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A SCENARIO-BASED ANALYSIS OF THE IMPLEMENTATION OF SUSTAINABLE DEVELOPMENT GOALS BY 2050

A CASE STUDY OF IRAN

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Contact details

Mojgan Chapariha, CUSP, Lisbon School of Economics and Management, University of Lisbon; Email: mojgan@phd.iseg.ulisboa.pt

Summary

This paper presents a systems dynamics model for exploring possibilities for achieving four SDGs (SDG-1, SDG-8, SDG-12, and SDG-13) in Iran. The model is used to generate four possible stories about the implementation of measures to achieve these SDGs in the future of the Iranian economy from 2020 to 2050: 1) the Scenario of *Business as Usual* continues current trends and projects them into the future, 2) the Scenario of *Inclusive Growth* is designed to simulate more income equality and faster economic growth, 3) the Scenario of a *Steady State* introduces measures to improve social, and environmental aspects while having zero economic growth, and 4) the Scenario of *Well-being for People and Planet* is designed to improve socio-economic and environmental aspects of the Iranian economy to achieve the four SDGs in Iran. The performance of the Iranian economy for progressing towards the SDGs is monitored through four SDG indexes which are measured based on the arithmetic mean of selected indicators for each SDG, and a Combined Index of SDGs which is measured based on the arithmetic mean of the four SDGs indexes. The results of the simulations of the SDGs model of Iran shows that the *transformational* scenarios (*Steady State*, and *Well-being* for *People and Planet*) provide better pathways in comparison to *conventional* scenarios (*Business as Usual* and *Inclusive Growth*) for achieving the SDGs. Moreover, transformational policy changes and extraordinary efforts are required for progress in achieving SDGs overall.

1. Introduction

The Sustainable Development Goals (SDGs) were adopted by the United Nations in 2015 to combat environmental issues within the broader context of economic and social development in the period 2015 to 2030. Discussions on SDGs illustrate that they are important development agenda for achieving sustainability, human and ecological well-being. Costanza et al. (2016) argue that "The SDGs represent a major potential tipping point in the future of humanity" (Costanza, Fioramonti, and Kubiszewski 2016). It is necessary to have global goals such as SDGs; however, implementing and achieving SDGs is another important factor. The implementation of SDGs can be challenging in different aspects, especially in developing countries. This is because the implementation of SDGs needs infrastructure, financial resources, availability of data, etc.

Monitoring the progress in achieving SDGs is important for analysing best possible pathways for achieving them. In this regard, Randers et al. (2018) constructed an integrated "Global Systems Model", Earth3, which links socio-economic and biophysical systems and then simulates the implementation of 17 SDGs within 9 planetary boundaries (Randers et al. 2018). Earth3 produces four scenarios of Business as Usual, Accelerating Economic Growth, Stronger Efforts on All Fronts, and Transformational Change which measures the number of SDGs achieved for seven World regions in the period of 2018 to 2050 (ibid). They concluded that for achieving SDGs within Planetary Boundaries, implementing transformational and extraordinary policy changes are required (ibid). Similarly, this research considers two categorizes of scenarios: conventional and transformational.

The focus of this paper is on implications of achieving four SDGs in Iran: SDG-1 (eradicating poverty), SDG-8 (economic growth and decent work), SDG-12 (sustainable production and consumption), and SDG-13 (climate action). Therefore, a systems dynamics model is constructed to examine the possible achievement of four SDGs in the period 2020 to 2050 under four scenarios. These four scenarios are categorized into two groups of *conventional* scenarios (Business as Usual, and Inclusive Growth) that are based on ordinary efforts and conventional policies and *transformational* scenarios (Steady State, and Well-being for People and Planet) which are based on extraordinary efforts and radical policy changes.

Scenario of "Business as Usual" is a projection of recent trends into the future. Scenario of "Inclusive Growth" considers socio-economic factors such as

higher economic growth, income redistribution, and a higher level of population growth as its main objectives. Scenario of "Steady State Economy" is based on zero economic growth, income redistribution, a lower level of population growth, and a reduction in working hours, and is supported by environmental plans including a carbon tax and the redirection of income from the fossil-fuel industry to renewable energy investment. Scenario of "Well-being for People and Planet" is based on income redistribution, a medium level of population growth, and a reduction in working hours, but does not control the GDP growth rate. It also considers a progressive carbon tax and the redirection of income from the fossil-fuel industry to renewable energy investment. Finally, the paper will compare the scenarios in terms of the extent to which they lead toward a sustainable economy that improves human and ecological well-being in Iran by 2050.

This paper has eight main sections (including the introduction and conclusions). In section 2, it explains the case study of Iran. Then in section 3, it explains the structure of the Iran's Ecological Macroeconomics Model of SDGs. Then in section 4, it describes four scenarios of the SDGs model categorized into *conventional* and *transformational* scenarios. Then in section 5, it describes the policy changes of the scenarios. Next, in section 6, it compares the results of simulations of the systems dynamics model of SDGs in Iran under the four scenarios. It will analyse progress toward achieving four goals of SDGs in Iran through measuring growth of SDGs index. Also, it illustrates the result of the combined index of SDGs in different scenarios. In section 7, it does a sensitivity analysis to assess the influence of parameters, variables, and policies on the output of the model.

2. Case Study of Iran

The Islamic Republic of Iran (Iran for short) is in the continent of Asia and the region of the Middle East. Iran, with an area of 1,628,760 square kilometres, ranks as the sixteenth biggest country in the world (World Bank 2020f). Iran shares borders with several countries, including Turkey, Azerbaijan, Armenia, Iraq, Pakistan, Afghanistan, and Turkmenistan. Also, Iran borders the Caspian Sea in the north and the Persian Gulf and the Gulf of Oman in the south. Figure 1 depicts a map of modern Iran. Iran has a population of around 81.8 million (World Bank 2020g), which forms around 1% of the world's population. Iran's population increased from 21 million in 1960 to 82 million in 2018 (World Bank 2020g).

Figure 1: *Modern Iran*
(Source: United Nations)

Iran is dealing with socio-economic issues such as poverty, income inequality, high inflation, a high unemployment rate, and lack of decent work which these macroeconomic indicators are addressed in the SDGs model of Iran through simulating SDG-1 and SDG-8. Moreover, Iran is dealing with some environmental issues such as high levels of CO2 emissions and ecological deficit which these environmental issues have been addressed in the SDGs model of Iran through simulating SDG-12 and SDG-13.

The IMF provides the inflation rate based on average consumer prices, which illustrate fluctuations between 4% and 50% in the period 1980 to 2020 (International Monetary Fund 2019). Income inequality[1] has been fluctuating over years, however; in comparison to a level of 46 in 1979, it has declined to 40 in 2017 (Central Bank of the Islamic Republic of Iran 2020). Poverty data reporting based on World Bank and Iranian sources are different. The World Bank reported that 11.6% of the population in 2016 were living below the

[1] Gini coefficient is measured based on disposable income (income after deducting tax).

poverty line (World Bank 2020h). However, an Iranian economist declared that in 2015, 40% of people were doing so (BBC 2015). This inconsistency among poverty data may be due to the use of different exchange rates, different poverty line definitions, and the use of data from different sources. The global unemployment rate was 5.5% in 2018 (International Labour Organization 2020), while the total unemployment rate in Iran was 12% in 2019 (World Bank 2020j). The number of children who are not in primary school has decreased from around one million in 1984 to 16,911 in 2017 (World Bank 2020c). Moreover, it shows that the number of girls who were not in school was significantly greater than that of boys from 1984 to 2012 (World Bank 2020a, 2020b).

Recent economic sanctions in Iran had five major effects on Iranian economy: 1) a trade ban on many goods (Rahmati et al. 2015); 2) a decrease in oil exports and revenue (Azarbaejani, Tayebi, and Dargiri 2015; Rahmati et al. 2015); 3) a sharp rise in the exchange rate (Rahmati et al. 2015); 4) restrictions on the country's banking system with other countries (Azarbaejani et al. 2015); 5) a significant impediment to economic growth (Garshasbi and Dindarlou 2016); and 6) positive significant influence on inflation through its effect on the exchange rate and government debt (Sadeghi and Tayebi 2017).

Iran is among the top ten countries with the highest level of total CO2 emissions. Total CO2 emissions and CO2 emissions per capita were increasing in the period 1960 to 2014. CO2 emissions increased from 37,392 kilotons in 1960 to 649,480 kilotons in 2014 (World Bank 2020d). CO2 emissions per capita increased from 1.7 metric tons per capita in 1960 to 8.38 metric tons per capita in 2014 (World Bank 2020e). Energy sector had highest contribution to CO2 emissions in Iran which 90% of total CO2 emissions in 2000 (Iranian National Climate Change Office 2010) and 88% in 2010 (Iranian National Climate Change Office 2017). As the energy sector in Iran contributed to 86-90% of total GHG emissions in Iran, so, (Daneshvar, Ebrahimi, and Nejadsoleymani 2019) recommended that for mitigating climate change in Iran it is required to focus on mitigation of GHG emissions in energy sector. Therefore, it is necessary for Iran to transit from an economy based on fossil-fuel energy to one that is based on renewable energy and finally becomes independent from fossil-fuel energy.

The ecological footprint per capita is the average impact that each resident of a country has on the environment. The ecological footprint measures our dependence and impact on the environment and the carrying capacity of nature (Rees 2013). The ecological footprint in Iran was measured at 3.2 global

hectares per person in 2017, which exceeded the biocapacity of 0.7 global hectares per person. In Iran, the carbon footprint is 2.5 global hectares per person of the total ecological footprint (3.2), and is around 70% of the total ecological footprint of consumption (York University Ecological Footprint Initiative and Global Footprint Network 2021).

3. Structure of Iran's Ecological Macroeconomics Model of SDGs

3.1. Overview of the Model

To transition toward sustainability, it is essential to consider the interactions of different systems of economy, society, and environment (Clayton and Radcliffe 2015), which systems thinking theory offers insights into and approaches to in dealing with these complexities (Kay 2008). Sustainable transition in ecological economics is rooted in the concept of systems thinking to deal with the complexities of the relationships among systems of economy, society, and environment. Conceptualizing the economy, society, and environment as nested systems is crucial for understanding the economy and its dependence on the wider world (Victor 2008, 2019).

Ecological macroeconomics models provide situation to analyse systems of economics, society, and environment in an integrated way. Victor and Jackson (2020) developed a research agenda for ecological macroeconomics which they proposed that ecological macroeconomics must consider three spheres of modelling and metrics including the ecological sphere, the real economy, and the financial economy (Victor and Jackson 2020). Jackson and Victor (2019) constructed an ecological macroeconomics model, called LowGrow SFC, for Canada which includes three interrelated spheres of environment, real economy, and financial economy (Jackson and Victor 2019). As O'Neill (2020) says, Ecological Macroeconomics Models are looking for non-substitutable goals of sustainability, equity, and human well-being. This research in line with Victor and Jackson (2019) construct a systems dynamics model which considers three systems of economy, society and environment embedded to each other.

