento, 2009). Regional input-output models are useful for a large economy such as that of the United States, which has 50 states, each of which produces different products, and where there is considerable spillover among these regions and state sectors (such as agriculture, manufacturing, etc.).
The I-O analysis is based on aggregate identities, in that the total output of a sector of the economy is assumed to be entirely consumed by other production sectors and final demand. Internally, the input is the production of the sectors, while the final demand users are household consumption, investor spending, government expenditure, and net export. The input-output method provides more detailed information about the interaction between internal sectors of production and final demands. Any change in final demands, such as increasing demand for renewable energy by the Saudi Job Guarantee (SJG) program, causes expansion not just in the renewable energy sector but all economic production sectors, providing such input to the renewable energy sector directly or indirectly. Using an economy’s I-O table, policymakers—given the case of increased investment in the renewable energy sector—can estimate the amount of expansion in the related production sectors, such as those that manufacture solar panels, steel, or plastic (Lee, 2011a, 2011b, 2012).

The aim of using the SJG program is to address Saudi unemployment stagnation and change the structure of the Saudi economy from having a single source of income (oil revenue) to maintaining more diversity through investment in renewable energy. This dissertation proposes to solve the problem of Saudi unemployment by investment in renewable energy through the SJG program. Measuring the impact of investment in renewable energy with other sectors of production and the Saudi labor market will be this dissertation’s main achievement. Hence, the renewable energy sector is included with the other sectors of production, especially non-oil sectors such as manufacturing, utilities, services, and construction (Callen, Cherif, Hasanov, Hegazy, & Khandelwal, 2014).

Leontief’s input-output model classifies the economy into two groups: one that is producing sectors, and the other that is the final demand sector (government spending,
household consumption, investments, net export). The economy has \( n+1 \) sectors, which are the number of producing sectors for a particular economy and the final demand sector. Hence, the total output of sectors of production will be an input to other sectors of production, and the final demand sector will consume the rest of these outputs. Therefore, the total goods and services that a particular production sector creates are to be consumed by \( n \) sectors of production and the final demand sector. In short, the input-output table displays the flow of goods and services among all economic production sectors.

The Leontief input-output method can be illustrated using these four equations:

\[
X_i = a_{i1}X_1 + a_{i2}X_2 + \ldots + a_{ij}X_j + FD_i \quad \ldots \quad 1
\]

\[
X = AX + FD \quad \ldots \quad 2
\]

\[
(I - A)X = FD \quad \ldots \quad 3
\]

\[
X = (I - A)^{-1}FD \quad \ldots \quad 4
\]

\( X_i \) in equation (1) is the total output of any production sector \( i \); \( x_{ij} = a_{ij}X_i \) is a portion of \( X_i \)'s output used as an input to the \( X_i \) sector; and \( a_{i1} \) is a percentage calculated as \((a_{i1} = x_{ij}/X_i)\). The total output of any production sector (such as refineries, manufacturing, or construction) is distributed among all sectors of production. In Table 6, the columns contain information about the total output of each sector of production while the rows contain the total input of each sector of production for all sectors of production. For instance, the total output of the agriculture sector regarding value is around SR28.419 billion (see Table 6). Some of this output is consumed by the agriculture sector as an input, while the rest is consumed by other production sectors and the final demand sector. For instance, approximately SR7.928 billion from the total agriculture sector is used as an input to the
agriculture sector; SR9.631 billion is used as an input to the manufacturing sector, and so on (see Table 6).

Table 6

*The Agriculture Sector Distribution to Different Sector of Production*

<table>
<thead>
<tr>
<th>#</th>
<th>GDP Economic Activities (millions of SR)</th>
<th>Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agriculture, Forestry &amp; Fishing</td>
<td>7,928</td>
</tr>
<tr>
<td>2</td>
<td>Crude Petroleum &amp; Natural Gas Extraction</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Other Mining</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Petroleum Refining</td>
<td>4,069</td>
</tr>
<tr>
<td>5</td>
<td>Other Manufacturing</td>
<td>9,631</td>
</tr>
<tr>
<td>6</td>
<td>Electricity, Gas and Water</td>
<td>902.5</td>
</tr>
<tr>
<td>7</td>
<td>Construction</td>
<td>1,210.6</td>
</tr>
<tr>
<td>8</td>
<td>Wholesale &amp; Retail Trade, Restaurants &amp; Hotels</td>
<td>1,122</td>
</tr>
<tr>
<td>9</td>
<td>Transport, Storage &amp; Communication</td>
<td>628</td>
</tr>
<tr>
<td>10</td>
<td>Ownership of Dwellings (Imputed Rent)</td>
<td>1,365</td>
</tr>
<tr>
<td>11</td>
<td>Other Finance, Insurance, Real Estate &amp; Bus. Services</td>
<td>1,365</td>
</tr>
<tr>
<td>12</td>
<td>Community, Social &amp; Personal Services</td>
<td>1190</td>
</tr>
<tr>
<td>13</td>
<td>Producers of Government Services</td>
<td>9,234</td>
</tr>
<tr>
<td></td>
<td>Total intermediate output</td>
<td>28419.7</td>
</tr>
</tbody>
</table>

Source: General Authority of Statistics (GSTAT, 2016)

Equation (2) ‘\(X = AX + FD\)’ is a matrix-vector equation in which notation \(X\) is an i by 1 matrix that contains the total output of each sector of production. The total output of each sector of production is distributed to itself and other sectors of production, while the rest of this output flows to the final demand users, such as government and households. On the right side of equation (2) is the \(A\) matrix, which is a square matrix or i by j identical matrix. A matrix has the percentage of distribution of output to each sector of production. Therefore, \(A\) matrix includes \(a_{ij} = x_{ij}/X_i\) values. The rest of the output for all production sectors would be consumed by the final demand users (FD). Thus, FD is a vector
matrix. FD is the final demand of users, such as household consumption, investment, government expenditure, and net exports. The total value of $X_i$ is equal to the summation of both parts on the right-hand side of this equation.

Equation (3) ‘$(I - A)X = FD$’ adds all the $X$’s on the left side. The main aim of this equation is to calculate the values of the final demand. In short, the right-hand side represents the domestic sector, and the left-hand side represents the exogenous sector. The causality in the right-hand side drives the change in the compensation of the right-hand side and $X$. After A and FD matrix have been calculated, it is possible to estimate the amount of change in $X$ in response to the change in the final demand sector.

Equation (4) ‘$X = (I - A)^{-1}FD$’ is the final step to calculate $X_i$. Hence, $(I-A)^{-1}$ is Leontief’s inverse matrix, which displays the kind of relationship between the production sector and final demand.

This research contains two main equations. Equation (A) calculates the effect of investment in renewable energy on the other production sectors, $X_i$. Equation (B) calculates the labor multiplier (LM) of investment in the renewable energy sectors (Albqami, 2004).

Equation 1, calculating the change of output ($X_i$) by investment of a certain amount of money in renewable energy is:

$$X_i = (I - A)^{-1}RE_t \quad \text{------ 1}$$

where:

$RE_t$ is the amount of direct investment in the renewable energy sector; the goal behind using direct investment is to estimate the impact of this investment on the other production sectors.

$$E_i = L (I - A)^{-1}RE_t \quad \text{------ 2}$$
Where \( L \) is the labor-output ratios \((L_i/ X_i)\).

Our empirical work involves five main tables. Table 7 is the recent input-output table for Saudi Arabia during 2015. The primary data was calculated from different sources, including the Organization for Economic Co-operation and Development (OECD), the Ministry of Economy and Planning (MEP), the General Authority for Statistics and Information (GSTAT), and the Saudi Arabian Monetary Authority (SAMA, 2015).

According to the Australian National Institute of Economics and Industry Research (NIER), the Leontief input-output table (LFIO) has three quadrants:

- **Quadrant (1):** The first quadrant of the LFIO table contains information about the consequential flows of goods and services among all intermediate production sectors.

- **Quadrant (2):** The second quadrant contains final demand, which includes government spending, investment, and household spending. Quadrant (1) and Quadrant (2) would absorb the total output in a closed economy. However, in an open economy, some production will be reserved for export.

- **Quadrant (3):** The third quadrant contains ‘all primary’ inputs to the production sectors, which include the compensation of employees, gross operating surplus, and value added at basic prices.

Table 7 shows the Saudi I-O table for 2015. This table includes 12 entities of production: agriculture forestry and fishing (ACT1), crude petroleum and natural gas extraction (ACT2), other mining (ACT3), petroleum refining (ACT4), other manufacturing (ACT5), electricity, gas, and water (ACT6), construction (ACT7), wholesale and retail trade (ACT8), restaurants and hotels, transport, storage, and communication (ACT9), financial,
insurance, real estate, and business services, ownership of dwellings (imputed rent) (ACT10), community, social, and personal services (ACT11), and producers of government services (ACT12). Table 7 places these economic activities (the domestic production sectors) into columns and rows (12 columns and rows). The columns’ values of these activities ACT from (1) to (12) are the amount of input to certain sectors of production in terms of value from other production sectors. For instance, ACT (1) must use SR7928.44 million of real value from the agriculture sector consumed by the agriculture sector. The rows’ value of each sector of production represents the total amount of output value from all 12 sectors of production. The columns’ value of each sector of production shows the total output of each sector of production to the other sectors of production. Table 7 is 12 by 12 entities, and the summation of the values of these columns and rows is equal. From these interactions among the internal sectors, any increase in demand from one internal sector or another would create a change in the entire production system. For instance, if the manufacturing sector increases demand in the construction sector, the construction sector must expand so that it matches the new demand from the manufacturing sector. This expansion of the manufacturing sector would increase demand on the other sectors of production as well. As a result, this increase in demand by the manufacturing sector would extend in different amounts to all production sectors and, consequently, the entire system of production would expand. The question is: How much would the total output change if the demand of one sector of production increased by one unit? Alternatively, what is the multiplier of each sector of production to the total sectors of domestic production? The LFIO table is a very useful tool for calculating the input-output multipliers, which is a matrix containing the level of reaction from different
sectors of production because of externally increased investment spending by the government sector or the private sector (Plumstead, 2012).

Table 7 also evaluates trade-offs among different entities of production in riyals as the amount of output from entity ACT1 goes to entity ACT2 and vice versa. It is clear from Table 7 that the Saudi economy suffers from a lack of diversification, as petrochemical activities are directly and indirectly involved in most Saudi economic activities. In other words, the non-oil sector depends primarily on the oil sector’s economic activities. The total amount of input and output of all production sectors is equal to zero.

The second part of the Leontief input-output table is the final use sectors. Table 8 contains the amount of demand from the final use sector to the domestic production sector. The final use table includes final consumption expenditure by households (FUSE1), final consumption expenditure by government (FUSE2), gross fixed capital formation (FUSE3), changes in inventories and errors and omissions (FUSE3), exports of oil (FUSE4), exports of non-oil goods (FUSE5), exports of services (FUSE6), exports (total) (FUSE7), imports of goods (FUSE8), imports of services (FUSE9), imports (direct imports by household) (FUSE10), and net exports (FUSE11). The final use sector includes the total demand from economic entities outside the production sector. The final use table presents the total amount of demand by each entity in the domestic production sector (see Table 8).
### Table 7

**Saudi Arabia Input and Output Table for 2015**

<table>
<thead>
<tr>
<th>National Income Accounts Supply and Use Tables (2015)</th>
<th>Input Output Table by (Purchases Prices By Economic Activities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millions SR</td>
<td>Original Matrix</td>
</tr>
<tr>
<td>GDP Activities</td>
<td>ACT (1)</td>
</tr>
<tr>
<td>No</td>
<td>Agriculture, Forestry &amp; Fishing (AGRF)</td>
</tr>
<tr>
<td>ACT (2)</td>
<td>Crude Petroleum &amp; Natural Gas Extraction (CPNG)</td>
</tr>
<tr>
<td>ACT (3)</td>
<td>Other Mining (MINQ)</td>
</tr>
<tr>
<td>ACT (4)</td>
<td>Petroleum Refining (PERF)</td>
</tr>
<tr>
<td>ACT (5)</td>
<td>Other Manufacturing (MANF)</td>
</tr>
<tr>
<td>ACT (6)</td>
<td>Electricity, Gas and Water (EGW)</td>
</tr>
<tr>
<td>ACT (7)</td>
<td>Construction (Con)</td>
</tr>
<tr>
<td>ACT (8)</td>
<td>Wholesale &amp; Retail Trade, Restaurants &amp; Hotels (WRTRH)</td>
</tr>
<tr>
<td>ACT (9)</td>
<td>Transport, Storage &amp; Communication (TrStgCo)</td>
</tr>
<tr>
<td>ACT (10)</td>
<td>Fin., Insur., Real Estate &amp; Bus. Svcs. And Ownership of Dwellings (Imputed Rent) (FinRB)</td>
</tr>
<tr>
<td>ACT (11)</td>
<td>Community, Social &amp; Personal Services (CommPSER)</td>
</tr>
<tr>
<td>ACT (12)</td>
<td>Producers of Government Services (PofGS)</td>
</tr>
<tr>
<td>TD</td>
<td>Total Input</td>
</tr>
</tbody>
</table>

Source: General Authority of Statistics (GSTAT, 2016)
### Table 8

**Saudi Arabia Input and Output Table for 2015 (Final Use Sector)**

<table>
<thead>
<tr>
<th>No.</th>
<th>Fuse (1)</th>
<th>Fuse (2)</th>
<th>Fuse (3)</th>
<th>Fuse (4)</th>
<th>Fuse (5)</th>
<th>Fuse (6)</th>
<th>Fuse (7)</th>
<th>Fuse (8)</th>
<th>Fuse (9)</th>
<th>Fuse (10)</th>
<th>Fuse (11)</th>
<th>Fuse (12)</th>
<th>Fuse Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuse (1)</td>
<td>39,097</td>
<td>2,142</td>
<td>0</td>
<td>25,278</td>
<td>22,278</td>
<td>1,902</td>
<td>0</td>
<td>25,180</td>
<td>0</td>
<td>0</td>
<td>25,180</td>
<td>0</td>
<td>89,698</td>
</tr>
<tr>
<td>Fuse (2)</td>
<td>0</td>
<td>260</td>
<td>0</td>
<td>575</td>
<td>575</td>
<td>0</td>
<td>0</td>
<td>575</td>
<td>599,573</td>
<td>599,573</td>
<td>-590,998</td>
<td>-590,998</td>
<td>-598,163</td>
</tr>
<tr>
<td>Fuse (3)</td>
<td>0</td>
<td>124</td>
<td>0</td>
<td>209</td>
<td>209</td>
<td>777</td>
<td>0</td>
<td>986</td>
<td>0</td>
<td>0</td>
<td>986</td>
<td>1,520</td>
<td>1,520</td>
</tr>
<tr>
<td>Fuse (4)</td>
<td>14,552</td>
<td>0</td>
<td>0</td>
<td>161</td>
<td>161</td>
<td>0</td>
<td>0</td>
<td>161</td>
<td>0</td>
<td>0</td>
<td>161</td>
<td>14,874</td>
<td>14,874</td>
</tr>
<tr>
<td>Fuse (5)</td>
<td>377,167</td>
<td>1,355</td>
<td>475,381</td>
<td>106,263</td>
<td>581,644</td>
<td>187,171</td>
<td>0</td>
<td>768,815</td>
<td>0</td>
<td>0</td>
<td>768,815</td>
<td>1,728,981</td>
<td>1,728,981</td>
</tr>
<tr>
<td>Fuse (6)</td>
<td>29,252</td>
<td>12,264</td>
<td>0</td>
<td>19</td>
<td>19</td>
<td>0</td>
<td>1</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>22</td>
<td>41,555</td>
<td>41,555</td>
</tr>
<tr>
<td>Fuse (7)</td>
<td>26,966</td>
<td>0</td>
<td>255,971</td>
<td>-1</td>
<td>255,970</td>
<td>0</td>
<td>625</td>
<td>256,394</td>
<td>9,285</td>
<td>9,285</td>
<td>247,309</td>
<td>530,245</td>
<td>530,245</td>
</tr>
<tr>
<td>Fuse (8)</td>
<td>73,848</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>78</td>
<td>79</td>
<td>72,072</td>
<td>72,072</td>
<td>-71,998</td>
<td>-144</td>
<td>-144</td>
</tr>
<tr>
<td>Fuse (9)</td>
<td>67,099</td>
<td>11,974</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>11,650</td>
<td>11,650</td>
<td>31,763</td>
<td>31,763</td>
<td>-20,113</td>
<td>59,771</td>
<td>59,771</td>
</tr>
<tr>
<td>Fuse (10)</td>
<td>62,531</td>
<td>2,047</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>0</td>
<td>2,918</td>
<td>2,934</td>
<td>20,153</td>
<td>20,153</td>
<td>-17,219</td>
<td>47,571</td>
<td>47,571</td>
</tr>
<tr>
<td>Fuse (11)</td>
<td>61,712</td>
<td>350,456</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>200</td>
<td>199</td>
<td>48,477</td>
<td>48,477</td>
<td>-48,278</td>
<td>365,890</td>
<td>365,890</td>
</tr>
<tr>
<td>Fuse (12)</td>
<td>15,842</td>
<td>352,785</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>36,639</td>
<td>36,639</td>
<td>-36,639</td>
<td>329,991</td>
<td>329,991</td>
</tr>
<tr>
<td>Fuse (12A)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-59,426</td>
<td>35</td>
<td>-59,426</td>
</tr>
<tr>
<td>Fuse Total</td>
<td>764,857</td>
<td>733,405</td>
<td>731,168</td>
<td>230,523</td>
<td>861,875</td>
<td>189,850</td>
<td>15,473</td>
<td>1,867,198</td>
<td>2,306</td>
<td>355,634</td>
<td>1,094,117</td>
<td>-26,919</td>
<td>3,206,620</td>
</tr>
</tbody>
</table>

Source: General Authority of Statistics (GSTAT, 2016)
Table 8 represents the amount of demand generated by the final use sector. The I-O table is static in terms of historical data, but has the ability to estimate the impact of the change in any sector of production or final demand in the entire system. Much debate exists about whether the I-O table is dynamic or static. The change in the I-O table usually comes from two sources; it is domestic change when the coefficient of any domestic production sector has changed due to the adoption of a new technology that requires less consumption of energy or when the structure of economic production had changed to one that is less reliant on manufacturing to services. In short, the coefficient among the production sectors usually changes over time. This is the endogenous change. The exogenous change is different in that it would flow from the change in the final use table. For instance, if the government increases its spending on the renewable energy sector, it will change the kind of demand in the sectors of production.