The intent of the SDGs is to develop a more integrated agenda, one that successfully combines three dimensions (economic, social, and environmental) of sustainable development, and one in which goal areas are interrelated (Osborn, Cutter, and Ullah 2015). It should successfully combine these three dimensions and recognize each goal area as interrelated (Osborn et al. 2015).

Goals and targets are interdependent, and they must be pursued together; many of the indicators are related to more than one of the targets in the SDGs. Therefore, the SDGs model of Iran consists of three main systems: economy, society, and environment, and their interactions (i.e. synergies and trade-offs) with each other. Figure 2 illustrates this integration of the three sectors of economy, society, and environment that lead to the achievement of human and ecological well-being.

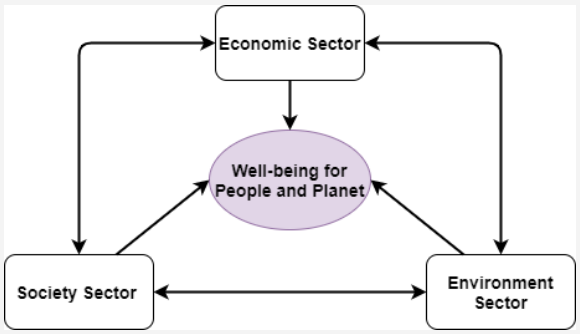

***Figure 2**: Three main sectors of the model*

Figure 3 gives an overview of the SDGs model of Iran. This model consists of exogenous and endogenous variables. Values for the exogenous variables are derived from real data. The values of the endogenous variables are the output of the model. The relationships among the variables in the model are explained in different parts of this paper. Then, the output of the model is used to measure four SDG indexes. Finally, these SDG indexes are used to measure a combined index to show the overall performance of each scenario.

Synergies and trade-offs among different SDGs will contribute to overall human and ecological well-being (Costanza et al. 2016). Therefore, considering the interactions among the SDGs is important to achieve both a healthy environment and productive economy. Moreover, as Singh et al. (2018) state, diverse environmental, social, and economic issues are related to each other in a complex way, therefore achieving the SDGs' results in many interrelated ecological, social, and economic consequences. Understanding the relationships among SDGs is important in prioritizing effective and efficient policy options (Singh et al. 2018). The International Council for Science (ICSU) and International Social Science Council (ISSC) also declare that different goals in SDGs are not isolated from each other, which means that they affect each

other (ICSU and ISSC 2015). On the one hand, some of the goals are helping the others to progress; on the other, some of the goals conflict with each other.

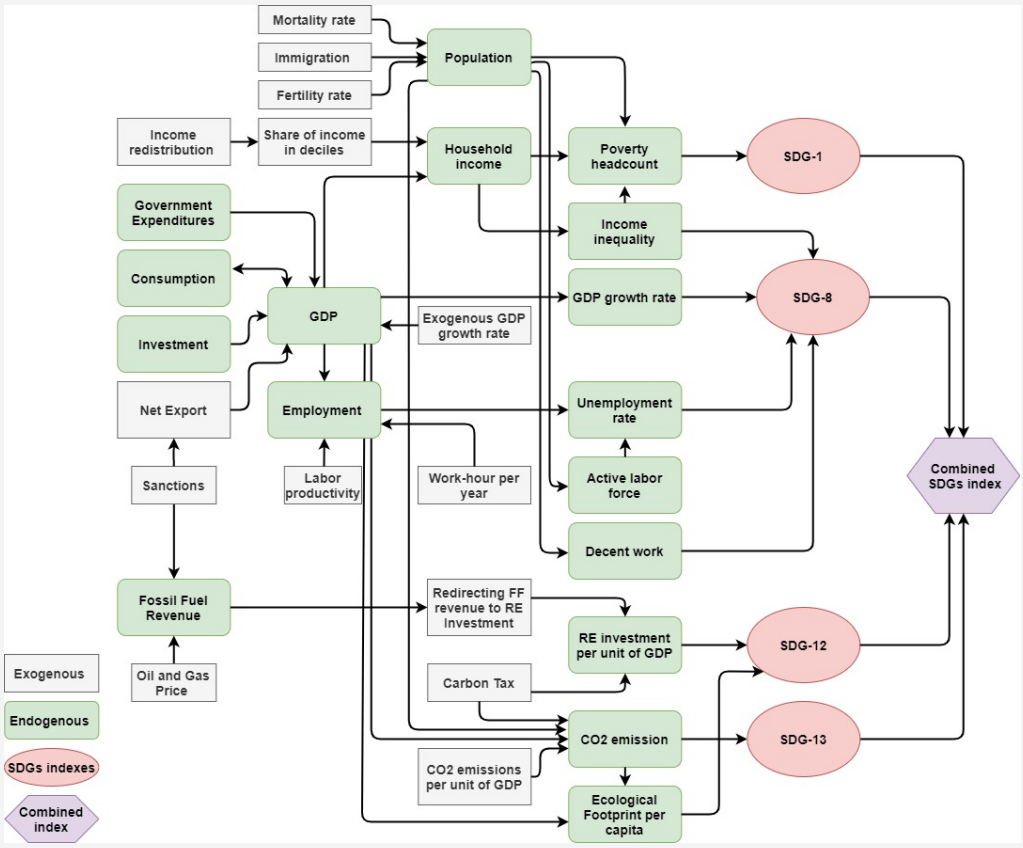

***Figure 3**: Overview of the SDGs model of Iran*

This research has utilized models that illustrate positive (synergies) and negative (trade-offs) causal effects (see Figure 4). Consider two variables *x* and *y*. A positive causal effect happens when changes in the level of *y*, *ceteris paribus*, cause a change in *x* in the same direction (Barlas 2007). For example, in this model consumption has a positive causal effect on GDP, which means that any increase in consumption increases GDP. A positive causal effect is symbolized by "+" in Figure 4. A negative causal effect happens when any change in *x*, ceteris paribus, causes a change in *y* in the opposite direction. The symbol "–" illustrates this negative causality in Figure 4. For example, in this model when GDP goes up, the unemployment rate goes down, *ceteris paribus*.

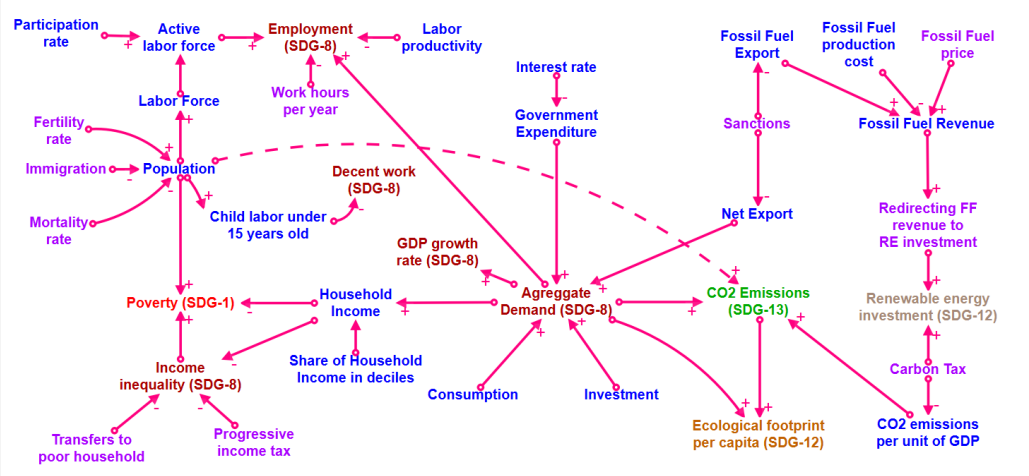

***Figure 4**: Causal Loop Diagrams (CLDs) of the SDGs model*

In this model, an increase in the GDP growth rate (SDG-8.1) reduces the unemployment rate (SDG-8.5), which means that they have a negative causal effect (trade-off). An increase in the GDP growth rate reduces poverty (SDG-1.2) and shows synergies between SDG-8 and SDG-1. Additionally, reducing income inequality (SDG-8.2) through income redistribution reduces poverty (SDG-1.2), which illustrates synergies between SDG-8.2 and SDG-1.2. CO2 emissions are calculated in the model using the IPAT[2] equation. Any increase in GDP (SDG-8.1) increases CO2 emissions (SDG-13.2). Achieving SDG-8 involves trade-offs with SDG-13. CO2 emissions (SDG-13.2) increase the ecological footprint (SDG-12), which shows synergy between SDG-12 and SDG-13. Any increase in consumption, which is part of GDP (SDG-8.1), increases the ecological footprint (SDG-12.2) and so SDG-12 and SDG-8 have trade-offs.

3.2. Sets of indicators to measure SDGs indexes

The United Nations Statistical Commission, meeting in March 2016, adopted a global indicator framework consisting of 230 indicators for the 17 SDGs. Main indicators of SDGs in this model are defined based on the context of "The 2030 agenda for sustainable development" (United Nations General Assembly 2015) and also "Global indicator framework for Sustainable Development Goals and targets of the 2030 agenda for sustainable development" (United Nations 2017). This model generates many indicators that can be used to measure the

[2] IPAT is an acronym for a mathematical formula (I=PAT) to describe impact of human activity on the environment where "I" is the human impact on the environment, "P" is population, "A" is affluence, and "T" is technology. IPAT was defined by Ehrlich and Holdren (1971).

SDGs indexes. The criteria used for selecting the indicators were: relevance to the targets of the SDGs, being compatible with the suggested SDGs indicators by the United Nations Statistical Commission (2016), broad availability of data for Iran and other countries, and the quality of the data. To measure the SDGs' indexes, indicators that has been measured in the model are shown in Figure 5.

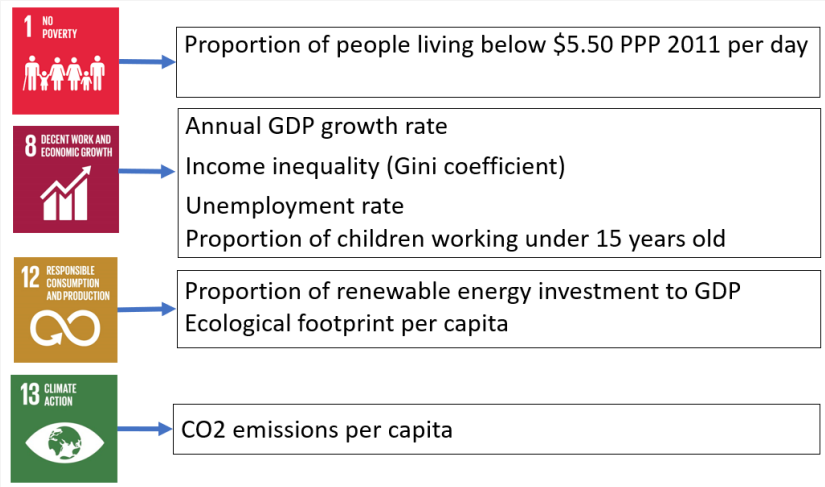

***Figure 5**: Sets of indicators to measure SDGs in the SDGs model*

3.3. Measuring SDGs Index

Each of the indicators used to measure SDGs indexes have different units; therefore, it is required to convert them into a normalized index for them to be comparable to each other. The SDGs index is normalized to be in the range of 0 to 100, where 0 shows complete failure in achieving the SDGs and 100 means complete success. In other words, if the SDG index approaches 100, this means that Iran has achieved that goal. On the other hand, if the SDG index decreases, this means that the attempt to achieve that particular SDG is worsening. For indicators whose increase is assumed as implausible (e.g. poverty), Equation 1 has been used to normalize that index, while for indicators (e.g. the ratio of renewable energy investment to GDP) whose increase is assumed plausible, Equation 2 has been used to do so.

$$Normalized\ x = 100 - \frac{x - Min(x)}{Max(x) - Min(x)} * 100 \qquad \text{(Eq. 1)}$$

$$Normalized\ y = \frac{y - Min(y)}{Max(y) - Min(y)} * 100 \qquad \text{(Eq. 2)}$$

Table I shows the minima and maxima of the SDG indicators in the model. The minima and maxima have been defined based on SDGs' context or performance of other countries. If the ideal level of a target has been defined in the context of SDGs, then this number would be used as the ideal level of that indicator. Otherwise, the ideal level is defined based on the best performance of other countries. On the other hand, the worst level of an indicator is defined based on the worst case in the world.

***Table I**: Targets of SDGs in the model*

SDGs	Modelled indicators	Minimum (worst case)	Maximum (Target)
SDG-1	Proportion of population living below 5.5 $ PPP per day	90.6% (Benin 2015)[a]	0%
SDG-8	GDP growth rate	−20.6% (Sierra Leone 2015)[a]	4%
	Gini coefficient	59.1% (Namibia, 2015)[a]	0
	Unemployment rate (total)	35%	<5%
	Proportion of child labor	15.39% (Colombia, 2015)[a]	0%
SDG-12	Ecological footprint per capita	14.5 gha per capita (Qatar, 2015) [b]	<0.7 gha (Iran's biocapacity)
	Percentage of renewable energy investment within GDP	0%	10% (South Africa and Chile)
SDG-13	CO2 emissions per capita	37.91 metric tons per capita (Qatar, 2014)[c]	0

Sources: [a]World Bank, [b]Ecological Footprint Network, and [c]Wordometers

4. Four Scenarios of the Model

This model consists of four predefined scenarios: Business as Usual, Inclusive Growth, Steady State Economy, and Well-being for People and Planet. Scenarios of this model are predefined in a way to describe different possible pathways of implementing SDGs. In line with Randers et al. (2018), scenarios of this model are categorized into two groups; conventional efforts and extraordinary efforts. The first two scenarios of this study, Business as Usual and Inclusive Growth, are based on conventional policies. Studies (e.g. Jackson and Victor 2020; O'Neill et al. 2018; Randers et al. 2018, 2019) show that for improving human and ecological well-being, transformational policies are required. Therefore, two scenarios of Steady State Economy, and Well-being for People and Planet are constructed based on transformational policies to

help in achieving SDGs in Iran by 2050. Figure 6 illustrates the major features of four scenarios of the model.

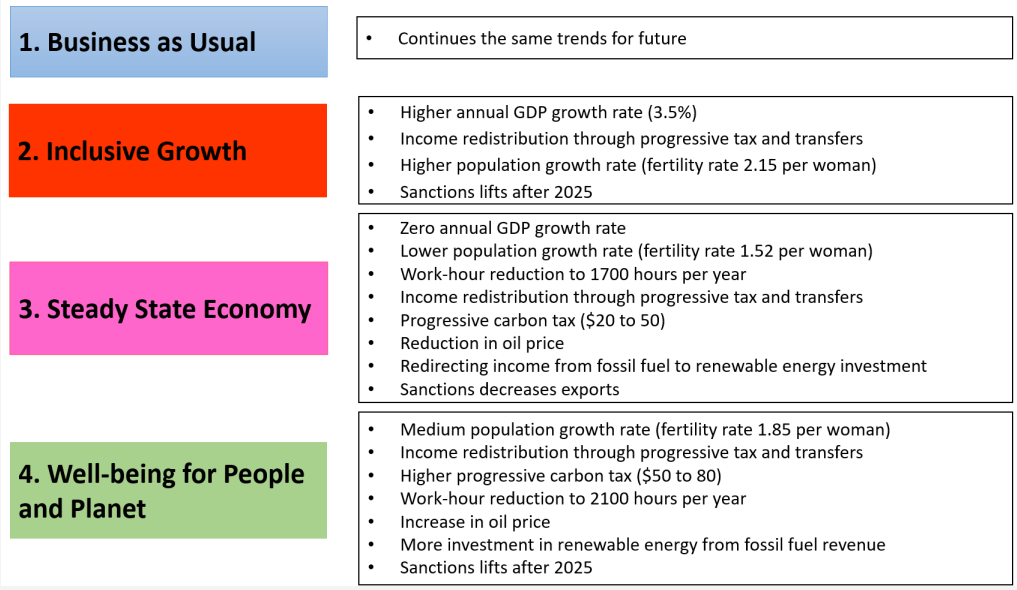

***Figure 6**: Four scenarios of this model*

4.1. Conventional Scenarios

Business as Usual

The first scenario is "Business as Usual," which is a projection into the future based on recent trends. Therefore, scenario of Business-as-Usual shows the possibility of achieving SDGs in Iran through continuing current policies. In the scenario of Business-as-Usual, sanctions reduce exports to 13% of their value in the year 2020. It has been assumed that sanctions are not lifted and, therefore, that this trend will continue.

Inclusive Growth

Some of the economists suggested that accelerating economic growth and redistributing income among people could improve macroeconomic indicators. Therefore, economic growth has been a major policy objective in many western countries (Raworth 2017; Victor 2008, 2019) and recently in many developing countries (Victor and Dolter 2017). Therefore, scenario of Inclusive Growth tests this conventional idea that accelerating economic growth and income redistribution provide a better life for people in Iran. The Inclusive Growth

scenario considers conventional policy reforms. These reforms include socio-economic policy reforms, a higher annual GDP growth rate of 3.5%, and income redistribution through a progressive tax and transfers system. It is assumed that in the Inclusive Growth scenario, as income is increasing, the population is therefore growing more than in other scenarios. Therefore, the population projection in Inclusive Growth is based on the upper 95% prediction interval of the UN's projection for Iran, in which an exogenous fertility rate of 2.15 has been considered. In the Inclusive Growth scenario, it has been considered that economic sanctions on Iran decrease exports to 13% of their value from 2020 to 2025 and then from 2025 it is assumed that sanctions are lifted. In this scenario, the oil price has been based on the projection of International Energy Outlook (2019), starting at $40 per barrel in 2020 and reaching $100 in 2050.

4.2. Transformational Scenarios

Steady State Economy

The other two scenarios, Steady State Economy and Well-being for People and Planet, are based on transformational and extraordinary policies. The scenario of Steady State Economy evaluates the possibility of achieving SDGs in Iran through steady state economy. Ecological economists (e.g. Bina and La Camera 2011) stated that mainstream economy disregards socio-ecological limits to economic growth. Therefore, discussions on alternative agendas that bridges the gap between economic system and socio-ecological systems became trendy. One of these alternative agenda is steady state economy which is based on planned reduction in economic output to improve well-being and ecological conditions (Demaria et al. 2013; Schneider, Kallis, and Martinez-Alier 2010). The idea of moving toward steady state economy roots to the idea that the "world is finite" as Daly (1977) mentions. The goal of Steady State Economy scenario is to achieve social justice and sustainability while managing economic growth.

The Steady State Economy scenario considers socio-economic and environmental policy reforms to achieve to its goal. In this scenario, the exogenous GDP growth rate has been zero to analyse the effect of a zero GDP growth rate on other SDGs indicators. This scenario also considers income redistribution through levying progressive rates of tax on rich income deciles and transferring them to poor people. In this scenario, as the economy is shrinking, the population projection is based on the lower 95% prediction interval of the UN for Iran; therefore, the exogenous fertility rate is 1.52 per woman. It has been considered that this scenario has the lowest population

projection to be compatible with the Steady State Economy Scenario. A reduction in working hours is another policy that has been suggested for the steady state economy. In this scenario, the working hours of employees have been reduced from 2,300 to 1,700 hours per year. In this scenario, sanctions decrease exports to 13% of their value from 2020 to 2025; then, they decrease exports to 50% of their value from 2025 to 2050. As regards ecological policy reforms, the Steady State Economy scenario considers carbon tax based on the amount of CO2 emissions. Here, it is assumed that carbon tax influences CO2 emissions per unit of GDP through the low-price elasticity of demand on carbon tax (0.20). Then, this revenue from the carbon tax is invested in renewable energy. In this scenario, fossil-fuel revenue is redirected to renewable energy investment which is increased from 10% in 2020 to 60% in 2050. Additionally, in this scenario, based on climate action policies, the oil price has been assumed to be reduced to $20 per barrel.

Well-being for People and Planet

Finally, the last scenario of Well-being for People and Planet bridges the gap between human and ecological well-being. The main goal of scenario of Well-being for People and Planet is to improve human and ecological well-being through extraordinary efforts for achieving SDGs. Scenario of Well-being for People and Planet considers more extreme transformational policies in comparison to the Scenario of Steady State Economy to help to improve human and ecological well-being. This scenario includes extraordinary socio-economic and environmental policy reforms including working hours reductions, income redistribution, carbon tax, and increased renewable energy investment.

In the Scenario of Well-being for People and Planet, it does not manage economic growth, therefore, economic growth continues the same trend. Like the Business as Usual scenario, in this scenario the GDP growth rate is based on previous trends. Income redistribution has been considered through progressive tax rates and transferring funds to poor people. In this scenario, the tax rates of richer deciles are higher than in Business as Usual to decrease income inequality. Working hours are reduced from 2,300 hours per year to 2,100. This helps to reduce the unemployment rate. In this scenario, the population projection is based on the median of the UN's projection for Iran, where the fertility rate has been considered to be 1.85 children per woman. In this scenario, it is assumed that from 2020 to 2025, sanctions reduce exports to 13% of their value, and then there are no sanctions from 2025 to 2050. Ecological policy reforms have been considered in this scenario; it considers

carbon tax to influence CO2 emissions per unit of GDP through a high elasticity of demand on carbon tax (0.80). Then, carbon tax revenue is redirected to renewable energy investment. Fossil-fuel revenue has been progressively redirected to renewable energy investment. In the period 2020 to 2050, this is set to increase from 10% in 2020 to 90% in 2050. Starting from 2020, oil prices are increased by 1% every year.