It was mentioned earlier that Table 7 also includes the distribution of the total output of the production sector to other production sectors. Table 9 presents the distribution of output of these sectors of production to each other in percentage units. For instance, there is around 36.8% of total other manufacturing output, which does not include petroleum refining consumed by the petroleum and natural gas sector. Also, around 22.1% and 26.3% of the construction output is distributed to petroleum refining and other manufacturing sectors, respectively. It is also clear from Table 9 that most Saudi economic activities are related to the petroleum sector. Hence, it is important for Saudi Arabia to shift its economy toward more diversification as a means of maintaining economic stability (Callen et al., 2014).
### Saudi Arabia Input and Output Table for 2015 (Percentage %)

**Table 9**

**NATIONAL INCOME ACCOUNTS SUPPLY AND USE TABLES (2015)**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>ACT (1)</td>
<td>Agriculture, Forestry &amp; Fishing (AGRF)</td>
<td>27.9%</td>
<td>0.0%</td>
<td>8.4%</td>
<td>0.0%</td>
<td>2.8%</td>
<td>17.7%</td>
<td>0.0%</td>
<td>2.0%</td>
<td>0.0%</td>
<td>3.2%</td>
</tr>
<tr>
<td>ACT (2)</td>
<td>Crude Petroleum &amp; Natural Gas Extraction (CPNG)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>10.3%</td>
<td>5.8%</td>
<td>36.8%</td>
<td>11.8%</td>
<td>10.7%</td>
<td>3.7%</td>
<td>0.0%</td>
<td>2.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>ACT (3)</td>
<td>Other Mining (MINQ)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>3.8%</td>
<td>3.2%</td>
<td>4.2%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>ACT (4)</td>
<td>Petroleum Refining (PERF)</td>
<td>14.5%</td>
<td>32.6%</td>
<td>7.7%</td>
<td>14.2%</td>
<td>5.9%</td>
<td>10.0%</td>
<td>22.1%</td>
<td>5.3%</td>
<td>5.6%</td>
<td>21.9%</td>
<td>5.8%</td>
</tr>
<tr>
<td>ACT (5)</td>
<td>Other Manufacturing (MANF)</td>
<td>33.9%</td>
<td>31.0%</td>
<td>33.9%</td>
<td>33.2%</td>
<td>10.3%</td>
<td>23.7%</td>
<td>26.3%</td>
<td>52.1%</td>
<td>20.3%</td>
<td>29.5%</td>
<td>36.3%</td>
</tr>
<tr>
<td>ACT (6)</td>
<td>Electricity, Gas and Water (EGW)</td>
<td>3.2%</td>
<td>3.2%</td>
<td>3.6%</td>
<td>3.2%</td>
<td>2.3%</td>
<td>4.0%</td>
<td>2.6%</td>
<td>2.2%</td>
<td>6.8%</td>
<td>3.4%</td>
<td>5.8%</td>
</tr>
<tr>
<td>ACT (7)</td>
<td>Construction (CoN)</td>
<td>4.3%</td>
<td>6.1%</td>
<td>8.1%</td>
<td>7.7%</td>
<td>8.1%</td>
<td>8.3%</td>
<td>5.8%</td>
<td>8.6%</td>
<td>10.1%</td>
<td>10.4%</td>
<td>17.6%</td>
</tr>
<tr>
<td>ACT (8)</td>
<td>Wholesale &amp; Retail Trade, Restaurants &amp; Hotels (WRTRH)</td>
<td>3.9%</td>
<td>2.3%</td>
<td>5.4%</td>
<td>3.3%</td>
<td>4.7%</td>
<td>4.8%</td>
<td>6.5%</td>
<td>5.2%</td>
<td>5.5%</td>
<td>5.2%</td>
<td>4.9%</td>
</tr>
<tr>
<td>ACT (9)</td>
<td>Transport, Storage &amp; Communication (TS&amp;Co)</td>
<td>2.2%</td>
<td>10.0%</td>
<td>10.3%</td>
<td>20.8%</td>
<td>8.5%</td>
<td>3.5%</td>
<td>6.3%</td>
<td>6.9%</td>
<td>27.0%</td>
<td>12.5%</td>
<td>7.1%</td>
</tr>
<tr>
<td>ACT (10)</td>
<td>Fin., Insur., Real Estate &amp; Bus. Svcs. And Ownership of Dwellings (Imputed Rent) (FinRB)</td>
<td>4.8%</td>
<td>7.9%</td>
<td>5.3%</td>
<td>5.6%</td>
<td>6.0%</td>
<td>6.1%</td>
<td>7.0%</td>
<td>6.7%</td>
<td>20.0%</td>
<td>7.0%</td>
<td>30.0%</td>
</tr>
<tr>
<td>ACT (11)</td>
<td>Community, Social &amp; Personal Services (CommPSER)</td>
<td>4.2%</td>
<td>5.4%</td>
<td>4.6%</td>
<td>4.2%</td>
<td>4.3%</td>
<td>4.2%</td>
<td>4.0%</td>
<td>4.0%</td>
<td>4.7%</td>
<td>3.5%</td>
<td>3.9%</td>
</tr>
<tr>
<td>ACT (12)</td>
<td>Producers of Government Services (PofGS)</td>
<td>1.3%</td>
<td>1.4%</td>
<td>2.5%</td>
<td>2.0%</td>
<td>2.4%</td>
<td>2.0%</td>
<td>2.3%</td>
<td>1.4%</td>
<td>1.6%</td>
<td>1.7%</td>
<td>1.8%</td>
</tr>
<tr>
<td><strong>TD</strong></td>
<td><strong>Total Input</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1.00</strong></td>
</tr>
</tbody>
</table>

Source: General Authority of Statistics (GSTAT, 2016)
Table 10 explores the amount of output consumed by different sectors of the final use in percentage units. It is clear from Table 10 that over 48% of the total final use demand comes from the manufacturing sector. Hence, most of the input comes from the import of goods, including raw materials and machines. The construction sector is the second highest contributor to the total value of the final demand. Spending on imported services is the dominant part of the final use demand by construction. Columns Fuse (1) and Fuse (2) contain information about household and government total final consumption by percentage. It is clear that government and household consumption will enhance the non-oil sector.

Table 11 is the value added table. This table explains the gross domestic product (GDP). The value added table presents the total value resulting from the domestic production sector for a year. Table 11 also includes the compensation of employees, other taxes less subsidies on production, and operating surplus. As is clear from this table, the manufacturing and construction sectors make a significant contribution to the total value added in the Saudi economy, as these sectors are highly capital-intensive.

Table 12 calculates the A matrix entities represented as \( a_{ij} \), where \( a_{ij} = \frac{X_{ij}}{X_j} \). A matrix calculates the input coefficients of all production sectors. This table calculates the coefficients of different production sectors as a percentage of each sector’s total output. Let us say that \( X_2 \) consumes 10% of the total production of \( X_1 \), and \( a_{12} \) is the percentage of \( X_1 \) used as input to \( X_2 \). In the Leontief model, this step is “A matrix.” Table 12 summarizes the relationship among different sectors of production: \( A = a_{ij} = \frac{X_{ij}}{X_j} \). Thus, Table 12 provides the distribution of output by one sector of production among all other sectors of production.
### Table 10

**Saudi Arabia Final Use Table for 2015 (Percentage %)**

<table>
<thead>
<tr>
<th>No</th>
<th>GDP Activities</th>
<th>Final Consumption Expenditure by Households (%)</th>
<th>Gross Fixed Capital Formation (%)</th>
<th>Changes in Inventories and Errors &amp; Omission (%)</th>
<th>Exports of Oil (%)</th>
<th>Exports of Non-Oil Goods (%)</th>
<th>Exports of Services (%)</th>
<th>EXPORTS (TOTAL) (%)</th>
<th>Import of goods (%)</th>
<th>Import (Total) * direct import by household (%)</th>
<th>Net export (%)</th>
<th>FINAL USES (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT (1)</td>
<td>Agriculture, Forestry &amp; Fishing (AGRF)</td>
<td>4.2%</td>
<td>0.53%</td>
<td>0.0%</td>
<td>16.99%</td>
<td>0.0%</td>
<td>1.0%</td>
<td>0.0%</td>
<td>0.1%</td>
<td>4.1%</td>
<td>0.0%</td>
<td>3.1%</td>
</tr>
<tr>
<td>ACT (2)</td>
<td>Crude Petroleum &amp; Natural Gas Extraction (CPNG)</td>
<td>0.0%</td>
<td>0.03%</td>
<td>0.0%</td>
<td>1.94%</td>
<td>42.87%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>36.4%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>ACT (3)</td>
<td>Other Mining (MINQ)</td>
<td>0.0%</td>
<td>0.04%</td>
<td>0.0%</td>
<td>0.16%</td>
<td>0.00%</td>
<td>0.4%</td>
<td>0.0%</td>
<td>0.1%</td>
<td>0.7%</td>
<td>0.0%</td>
<td>0.5%</td>
</tr>
<tr>
<td>ACT (4)</td>
<td>Petroleum Refining (PERF)</td>
<td>1.6%</td>
<td>0.00%</td>
<td>0.0%</td>
<td>1.66%</td>
<td>6.77%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>5.7%</td>
<td>0.7%</td>
<td>0.0%</td>
<td>0.5%</td>
</tr>
<tr>
<td>ACT (5)</td>
<td>Other Manufacturing (MANF)</td>
<td>40.2%</td>
<td>0.46%</td>
<td>65.0%</td>
<td>79.21%</td>
<td>50.36%</td>
<td>98.6%</td>
<td>0.0%</td>
<td>56.5%</td>
<td>94.5%</td>
<td>0.0%</td>
<td>70.9%</td>
</tr>
<tr>
<td>ACT (6)</td>
<td>Electricity, Gas and Water (EGW)</td>
<td>3.1%</td>
<td>3.56%</td>
<td>0.0%</td>
<td>0.02%</td>
<td>0.00%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>ACT (7)</td>
<td>Construction (CoN)</td>
<td>2.9%</td>
<td>0.00%</td>
<td>35.0%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>ACT (8)</td>
<td>Wholesale &amp; Retail Trade, Restaurants &amp; Hotels (WRTRH)</td>
<td>7.7%</td>
<td>0.00%</td>
<td>0.0%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>ACT (9)</td>
<td>Transport, Storage &amp; Communication/Telecom (TrStgCo)</td>
<td>7.3%</td>
<td>3.86%</td>
<td>0.0%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>75.3%</td>
<td>0.9%</td>
<td>0.0%</td>
<td>14.5%</td>
</tr>
<tr>
<td>ACT (10)</td>
<td>Fin, Insur., Real Estate &amp; Ins. Sec. And Ownership of Dwellings (Imputed Rent) (FinRB)</td>
<td>25.0%</td>
<td>0.88%</td>
<td>0.0%</td>
<td>0.01%</td>
<td>0.00%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>18.9%</td>
<td>0.2%</td>
<td>0.0%</td>
<td>9.2%</td>
</tr>
<tr>
<td>ACT (11)</td>
<td>Community, Social &amp; Personal Services (CommuPSER)</td>
<td>6.6%</td>
<td>45.17%</td>
<td>0.0%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>1.3%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>22.2%</td>
</tr>
<tr>
<td>ACT (12)</td>
<td>Producers of Government Services (ProGS)</td>
<td>1.5%</td>
<td>45.47%</td>
<td>0.0%</td>
<td>0.00%</td>
<td>0.00%</td>
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| TD | Total Input | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

Source: General Authority of Statistics (GSTAT, 2016)
Table 11

Saudi Arabia Value Added Table for 2015

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<th>Million SR</th>
<th>Original Matrix</th>
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<th>ACT (2)</th>
<th>ACT (3)</th>
<th>ACT (4)</th>
<th>ACT (5)</th>
<th>ACT (6)</th>
<th>ACT (7)</th>
<th>ACT (8)</th>
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<th>ACT (10)</th>
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</table>

Source: General Authority of Statistics (GSTAT, 2016)
### Table 12

**Saudi Arabia A Matrix Input and Output Table for 2015**

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<th>Millions SR</th>
<th>Orginal Matrix</th>
<th>A matrix A⁻¹</th>
<th>Fin., Ins., Real Estate &amp; Bus. Svcs. And Ownership of Dwellings (Imputed Rent)</th>
<th>Community, Social &amp; Personal Services</th>
<th>Producers of Government Services</th>
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</thead>
<tbody>
<tr>
<td>No</td>
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<td>ACT (1)</td>
<td>ACT (2)</td>
<td>ACT (3)</td>
<td>ACT (4)</td>
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<td>Other Mining (MINQ)</td>
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<td>Petroleum Refining (PERF)</td>
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**Source:** General Authority of Statistics (GSTAT, 2016)
The next step in the Leontief I-O methodology is the identity matrix (see Table 13). This step is vital for calculating Leontief’s inverse matrix. This matrix is used to calculate the next table (Table 14), which is the (I-A) matrix. (I) is the identity matrix and A is the coefficient matrix. Table 14 has one condition, which is that diagonal values must be positive and off-diagonal values must be negative.
### Table 13

**Saudi Arabia Identical Matrix Table for 2015**

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<th>Leontief Inverse Matrix of Saudi Arabia for 2015</th>
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<th>ACT (2)</th>
<th>ACT (3)</th>
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<th>ACT (6)</th>
<th>ACT (7)</th>
<th>ACT (8)</th>
<th>ACT (9)</th>
<th>ACT (10)</th>
<th>ACT (11)</th>
<th>ACT (12)</th>
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</thead>
<tbody>
<tr>
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<td>GDP Activities</td>
<td>Agriculture, Forestry &amp; Fishing</td>
<td>Crude Petroleum &amp; Natural Gas Extraction</td>
<td>Other Mining</td>
<td>Petroleum Refining</td>
<td>Other Manufacturing</td>
<td>Electricity, Gas and Water</td>
<td>Construction</td>
<td>Wholesale &amp; Retail Trade, Restaurants &amp; Hotels</td>
<td>Transport, Storage &amp; Communication</td>
<td>Community, Social &amp; Personal Services</td>
<td>Producers of Government Services</td>
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<td>ACT (12)</td>
<td>Producers of Government Services (ProGbS)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: General Authority of Statistics (GSTAT, 2016)
Table 14