5. Description of Policy Changes in Scenarios of the Model

5.1. Managing Economic Growth

This research considers GDP growth rate as one of the indicators of the model that varies in different scenarios. There are two extreme ideas about the role of GDP growth on well-being: 1) pursuing economic growth for improving human well-being, and 2) managing economic growth for improving human and ecological well-being in the context of sustainability. In this model, different scenarios consider different ranges of GDP growth rate. The Inclusive Growth scenario considers 3.5% to be the GDP growth rate, while the Steady State economy scenario considers zero as the GDP growth rate. The two scenarios Business as Usual and Well-being for People and Planet do not consider the exogenous GDP growth rate. Table II shows the exogenous GDP growth rates in different scenarios. This helps to assess the role of GDP growth rate in different aspects of socio-economic and environmental.

Table II: *Exogenous annual GDP growth rate in different scenarios*

	Business as Usual	Inclusive Growth	Steady State Economy	Well-being for People and Planet
Annual GDP growth rate	–	3.5%	0	–

Many writers and notable economists (e.g. (Graham 2005); (Jackson 2009)) articulated that economic growth is important for a period of time to meet basic needs, supply basic infrastructure, and eradicate poverty, but it is not enough for a happy society, because significant factors of well-being go beyond economic growth (Easterlin 2013). Ecological economists (Daly and Farley 2010; Easterlin 1974; Jackson 2009) have stated that meeting material needs is necessary for achieving well-being up to a certain threshold point, during which the benefits of economic growth exceed its costs. After this threshold

point, we are faced with "uneconomic growth" (Daly 1975). Therefore, well-being that is brought about by economic growth is achieved by social costs and sacrifices to society (Georgescu-Roegen 1977) and environmental externalities (Victor 2008). Consequently, moving toward a de-growth economy has been suggested for developed countries, in order to give developing countries opportunity to build the necessary infrastructure.

We are living in a finite system; inevitably, the sub-systems of this system cannot grow infinitely (Jackson 2009). This raises the issue of reshaping the economic system in a way that is in line with the finite ecological system. The De-growth Economy is an alternative paradigm to the Mainstream Economy. De-growth means "an equitable downscaling of production and consumption that increases human well-being and enhances ecological conditions at the local and global level, in the short and long term" (Schneider et al. 2010:512). In other words, de-growth is an emerging term for (planned) reductions in economic output (Tim. Jackson 2009:8). De-growth is a pathway for achieving steady state economy (Cosme et al. 2017). Daly (2008) defined steady state economy as economy which stock of population and capital is constant and throughput is held below capacities of the ecosystem (Daly 2008). Daly (2008) explained "state economy in terms of a constant flow of throughput at a sustainable (low) level, with population and capital stock free to adjust to whatever size can be maintained by the constant throughput that begins with depletion of low-entropy resources and ends with pollution by high-entropy wastes (Daly 2008:3)". In this definition of steady state, stock of population and capital are measured in physical terms, not as a constant GDP.

Ecological economists believe that in developed countries they must manage economic growth. As Hickel states, rich nations must abandon economic growth as major policy objective to stay within planetary boundaries (Hickel 2018). Many ecological economists who suggested de-growth for developed countries stated that developing countries must have the opportunity to move toward economic growth: "Growth should be a target only for the underdeveloped nations and only up to the modest level that must ultimately become the rule for all" (Georgescu-Roegen 1977:373). Daly states that the steady state paradigm must be implemented in developed countries first (Daly 1975). The implications of a de-growth economy in developing countries are largely neglected (Cosme et al. 2017). Therefore, in the Steady State Economy scenario of this model, it analyses the role of zero GDP growth rate on achieving SDGs in Iran.

5.2. Income Redistribution Through Tax Reforms and Transfers

Income inequality in developing countries can be an obstacle to raising growth and reducing poverty. Therefore, income redistribution can help to achieve more income equality, faster economic growth, and faster poverty reduction in developing countries (Bourguignon 2018). Based on an OECD report, the tax and transfer system is still one of the fundamental policies for inclusive growth that shares economic growth among all people (Causa and Hermansen 2018). Tax and transfers are specifically useful when the benefits of growth fail to be distributed to all people equally (Bourguignon 2018). Transfers to poor people must not merely consist of cash transfers; they must improve people's ability to earn money, education, training, healthcare, etc.

Income tax is an example of direct tax, which is levied based on the individual's level of income and can be designed to take into account the circumstances of taxpayers (Sandmo 2001). However, indirect tax is the same for all individuals and it cannot trace specific people (ibid). Developing economies are more reliant on indirect taxes rather than advanced economies (Bourguignon 2018). The possibility to design tax based on the individual's circumstances makes it a very useful tool for income redistribution (Sandmo 2015). The effectiveness of income tax is maybe greater than taxes on goods and services, because both poor and rich are consuming those goods and the proportion of tax on consumption from the total income of poor people is greater than that of rich people. Tax rates can be progressive, proportional, and regressive. Progressive tax rates mean that tax rates increase with one's level of income (ibid). This can used as an argument for subsidies on purchases of basic goods and targeting income transfers better to poor people (Bourguignon 2018).

Tax on personal income is 4.27% of GDP in Iran, while, in 2018, the average rate of tax on personal income in OECD countries was 8.28% of GDP (OECD 2020b). In 2009, Iran's tax revenue proportion of GDP was 7% (World Bank 2020i). In other oil exporting countries in the Middle East, such as the United Arab Emirates, Kuwait, and Iraq, the proportion of tax revenue of GDP in 2015 was respectively 0.06%, 1.38%, and 1.24% (World Bank 2020i).

In this research, the redistribution of income means transfer of income from some individuals to others through income taxation and cash transfers. In various scenarios of the model, progressive tax rates have been considered to reduce income inequality and poverty. Table III shows the income tax rates in different scenarios.

Table III: *Income tax rates (%) in different scenarios*

	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
Business as Usual	0	0	0	0	0
Inclusive Growth	10	10	15	15	20
Steady State Economy	5	5	10	15	20
Well-being for People and Planet	20	25	30	30	35

Social protection and cash transfers were effective in Iran to reduce poverty and income inequality (World Bank 2018). Therefore, in the scenarios of Inclusive Growth, Steady State Economy, and Well-being for People and Planet, cash transfers to low-income households are used as a policy to reduce poverty and income inequality. Table IV illustrates the percentage of income transfer rates in different scenarios. In these scenarios, transfers are designed in a way that the poorest household (decile 1) receives more income transfers rate than the richest (decile 5).

Table IV: *Income transfer rates (%) in different scenarios*

	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5
Business as Usual	0	0	0	0	0
Inclusive Growth	10	5	5	5	5
Steady State Economy	10	5	5	5	5
Well-being for People and Planet	10	10	10	10	10

5.3. Reduction in Working Hours

Reducing the GDP of developed economies is often suggested by ecological economists to reduce their impacts on the environment. De-growing GDP means that a lower amount of paid work is required in a nation, which leads to a decrease in working hours. Therefore, a reduction in working hours can be implemented in those countries to support the de-growth of GDP. Reducing working hours has economic benefits such as reducing the unemployment rate, as argued by Victor (2008). It has also been argued that a reduction in paid

working hours can contribute to decreasing the environmental impacts of the economy and help to achieve environmental sustainability (Schor 2005). Coote and Goodwin (2010) called for a gradual transition in reducing working hours to employ more workers and provide opportunities for workers to spend more time with their families (Coote and Goodwin 2010). Additionally, Victor (2008) states that a shorter working week increases people's general level of happiness as they have more time for themselves. Juliet B. Schor (2005) conducted a linear regression among 18 OECD countries to assess the relationship between the ecological footprint and working hours per employee which realized that hours of employment per worker is a significant predictor of the ecological footprint (Schor 2005). A reduction in working hours improves environmental sustainability and human well-being (Pullinger 2014).

In economics, the number of employed people is calculated based on the equations below. Based on Equation 3, the total number of hours of employment per year is calculated by dividing GDP into labour productivity per hour. Then, in Equation 4, the number of employed persons is calculated by dividing the total number of hours of employment per year by the number of working hours per employee. Based on Equation 4, if the total number of working hours per employee decreases, then the number of employed persons increases, *ceteris paribus*. The unemployment rate is calculated based on Equation 5, which divides the difference between the number in the active labour force and the employed labour force by the active labour force.

$$Hours\ of\ employment\ per\ year = \frac{GDP}{Labor\ productivity\ per\ hour} \qquad \text{(Eq. 3)}$$

$$Number\ of\ employed\ persons = \frac{Hours\ of\ employment\ per\ year}{Work\ hour\ per\ employee} \qquad \text{(Eq. 4)}$$

$$Unemployment\ rate = \frac{Active\ Labor\ Force - Employed\ Labor\ Force}{Active\ Labor\ Force} * 100 \qquad \text{(Eq. 5)}$$

In OECD countries, the average of the annual working hours per employee has decreased from 1,945 in 1970 to 1,734 in 2018 (OECD 2020b). The annual working hours in Iran have decreased from 2,550 hours in 2005 to 2,193 in 2017 (Statistical Center of Iran 2020). The average annual working hours per employee in Iran are greater than those in OECD countries. Therefore, in the scenarios of the Steady State and Well-being for People and Planet, the annual

working hours per year have been decreased to 1,700 and 2,100 respectively. Table V illustrates annual working hours per employee in different scenarios.

***Table V**: Annual working hours per employee in different scenarios*

	Business as Usual	Inclusive Growth	Steady State Economy	Well-being for People and Planet
Working hours per year	2,193	2,193	1,700	2,100

5.4. Managing Population Growth

Population is an important element of different aspects of the economy and the environment. Total population can influence different parts of the model, including unemployment rate, poverty, CO2 emissions, ecological footprint, etc. If the population is growing and consumption per capita is not to decline, then GDP growth is essential (Victor 2019). Moreover, if a country is to manage economic growth, it is crucial to have a stable population (Victor 2019). Therefore, in the scenario of the Steady State Economy, with an economy which economic growth is zero, it is assumed that the fertility rate is less than in other scenarios.