Saudi Arabia (I-A) Matrix Input and Output Table for 2015

<table>
<thead>
<tr>
<th>Millions SR</th>
<th>I-A</th>
<th>ACT (1)</th>
<th>ACT (2)</th>
<th>ACT (3)</th>
<th>ACT (4)</th>
<th>ACT (5)</th>
<th>ACT (6)</th>
<th>ACT (7)</th>
<th>ACT (8)</th>
<th>ACT (9)</th>
<th>ACT (10)</th>
<th>ACT (11)</th>
<th>ACT (12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT (1)</td>
<td>Agriculture, Forestry &amp; Fishing</td>
<td>0.915664857</td>
<td>0</td>
<td>-0.00663548</td>
<td>0</td>
<td>-0.032263556</td>
<td>-0.729364232</td>
<td>0</td>
<td>-0.006765142</td>
<td>0</td>
<td>-0.05179336</td>
<td>0</td>
<td>-0.029342598</td>
</tr>
<tr>
<td>ACT (2)</td>
<td>Crude Petroleum &amp; Natural Gas Extraction</td>
<td>0</td>
<td>1</td>
<td>-0.01623005</td>
<td>-0.03149944</td>
<td>-0.383319266</td>
<td>-0.435120537</td>
<td>-0.04220237</td>
<td>-0.097106762</td>
<td>0</td>
<td>-0.030403482</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ACT (3)</td>
<td>Other Mining</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>-0.529024092</td>
<td>-0.04591916</td>
<td>-0.426365765</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ACT (4)</td>
<td>Petroleum Refining</td>
<td>-0.024061233</td>
<td>-0.012289583</td>
<td>-0.006977802</td>
<td>0.950238435</td>
<td>-0.056219127</td>
<td>-0.327995953</td>
<td>-0.077927423</td>
<td>-0.118398408</td>
<td>-0.046624717</td>
<td>-0.276604048</td>
<td>-0.011224399</td>
<td>-0.019400717</td>
</tr>
<tr>
<td>ACT (5)</td>
<td>Other Manufacturing</td>
<td>-0.026183769</td>
<td>-0.038083759</td>
<td>-0.006081904</td>
<td>-0.049906393</td>
<td>0.947217632</td>
<td>-0.245127394</td>
<td>-0.027524844</td>
<td>-0.384614248</td>
<td>-0.074155359</td>
<td>-0.18310984</td>
<td>-0.018407706</td>
<td>-0.039094014</td>
</tr>
<tr>
<td>ACT (6)</td>
<td>Electricity, Gas and Water (EGW)</td>
<td>-0.024201591</td>
<td>-0.003832026</td>
<td>-0.005039891</td>
<td>-0.009561047</td>
<td>-0.054268833</td>
<td>0.600078012</td>
<td>-0.02340725</td>
<td>-0.137706204</td>
<td>-0.206537417</td>
<td>-0.111465211</td>
<td>-0.029513098</td>
<td>-0.014203851</td>
</tr>
<tr>
<td>ACT (7)</td>
<td>Construction (CoN)</td>
<td>-0.01156507</td>
<td>-0.002671955</td>
<td>-0.00922788</td>
<td>-0.046968612</td>
<td>-0.081985010</td>
<td>-0.298010871</td>
<td>0.968823894</td>
<td>-0.215883228</td>
<td>-0.109865467</td>
<td>-0.143166485</td>
<td>-0.022211399</td>
<td>-0.07603341</td>
</tr>
<tr>
<td>ACT (8)</td>
<td>Wholesale &amp; Retail Trade, Restaurants &amp; Hotels (WRTRH)</td>
<td>-0.018803183</td>
<td>-0.001784787</td>
<td>-0.00701712</td>
<td>-0.00504717</td>
<td>-0.082970173</td>
<td>-0.301279252</td>
<td>-0.04104427</td>
<td>0.762442577</td>
<td>-0.123299605</td>
<td>-0.12695156</td>
<td>-0.01876984</td>
<td>-0.055950444</td>
</tr>
<tr>
<td>ACT (9)</td>
<td>Transport, Storage &amp; Communication (TSWindCo)</td>
<td>-0.005563763</td>
<td>-0.004856489</td>
<td>-0.010228742</td>
<td>-0.01048272</td>
<td>-0.083902093</td>
<td>-0.125707711</td>
<td>-0.022084197</td>
<td>-0.177196886</td>
<td>0.65581102</td>
<td>-0.172786802</td>
<td>-0.015703127</td>
<td>-0.025576499</td>
</tr>
<tr>
<td>ACT (10)</td>
<td>Fin., Insur., Real Estate &amp; Bus. Svcs. And Ownership of Dwellings (Imputed Rent) (FinRB)</td>
<td>-0.031320218</td>
<td>-0.00354002</td>
<td>-0.00582027</td>
<td>-0.0302076</td>
<td>-0.066183093</td>
<td>-0.23306161</td>
<td>-0.028746773</td>
<td>-0.17037350</td>
<td>-0.260404253</td>
<td>-0.09195025</td>
<td>-0.09195025</td>
<td>-0.069261217</td>
</tr>
<tr>
<td>ACT (11)</td>
<td>Community, Social &amp; Personal Services (CommuPSER)</td>
<td>-0.027182368</td>
<td>-0.007733336</td>
<td>-0.01104904</td>
<td>-0.00537571</td>
<td>-0.104859499</td>
<td>-0.36706335</td>
<td>-0.013531649</td>
<td>-0.120383664</td>
<td>-0.142716075</td>
<td>-0.107556457</td>
<td>0.980067752</td>
<td>-0.059253958</td>
</tr>
<tr>
<td>ACT (12)</td>
<td>Producers of Government Services (ProGS)</td>
<td>-0.017263204</td>
<td>-0.003007795</td>
<td>-0.012724187</td>
<td>-0.005107504</td>
<td>-0.11861467</td>
<td>-0.341348659</td>
<td>-0.040746767</td>
<td>-0.19554836</td>
<td>-0.094858371</td>
<td>-0.115548591</td>
<td>-0.01804548</td>
<td>0.964816973</td>
</tr>
</tbody>
</table>

Source: General Authority of Statistics (GSTAT, 2016)
Table 15 shows the inverse matrix $(I-A)^{-1}$ for 2015. The inverse matrix calculates coefficient vectors among different sectors of production. Agriculture and utility made the lowest contribution to the total Saudi output. Their coefficients with other sectors of production are very small compared to mining, quarrying, and manufacturing, which have the highest coefficients with all sectors of production (see Table 15).
<table>
<thead>
<tr>
<th>Millions SR</th>
<th>Leontief Inverse Matrix of Saudi Arabia for 2015</th>
<th>ACT (1)</th>
<th>ACT (2)</th>
<th>ACT (3)</th>
<th>ACT (4)</th>
<th>ACT (5)</th>
<th>ACT (6)</th>
<th>ACT (7)</th>
<th>ACT (8)</th>
<th>ACT (9)</th>
<th>ACT (10)</th>
<th>ACT (11)</th>
<th>ACT (12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>GDP Activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agriculture, Forestry &amp; Fishing (AGRF)</td>
<td>1.0346</td>
<td>0.0016</td>
<td>0.0226</td>
<td>0.0005</td>
<td>0.0026</td>
<td>0.5387</td>
<td>0.0018</td>
<td>0.1021</td>
<td>0.0207</td>
<td>0.0185</td>
<td>0.0127</td>
<td>0.0126</td>
</tr>
<tr>
<td>ACT (2)</td>
<td>Crude Petroleum &amp; Natural Gas Extraction (CPNG)</td>
<td>0.0031</td>
<td>1.0001</td>
<td>0.0262</td>
<td>0.0017</td>
<td>0.0210</td>
<td>0.3783</td>
<td>0.0066</td>
<td>0.1596</td>
<td>0.0139</td>
<td>0.0159</td>
<td>0.0051</td>
<td>0.0051</td>
</tr>
<tr>
<td>ACT (3)</td>
<td>Other Mining (MINQ)</td>
<td>0.0011</td>
<td>5.4159</td>
<td>0.0012</td>
<td>0.0005</td>
<td>0.0052</td>
<td>0.3462</td>
<td>0.0031</td>
<td>0.1220</td>
<td>0.0072</td>
<td>0.0036</td>
<td>0.0006</td>
<td>0.0018</td>
</tr>
<tr>
<td>ACT (4)</td>
<td>Petroleum Refining (PERF)</td>
<td>0.0194</td>
<td>0.0023</td>
<td>0.0210</td>
<td>0.0027</td>
<td>0.0048</td>
<td>0.3462</td>
<td>0.0180</td>
<td>0.1925</td>
<td>0.0478</td>
<td>0.0764</td>
<td>0.0047</td>
<td>0.0019</td>
</tr>
<tr>
<td>ACT (5)</td>
<td>Other Manufacturing (MANF)</td>
<td>0.0516</td>
<td>0.0027</td>
<td>0.0954</td>
<td>0.0008</td>
<td>0.0052</td>
<td>0.3462</td>
<td>0.0180</td>
<td>0.1925</td>
<td>0.0478</td>
<td>0.0764</td>
<td>0.0047</td>
<td>0.0019</td>
</tr>
<tr>
<td>ACT (6)</td>
<td>Electricity, Gas and Water (EGW)</td>
<td>0.0048</td>
<td>0.0002</td>
<td>0.0098</td>
<td>0.0009</td>
<td>0.0008</td>
<td>0.3462</td>
<td>0.0180</td>
<td>0.1925</td>
<td>0.0478</td>
<td>0.0764</td>
<td>0.0047</td>
<td>0.0019</td>
</tr>
<tr>
<td>ACT (7)</td>
<td>Construction (Con)</td>
<td>0.0179</td>
<td>0.0015</td>
<td>0.0012</td>
<td>0.0008</td>
<td>0.0052</td>
<td>0.3462</td>
<td>0.0180</td>
<td>0.1925</td>
<td>0.0478</td>
<td>0.0764</td>
<td>0.0047</td>
<td>0.0019</td>
</tr>
<tr>
<td>ACT (8)</td>
<td>Wholesale &amp; Retail Trade, Restaurants &amp; Hotels</td>
<td>0.0063</td>
<td>0.0020</td>
<td>0.0147</td>
<td>0.0015</td>
<td>0.0008</td>
<td>0.3462</td>
<td>0.0180</td>
<td>0.1925</td>
<td>0.0478</td>
<td>0.0764</td>
<td>0.0047</td>
<td>0.0019</td>
</tr>
<tr>
<td>ACT (9)</td>
<td>Transport, Storage &amp; Communication (TS&amp;Co)</td>
<td>0.0052</td>
<td>0.0003</td>
<td>0.0274</td>
<td>0.0008</td>
<td>0.0052</td>
<td>0.3462</td>
<td>0.0180</td>
<td>0.1925</td>
<td>0.0478</td>
<td>0.0764</td>
<td>0.0047</td>
<td>0.0019</td>
</tr>
<tr>
<td>ACT (10)</td>
<td>Fin., Insur., Real Estate &amp; Bus. Svcs. And Ownership of Dwellings (Imputed Rent)</td>
<td>0.0081</td>
<td>0.0017</td>
<td>0.0017</td>
<td>0.0011</td>
<td>0.0008</td>
<td>0.3462</td>
<td>0.0180</td>
<td>0.1925</td>
<td>0.0478</td>
<td>0.0764</td>
<td>0.0047</td>
<td>0.0019</td>
</tr>
<tr>
<td>ACT (11)</td>
<td>Community, Social &amp; Personal Services (CommSERS)</td>
<td>0.0059</td>
<td>0.0003</td>
<td>0.0117</td>
<td>0.0017</td>
<td>0.0008</td>
<td>0.3462</td>
<td>0.0180</td>
<td>0.1925</td>
<td>0.0478</td>
<td>0.0764</td>
<td>0.0047</td>
<td>0.0019</td>
</tr>
<tr>
<td>ACT (12)</td>
<td>Producers of Government Services (ProGS)</td>
<td>0.0021</td>
<td>0.0001</td>
<td>0.0005</td>
<td>0.0005</td>
<td>0.0008</td>
<td>0.3462</td>
<td>0.0180</td>
<td>0.1925</td>
<td>0.0478</td>
<td>0.0764</td>
<td>0.0047</td>
<td>0.0019</td>
</tr>
</tbody>
</table>

Source: General Authority of Statistics (GSTAT, 2016)
This study is interesting in that it calculates three multipliers: labor, value-added, and output. These multipliers would reflect the impact of investment in renewable energy on the economy. Making a decision on the macroeconomic level is not an easy thing to do for any policymaker due to the complex interconnections among different economic entities. In this case, the Leontief I-O multipliers are a very useful tool for connecting all parts of the economy to catch any change in all entities of the economy. These multipliers can stimulate the possible economic output after the implementation of any policy and help policymakers select the right policy. Moreover, the output multiplier of investment in the Saudi renewable energy sector is estimated to be around 0.8. This means that increasing demand for the renewable energy sector by one million is expected to increase the total economic demand, on average, by 0.8 million. The value-added multiplier is estimated to be around 4 percent, which means that an investment of one million SR in Saudi renewable energy will generate SR40,000 thousand value added. Two new permanent direct jobs are expected to be generated from each SR 1 million spent on renewable energy in Saudi Arabia (see Figure 7).

Source: Author’s calculation

*Figure 7.* The Saudi renewable energy sector multiplier.
As is clear from Figure 7, investment in renewable energy is expected to make a significant contribution to most of the production entities, whether directly or indirectly. The Saudi Arabia I-O table of 2015 did not include a specific production sector for the Saudi renewable energy sector. This means that tracking a change in the Saudi renewable energy sector could be very difficult. Therefore, this research has reviewed different studies and papers that estimated the impacts of new investment in renewable energy in the other sectors of production and on the whole economy. Based on this literature, new investment in the Saudi renewable energy has been distributed to different sectors of Saudi economic activities. The entire Saudi economic system will expand following new investment in renewable energy. This expansion in the production system depends on various factors, such as the level of diversification, the amount of money, and the kind of investment. However, the Saudi I-O table has 12 sectors of production. The reason is that the expansions will be different among these different sectors of production. This means that some sectors of production would expand by more than one time the amount of new value invested in the Saudi production system. For renewable energy, as a result of an investment of one million riyals in any sector related to renewable energy, it has been found that a significant amount of money flows to the construction sector.

Thus, the expansion in the construction sector witnesses an average increase of 4.2 times by increase investment in renewable energy by one unit. However, the entire expansion of the economy is expected to increase by 0.8 times. For every million riyals invested in renewable energy, there is an expectation that more than one job will be generated on average. Some sectors of production might generate more jobs than others, but in general, the
labor in the entire economy would increase by two new job opportunities per one million riyals invested in renewable energy.

The next section will build different scenarios for investment in renewable energy.

**Empirical Scenarios**

After calculating the major multipliers (output, value added, and labor), this section aims to build different scenarios of investment in the Saudi renewable energy sector. There are three likely investment scenarios, which include the investment of SR100 billion, SR150 billion, and SR200 billion. For three scenarios, these amounts of investment are divided into a four-year (2018-2021) period. There are three reasons to distribute the flow of money over four years: avoiding inflationary pressures, reducing remittances, and controlling leakages. The other reason for having different scenarios is that policymakers have various agendas and budgetary constraints. These scenarios can provide a different output with different budgets. Another benefit of having these different scenarios is the ability to show the magnitude of impacts of different investments on the number of laborers, the total output, and the total value added.

**Scenarios of Investment in the Saudi Renewable Energy Sector (Investment SR of 100 Billion)**

As shown in Figure 8, scenario 1 assumes that the government decides to invest SR100 billion in the Saudi renewable energy sector for the next four years starting in 2018. This SR100 billion is divided into SR25 billion each year for four years (from 2018-2021). For 2018, the value added is estimated to be around SR10 billion and the total GDP growth is expected to be around 1.8% from direct and indirect expansion in the Saudi economic activities of investment SR25 billion. The expected contribution ratio of this sector to the
total Saudi GDP is around 1.3% for the first year, while the total value added from an investment of SR100 billion in Saudi renewable energy is estimated to be around SR71 billion by the end of 2021. The contribution ratio to the total Saudi GDP is expected to be around 3.4% by the end of 2021. The number of new permanent jobs is expected to be around 85,000 from investment SR100 billion in the Saudi renewable sector.

Source: Author’s calculation

*Figure 8. Investment (SR100 billion) in the Saudi renewable energy sector for four years.*

**Scenarios of Investment in the Saudi Renewable Energy Sector (Investment of SR150 Billion)**

Figure 9 of scenario 2 assumes that if the government decides to invest SR150 billion in the Saudi renewable energy sector for the next four years starting in 2018, the value added is estimated to be around SR15 billion, while the renewable energy sector’s contribution to total GDP growth will be around 2.0% from direct and indirect expansion in the economic
activities of an investment of SR37.5 billion in 2018. Overall, the expected contribution ratio of the renewable energy sector to the total Saudi GDP is predicted to be around 4.21% from an investment of SR150 billion and the total value added is estimated to be SR83.76 billion by the end of 2021. The total number of new permanent jobs expected is 124,000.

Figure 9. Investment (SR150 billion) in the Saudi renewable energy sector for four years.

Source: Author’s calculation
Scenarios of Investment in the Saudi Renewable Energy Sector (Investment of SR200 Billion)

Figure 10 shows that scenario 3 has an initial total investment of SR200 billion in the Saudi renewable energy sector, which is divided into SR50 billion over each year for four years. The total value added from an investment of SR200 billion will be around SR111.6 billion by the end of 2021, while the estimated contribution ratio of renewable energy activities to the total Saudi GDP is expected to be around 5.6% by the end of 2021. The total number of new permanent jobs is expected to be around 148,000 from an investment of SR200 billion in the Saudi renewable energy sector.

Source: Author’s calculation

*Figure 10.* Investment (SR200 billion) in the Saudi renewable energy sector for four years.
Comparing Our Scenarios with the National Transformation Plan (NTP 2020)

The purpose of Table 16 is to compare the results we calculated for these three scenarios to the results of the NTP 2020. According to the NTP 2020, the total investment in the Saudi renewable energy sector will be around SR200 billion by the end of 2023. Our empirical work contains three scenarios of investment in the renewable energy sector; these scenarios are investments of SR100 billion, SR150 billion, and SR200 billion during the next four years until 2021. The value added calculated by NTP 2020 of an investment of SR200 billion by 2023 is around SR128 billion. We have found that the value added would be, on average, around SR71 billion for the first scenario, SR83.8 billion for the second scenario, and SR112 billion for the third scenario.

NTP 2020’s expectation regarding the total contribution that the renewable energy sector will make to the Saudi GDP is 10.28% by the end of 2023. However, according to our calculation, the renewable energy sector’s contribution to the Saudi GDP would be around 3.4% for the first scenario, 4.2% for the second scenario, and 5.6% for the third scenario.

Finally, NTP 2020 estimated that more than 137,000 direct new jobs would be generated in the renewable energy sector by the end of 2020. In our calculations, we have found that the number of new permanent jobs generated in the Saudi economy would be 85,000, 124,000, and 148,000.
Table 16

Comparing Results of NTP and Our Scenarios

<table>
<thead>
<tr>
<th>Key Performance Indicators</th>
<th>2020 Target</th>
<th>SCEN\textsuperscript{14} (1)</th>
<th>SCEN (2)</th>
<th>SCEN (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total All New Renewable Energy Investment (SAR BN)</td>
<td>200</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Value Added (SAR BN)</td>
<td>128</td>
<td>71</td>
<td>83.8</td>
<td>112</td>
</tr>
<tr>
<td>% Contribution to GDP</td>
<td>10.28%</td>
<td>3.4%</td>
<td>4.21%</td>
<td>5.6%</td>
</tr>
<tr>
<td>Number of New Jobs (Thousand Jobs)</td>
<td>137</td>
<td>85</td>
<td>124</td>
<td>148</td>
</tr>
</tbody>
</table>

Source: Author’s calculation

The Advantages and Limitations of Using Leontief’s Input-Output Model

The I-O model is beneficial for calculating the expected effects of imposing new economic policies and activities on the entire economy at the aggregate level (Miller & Blair, 2009). For instance, if the government decides to build a new public university in a far-flung area, an I-O model can evaluate the direct and indirect impacts of this new investment on the whole economy. The kind of data and coefficients that the I-O model provides are essential for constructing macroeconomic policies (Caldés, Varela, Santamaría, & Sáez 2009; Lehr et al., 2008). One of the most important advantages of using the I-O model is to calculate the direct, indirect, and induced effects for any new government policy (Lambert & Silva, 2012). Hence, the I-O model was designed to calculate the economic activities in real terms as well as nominal terms (Duchin & Steenge, 2007). The real-term I-O model is the total value of the system or the flow of values among different sections of production using base year prices. In addition, some existing studies use the current prices inside the model, which may redefine...
the Leontief model in nominal terms (Duchin & Steenge, 2007). Finally, another significant advantage of using the I-O model is the model’s ability to calculate the amount of pollution reduction by increasing investment in the renewable energy sector (Leontief, 1966). The decrease in environmental pollution is calculated by having the coefficient between production sectors and carbon level (CO₂) (Liping & Bin, 2010; Schaffartzik, Sachs, Wiedenhofer, & Eisenmenger, 2014). The literature includes research papers that have evaluated the economic impact of new investment in renewables by studying the relationship between new investment in the renewable energy sector and the number of new jobs created. Other studies go deeper in discussing the level of quality and skills that renewables require, and the level of expected impacts on laborers in the fossil fuel sector. The I-O model is also more beneficial for calculating the expected effects of imposing new economic policies over the entire economy (Caldés et al., 2009; Lehr et al., 2008; Miller & Blair, 2009).

One limitation of the I-O model is the problem of double-counting. The I-O model is the output of one sector that is supposed to be the input to another sector of production. The problem of double-counting is that the output of one sector of production would be an input to another sector. Also, it is difficult to account for the labor value-added, especially in the services sectors. Finally, the process of collecting data is arduous. However, despite these limitations of the input-output methodology, it is still considered the better methodology to use for calculating or simulating the expected results of different fiscal policy practices.

Conclusion

The primary goal of this chapter is to provide underlying evidence about investment in renewables. Investment in renewables should be an optimum solution for solving different kinds of problems, such as unemployment and diversification. The first part of this chapter
covers different research papers. Most of these empirical works concluded that investment in renewables is an optimum solution for generating more jobs and driving economic growth. The second section of this chapter is the empirical work of investment in renewable energy, which is the best solution for Saudi Arabia to increase the rate of Saudi employment, create a new source of income for Saudi Arabia, learn by doing, and stabilize the Saudi economy. There is another goal behind investment in renewables, which is to reduce the domestic consumption of fossil fuel, reduce the level of carbon emission, and save more oil for export.
CHAPTER 5
RENEWABLE ENERGY CHALLENGES AND OPPORTUNITIES
IN SAUDI ARABIA

Introduction

Oil revenue is the primary source of income for the Saudi government, representing over 65% of total revenue at the end of 2017 (GSTAT, 2018).\textsuperscript{15} Since 2014, the oil markets have been less stable—a factor that encouraged many oil countries to be more serious about diversification (Horwich & Weimer, 1984; Janardhan, 2011; Kitous et al., 2016).

Diversification in Saudi Arabia may face some social and economic obstacles (Manama, 2016; Nelson, 2009). For instance, Saudi oil and oil-related companies are expected to resist any new Saudi economic structural transformation plans due to their eagerness to retain their powers as participants in the major economic activity. Also, Saudi Arabia has an essential mission of maintaining its status as a significant supplier of energy to the world for over 70 years. Increasing development in the non-oil sector may have some negative impacts on oil sector development. However, the Saudi manufacturing sector could be the primary supplier of equipment and services to the oil sector. Instead of importing machines and equipment, a connection channel could be built between the research centers of these major oil companies, domestic manufacturers, and public university research centers to share their interest in such topics as developing a new technology to increase the efficiency of oil production. This is a win-win-win situation; the oil sector should have access to new technology to increase its productivity, boost development in the Saudi manufacturing sector, and create opportunities for Saudi students at universities by providing more funds for public research centers.

\textsuperscript{15} Saudi General Authority for Statistics
Saudi domestic consumption of conventional energy is very high—approximately three million barrels of oil per day. There are many reasons for this high domestic consumption of energy, such as less consumption efficiency, a long summer, and a shortage of fresh water. In addition, the Saudi government generously subsidizes petroleum products. The prices of domestic petroleum products are among the lowest in the world (after Kuwait and Venezuela), according to Global Petrol Prices (January 22, 2018). The low price of domestic fossil fuel energy encourages overconsumption of this highly polluting energy source and harms the local environment. Furthermore, energy subsidies place a heavy burden on the government budget, and the country may lose the opportunity to export more barrels of oil, as it is a member of OPEC, with a fixed production quota (Sdrellech, Sab, Zouhar, & Albertin, 2014). Saudi Arabia is poor in fresh water. Desalinated water is one of the primary sources of fresh water for the Kingdom, representing around 50% of all drinking/fresh water. Because desalination plants use oil, burning oil is the primary source of energy. This means that increasing demand for water will increase demand for oil as well. The desalination industry used around 1.5 million barrels of oil daily by the end of 2016 (Amery, 2015).

Overall, the demand for water and energy is expected to increase significantly in Saudi Arabia due to the high population growth (an average of 3.2% for the last five years [2012-2017]), economic growth, and wasteful/inefficient use of utilities.

The primary purpose of this chapter is to shift environmental issues such as global warming and pollution into investment opportunities. Therefore, it seems as though the renewable energy sector is a promising solution with respect to Saudi Arabia’s efforts to promote diversification, as examined in Chapter 4. Enhancing investments in renewable energy projects can increase demand mainly in the non-oil sector. The use of renewable
energy will also reduce the level of pollution and help save the global ecosystem. Because the Saudi oil sector has a high level of technological development for competition purposes, increased investments in mining and refining projects will not generate additional jobs for Saudis. However, because Saudi Arabia is suffering from the problem of unemployment, especially among Saudi youth, renewable energy investments will increase domestic economic activities such as construction, manufacturing, services, utilities, and small and medium enterprises (SMEs), which will help generate more jobs for Saudis (Galambos & Amatori, 2016; Zulfiqar, 2012).

Renewable Energy: Challenges and Opportunities

By the end of 2010, the Saudi domestic consumption of electricity was around 40 GW. It is expected to be around 120 GW by the end of 2028. If we assume that fossil fuel is the only source of energy to generate electricity inside the Kingdom, Saudi Arabia will need to burn more oil, producing more CO₂, to generate this tremendous increased demand for electricity (Baras, Bamhair, AlKhoshi, Alodan, & Engel-Cox, 2012). According to the World Bank’s development economic indicators by the World Bank, Saudi Arabian emissions of carbon dioxide per capita are around 17 metric tons, versus 7 metric tons in the case of the United States. The emissions of carbon dioxide per capita for the European Union is only 6 metric tons by 2017. This fact should place additional pressure on the Kingdom to reduce emissions further.

Saudi Arabia can avoid this high level of carbon emissions by taking advantage of its high level of Direct Normal Irradiation (DNI) resources. This is an essential input to the PV and CSP solar system. In addition, enhancing investment in renewable energy should be a good strategy for generating new local jobs. The existence of more employees will increase
the level of aggregate income and reduce the poverty level. Using renewable energy, even if only partially, will help reduce the level of pollution and boost air quality (Hostettler, Gadgil, & Hazboun, 2015). However, the challenges of investment in renewable energy in Saudi Arabia include high temperatures and significant amounts of dust, which are not appropriate for PV and CSP technologies. The efficiency of PV systems is found to decrease at high temperatures, while dust reduces the output level of reflectors, especially of the CSP system. The addition of cooling and washing systems could solve these problems (Baras et al., 2012; El-Nakla, Yahya, Peterson, Ouda, & Khobar, 2006).

The challenges that typically impede the development of the renewable energy sector are a lack of financial support, technical problems, and cost issues (Sen & Ganguly, 2017). This research proposes that we regard renewable energy differently: as an investment opportunity that aims to attract the attention of the Saudi government and investors. It has also been found that investment in renewable energy in Saudi Arabia is a promising solution to the problems of unemployment, inequality, and the fragility of the economy (Taher & Hajjar, 2014). However, attracting large-scale investment in the renewable energy sector requires government regulations and financial support.

This research claims that investment in the renewable energy sector is an optimal way for Saudi Arabia to reduce the level of carbon dioxide (CO₂), develop the non-oil sector, and increase the non-oil sector’s contribution to the total Saudi Arabian GDP. Moreover, investment in renewable energy will be an excellent opportunity to generate income and jobs. This research represents an incentive to insist on an increase in the efficiency of domestic energy consumption as an important factor for decrease of domestic consumption of fuel and more development in the renewable sector. However, the decision to replace any energy
reform is a tough one for any government to make due to the expected political and social ramifications that may emerge—ramifications stemming from the replacement and reversion of energy subsidy reform as a means of increasing energy consumption efficiency.

**Energy Efficiency (EE)**

Many economic/social benefits arise from investment in the renewable energy sector. These include enhancing development in the non-oil sector, generating jobs, and keeping the supply of energy running. Other problems may result from the irrational burning of fossil fuel domestically. These problems include the pollution of water and air, increased incidences of cancer, kidney failure, and fibrosis, and the spreading of other chronic diseases (Taher & Hajjar, 2014). On the other hand, different types of challenges have resisted the development of renewable energy worldwide. For instance, a significant correlation has been found between energy consumption efficiency and development in renewable energy (Clements et al., 2013). Importantly, it is not expected that people who do not consume energy efficiently will use an expensive source of energy, such as renewable energy. Hence, increasing energy consumption efficiency is a precondition for any further development of renewable energy. That is why EE is a crucial step for Saudi Arabia, one that should be kickstarted before investment in renewable energy. One possible solution for increasing consumption efficiency is to implement an energy subsidy reform for the domestic consumption of fossil fuel; this has been found to be a good strategy for increasing energy consumption efficiency (Clements et al., 2013). This section will discuss the relationship between energy subsidies and energy efficiency, as well as development in the renewable energy sector. The last part of this section studies methods of increasing energy efficiency.
Saudi Arabia Energy Consumption Efficiency (SEE)

Saudi Arabia has a high rate of domestic consumption of fossil fuel per capita as compared to the rates of many developed and industrial countries. This is why increasing domestic energy consumption efficiency is an essential step in the development of renewable energy. An energy efficiency (hereafter EE) is a process that provides the same amount of benefit using a lower amount of fuel. There are two objectives for the efficient use of energy: saving the environment by burning less fossil fuel and saving money (Asplund, 2008).

According to a study by the International Energy Agency (IEA), the savings achieved from the development of EE could equal around US$10 trillion worldwide during the period between 2003 and 2033 (Chow, Kopp & Portney, 2003). The EE business is an up-and-coming sector that will generate new jobs in such areas as greenhouses, construction, and local businesses.

According to the IEA\(^\text{16}\) that if Saudi Arabia increased the efficiency of electricity consumption, it could save as many as 120,000 barrels of oil per day. Many research papers found great benefits—whether financially or environmentally—stemming from an increase in energy consumption efficiency. By decreasing the domestic consumption of energy, the Saudi government could save around SR150 billion each year (Al Omar, 2010). This research suggests that additional income from EE can enhance development in other social projects, such as the Saudi renewable energy sector. Many research papers found that implementing energy subsidy reforms is one necessary means of increasing energy consumption efficiency. Hence, the next section will discuss the energy subsidy reform.

\(^{16}\)https://www.iea.org/policiesandmeasures/pams/saudiarabia/name-147402-en.php
Energy Subsidy Reforms

According to the U.S. Congress Joint Economic Committee of 1972, a subsidy is “any government assistance, in cash or kind, to private sector producers or consumers for which the government receives no equivalent compensation in return, but conditions the assistance on a particular performance by the recipient” (p. 15). A subsidy is a governmental tool for reducing the cost of living and cutting down on poverty. In some cases, the government subsidizes raw materials for domestic producers, and social community activities—such as schools or certain semi-government organizations—are launched free of cost (Schrank & Keithly, 1999). One could argue that the purpose for an energy subsidy is to enhance development objectives and give a competitive advantage to domestic producers. The subsidy may have some benefits, such as reducing the cost of living. For instance, the Saudi government supports the prices of rice, corn, sugar, some medicines, other utilities (water, electricity, and gas), education, health, and other services. However, different research papers have found that energy subsidies have not achieved their goal of enhancing domestic development (Clements et al., 2013; Fattouh & El-Katiri, 2013; Coady et al., 2013). Subsidies can also increase the load on the government budget (Coady et al., 2010). Overconsumption of subsidized goods and services is an expected result (Ladislaw & Cuyler, 2015). In addition, a strong rationale exists to support our argument of taking subsidy reform seriously. There are, on average, more than 10 million foreign laborers in Saudi Arabia and approximately 15 million pilgrims per year. All these non–Saudi citizens will have access to subsidized goods and services. The foreigners will share these subsidies with the Saudis, which is said to decrease the efficiency of subsidy reform (Alyousef & Stevens, 2011).
It has been found that a possible negative correlation exists between energy consumption efficiency and energy prices. For instance, if the consumption per capita is taken for lower-energy-subsidy countries (such as highly developed countries) and higher-energy-subsidy countries (such as OPEC countries), it turns out that the countries with high energy subsidies have high levels of energy consumption per capita, according to the World Bank. In higher income developed countries, consumption per capita is less than that of most of the oil-rich countries. In developed countries, the cost of fossil fuel is higher for two reasons: there is no energy subsidy, and some developed countries add environmental taxes to the prices of fossil fuel. However, energy prices in oil countries are very low—in most cases, less than international market prices. These lower energy prices encourage irrational consumption. So long as energy is very cheap, people do not have a real reason to be more rational in their energy use. Therefore, the governments of oil-rich countries must seriously review their energy subsidy systems. Replacing subsidy reforms is the first step toward increasing energy consumption efficiency (Haufler & Wooton, 2006).