The fertility rate in Iran has declined from seven children per woman in 1960 to 2.11 in 2017 (World Bank 2019). To project the total population in the scenarios of this model, the UN's projection of the population of Iran has been used. The UN has projected three levels of population, lower 95, median, and higher 95 for Iran by 2050: 96.6, 103, and 109.5 million respectively (United Nations 2019). In the SDGs model, different fertility rates have been used to achieve these UN population projections for Iran. It has been assumed that in the Inclusive Growth scenario, the fertility rate is at its highest rate, 2.15, as a higher GDP growth provides the opportunity to have more children. It has been assumed that in the Steady State Economy scenario, which is based on a GDP growth rate of zero, population growth is based on the lowest projection of the UN; therefore, the fertility rate is 1.52. In the Well-being for People and Planet scenario, population growth is based on the median of the UN's projection of population, for which the fertility rate is 1.85. Table VI illustrates all the fertility rates that have been used in the SDGs model of Iran.

***Table VI**: Fertility rate under different scenarios of the model*

	Business as Usual	Inclusive Growth	Steady State Economy	Well-being for People and Planet
Fertility rate per woman	2.11	2.15	1.52	1.85

5.5. Sanctions

Economic sanctions significantly influence Iran's economy. Because Iran's economy is based on exports of oil and gas, sanctions can therefore directly affect exports and, consequently, GDP. As it is not clear when sanctions will be lifted from Iran, therefore, in different scenarios different levels of sanctions have been considered. In all the scenarios, it is assumed that for the period of 2020 to 2025, the situation of sanctions would be the same as current. Therefore, exports of oils reduced to 13% of its value in the period of 2020 to 2025. Because of uncertainty about future of Iran's nuclear deal, it is assumed that in scenario of Business as Usual, continues the same trend and therefore, sanctions reduced exports to 13% of its value in the period of 2025 to 2050. In scenarios of Inclusive Growth and Well-being for People and Planet, sanctions are lifted in 2025. In scenario of Steady State Economy, it is assumed that sanctions will decline exports to 50% of their value from 2025. Moreover, it is not certain when and how sanctions will be lifted from Iran's economy. Table VII illustrates the effect of sanctions on exports in different scenarios.

***Table VII:** The effect of sanctions on exports in different scenarios*

	2020-2025	2025-2050
Business as Usual	Reduces exports to 13% of its value in base year	Reduces exports to 13% of its value in base year
Inclusive Growth	Reduces exports to 13% of its value in base year	Sanctions lifted
Steady State Economy	Reduces exports to 13% of its value in base year	Reduces exports to 50% of its value in base year
Well-being for People and Planet	Reduces exports to 13% of its value in base year	Sanctions lifted

5.6. Carbon Tax

GHG emissions are gases in the atmosphere such as water vapours, carbon dioxide (CO2), methane and nitrous oxide that absorb infrared radiation and

trap heat in the atmosphere (Intergovernmental Panel on Climate Change (IPCC) 2019). Greenhouse effect happens when GHG emissions released to the atmosphere through human activities cause global warming (Intergovernmental Panel on Climate Change (IPCC) 2019). CO2 emissions is by-product of energy production which accounts for the largest share of the total GHGs. GHG emissions resulting from energy services have contribute to increase in atmospheric GHG concentrations (Edenhofer et al. 2011). The IPCC Fourth Assessment Report (AR4) concluded that "Most of the observed increase in global average temperature since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations" (ibid). Also, "Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate" (Masson-Delmotte et al. 2018). Solomon et al. (2009) have warned that accumulation of CO2 emissions and GHGs is irreversible for 1,000 years after emissions stop. In the model of this paper, CO2 emissions per capita is used as an indicator of climate change.

The carbon tax is a fixed price set by governments. Carbon taxes are designed to achieve carbon reduction targets; for example, Calderon et al. (2016) analysed the effects of carbon tax and abatement targets on achieving CO2 reductions in Colombia (Calderón et al. 2016). They concluded that significant CO2 reductions may be achieved through high carbon prices and abatement costs. Carbon taxes are important because they correct market failures that cause negative externalities on the environment. The carbon tax is designed to internalize the externalities of fossil-fuel usage (Poterba 1991). Carbon taxes can be regressive; therefore, they must be supported by the tax system or transfers (ibid). This is important because the carbon tax comprises a greater proportion of the budget of poor individuals than that of rich individuals. Therefore, this model has used tax and transfers to eliminate this regressive effect of carbon tax.

The International Energy Agency (IEA) (2018) estimates fossil-fuel subsidies through the amount that is consumed directly by end-users as inputs to electricity generation. Iran gives huge amounts of subsidies to oil, gas, and electricity (ibid). Eliminating fossil-fuel subsidies is one of the most efficient ways of reducing CO2 emissions and mitigating climate change (ibid). Achieving climate targets is impossible without the phasing out of fossil-fuel subsidies (Clark and Senik 2011). Based on the IEA figures, in 2018 Iran gave the highest amount of fossil-fuel subsidies to its citizens. The average subsidy

rate was 79% which is equivalent to $844 per person (International Energy Agency 2018). After Venezuela, Iran has the highest average subsidy rate. The total amount of subsidies is equal to 15.3% of GDP (ibid).

In this model, the carbon price affects CO2 emissions per unit of GDP through the price elasticity of demand on the carbon tax. In this model, in the Steady State Economy scenario, the elasticity of demand on carbon tax is 0.2 and in the Well-being for People and Planet scenario, it is 0.8. This means that in the Well-being for People and Planet scenario, the CO2 emission per unit of GDP is more dependent on the carbon tax. Table VIII illustrates carbon tax in different scenarios.

***Table VIII**: Carbon tax in different scenarios*

	Business as Usual	Inclusive Growth	Steady State Economy	Well-being for People and Planet
Carbon tax (per tonne of CO2)	–	–	$20–50	$50–80

5.7. Oil Price

Projecting fossil-fuel prices (oil, gas, etc.) is not easy. However, there are some factors that will influence fossil-fuel prices in the future. Firstly, technological innovation in renewable energy will make it cheaper and more efficient; therefore, demand for renewable energy will increase while demand for fossil fuels will decrease and finally the price of fossil fuel will decrease. Secondly, climate actions such as carbon taxes make fossil fuel more costly to produce.

In this model, oil prices are varying in different scenarios. Oil price of 2020 is considered $40.7 per barrel (Fars News 2021). In the Inclusive Growth scenario, the IEA oil price projection has been used. The IEA has forecast the oil price increases $100 per barrel in 2050 (International Energy Agency 2020). A decrease in the oil price is a climate action policy, which can be a nudge to motivate investment in renewable energy. Therefore, in the Steady State Economy scenario, the price of oil has been decreased to $20 per barrel; this will decrease the fossil-fuel revenue of Iran. In the Well-being for People and Planet scenario, the oil price increases by 1% every year from 2020 to 2050. In Table IX shows the fossil fuel prices in four scenarios.

Table IX: Oil Price in different scenarios

	Business as Usual	Inclusive Growth	Steady State Economy	Well-being for People and Planet
Oil price (per barrel)	Continues oil prices published by CBI	$40.7 to $100 in the period of 2020 to 2050	Decreased to $20	Oil price published by CBI increases 1% every year

Source: IEA (2020) and Fars News (2021)

5.8. Redirecting Income from Fossil-Fuel Industry to Renewable Energy Investment

This policy is based on redirecting income from the fossil-fuel industry to renewable energy investment. Its aim is to provide revenue for clean energy investment to reduce CO2 emissions and the ecological footprint. In this model, the revenue from exporting fossil fuels (including oil and gas) to other countries is redirected to renewable energy investment. In the Steady State Economy scenario, 10% of revenue of fossil-fuel exports in 2020 has been redirected to renewable energy investment, increasing to 60% in 2050. In the Well-being for People and Planet scenario, 10% of fossil-fuel revenues in 2020 have been redirected to renewable energy investment, rising to 90% in 2050. Table X shows percentage of income redirected from fossil fuel industry to renewable energy investment.

***Table X**: Redirecting Income from Fossil-Fuel Industry to Renewable Energy Investment in different scenarios*

	Business as Usual	Inclusive Growth	Steady State Economy	Well-being for People and Planet
Revenue redirected from fossil-fuel industry to renewable energy (%)	–	–	10% in 2020 to 60% in 2050	10% in 2020 to 90% in 2050

6. SDGs Indexes in Iran

6.1. Index of SDG-1

Figure 7 demonstrates that in 2020, 7 million people are living below $5.50 a day. In the Business as Usual and Steady State Economy scenarios, poverty increases rapidly from 7 million in 2020 to 10 million and 13 million people in 2050. In the Inclusive Growth scenario, the number of people living below $5.50 per day declines to 4.2 million in 2050. The Well-being for People and Planet scenario sees a smaller number of poor people than the other scenarios, where, in 2050, 3.9 million people are living below $5.50 per day. It can be concluded that in the Scenario of Business as Usual and Steady State Economy, poverty is increasing rapidly. In the Inclusive Growth and Well-being for People and Planet scenarios, poverty has declined rapidly.

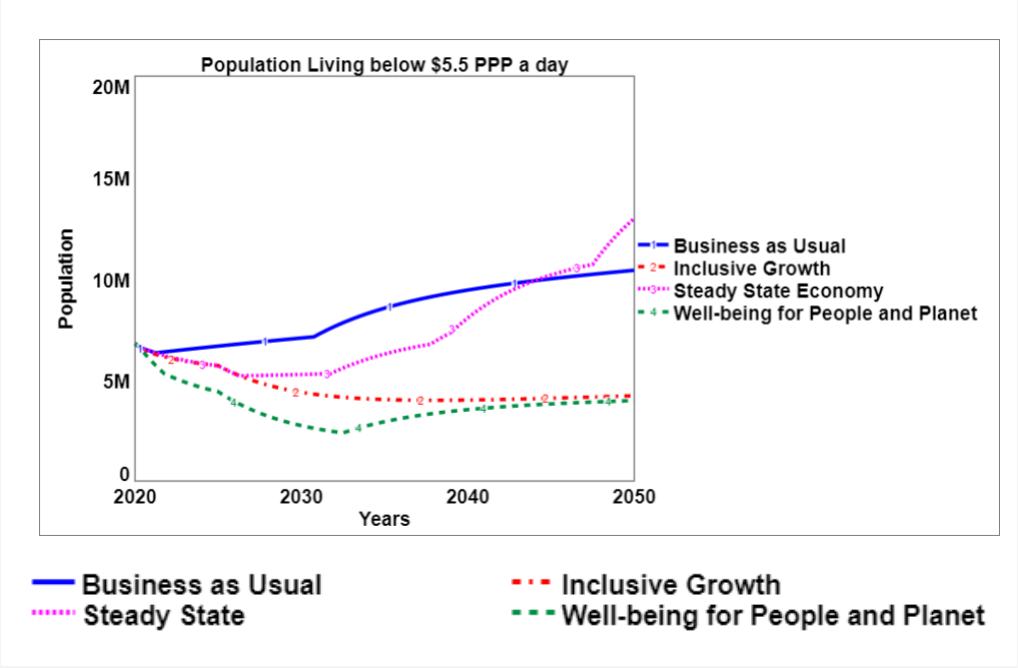

***Figure 7**: Population of people living below $5.50 a day*

Figure 8 compares the implementation of SDG-1 in the four scenarios. To interpret SDG-1, it is crucial to consider that if SDG-1 achieves 100, this means that the goal has been met, and if it is decreasing toward zero, it is getting worse.