The removal of energy subsidies has both advantages and disadvantages for local businesses and households. The advantages could be the stability of the economy against any shock in the oil market. However, Faith Bicol, chief economist at the IEA, believes that removing subsidies from fossil fuel may have more benefits than disadvantages. Subsidy reforms could help reduce the prevalence of irrational fossil fuel consumption (Clements et al., 2013). Consumption of less fossil fuel means less CO₂ emissions in the atmosphere. Also, consumers will learn how to adapt to unexpected fluctuations in the oil market. Disadvantages could arise from the temporary implementation of energy subsidy reform (for
several years) and could include increased costs of living and the loss of competitive advantage among some local industries.

An unexpected increase in oil prices during the period from 2000 to 2008 was one significant reason for issuing new energy reforms by some countries—such as China, Mexico, Iran, and India (Clements et al., 2013). These countries applied subsidy reforms to their domestic energy pricing systems, such as for fossil fuel and electricity prices. Some economists studied a number of countries’ energy reform experiences. For example, Paul Segal, an economics lecturer at Sussex University, has studied Mexico’s subsidy reform experiment. Paul believes that oil revenue distribution could be handled more efficiently than the subsidized oil products. Many economists agree with Segal that, for certain tangible reasons, oil revenue distribution through the subsidizing of oil prices is not an efficient practice. Because of wealthy citizens usually consume more energy than do members of low-income households, as they have more cars and larger houses (Segal, 2012; Sen & Jamasb, 2010). A similar study by Sen et al. (2016) of the Oxford Institute for Energy Studies, which investigated the Indian transformation subsidy reforms (electricity, in the case of India), came up with the same results. This study used panel data from 19 Indian states during the period from 1991 to 2007. The paper’s initial goal was to evaluate the impact of Indian electricity reforms on regional outcomes. The results showed that the degree of impact varied among Indian states. Thus, this study suggested that any energy reforms should be designed based on the country’s economic characteristics.

The Chinese government subsidized petrochemical raw materials to enhance development in the Chinese petrochemical manufacturing sector (Tobin, 2012, 2014). However, the growth rate of the Chinese petrochemical manufacturing sector has been rapid.
The amount that subsidies for petrochemical products cost the Chinese government was around $27 billion in 2017. The Chinese government decided to apply some subsidy reforms to petrochemical raw materials due to the high cost on the Chinese government budget and the Chinese government’s other objective for removing subsidies from petrochemical products was to change the structure of Chinese domestic economic activities so that they became more service-oriented activities with fewer polluting projects. This paper concluded that while subsidies could be a temporary policy for some government development agendas, the government should be cognizant of the fact that the cost of this policy is quite high due to an expected increase in demand for subsidized products.

The subsidy policy has been criticized for its non-equality-based distribution between rich and poor (Commander, 2012). In terms of energy, wealthy families—because they have big houses and many cars—are expected to consume more energy than low-income families. The Iranian government changed the subsidy format to a cash check instead of subsidy prices for the selected goods and services. Therefore, both poor and wealthy families would receive the same amount of cash. It is possible for a family that does not own cars to spend subsidy money on other goods and services. This distribution of cash among Iranian citizens before the implementation of the first stage of Iranian energy reform was an effective strategy for absorbing political backlash. Iranian energy reforms are implemented in different stages to reduce likely inflation pressure (Fattouh & El-Katiri, 2013).

Subsidized energy sources are the main reason for waste, smuggling, and the discouragement of energy efficiency. Additionally, the cost of the subsidy could be very high, especially if the price of oil is high (Ladislaw & Cuyler, 2015). That is why this study has recommended the implementation of consumption-oriented fossil fuel subsidies. Because
oil prices have been quite low recently, now is a good time for oil-rich countries to replace subsidy reforms due to the fact that the impacts of these new energy subsidy reforms will be inconsequential. In addition to gasoline, the Saudi electricity sector is highly subsidized, making the cost of electricity in Saudi Arabia among the cheapest in the world (Matar, Murphy, Pierru, Rioux, & Wogan, 2017). Removing the entire subsidy from Saudi electricity may have a significant impact on middle- and lower-class households. In that case, the Saudi government should gradually implement subsidy reforms for gasoline and electricity. These subsidy reforms will serve three purposes: lessen the burden on the fiscal budget, increase consumption efficiency, and result in less domestic pollution (Van der Burg & Pickard, 2015).

Increasing the efficiency of energy consumption and reducing the load on the government budget are the main benefits of the Saudi subsidy reforms (KAPSARC, 2016). On the other hand, concerns exist about the ability of domestic manufacturers to maintain their global competitiveness upon the removal of subsidies from fossil fuels. In addition, there is an expected negative impact on short-term economic growth. Blazques, Hunt and Manzano (2017) claim that energy subsidy reforms and investment in renewables could have a positive effect on Saudi economic growth in the long run. In the long run, the impact on GDP growth is positive for two reasons: increased energy consumption efficiency and additional income for the government due to the implementation of energy reform. The government should invest this income in domestic public projects and renewable energy projects. The subsidy reform money could be spent on development projects such as schools, universities, hospitals, airports, roads, and so on. The cost of renewable energy is higher, by 30-40%, but the benefits of having a more stable and sustainable source of energy must be
considered in light of the current pains being suffered as a result of energy structure transportation reforms. Also, investment in renewable energy is a solution for addressing climate change agendas, reducing dependency on oil exports, and increasing stability (Blazquez et al., 2017).

From all the literature and studies, it becomes abundantly clear that Saudi Arabia must adopt a new energy subsidy reform policy. This research suggests two essential steps for Saudi Arabia; these steps could reduce the negative impact of new government subsidy reforms (efficiency and investment in renewables) by increasing energy consumption efficiency that requires the rebuilding of public transportation and the restructuring of the process used by the water desalination industry to make it more environmentally friendly. In conclusion, it becomes clear that a subsidy by any means is not an efficient method of helping the poor. Instead, it is an impetus for the irrational consumption of energy and adds a burden to the government budget (Clements et al., 2013). Also, the impact of energy reforms could become substantial over time. In the short term, subsidy reform may have some inflationary effects and reduce industrial competitiveness. In the medium and long terms, there would be positive effects such as an increase in the efficiency of energy consumption. Also, more oil will be available for export, and the budget structure will face fewer burdens. Some studies claim that it might be enough if the only benefit of subsidy reform is to remove some burden from the fiscal budget. Other benefits include increased energy consumption efficiency and environmental preservation (Alshehry & Belloumi, 2015; Rentschler & Bazilian, 2017; Vagliasindi, 2012).
Solutions for Increasing Efficiency

In the relevant literature, some studies discuss factors that encourage consumption efficiency. This research also focuses on increasing the efficiency of energy consumption, including such sources as fossil fuel, electricity, water, and all kinds of utilities. Energy consumption efficiency is a habit, and people need time to change their consumption behavior so that they engage in more energy-efficient consumption (Eccles, Ioannou & Serafeim, 2012). Some elements of Saudi citizens’ lifestyles require changes. For instance, regarding houses, it has been noted that Saudi houses usually consume more electricity for lighting, cooling, heating, and other purposes due to the fact that those houses are large (Reiche, 2010). If utility prices are low, the Saudi families had no incentive to increase their energy consumption efficiency. On the other hand, the government must step in to build a green society through such measures as improving public transportation and maximizing the utility of desalination plants. In the end, these economic activities would generate jobs for Saudis. This research discusses, in particular, how the Saudi government would decrease the domestic consumption of oil by increasing efficiency of the Saudi water desalination plants and developing the Saudi public transportation.

Water Desalination

Desalination provides around 50% of the fresh water in Saudi Arabia (Nachet & Aoun, 2015). Saudi Arabia has invested a significant amount of money in desalination projects. For instance, during the period between 1975 and 2000, Saudi Arabia spent around SR380 billion on the water supply; to generate a sustainable water supply inside the Kingdom (Abderrahman, 2006; Okafor, 2011). On average, Saudi Arabia established a plan to spend around SR500 billion during the period between 2002 and 2022 on the water supply.
This equals SR800 per person every year (Al-Zahrani, 2010). It is a significant amount of money; the Saudi water supply’s contribution to the GDP is estimated to be around 1.5%. Due to this major investment in desalination, Saudi Arabia has a unique advantage in desalination technology. The Saudi desalination capacity grows by around 14% per year, which is six times the population’s growth rate (Ouda, 2014). Because water desalination in Saudi Arabia is highly subsidized, Saudi households pay only around 15% of the total cost of water desalination. This low price promotes less-efficient domestic water consumption. All these irregularities in utility consumption place a burden on the Saudi government’s budget. The cost of utilities in the Saudi government budget must be reduced through an increase in the cost of the domestic utility, which is going to increase the efficiency of the domestic consumption of energy. The level of Saudi carbon emissions should be decreased through an increase in the efficiency of the domestic consumption of utilities and by using renewable sources of energy in Saudi desalination plants (Alshehry & Belloumi, 2015; Al-Karaghouli, Renne, & Kazmerski, 2009).

Hence, some interaction takes place between the production activities of desalination and concentrating solar power (CSP), which is a renewable energy technology. CSP involves steaming water to drive the turbine. In desalination, steaming water is the critical step for getting salt out of seawater. Thus, instead of burning oil as a means of steaming water, CSP technology could be used (Baras et al., 2012; Reif & Alhalabi, 2015). Using renewable energy as a secondary source of energy for desalination, Saudi Arabia would reduce the amount of fossil fuel burned, lower CO₂ emissions, and increase the contribution of non-oil-sector economic activities to Saudi Arabia’s total GDP activities. In conclusion, through investment in CSP, Saudi Arabia should realize two goals: reducing the cost of desalination
and reducing the level of CO$_2$ emissions. The use of CSP technology in desalination processes should generate many jobs for Saudis, which represents an additional benefit for the Saudi economy.

**Public Transportation**

The Saudi population is growing by around 3.1%—a rate that is among the highest when compared to the population growth rates of developed countries. This increase in population will cause an increase in the number of cars, which are the primary means of transportation due to the dearth of public transportation systems available to Saudi citizens.

Saudi energy reforms will cause an increase in the cost of transportation. Many economists suggest that the Saudi government should develop an alternative source of transportation, such as public transportation, before implementing additional energy reforms. The enhancement of public transportation would have a direct impact through the reduction of gasoline consumption. Therefore, enhancing the development of Saudi public transportation would have three purposes: reducing the level of CO$_2$ emissions, reducing the cost of living, and generating more revenue for the government. Building the Saudi public transportation system will create more jobs for Saudi citizens and further develop the Saudi non-oil sector (Alotaibi & Potoglou, 2018).

Until recently, public transportation has been only nominally developed in Saudi Arabia. Because they lack appropriate public transportation, people may have no choice but to use less efficient and more polluting sources of transportation. Saudi Arabia has a large number of cars despite the fact that a social constraint existed against women driving cars (though in the middle of 2018, women were able to drive cars for the first time). The projected number of cars in Saudi Arabia is expected to increase rapidly. Hence, it is
imperative that the Saudi government increase the development of—and encourage people to use—public transportation. The high number of cars inside the Kingdom of Saudi Arabia causes various problems, such as traffic congestion and pollution inside big cities. There is an additional cost in the form of a need for more police officers, road patrol security officers, and road service staff.

Because these cars are all imported, the increased number of imported cars is a significant factor burdening the Saudi balance of payment (BoP). In addition, the availability of public transportation could help reduce the level of public opposition to any government decision to implement energy subsidy reforms. Various studies reveal additional social benefits arising from the development of public transportation, such as the fact that public transportation causes fewer accidents and road fatalities (Litman, 2015).

Investment in public transportation in Saudi Arabia could be a good policy for generating new jobs for Saudis. Public transportation could be defined as including three essential components: taxis, subways, and buses and trains. As we have discussed in Chapter 1, the Saudi government’s efforts to promote the Saudization of taxi drivers did not achieve the desired results due to social concerns. However, modern taxi drivers—including those who drive for Uber and Kareem—are suitable for Saudi youth to work for these services because the car used is not a yellow and black taxi. These companies (Uber and Kareem) adhere to a more stylish and technological standard, one that aligns with the Saudi lifestyle. They also provide more flexible working hours for Saudi citizens.

The development of public transportation such as trains and subways requires the construction of stations and other facilities. After the new public transportation system is developed, Saudi citizens will need time to develop the habit of using public transportation
inside the Kingdom of Saudi Arabia, especially in big cities. Moreover, some studies have found that using public transportation helps people become more systematic and aware of time, and helps organize people’s movement in big cities (Alotaibi & Potoglou, 2018).

Investment in public transportation offers many benefits; it saves people time and money, lowers the level of pollution, and organizes life in big cities (Aljoufie, 2014). The main problem with public transportation could be that the initial investment is very high due to the significant cost involved in building new train stations and buying trains and buses. The Saudi government could have developed this sector by providing financial solutions and reducing the level of competition by monopolizing these kinds of economic activities. An advanced/smart system of transportation will increase foreign investors’ attraction to urban areas. Increasing the flow of foreign investors would promote Saudi economic development and diversification. There is an expectation that new jobs for Saudis will be created and that competition inside the country will increase (Jones, Tefe & Appiah-Opoku, 2013). In short, the development of public transportation will create a number of benefits for the Saudi economy, such as an increased number of jobs for Saudis, the contribution of non-oil GDP, a reduction in the gasoline subsidy cost on the government budget, and a reduction in the level of pollution in big cities.

**Development in the Renewable Energy Sector**

The first part of this chapter describes the main challenges and opportunities for renewable energy development in the Kingdom of Saudi Arabia. Cheap domestic energy and inefficient energy consumption are the main barriers to the development of the renewable energy sector. The cost of renewable energy is still very high compared to the cost of fossil fuels, which means Saudi Arabia must increase cost of fossil fuel and domestic energy
efficiency (Halkos & Tzeremes, 2013). Other barriers may impede development in the renewable energy sector; these barriers include financial barriers, an inadequate institutional capacity, and a lack of a comprehensive policy agenda and political commitment. These issues prevent the private sector from investing in renewable energy. Therefore, to increase the profitability of this kind of investment, the public sector must be involved. Overall, the cost of investment in renewable energy is very high, especially in the short term, though it is more fruitful and less risky in the long run (Alawaji, 2001).

Recently, the Saudi government implemented energy reforms for two primary reasons: increasing the efficiency of domestic energy consumption and reducing pressure on the government budget. These government energy reforms may increase the cost of energy. If that happens, the Saudi government must help citizens consume less energy. On the other hand, public services must be developed, especially public transportation, smart cities, and green buildings. It is also essential for the government to provide some form of financial support to citizens to purchase independent sources of energy, such as the installation of the PV system. After a discussion of the need for increased domestic EE, the next step is to discuss the future of the Saudi renewable energy sector. The scope of this research includes two types of energy: solar energy (PV, CPS) and wind energy. These forms of renewable energy are more suitable for Saudi Arabia’s geographic location. Overall, the reset this chapter covers two sections. The first section introduces some of these technologies (i.e., PV, CPS, and wind energy) while the second section discusses the recent development of the renewable energy sector inside the Kingdom.
Solar Energy (PV, CSP)

**Solar photovoltaic (PV).** Solar Photovoltaic (PV) is a renewable energy technology that generates electricity using sunlight. Each PV panel contains six solar cells in a row and 10 PV solar cells in a column. The efficiency of a solar panel depends on three main factors: the efficiency of the model used for a particular panel, the number of the PV model inside each solar cell, and the amount of sunlight that the PV panel received. After installation of the panel cell, an inverter must be added to transfer electricity from direct current (DC) to alternating current (AC). When the sunlight is vertical, the efficiency of any particular solar panel is at its maximum. A solar tracking machine can help move the solar panel to the right angle but it also consumes energy while moving. PV is very sensitive to high temperatures and dust, which reduce its efficiency. Overall, Solar PV is more practical for houses and commercial buildings. While PV technology is very costly, its cost has decreased dramatically over time, especially in the last five years. According to the International Energy Association (IEA), the total amount of electricity generated using PV was around 177 GW at the end of 2014. At that time, this was around one percent of the total worldwide demand for electricity. The IEA estimates that the total amount of electricity generated by this technology should be around 1396 GW by the end of 2040. However, it is too early for PV technology to be the primary source of energy, though the solar PV system will help reduce electricity price hikes during the summer. Therefore, it is fair to look toward this technology as a complementary source of energy rather than as a primary source of energy. Saudi Arabia could use solar PV technology in remote areas because these small villages need a limited amount of electricity for essential uses such as water pumps and lighting.
Also, solar PV energy can be used for road lights, road instruction signals, and tunnel and traffic lights (Al-Karaghouli et al., 2009; Dargin, 2009).

In terms of jobs, a large number of them can be generated through investment in solar PV. Direct jobs are in such areas as modules, inverters, installation, other administration, engineering, and sales services. Solar Power Europe (EPIA) estimated the number of jobs produced by solar PV energy as following. In the process of production, the solar module accounts for about 45% of total jobs, whereas installation, administrating, engineering, and other sales services account for around 55%. Most countries have recently imported solar PV panels from countries such as China because of the high cost of production and the high level of competition in this market. However, 55% of solar PV technology activities will be handled domestically (European Photovoltaic Industry Association [EPIA], 2012). Moreover, increasing investments in solar PV will increase demand for some local/domestic activities and businesses. These businesses existed even before investment in a solar PV system. This new demand would be for raw material suppliers (glass, dopant gases, silver paste, steel bars, electrical devices, etc.), some public sectors, and the financial sector. In addition, this new demand for goods and services will place an additional demand on the other sectors of production. This increase in demand will generate expansion in the production sector, which in turn will generate more jobs (Sastresa et al., 2010).

For the solar PV project, it is imperative to focus on the number of indirect jobs because the number of jobs in this category is higher than the number of direct jobs. The increase in induced jobs is significant as well. Induced jobs could be generated in various sectors such as banking and insurance institutes, legal institutes, universities, research institutes, etc. In Europe, for instance, there are 12 to 20 new indirect jobs for every 3 to 7
direct jobs in PV (EPIA, 2012). Overall, the contribution of total direct jobs in PV energy development is no less than 32%. The remainder of the jobs is distributed between indirect and induced, accounting for 68% of the total jobs on average, according to the EPIA. Moreover, in 2012 the total number of direct and indirect jobs in PV energy worldwide was slightly above 1.3 million. This number is expected to reach 1.8 million in 2022 (EPIA, 2012). In the literature, researchers have calculated the number of employees in the renewable energy sector per each Megawatt Peak (MWP). For instance, a study by Cetin and Egrican, entitled “Employment Impacts of Solar Energy in Turkey” (2011), estimated the PV industry in Turkey. The researchers found that there are more than 346 jobs for each MWP in installation compared to 10 jobs per MWP in PV panel production (2011) (Çetin & Eğrican, 2011). In the United States, more than 194,000 employees were working in the solar PV energy industry by the end of the first quarter of 2016 (U.S. Energy and Employment Report, 2016). Saudi Arabia has a strong reason to invest in solar energy because it receives over 3,000 hours of sunshine per year (Aksakal & Rehamn, 1999; El-Sebaii, Al-Hazmi, Al-Ghamdi, & Yaghmour, 2010; Pollin, Heintz & Garrett-Peltier, 2009).

**Concentrated solar power (CSP).** The main difference between solar PV and other types of solar energy is that solar PV converts sunlight directly into energy. The other dominant solar energy technology, CSP, uses solar heat to generate electricity. It is instrumental, especially in places that have vast space and receive high temperatures. Concentrated Solar Power (CSP) uses mirrors to concentrate solar energy on a single point. The aim of this concentration is to maximize solar heat up to 10,000 times. This tremendous amount of heat is used to heat water and generate steam that drives the electrical generate turbine.
CSP is very easy to produce. The system has three essential parts: the mirror system, the receiver, and the pipeline system. The advantage of CSP is that it does not require advanced technology and can be designed locally. Because less-advanced technology is used in CSP, investment in this technology is very promising regarding generating domestic jobs. It is, also, a cheaper technology because there is no need for a huge battery to save energy. The United States and Spain are the dominant countries using this kind of energy. Emerging countries such as China, other Asian countries, and some African countries, have substantial investments in CSP. In 2014, the total energy produced by CSP was estimated to be around 4 GW; it was expected to be around 12.4 GW by the end of 2018, and 330 GW by the end of 2040 (Sieminski, 2014). In addition, according to the European Solar Thermal Electricity Association (ESTELA), which estimated the production of CSP in 2010, the global installed capacity of CSP was expected to reach up to 100 GW by 2025.17

CSP could be used to generate electricity on a large scale, and the chain of value of this technology could be distributed among different sectors, including the production of mirrors, receiver parts, pipelines, steam engines, and turbines. This extensive distribution of activities is vital for generating jobs. Thus far, there are four well-known methods of generating CSP energy: parabolic trough (PT), central tower (CT), linear fresnel (LF), and sterling dish (SD). The number of new (direct) jobs in this CSP sector was expected to be approximately 100,000-130,000, which 45,000 of the total new jobs being permanent or full-time jobs. Only manufacturing would generate, on average, around 10,000 person-year direct

full-time jobs. In conclusion, CSP requires many laborers for construction and machinery (Asplund, 2008). CSP and PV is a good strategy for Saudi Arabia because the Kingdom has a long summer, a vast desert, and a significant amount of sand with which to manufacture glass.

**Wind energy.** Wind energy is one of the renewable energy technology, and it is expected to be a dominant source of renewable energy because of its faster growth rate as compared to the growth rates of other renewable energy methods. It is a process of generating energy by converting wind into electric power. Wind energy does not produce any gas emission during its operation, but the only harms might cause by wind energy are deforestation and killed birds. In addition, the impeded cost of wind energy is very high includes the value of the turbine, transmission facilities, and O&M expenditures. On average, the global wind turbine industry has grown around 20% per year for the past 10 years (Alawaji et al., 1996; Asplund, 2008). Table 17 provides the wind power capacity (MW) of different countries in 2015.

Table 17

**Wind Power in Countries, 2015**

<table>
<thead>
<tr>
<th>Country</th>
<th>Wind Power Capacity (MW) and the Level of Contribution by Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>145,362 MW (34.1%)</td>
</tr>
<tr>
<td>USA</td>
<td>74,471 MW (17.5%)</td>
</tr>
<tr>
<td>Germany</td>
<td>44,947 MW (10.5%)</td>
</tr>
<tr>
<td>Spain</td>
<td>23,025 MW (5.4%)</td>
</tr>
<tr>
<td>India</td>
<td>27,151 MW (6.4%)</td>
</tr>
<tr>
<td>Italy</td>
<td>8,958 MW (2.1%)</td>
</tr>
<tr>
<td>France</td>
<td>10,358 MW (2.4%)</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>13,603 MW (3.2%)</td>
</tr>
<tr>
<td>Canada</td>
<td>11,205 MW (2.6%)</td>
</tr>
<tr>
<td>Rest of the world</td>
<td>58,275 MW (13.7%)</td>
</tr>
</tbody>
</table>

Moreover, the number of employees in the wind energy sector varies from country to country. In Europe, the total number of direct and indirect jobs in wind energy was around 238,155. It was estimated that 520,000 jobs would be created by the end of 2020 and 800,000 jobs by the end of 2030 (European Wind Energy Association, 2012; Singh & Fehrs, 2001), or each megawatt of wind power requires around 10-15 employees each year (European Wind Energy Association, 2012). In Greece, to produce one megawatt, more than 17 laborers are employed solely for operation and construction (Tourkolas & Mirasgedis, 2011).

Saudi Arabia has many areas that present the possibility of producing wind energy around the Arabian Gulf and the Red Sea coastline zones. Saudi Aramco has calculated the average annual wind speed in the Arabian Gulf coastline zones as being between 14-22 km/ph and 16-19 km/ph on the Red Sea coastal areas (Al-Abbadi, 2005; Rehman, 2005; Rahman, Rehman, & Abdul-Majeed, 2012). From the literature, we found that investment in RE could be a good diversification strategy for Saudi Arabia. Also, investment in renewable energy should be an excellent opportunity for Saudi Arabia to generate more jobs for Saudis.

**Recent Saudi Energy Efficiency and Renewable Energy Development**

There are many expected benefits from increasing domestic investment in renewable energy. For instance, the Saudi government could use the generated savings from implement new energy reforms, decrease domestic consumption of energy, and increase oil export revenues, which could be spent on local development projects. This new investment spending could have a positive effect on domestic development (GDP). Investment in renewable energy will also have a significant impact on different sectors of the economy, especially small business enterprises (SMEs). Saudi Arabia will reap significant benefits, as the development of renewable energy will constitute a new sector of production (AlYahya &
Irfan, 2016; Tlili, 2015; Rahman et al., 2012). This new sector would generate investment opportunities for construction, services, and research and development (R&D).

Expanding demand for these non-oil economic activities will create more jobs for Saudis. Many renewable energy activities could be handled by small and medium business enterprises (SMEs) that are usually highly labor-intensive. Involvement in these diversified economic activities will give Saudis an opportunity to learn by doing. This section will review the recent development in the Saudi renewable energy sector.

Unfortunately, the renewable energy sector (wind energy in particular) in Saudi Arabia is very slow compared to that in other developed countries such as Germany, the United States, Denmark, Spain, and India in that their capacity is around 80% of the total world clean energy supply (Junginger, Faaij, & Turkenburg, 2005). Hence, extensive development in renewable energy is generally associated with developed countries because the initial cost of a renewable energy project is very high. However, the goal of NTP is to drive the Saudi economy toward the post-oil era. Its objectives include ensuring that 4% of Saudi Arabia’s total energy use will come from renewable energy by 2020, with almost 137,000 jobs supplied by the nuclear and renewable energy sectors in the same timeframe. King Abdullah City for Atomic and Renewable Energy (KACARE)’s goals are for 72 GW of electricity by 2023 distributed as follows: PV (16 GW), CSP thermal (25 GW), wind (9 GW), nuclear (17.6 GW), waste to energy (WTE, 3 GW) and geothermal (1 GW) (Abdul Latif, 2017; Moody’s, 2017).

**Conclusion**

Investment in renewable energy inside the Kingdom of Saudi Arabia has many social, economic, and political benefits. The primary hypothesis of this research is that “investment
in renewable is an optimum solution for solving many economic problems such as
unemployment and diversification.” The first part of this chapter argues that it is important
for the Saudi government to increase the domestic consumption efficiency of energy before it
begins development in the renewable energy sector. This chapter recommends implementing
some energy reforms to increase the efficiency of domestic energy consumption. The Saudi
government must provide an alternative service for Saudi citizens, such as enhancing the
development of public transportation and the availability of clean sources of energy with
acceptable prices in the domestic market. Furthermore, this research introduces different
kinds of renewable energy (i.e., PV, CPS, and wind energy) and discusses the advantages and
disadvantage of these technologies. In the end, it also discusses the recent developments in
the renewable energy sector within the Kingdom of Saudi Arabia and the future of this
market.

The government can provide financial incentives for the renewable energy sector by
encouraging green investment bonds and enhancing development in the Green Bonds market.
The government can further participate in green investment by establishing a direct
partnership in the renewable project with the private sector, such as Public-Private
Partnerships (PPP).
CHAPTER 6
PROMOTING DEVELOPMENT IN THE SAUDI
RENEWABLE ENERGY SECTOR

Introduction

Renewable energy development faces various challenges, such as technological issues, the high initial cost of renewable energy projects, low efficiency, and a shortage of funding. Despite these challenges, it is unwise to ignore the enormous opportunities for investment in renewable energy. This chapter provides three promising solutions that could enhance the development of the Saudi renewable energy sector. These solutions are aimed at helping renewable energy investors overcome these barriers. These solutions also indicate the necessity of direct intervention on the part of the government through the Job Guarantee Program (JGP) and Green Bonds (GB), and by building a suitable partnership between the public and private sectors in the form of a Public-Private Partnership (PPP).

The Job Guarantee Program (JGP) is a public program that endeavors to provide a job with a minimum wage to anyone who is looking, seeking, and willing to have a job, but who cannot find a job in the private sector (Forstater, 2002a, 2002b; Wray, 2008). Theoretically, the primary purposes of JGPs are to maintain full employment and price stability. The size of a JGP depends on the domestic business cycle. The JGP should be large during economic slowdowns to absorb all laborers who lose their jobs. Thus, the size of a JGP should act in a fashion that is countercyclical with respect to the local business cycle (Mitchell & Mosler, 2001). Moreover, the JGP pays a minimum wage to its workers, which creates a floor under the local minimum wage and stabilizes the prices of goods and services, as well as incomes. The main activities that a JGP typically handles are public sector products or activities such
as social services and any projects that are very risky for the private sector to undertake but that are necessary for society, such as renewable energy.

The Green Bond (GB) concept has been initiated to encourage the development of a project that helps protect the environment from climate change (World Bank, 2011). The GB is an essential financial instrument for green/renewable energy projects. Renewable energy projects must have access to the financial market, which will evaluate, rate, and introduce renewable energy to financial sector investors. This new financial instrument is initially issued by a local government and by international organizations such as the World Bank. This step is necessary to reduce investors’ uncertainty regarding investing in the GB market. GB markets have recorded significant growth this decade. This research will discuss the recent and future development of the GB market and the possibility of establishing a GB market inside the Kingdom of Saudi Arabia.

A long-term contract between the public and the private sector is a Public-Private Partnership (PPP) (Hodge & Greve, 2007). The World Bank has already identified the PPP as “a long-term contract between a private sector and a government agency, for providing a public asset or service, in which the private party bears the significant risk and management responsibility, and remuneration is linked to performance” (World Bank Institute, 2018). The goal of this arrangement between the public and private sectors in the form of a PPP is to increase the efficiency of government investments/projects (Roehrich, Lewis, & George, 2014). Also, the PPP is a useful program to increase the quality of public projects such as hospitals and airports (Kwak, Chich, & Ibbs, 2009). The private sector could become involved in businesses in which, without a partnership with the public sector, it could otherwise not become involved (such as defense projects). Meanwhile, the public sector
would have access to the private sector’s technology and experiences. In addition, the
government could add more conditions to the private sector in PPPs contracts, such as that
the private sector should hire a significant number of Saudi employees and use fewer
pollution-causing sources of energy.

This research intends to build a Saudi Job Guarantee Program (SJGP), which could be
a Saudi version of a JGP. Because this program is not for purposes of achieving a profit, an
SJGP should be an excellent opportunity for Saudi Arabia to increase development in the
Saudi renewable energy sector. Public-Private Partnerships (PPPs) and GBs are other
essential policies for enhancing development in the Saudi renewable energy sector.
Moreover, increasing social awareness of climate change is a primary factor for increasing
development in the renewable energy sector.

The Job Guarantee Program (JGP)

The JGP has two fundamental conditions, which are providing a job for anyone who
is looking, seeking, and willing to work in a job, and paying a minimum wage. Public
Services Employment (PSE) and Buffer Stock Employment (BSE) are different names for a
JGP. The Employer of Last Resort (ELR) varies among economists such as Mosler (1997),
Program (JGP) is sponsored by the government and is designed to employ the portion of the
population that has difficulty finding jobs in the private sector; these include older people,
people with minor disabilities, and people who have lower levels of education (Mitchell &
Watts, 1997; Vickrey, 2004). JGP’s employees should have the ability to buy necessary
goods and services (Wray & Forstater, 2006).
Under the existing capitalist system, full employment is not an ordinary case due to the financial marketing mechanism (Keynes, 1936). The role of JGPs is significant so long as increasing investments in the financial sector are not necessarily associated with additional jobs. The elasticity between economic growth and the demand for labor is not necessarily high. In fact, some economists believe that the government’s responsibilities include ensuring jobs for citizens—a national obligation along with providing education, food, and medicine (Harvey, 1989; Mitchell, 1998). The social benefits of JGP are to save society from the problems of hunger, crime, drugs, and limited national development due to school dropouts (Kaboub et al., 2015).

Any economy must have an economic entity with an infinitely elastic demand for laborers, such as JGP, which is a government-sponsored entity (Minsky, 1986; Wray, 1998). A powerful government is essential—one that can employ laborers when needed. A JGP is designed to start hiring from the bottom, which means starting with the person who has the lowest chance of working in the private sector or who will be the first to be fired (Tcherneva, 2005). In short, it is a program that closes the gap in the labor market. In addition to its social benefit, JGP has many economic benefits, which include maintaining the domestic aggregate demand and price stability (Vickrey, 2004).