In 2020, all the scenarios start at a level of 59 (out of 100), and then end in 2050 with a higher figure for SDG-1. The trend while implementing SDG-1 in different scenarios gives different results. However, none of these scenarios lead Iran to achieve SDG-1 by 2050. The Well-being for People and Planet scenario gives the best results in achieving SDG-1 followed by the Inclusive Growth scenario. The worst scenario for SDG-1 are the Steady State Economy and Business as Usual.

Based on Business as Usual, in 2020 Iran's SDG-1 index is 59, which increases to 73 in 2050. Inclusive Growth, which considers redistribution policies, has better results in reducing poverty. Based on the simulation, SDG-1 achieves a level of 75 in 2050, which is more than the result of Business as Usual. The Steady State Economy demonstrates achieves 73 in 2050. However, Steady State Economy considers income redistribution policies, but GDP is remaining constant, therefore, poverty does not decline as much as the Scenario of Well-being for People and Planet. Based on the Well-being for People and Planet scenario, achieving SDG-1 has been the most successful among all the scenarios. Based on this scenario, SDG-1 achieves a level of 76 in 2050. This improvement in declining in poverty in the scenario of Well-being for People and Planet is as a result of income redistribution policies and rise in GDP.

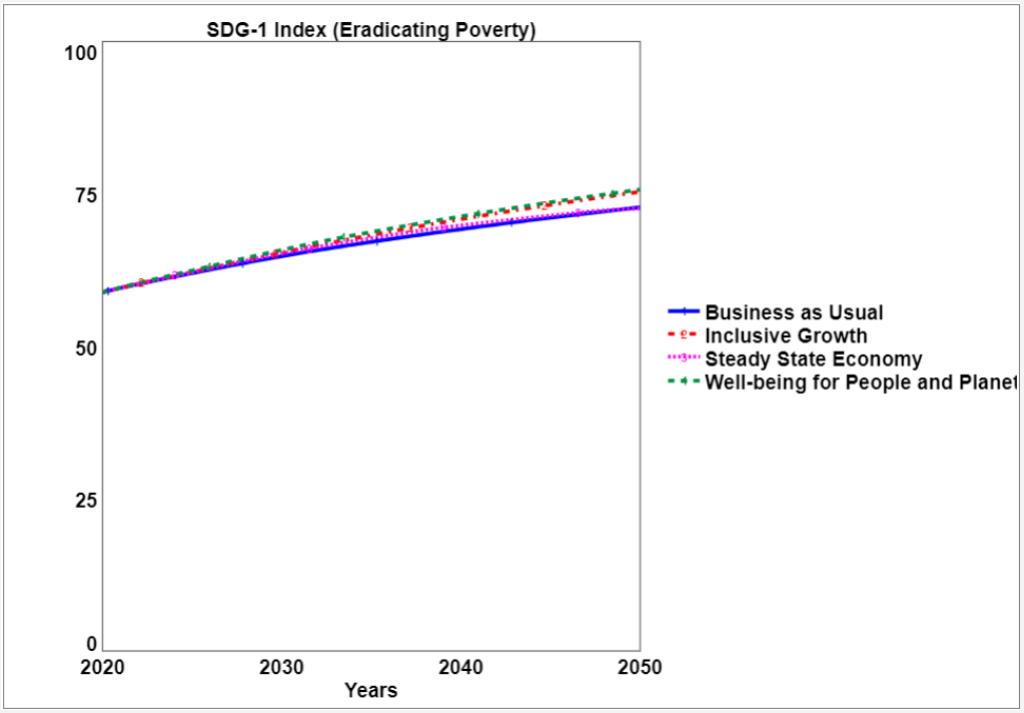

Figure 8: *Implementation of SDG-1 in the four scenarios in Iran in the period 2020 to 2050*

6.2. Index of SDG-8

In the Business-as-Usual scenario, GDP increases from 6 thousand trillion rials in 2020 to 9.7 thousand trillion rials in 2050. In the Inclusive Growth scenario, which is based on a higher GDP growth rate, GDP has jumped to 15.9 thousand trillion rials; while in the Steady State Economy scenario, which is based on a zero GDP growth rate, GDP remains at 6.7 thousand trillion rials from 2025 to 2050.[3] In the Well-being for People and Planet scenario, it rises to 10.9 thousand trillion rials in 2050. This trend is illustrated in Figure 9(A).

Income inequality has different trends in each of these scenarios (see Figure 9(B)). In the Business-as-Usual scenario, the Gini coefficient is around 0.4 and remains constant, because it continues the same shares of income among people. In the Inclusive Growth scenario, which is based on the tax and transfers system, the Gini coefficient has decreased from 0.4 in 2020 to 0.31 in 2050. In the Steady State Economy scenario, it has decreased to 0.32 in 2050. In the Well-being for People and Planet scenario, the Gini coefficient has been reduced to 0.21 in 2050.

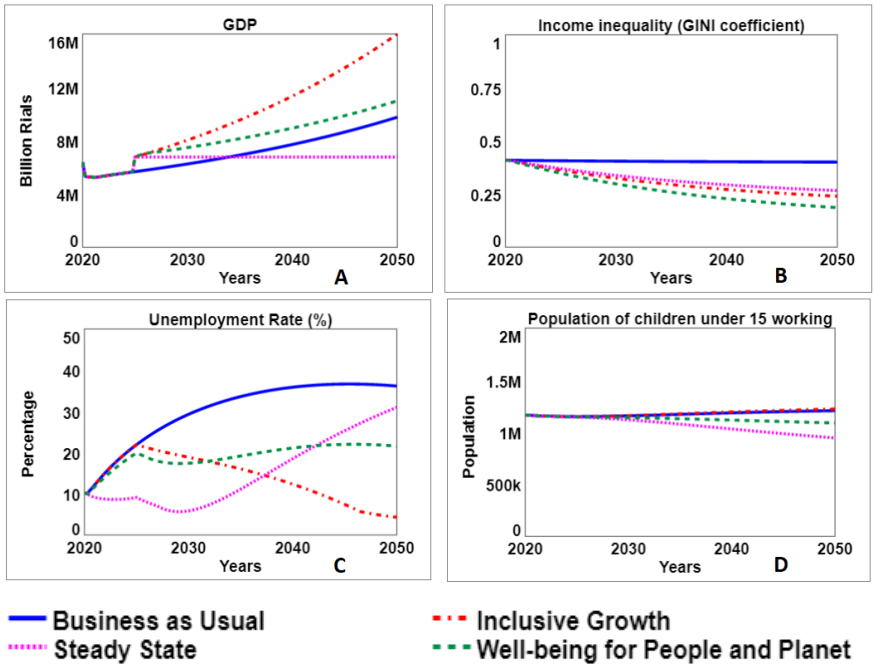

***Figure 9**: Indicators of SDG-8 in the model*

[3] Zero GDP growth rate in the Scenario of Steady State Economy applies to 2025 and after that.

Figure 9(C) illustrates the total unemployment rate in the four scenarios of the model. The unemployment rate is highest in the Business-as-Usual scenario: it rises from 10% in 2020 to 36% in 2050. The Inclusive Growth scenario is based on higher GDP growth; the unemployment rate decreases to reach 4% in 2050. In the Steady State Economy, the unemployment rate declines to 6% in 2030, and then it increases to 31% in 2050. In the Well-being for People and Planet, the unemployment rate is constantly increasing to reach 22%.

In this model, population of child work is dependent on the population growth. Therefore, in the Business-as-Usual scenario, the population of children rises from 1.16 million in 2020 to 1.21 million in 2050 (see Figure 9(D)). In the Inclusive Growth scenario, the population of children working rises to 1.22 million in 2050. In the Steady State Economy scenario, the population of children working declines to 945,000 in 2050, which is because of a decline in the population. In the Well-being for People and Planet scenario, the number of children in work declines to 1.08 million in 2050.

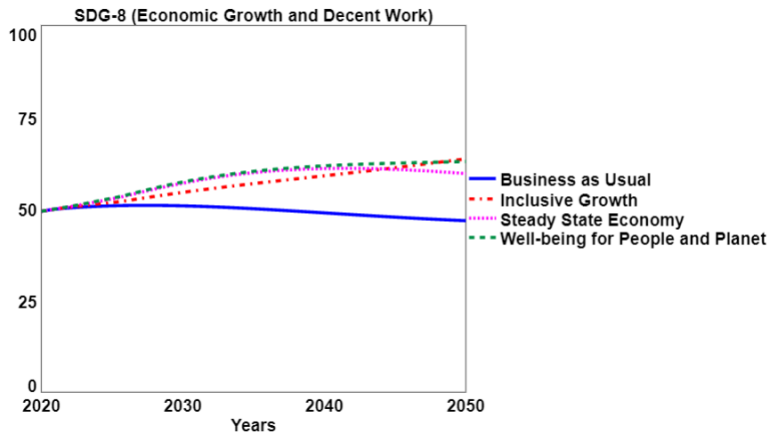

***Figure 10**: Implementation of SDG-8 in the four scenarios in Iran in the period 2020 to 2050*

SDG-8 index in Figure 10 compares the progress of implementation of SDG-8 in the four scenarios. None of them achieve 100% of the goal of SDG-8. It is an interesting result that Business as Usual does not provide good progress in achieving SDG-8. In Business as Usual scenario, SDG-8 decreased gradually from around 49 in 2020 to 47 in 2050. However, in the Inclusive Growth scenario, SDG-8 increases from 49 in 2020 to 64 in 2050. Based on the Steady State Economy scenario, SDG-8 will slightly increase from 49 in 2020 to 60 in 2050. In the Well-being for People and Planet scenario, SDG-8 achieves its

highest level among all the scenarios. It rapidly increases from 49 in 2020 to 63 in 2050.

6.3. Index of SDG-12

Steady State Economy and Well-being for People and Planet scenarios redirect fossil-fuel income to renewable energy investment (see Figure 11(A)). Therefore, in the Steady State Economy, renewable energy investment reaches 6% of GDP in 2050. In the Well-being for People and Planet scenario, renewable energy investment increased to 10% of total GDP in 2050. Therefore, the scenario of Well-being for People and Planet almost achieves the target of SDG-12.2.