A JGP is a job buffer stock in that its size depends on the business cycle (Mitchell, 1998). Having such a job buffer stock with a minimum wage is expected to create two benefits. First, a JGP program will prevent the minimum wage from collapsing (Mosler, 1997; Tcherneva, 2005). Second, saving the minimum wage from falling is very important for demand and price stability (Forstater, 1999b). Therefore, the existence of a powerful government that can back up the economy during bad times can create a positive signal for
investors, encouraging long-term investment. Hence, government spending will not cause inflation due to the size of the JGP, which must be no more or less than full employment (Mitchell & Wray, 2005). Moreover, the JGP could be a solution for increasing the efficiency of government spending (fiscal multiplier) (Tcheneva, 2005). If the government decided to expand the JGP, this new expansion would directly/indirectly increase demand on the other sectors of production and increase aggregate demand due to the new demand among JGP employees for other local goods and services. Without the JGP, this new government spending may not flow to the production sector, thereby ceasing the encouragement of economic development. This government spending on JGP may prevent the purchase of additional imported goods and services. Thus, a JGP is a more efficient method of stabilizing the business cycle. The government, through the JGP, would be able to adapt to any change, whether exogenous or endogenous, such as new technologies, new products, the supply shock (natural resources) or demand shock (productivity), etc. (Forstater, 1999a). It is important to note that the JGP would always exist, but that the size of this program would depend on the condition of the domestic business cycle (Harvey, 2000).

For Keynes, it was evident that the level of unemployment must always be less than one percent. Some economists have referred to Keynes as a Great Depression economist (Skidelsky, 2003). This is not necessarily correct, but the Great American Depression had a significant impact on Keynes’ theory. During World War II, most industries were producing goods and services for the military. Before the end of the war, American industries were utilizing their full capacities, and the level of unemployment was less than one percent. The problem started after the war when the total domestic demand suddenly collapsed and a large number of industries closed. They fired their laborers, which caused a further decline in
domestic aggregate demand. More unemployment and low aggregate income caused an additional decline in aggregate demand. In addition, unemployment was high in the United States at that time. The level of inflation and the resultant shortage of goods further led to the closure of industries.

Keynes’ book GT concluded that a positive relationship exists between domestic aggregate demand and employment, as was clear from the Great American Depression. This means the private sector would not be able to get the economy back on track. In this connection, government intervention was a necessary solution. Therefore, government intervention through a JGP is the most efficient means of maintaining the Keynesian effective demand at a high level of employment and price stability. Because a JGP utilizes the excessive labor supply, aggregate demand will not suffer. However, the possibility still exists of a minor slowdown in aggregate demand because some laborers would be losing their high-paying occupations during the crisis. Yet this reduction in economic growth would not be very sharp due to the JGP, which would be keeping the workers’ income above zero.

A JGP maintains price stability by preventing the domestic aggregate demand from collapsing during bad times. A JGP is not only a job creation program but also a production program that fills any shortage in the supply side. The JGP goods and services replace the shortage of goods and services resulting from the default of the private sector. Thus, the JGP maintains price stability by keeping the balance between supply and demand curves at the full employment level.

One of a JGP’s fundamental features is that it targets unemployment. There is no limitation on locations for a JGP, but the program aims to be wherever it must be to target unemployed citizens (Forstater, 2006). More job opportunities are available in large and
industrial cities than in smaller towns. A JGP could establish businesses in small towns and employ locals. Some authors have referred to this situation as target unemployment (Tcherneva, 2005). Moreover, establishing a JGP in a local rural area creates a new demand for these small businesses and manufacturers. Small and medium entrepreneurs (SME) are vital to the stability and sustainability of any economy, for two reasons. Local SMEs usually employ local engineering and skilled laborers. Also, they are the primary sources of diversification, as SMEs are willing to take on more high-risk projects. Also, it is healthier for the economy to distribute risky projects to SMEs, as any collapse in large corporations would have a significant effect on the economy. At this time, Saudi SMEs need more support from the Saudi government due to the large number of unemployed Saudi youth.

The JGP program does not only stabilize the economy; it is also a significant factor in stabilizing the political condition. Unemployment has a negative impact on the population, leading them to protest and commit crimes. It has been noted that every politician seeks to decrease the level of unemployment during his political term. This is why a JGP is a critical program for political stability. Additionally, in any country, a high level of unemployment is a negative sign for investors who are considering investment in the domestic economy. Investors would not be convinced to invest in a less-stable economy with a high unemployment rate. The unemployment issue is not only a personal problem for the unemployed laborer but also an economic problem affecting the entire economic system.

The JGP would help create a dynamic macroeconomic model to absorb exogenous shocks. The central power for economic stability lies in the government’s role in making a suitable contribution to the market. There are two conditions for government intervention in the business sector. One condition is that government intervention should not crowd out
private sector investments. The second condition is that the JGP should be able to resize itself; in other words, the program must be large enough to face impacts during a crisis, yet small enough to have less of an impact during times of strong economic conditions. The other goal of a JGP is to guarantee a solution to such socioeconomic issues as gender inequality (Kostzer, 2008). Some countries have a problem with gender inequality in that women have fewer job opportunities than do men. A JGP could solve this problem by designing its investment in a way that produces job opportunities for women.

The literature is full of discussions about the cost of unemployment; these are categorized into social, political, and economic costs (Kaboub et al., 2015). One social cost of unemployment could be the instability of a family. Such problems are expected due to the fact that unemployed parents may not have the money to provide their family with necessary goods and services. The shortage of financial resources creates tension and anxiety in the family environment. It could force family members to use illegal means of generating money, such as drug smuggling. Also, this negativity inside the household would not create an environment that allows children to succeed in school. Children who drop out of school will earn less income for the next generation, causing long-term fragility throughout the community and the country at large. In short, the problem of unemployment destabilizes the community and the entire economy. Due to the lack of a stable income, an unemployed person may struggle to pay for his or her family’s healthcare insurance and education. There is no possibility of a retirement income because the person is not earning a regular income. In the future, a number of elderly people will likely have no (or a modest) income. Over time, unemployed laborers will lose some of their skills, as well as opportunities to become familiar with new skills that can provide work during periods of rapid advancement in
innovation and technology. The loss of skills means the loss of efficiency and productivity, which may itself create an additional output gap (Kaboub et al., 2015). Briefly put, unemployment is a chronic issue for an economy.

Many countries, such as the United States, the United Kingdom, Argentina, and India, have achieved positive results after implementing JGPs. One of the main contributions of this research is to examine the possibility of implementing a JGP inside the Kingdom of Saudi Arabia in the form of the Saudi Job Guarantee Program (SJGP). The JGP in the United States dates back to the Works Progress Administration (WPA)—or the Work Projects Administration, as it was renamed in 1939—as part of the American New Deal agenda. On April 8, 1935, President Franklin D. Roosevelt issued Executive Order 7034, which was based on the law to establish the Works Progress Administration designed by Harry Hopkins. This program was designed to carry out public works projects such as the construction of public buildings and roads (Lal, Miller, Lieuw-Kie-Song, & Kostzer, 2010). A large majority of employees in the WPA were unskilled laborers (Taylor, 2008). The programs and projects were established by the WPA and were designed to produce 40,000 new buildings and 85,000 improved buildings as indicated in Table 18.
Table 18

*Projects by the Works Progress Administration (WPA)*

<table>
<thead>
<tr>
<th>Type of Project</th>
<th>No. of Buildings</th>
<th>Type of Project</th>
<th>No. of Buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Schools</td>
<td>5,900</td>
<td>Auditoriums, gyms, and recreational building</td>
<td>9,300</td>
</tr>
<tr>
<td>New libraries</td>
<td>1,000</td>
<td>Dormitories</td>
<td>7,000</td>
</tr>
<tr>
<td>New armories</td>
<td>900</td>
<td>stadiums, grandstands, and bleachers</td>
<td>2,302</td>
</tr>
<tr>
<td>Fairground and rodeo grounds</td>
<td>52</td>
<td>Parks covering</td>
<td>1,686</td>
</tr>
<tr>
<td>Acres</td>
<td>75,152</td>
<td>Playgrounds</td>
<td>3,185</td>
</tr>
<tr>
<td>Athletic fields</td>
<td>3,026</td>
<td>Swimming pools</td>
<td>805</td>
</tr>
<tr>
<td>Handball courts</td>
<td>1,817</td>
<td>Tennis courts</td>
<td>10,070</td>
</tr>
<tr>
<td>Horseshoe pits</td>
<td>2,261</td>
<td>Ice-skating areas</td>
<td>1,101</td>
</tr>
<tr>
<td>Outdoor theatres</td>
<td>138</td>
<td>Golf courses</td>
<td>254</td>
</tr>
</tbody>
</table>


The WPA also presented a significant opportunity for women and African Americans to obtain jobs. So long as the WPA was a non-profit organization, there was much room for innovation. The United Kingdom has a similar program, one that provides short-term training for new graduates.

Also, the United States had the Humphry-Hawkins Full Employment Act of 1978. The main idea behind this act was to build a “reservoir of public employment.” This program was designed to employ laborers who had few skills and earned low wages. The program was intended to operate when the level of unemployment was higher than three percent. Unfortunately, this program was not implemented.

Additionally, in 2004 Argentina established a JGP, called “Plan Jefes y Jefas de Hongar Desocupados.” This program focuses in particular on unemployed parents and single
mothers (Tcherneva & Wray, 2005) and was designed primarily for low-income families with children. It has more than two million participants, 60% of whom are female. The primary purpose of this program is to address the unequal participation of women in the Argentinean labor force. Through training, female participants can receive excellent jobs in the private sector. By earning a minimum wage, they can save their families from drug addiction, help prevent their children from dropping out of school, and avoid many social issues. This program provides a job for four hours a day, with a minimum wage of 150 pesos per month, and its cost is considered to be as low as one percent of Argentina’s GDP. The main feature of the Argentinian program is that it targets poor women and maintains their minimum wages. Through this program, Argentina has been able to provide essential services and infrastructure for impoverished communities (Palangyo, 2006).

India has a JGP, known as the National Rural Employment Guarantee Act (NREGA), enacted in August 2005. On October 2, 2009, NREGA became known as the Mahatma Gandhi Rural Employment Guarantee Act (MGN-REGA). The program was designed to employ people for at least 100 days and has targeted poor citizens in rural India. The first phase of the program covered approximately 200 districts in India; the program added another 130 districts during its second phase from 2007-2008. The NREGA program increased the aggregate income of women by eight percent and of men by one percent. This program was designed not only to give jobs to the unemployed but also to address the problem of inequality in India (Azam, 2012). The types of projects falling under the NREGA are road construction, irrigation work, and water conservation. However, the NREGA program uses no contractors or machinery—an indication that this program’s objective is to employ more laborers at a minimum wage. The program cost $4 billion, which is around
2.3% of total central government spending. The program’s cost is not high for an anti-poverty program in India (Azam, 2012). In one district (Medhak), the program increased expenditures on food by 40% and on non-food items by 69% (Ravi & Englar, 2009). It also helped local women find good local jobs (Khera & Nayak, 2009). This program has helped increase Indians’ participation in the local market as well as increased their aggregate income (Azam, 2012).

This research also aims to establish the theoretical foundation for the Saudi Job Guarantee Program (SJGP). The Saudi economy is classified as upper-income, and the government can sponsor any large program, such as the Saudi Job Guarantee Program (SJGP). Moreover, Saudi Vision 2030 includes many initiatives, and the call for increased economic diversification is one of the core goals of this vision. Thus, through the SJGP, the Saudi government could enhance the development of sectors besides oil. The study of related literature has revealed that a JGP can carry some high-risk projects so long as this program is not for profit. Furthermore, because the unemployment rate among Saudi females is very high, the current Saudi labor market does not generate enough opportunities for females. This program could be designed to target unemployment among females.

It is also true that this program is intended to stabilize the Saudi economic business cycle, protecting it from sharp fluctuations due to endogenous or exogenous shocks. The SJGP protects domestic wages from sinking below the SJGP’s wages. Because the SJGP is directly involved in the production sector, some additional supply is in the market. An increase in the supply of domestic goods and services can protect the domestic economy from unexpected demand shock. Additionally, the SJGP would be an excellent opportunity to
train Saudi citizens—a form of training through practice. This is how Saudi laborers who have enough time for training could earn high wages in the labor market.

The government could directly invest in the renewable energy sector until it is well-developed (Forstater, 2003a). For instance, the Saudi Telecom Company and the Saudi Electric Company were founded and established by the Saudi government. After these sectors were well-developed, the government transferred these public companies to partial private ownership (corporatization). The other goal for the SJGP is to maintain the aggregate demand by hiring unemployed citizens. It is also a good program for minimizing the cost of unemployment. The SJGP could provide training to Saudi soldiers, as there is a vast army with a retirement age of 45 years but with no social and employable skills that would be useful in the post-retirement period. The SJGP could create a new training program for these retirees.

In brief, the SJGP has great potential to enhance growth and development in the Saudi economy on two fronts. First, SJGP investment flows will generate demand on the other sectors of production. To a certain point (which is the time that the production sector requires to consume the inventory), more demand on goods and services will lead to an increase in demand in another sector of production. This increase in demand will encourage expansion in the production sector. This also means that the JGP is to invest in research and development, which is costly and risky, though a significant factor for growth. In fact, this obstacle causes a developmental delay in the renewable energy sector. Therefore, improvement in terms of renewable energy efficiency is required.

It is also true that Saudi Arabia has invested much in the development of its education system. Today, Saudi Arabia has more than 26 public universities, which include highly
qualified research centers and researchers who have graduated from high-ranking schools and universities in the United States and Europe. Saudi Arabia could take advantage of its highly developed oil research centers, which have made a significant contribution to the development of oil production technology. These research centers could be driven to contribute to the renewable energy sector as well. Saudi Arabia could seriously participate in the process of developing the renewable energy sector. Some renewable energy projects, such as Concentrated Solar Power (CSP), must start on a significant scale. The problem is that the private sector cannot handle CSP megaprojects. This is why the government must participate in a project—such as a CSP project—that would create a huge benefit for society, and that would be associated with high risk and cost. Government participation is possible through the SJGP.

In short, investment in renewable energy through the SJGP is linked to research intended to solve the problems of the high unemployment rate and Saudi economic diversification. Saudi Arabia could drive its investment in renewable energy through the SJGP. Moreover, Saudi Arabia has had some social projects similar to the JGP, but they are not structurally linked to the JGP’s theoretical framework. Therefore, these program’s results do not reflect the promising results expected from the JGP.

**Green Bonds and Sukuk**

Climate change and the environmental crisis are going to be the main issues in the world. These issues are expected to intensify due to massive development in the industrial sector worldwide, with fossil fuels still being the primary source of energy. Since the late 20th century, environmental scientists have issued warnings about the expected climate crisis. However, the high initial costs of investment in the renewable energy sector and the lower
efficiency of production are two main problems still associated with investment in the renewable energy sector. Because of these two problems, renewable energy investors have had a difficult time obtaining financing for their projects. Also, renewable energy projects are associated with high risks. The continuous fluctuation of oil prices is another problem, as a slight drop in the price of oil will cause a simultaneous decrease in demand for renewable energy. Also, wind and sunlight depend on unpredictable weather conditions.

For the further development of green energy, there must be a new financial instrument, such as Green Bonds and Green Sukuk. Investment in Green Bonds and Green Sukuk is an optimal method to finance renewable energy projects (Voica, Panait & Radulescu, 2015). That is why this research proposes alternative sources of finance—Green Bonds and Green Sukuk. Both financial instruments could provide financial support for highly risky and long-term investments (Petrova, 2016). This new development is expected to generate more demand for other sectors of production, such as manufacturing, utilities, and construction. Hence, development in green investment is expected to increase aggregate demand and create jobs, increase income, and promote overall growth. It is possible to define Green Bonds as having a social responsibility for climate change.