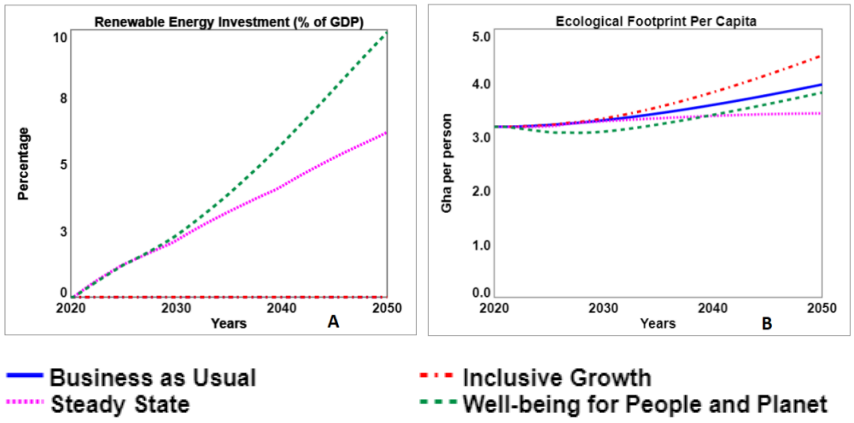

***Figure 11**: Renewable energy investment within GDP and ecological footprint per capita*

In the Business as Usual and Inclusive Growth scenarios, the ecological footprint per capita increases from 3.1 in 2020 to 4 and 4.5 respectively in 2050 (see Figure 11(B)). The Steady State Economy scenario has a lower ecological footprint which it reaches to 3.4 in 2050. In the Well-being for People and Planet scenario; it increases to 3.8 in 2050. Steady State Economy scenario has lowest ecological footprint in 2050.

Figure 12 illustrates the implementation of SDG-12 in four scenarios. The SDG-12 index decreases in the *conventional* scenarios of Business as Usual and Inclusive Growth from 41 in 2020 to 38 and 36 respectively in 2050. However, the *transformational* scenarios of Steady State and Well-being for People and Planet show rapid improvement in achieving SDG-12 by 2050. In the Steady

State Economy scenario, the SDG-12 index jumped to 71 in 2050 and in the Well-being for People and Planet scenario it increased to 88.

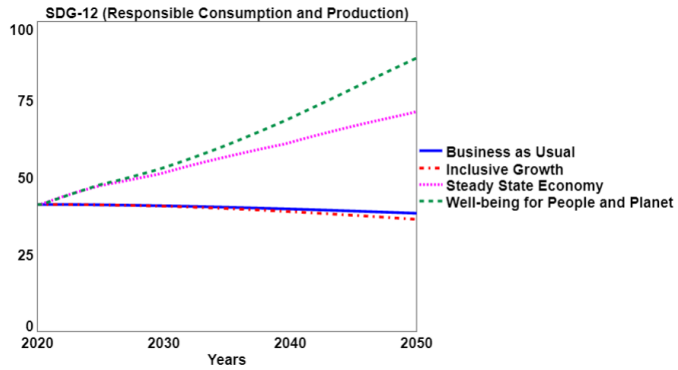

***Figure 12**: Implementation of SDG-12 in the four scenarios in Iran in the period 2020 to 2050*

6.4. Index of SDG-13

Figure 13(A) shows that CO2 emissions in the base year is 769 million metric tonnes. Figure 13(A) illustrates that CO2 emissions are increasing in the Business as Usual, Inclusive Growth, and the Steady State Economy scenarios to 1.7 billion metric tonnes, 2.2 billion metric tonnes, and 946 million metric tonnes, respectively. However, in the Well-being for People and Planet scenario, CO2 emissions decline to 332 million metric tonnes in 2050.

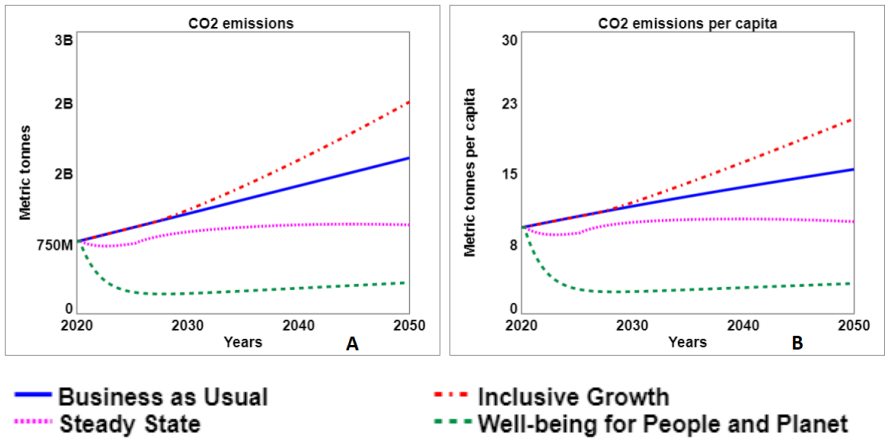

***Figure 13:** CO2 emissions and CO2 emissions per capita in the four scenarios*

In the Business as Usual and Inclusive Growth scenarios, CO2 emissions per capita increase rapidly from 9.2 metric tonnes per capita in 2020 to 15.4 and 20.77 metric tonnes per capita in 2050 respectively (see Figure 13(B)). However, in the Steady State Economy, where environmental policy changes have been considered, CO2 emissions per capita have slightly increased to 9.8 in 2050 (see Figure 13(B)). The Well-being for People and Planet scenario, in which more extraordinary environmental policies has been considered, performs the best among all scenarios in reducing CO2 emissions per capita; they gradually decrease to 3.2 in 2050. The reason that CO2 emissions in the scenario of Steady State Economy did not decline as much as the scenario of Well-being for People and Planet is that price elasticity on carbon tax is lower in the scenario of Steady State Economy.

Figure 14 compares the achievement of SDG-13 in the four scenarios. In the Business as Usual and Inclusive Growth scenarios, the SDG-13 index decreases from around 76 in 2020 to 59 and 45 in 2050, respectively. In the Steady State Economy scenario, it slightly decreases from 76 in 2020 to 74 in 2050. Also, in scenario of Well-being for People and Planet, the index achieves 91 in 2050, which is a huge success in comparison with other scenarios. Therefore, in comparison to other scenarios, Well-being for People and Planet scenario provides the best results in achieving SDG-13.

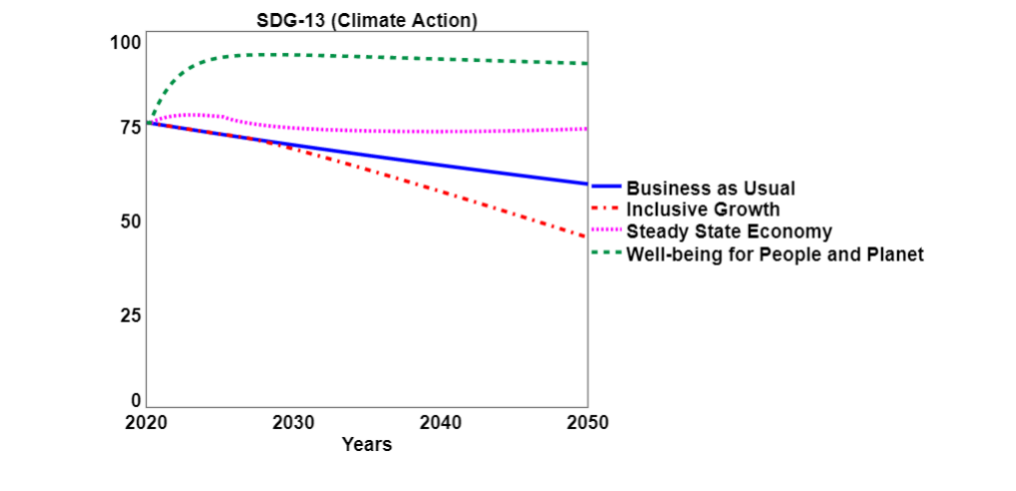

Figure 14: *Implementation of SDG-13 in the four scenarios in Iran in the period 2020 to 2050*

6.5. Combined Index of SDGs

The combined SDGs index illustrates that, on average, achievement of the four goals of the SDGs in the Business as Usual and Inclusive Growth scenarios worsens in the period 2020 to 2050 (see Figure 15). On the other hand, the Steady State Economy and Well-being for People and Planet scenarios show improvement in achieving these four goals of the SDGs by 2050. Among all the scenarios, scenario of Well-being for People and Planet provides better pathway for achieving these selected four goals of SDGs. The result illustrates that the *conventional* scenarios are not appropriate for achieving the combined index of the four SDGs, while the *transformational* scenarios show improvement in doing so.

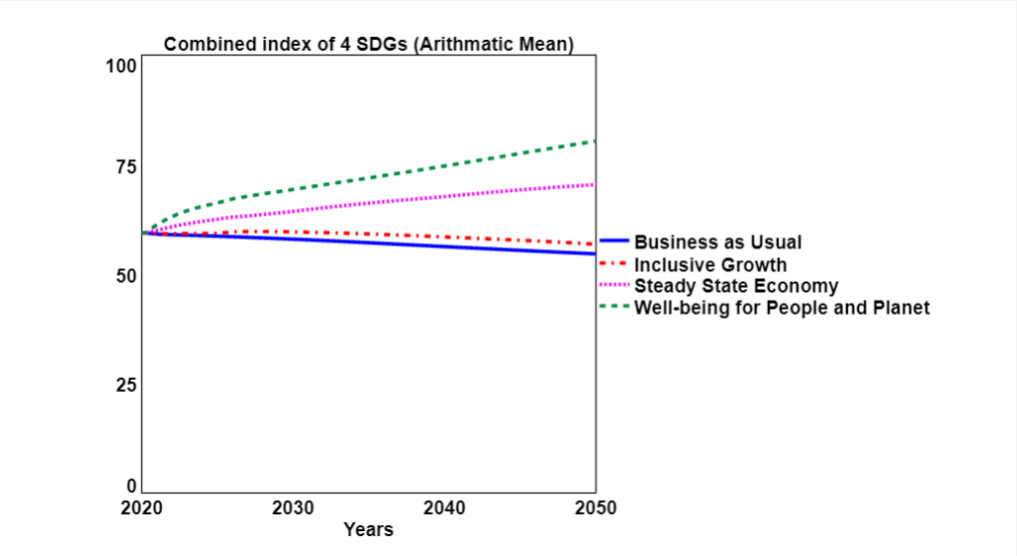

Figure 15: *Combined index of SDGs in the four scenarios in Iran in the period 2020 to 2050*

7. Sensitivity Analysis

Sensitivity analysis is a series of simulations to assess how much behaviour of selected inputs effect on the outputs (Barlas 2007) these inputs include parameters, variables, and policies. In this section, I apply a sensitivity analysis to analyse the role of policy transformation on the results of the scenarios. Sensitivity analysis is done on inputs of the model with considering incremental distribution in 5 runs. As each of the scenarios have different policy changes, the results of the sensitivity analysis are shown based on one of the scenarios. For conducting sensitivity analysis some of the variables are

modified; for example, time series variables are changed into constant variables.