The principal issuers of Green Bonds are international financial institutions such as the World Bank, and as such, the issuance are highly rated whilst those issued by some renewable energy institutions have a lower rating. The financial market must have collateral against the risk associated with uncertainty. For instance, the World Bank’s issued bonds have a high market rating because a prominent international institution backs these green bonds up. Many economists who believe that Green Bond markets have an auspicious future (Mulki & Hinge, 2010). According to the Sustainable Prosperity Report 2012, the role of
government in enhancing development in the Green Bond market has different phases. For instance, the public sector (government) could play the role of increasing development in the Green Bond market by providing a Collateralized Debt Obligation (CDO), which must be reduced the risk of default. Table 19 includes the types and qualities of Green Bonds; it is clear from table 19 that the green bonds that issued by the trusted organization have a high rated. Moreover, the government could also invest some funds (such as a pension fund) into this market to increase the level of confidence in it. The government itself may become the issuer of these Green Bonds, and use this money to fund green projects, as was done in Canada. Some countries, like the United States, use tax referencing such that Green Bonds’ income becomes tax-free or is taxed at a lower rate (Sustainable Prosperity, 2012). In addition, two main strategies would increase the green bond markets development globally, which are increase the fixed income allocations and improve the rating of these bonds (Cui & Huang, 2018; Kochetygova & Jauhari, 2014). In short, further development in the Green Bonds markets requires social awareness and government support (Bailer & Weiler, 2015; Donner, Kandlikar & Zerriffi, 2011; Hannam, Liao, Davis, & Oppenheimer, 2015; Harrison & Sundstrom, 2007; Ockenden, Warrander, Eales & Streatfeild, 2012).

In brief, development in the Green Bond markets is a vital source of financing for renewable energy projects. There are high expectations for the world governments to take additional steps toward developing Green Bond markets. Also, researchers play a significant role—through articles, speeches, and social media—in promoting development in Green Bond markets. In the case of Saudi Arabia, it is important to mention that no Green Bond market exists in the Kingdom at this time. This is due to many issues. One issue is the risks involved with it, which create concerns about Saudi financial stability. The other issue is a
political one: Saudi Arabia is one of the world’s major exporters of oil, and issuing domestic Green Bonds may send a negative message regarding the oil market’s stability. However, I believe that the Saudi position on Green Bonds will change in the near future and that once the Saudi government allows the domestic trading of Green Bonds, it will be a significant factor promoting further development in the Saudi domestic renewable energy sector.

Table 19

*Green Bond Market Segmentation by Issuer, Green Label, and Credit Quality*

<table>
<thead>
<tr>
<th>Type</th>
<th>Green Attributes</th>
<th>Credit Quality</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sovereigns, quasi-sovereigns</td>
<td>Labeled</td>
<td>High investment-grade</td>
<td>Bonds issued by country governments or entities</td>
</tr>
<tr>
<td>Supranational</td>
<td>Labeled</td>
<td>High investment-grade</td>
<td>Issued by development banks and international organizations</td>
</tr>
<tr>
<td>Sub-nationals</td>
<td>Labeled</td>
<td>Investment-grade</td>
<td>Regional, local or cities</td>
</tr>
<tr>
<td>including regional, state, municipality, and city governments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corporates</td>
<td>Labeled</td>
<td>Investment-grade/ sub investment-grade</td>
<td>Commercial banks such as Bank of America,</td>
</tr>
<tr>
<td>Asset-backed securities (ABS)</td>
<td>Unlabeled</td>
<td>Low investment-grade/ sub investment-grade</td>
<td>Cash flows to repay coming from specific assets, solar farms,</td>
</tr>
<tr>
<td>Project bonds/loans</td>
<td>Unlabeled</td>
<td>Low investment-grade/ sub investment-grade</td>
<td>Specific-assets Green Bonds</td>
</tr>
<tr>
<td>Corporate-pure play green or renewable</td>
<td>Unlabeled</td>
<td>Low investment grade/ sub investment-grade</td>
<td>Portfolio of renewable energy and energy efficiency, assets issuing debt at the corporate level</td>
</tr>
</tbody>
</table>

Source: Kochetygova & Jauhari (2014)
Public-Private Partnerships (PPPs)

So far, the significant barriers to investment in the renewable energy sector have been the high risks of renewable energy projects, a shortage of required funds, and the very high initial cost of most renewable energy projects. Enhancing development in the Green Bond markets is not enough to meet the deficiency in the financial sources for the renewable energy sector and to remove the high risks associated with renewable energy investments. Green Bond markets still account for less than seven percent of the total world bond markets. This research believes that a need exists for solutions that complement Green Bonds. One such solution would be a Public-Private Partnerships (PPPs) (Rajpurkar, 2015).

One conceivable solution for enhancing development in the renewable energy sector is to build a partnership between the public and private sectors in the form of Public-Private Partnerships (PPPs), specifically in the case of Saudi Arabia. The PPP is an economic framework that enhances the efficiency of government services (Biygautane, 2017). For instance, despite the Saudi government significant spending on public services, the quality of those services falls below the threshold of expectations. Whilst some may question why a rich country like Saudi Arabia needs to establish such partnership with the private sector, the inclusion of PPPs could be a convenient solution for increasing the quality of public services and cutting the cost impact on the government budget. On the other hand, the private sector usually cannot handle big government projects due to budget constraints and a lack of experience (Carbonara & Pellegrino, 2018). A partnership between the private sector and the public sector could be the bridge that allows the private sector to enter public services investments while allowing the public sector to privatize some of its services, as shown in Figure 11 (Mustafa, 2016).
To consolidate the Saudi Vision 2030 initiatives, one crucial point is to privatize the Saudi public sector and let the government focus on its core business as a regulatory entity. The Saudi government can use the PPP framework for new government projects and operate some existing public services (Bennett & Iossa, 2006). This section will define Public-Private Partnerships (PPPs), examine the possibility of using this framework to enhance development in the renewable energy sector, and discuss some best practices of PPPs.

The economic literature is replete with definitions of PPPs. Generally, a PPP is a partnership between the public sector and the private sector. It is a long-term contract with a range of 15 to 30 years (Custos & Reitz, 2010). Some economists believe that PPPs could be a path for the private sector’s participation in some public sector projects. Others defined Public-Private Partnerships (PPPs) as a long-term cooperation between the public and one or many private sector entities, in which some of the government services or functions operated by the private partners. In economic literature, also, PPPs were discussed under the type of...
contract theory (Hart, 2003). Overall, the primary benefit of PPPs is that they increase efficiency and the possibility of success (Naditz, 2017). One possible solution for a government to achieve its development goals is to obtain the help of the private sector, which in many cases is designed to be more efficient than the government for building or establishing large projects such as airport, hospital, or school (Roberts & Siemiatycki, 2015). There are three crucial traits for any PPPs, which are sharing risk, ownership, and financial responsibility. There are certain factors that guarantee the success of any PPPs contract such as small details between both parties have to be clear in the contract and parties should know its responsibilities. The private sector partners, moreover, have to be very selective by the government (JLL MENA, 2017; Koontz & Thomas, 2012; Rajpurkar, 2015).

Various countries have used PPPs with outstanding results. Examples include the Cairo Metro Extension in Egypt, the Suez Canal in Egypt, the Queen Alia Airport expansion in Jordan, the Tangier-Marrakech Railway, and the Casablanca Port expansion in Morocco. In Saudi Arabia, many large projects have been established using the PPP framework, such as the 2011 Prince Mohammad Bin Abdulaziz Airport (PMAA) expansion in Madinah between the General Authority of Civil Aviation (GACA), and a consortium comprising TAV Airports, Ta’if International Airport, Prince Abdul Mohsin bin Abdulaziz Airport in Yanbu, Prince Nayef bin Abdulaziz Regional Airport in Qassim, Ha’il Regional Airport, King Khalid International Airport (Terminal 6) in Riyadh and King Abdulaziz International Airport in Jeddah in 2018 (JLL MENA, 2017).

There are various benefits for the private and public sectors, such as an increase in training opportunities for public sector employees. This would be an expected result of having the employees of these two sectors work together on the same project. Typically,
PPPs projects are considerably large projects. If one entity handles them, there is a possibility of deviation from the project’s core goals. Distributing the project to one or more entities between the private and public sectors could strengthen the focus on the core business, which is expected to increase the efficiency of production. It would also increase the skill and knowledge of the people who take part in these kinds of activities, which presents another possibility for innovation and development in the production scheme. Table 20 and Table 21 provide summaries of most of the benefits and challenges for both the public sector and the private sector.

Table 20

*Benefits and Challenges for the Public and Private Sectors (Public Sector)*

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>The quality of public services and goods is increased.</td>
<td>The process of establishing PPPs is a long one, with complex details.</td>
</tr>
<tr>
<td>The cost of public sector operations is reduced.</td>
<td>The contract lacks regulations for Saudi PPPs.</td>
</tr>
<tr>
<td>The productivity of the government sector is increased.</td>
<td></td>
</tr>
</tbody>
</table>

Table 21

**Benefits and Challenges for the Public and Private Sectors (Private Sector)**

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access is obtained to some public sector projects.</td>
<td>These PPP projects have low returns due to the fact that they are still semi-public sector.</td>
</tr>
<tr>
<td>The ability exists to access some government properties.</td>
<td>There are issues involving long-term remuneration/financial returns.</td>
</tr>
<tr>
<td></td>
<td>PPPs usually include more than one partner.</td>
</tr>
</tbody>
</table>


So far, Saudi Arabia has the highest share of contributions to the PPP framework among a number of Arabic countries. Over SR 42.9 billion of the total PPP value is in Saudi Arabia, distributed as follows: 54% for housing, 26% for transportation, 11% for airports, 5% for utilities, 2% for education, and 2% for health care. See Figure 12 (JLL MENA, 2017).

![Value of PPP Projects by Country (2017)](image)


*Figure 12.* Value of PPP projects by MENA country.
Today, Saudi Arabia works hard to achieve the initiatives of NTP 2020 and Vision 2030. One initiative is to increase the private sector’s participation to 65% by the end of 2030. PPPs could represent a middle step or pathway that Saudi Arabia can take toward privatization. This could be the reason for the significant development of Saudi PPP projects. Moreover, much debate exists over the relationship between development in renewable energy and the role of PPPs. Most renewable energy projects are large projects that require a significant amount of initial capital. PPPs could represent an excellent opportunity for both the public and private sectors to take on a large renewable energy project and share its risk—a task that would not be feasible otherwise (Schmaus, 2017).

**Conclusion**

The last five chapters have discussed in detail why it is important for Saudi Arabia to invest in renewable energy. They have also have discussed how much renewable energy is expected to contribute to the growth of the Saudi GDP and labor market. This chapter is very important because it serves as a complement to the research objective. This chapter discusses three essential factors that will help increase development in Saudi Arabia’s renewable energy sector, thereby creating a promising solution for the issues of Saudi unemployment and a lack of diversification. The first part discusses the role of the SJGP in enhancing development in the Saudi renewable sector. The second part proposes the development of the Green Bond and Sukuk market in the domestic financial market, which would be an essential source of financing for renewable energy projects. The third part discusses Public-Private Partnerships (PPPs).

PPPs are very important for establishing the foundation for the Saudi renewable energy sector. It has been deduced from the research that the most useful application of
renewable energy is for building the construction sector. However, the government would own the final product. For most solar energy projects, the cost of establishing the foundation is very high. However, the operation and maintenance costs are quite low. That is why a different study has stated that PPPs could play a useful role in building the foundation of the renewable energy sector with more efficiency and at a low cost.
CHAPTER 7

CONCLUSION AND RECOMMENDATIONS

This dissertation has discussed and investigated the problem of unemployment among Saudi citizens (male/female) and the solution of moving toward diversification by enhancing development in the renewable energy sector. This promising solution could generate more jobs for Saudis. Additionally, the dissertation has proposed localizing the supply chain for major industries such as oil and gas. It has found that the Saudi private sector makes a significant contribution to the Saudi services sector, and employs a large number of foreign laborers, with low salaries and productivity. The major reason for low productivity in the private sector is the existence of low domestic competition and easy access to low-wage-earning foreign laborers. With this low level of productivity, there does not seem to be any likelihood of Saudis working in the private sector. That is why the Saudi government must increase the cost of foreign laborers and the productivity of its citizens.

In fact, unemployment is a very complicated issue in Saudi Arabia, as evidenced by the fact that it has taken six chapters of this research to suggest a solution to address it. I have discussed the problem in such a manner that the reader can easily proceed through these six chapters and see three essential elements: the author’s motivation for writing this dissertation, unraveling these chronic problems, and suggesting solutions.

Chapter 2 can be summarized in three parts. The first part covers Saudi Arabia’s geographical location and historical events that have played an important role in shaping the modern Saudi economy. The Kingdom’s geographic location is interlinked with its trade in the Middle East, due to its being the center of the Arab world. Also, the Kingdom has easy access to the Red Sea and the Arabian Sea, which connect the country over two continents:
Asia and Africa. This chapter also studies Saudi economic development plans to evaluate all the stages of Saudi development beginning with the discovery of oil.

Moreover, the chapter indicates how Saudi Arabia was able to take on the responsibility of being the dominant global oil producer and supplier in a short period of time. The conclusion this research has drawn from these development plans is that a mismatch exists between economic development and human development, specifically in their early stages. In the beginning, the Saudi government’s primary goal was to increase the productive capacity of oil. As this goal required significant infrastructure development, the government used all possible resources and strategies to achieve that goal.

On the other hand, Saudis’ contribution to the total Saudi labor force had decreased to 30% by the end of 2015. This lower contribution of Saudi labor to the country’s total labor force was associated with increased unemployment among Saudis. It served as a wake-up call for the Saudi government to quickly address the problem of Saudi economic fragility and to create jobs for its citizens.

The third part of Chapter 2 is a review of the literature about Saudi unemployment. The issue of Saudi unemployment is not a problem of supply and demand in the Saudi labor market but is a structural problem of the Saudi economy resulting from its inability to employ Saudis. A temporary policy, such as the Saudization program, will not address the Saudi unemployment issue. In fact, the Saudi economy is suffering from less diversification and low labor productivity, specifically in the services sector. This low productivity in the private sector is believed to be a barrier preventing the employment of Saudi citizens who demand high wages.
Chapter 3 establishes the theoretical foundation of this dissertation. Because the problem of unemployment is an essential feature of the capitalist system, this chapter provides likely reasons for the existence of this issue, such as structural and technological unemployment. It also claims that these two kinds of unemployment are temporary phases. A decline in investors’ expectations is the primary reason for unemployment in an economy. In the case of Saudi Arabia, the collapse in the oil market and the implementation of various economic reforms has rapidly increased the level of uncertainty among Saudi investors. This is why we are now seeing a high level of unemployment among Saudis: 12.9%, an increase from the 7% rate of 2014. Therefore, the government must keep investors’ expectations high—a goal important for moving the economy forward. It is also the case that a highly flexible and diversified economy is essential for absorbing endogenous and exogenous shocks and keeping investors’ expectations high.

Chapter 4 of this dissertation includes empirical work. It uses Leontief’s input-output methodology to calculate the number of jobs generated and the value added to the Saudi GDP by new investments in the renewable energy sector. This method is a valuable economic tool for evaluating economic policy. Leontief’s input-output method includes the type of relationship that exists among different entities of production sectors, the amount of tradeoff between these different entities of production, and the type of relationships between the domestic production sector and the final demand sector. In such a way, this method can calculate precisely how much investment in the renewable energy sector is required for the Saudi economy to produce satisfactory results. Also, this model can examine the outputs of different investment cases. Discussing the reasons for the proposed investments in the
renewable energy sector would be a good strategy for addressing the high rate of Saudi unemployment and driving the economy to diversify.

Chapter 5 discusses the challenges and opportunities of investment in the renewable energy sector. This chapter argues that increasing domestic energy consumption efficiency is an essential step toward further development in the renewable energy sector. It also takes into account the cost to the government due to its generous subsidy system on all kinds of utilities including fuel. It has been found that the benefits of implementing energy reforms and investment in the renewable energy sector are enormous.

Chapter 6 proposes to provide solutions that the renewable energy sector can use to confront challenges. These solutions are direct investment from the public sector in the form of the SJGP, the involvement of Public-Private Partnerships, and the establishment of a green finance market inside the Kingdom. In addition, this research believes that the social adoption of renewable energy is a significant step toward further development in the Saudi renewable energy sector.

Overall, this research encourages the Saudi government to actively invest in the renewable energy sector and localize relevant supply chains. Some can argue that it is cheaper to import renewable energy items and machines from China. While localizing renewable energy industries could increase the cost, this localization does offer social and economic benefits. The primary goal of the SJGP, which could become the major contributor to the Saudi renewable energy sector, is to address the unemployment issue, not to maximize profits. The other benefit of localizing renewable energy production is the creation of opportunities for Saudi universities to establish research centers, thereby boosting participation in the development process of this sector.
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doi:10.4337/9781781950845.00001


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Mr. Al Yousif entered the University of Missouri at Kansas City Interdisciplinary Ph.D. program with a passion for learning more about the theory of Job Guarantee Program and Ecological Economics. Upon completion of the Doctor of Philosophy degree, Mr. Al Yousif plans to continue working in the research department at Saudi Arabia Monetary Authority (SAMA) and teaching ecological economics in local universities.