7.1. GDP growth rate

GDP growth rate affects outputs of the model. In Figure 16, GDP growth rate varies between 0 to 5% in 5 runs in the Inclusive Growth scenario. Figure 16 shows that when GDP growth rate increases, then SDG-1 Index increases as well. This means that if everything remains the same, increasing in GDP growth rate decreases poverty and finally increases SDG-1 Index. Moreover, Figure 16 illustrates that SDG-8 Index increases as GDP growth rate increases. Varying GDP growth rate influences on SDG-8 through GDP growth and changing unemployment rate. On the other hand, as GDP growth rate increases, SDG-12 and SDG-13 indexes decreases. This shows that merely increasing economic growth has negative effect on environmental goals through affecting on CO2 emissions and ecological footprint (SDG-12 and SDG-13). It shows that if economic growth varies while everything else remains the same, then socio-economic goals (SDG-1 and SDG-8) have trade-offs with environmental goals (SDG-12, and SDG-13).

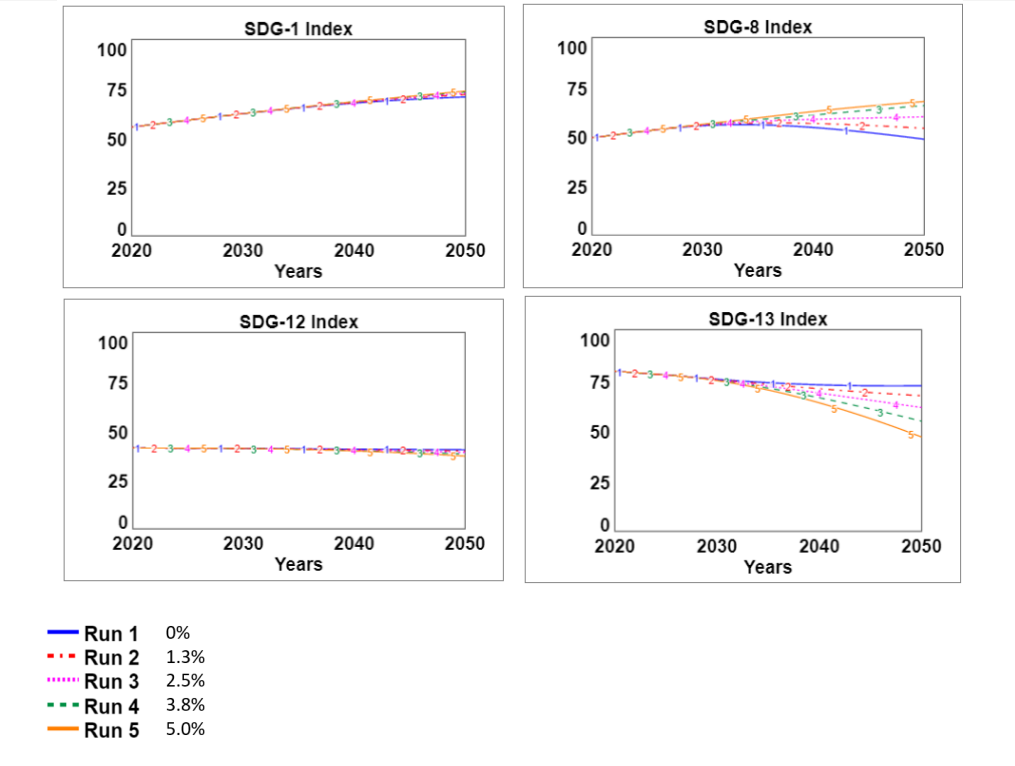

Figure 16: *Sensitivity Analysis on GDP growth rate*

7.2. Income redistribution

Figure 17 shows the effect of varying income tax rate between 0 to 50%, with incremental distribution in 5 runs in the scenario of Well-being for People and Planet, on the SDGs indexes. It shows that by increasing the income tax rate, income inequality decreased, therefore, SDG-1 and SDG-8 improved. In this model, varying Income tax rate does not effect on the SDG-12 and SDG-13 Index.

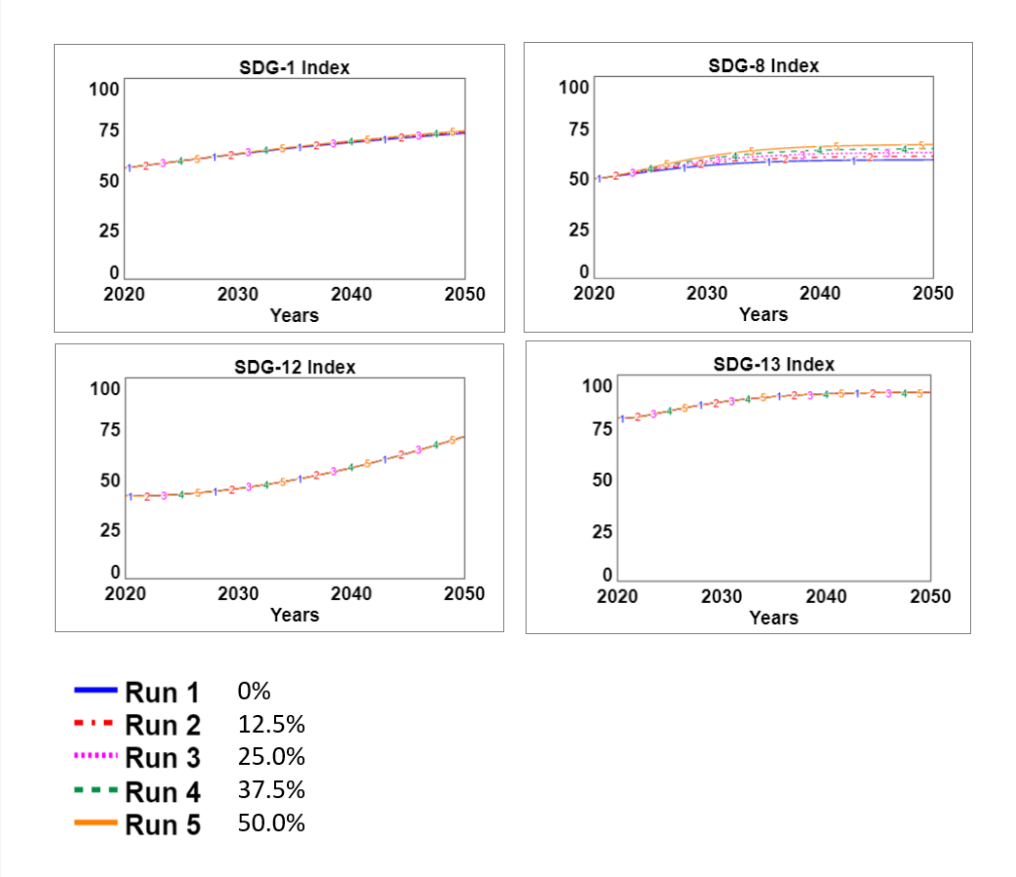

***Figure 17**: Sensitivity Analysis on tax rates*

7.3. Working Hour Reductions

Figure 18 shows the sensitivity of working hour reductions on SDGs indexes. In these 5 runs, annual working hours varies between 1,900 and 2,500 per worker with incremental distribution in the scenario of Well-being for People and Planet. This means that one of the policies for achieving SDG-8 is to reduce work hours so that more people can work and therefore it reduces unemployment rate. As working hour reduces, SDG-8 Index increases. In the SDGs model of Iran, working hour reduction does not have effect on SDG-1, SDG-12, and SDG-13.

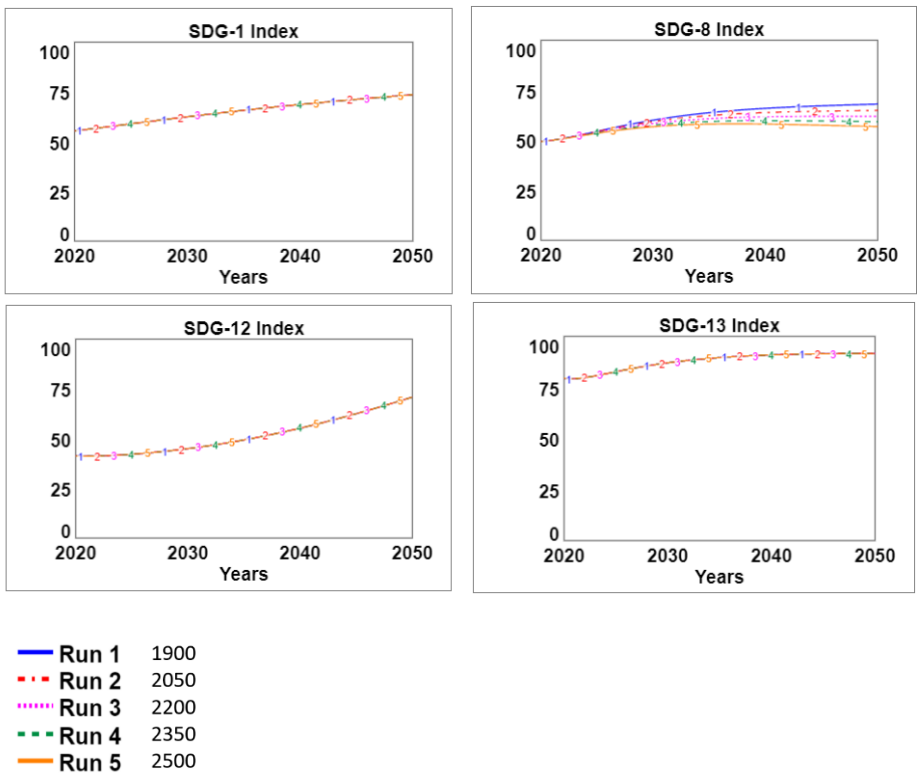

***Figure 18**: Sensitivity Analysis on working hours*

7.4. Fertility Rate

Figure 19 shows the sensitivity of the SDGs index to fertility rate in Iran. In Figure 19, fertility rate per woman in scenario of Inclusive Growth varies between 1 and 3 with incremental distribution in 5 runs. Figure 19 shows that as population grows, poverty increases which finally declines SDG-1 index; however, because the difference is small, it is not very clear. Moreover, as population grows number of unemployed increases as well, so it reduces SDG-8 Index. SDG-13 index is based on CO2 emissions per capita, therefore, by increasing fertility rate, SDG-13 declines. In this model, varying fertility rate does not affect on SDG-12 index.

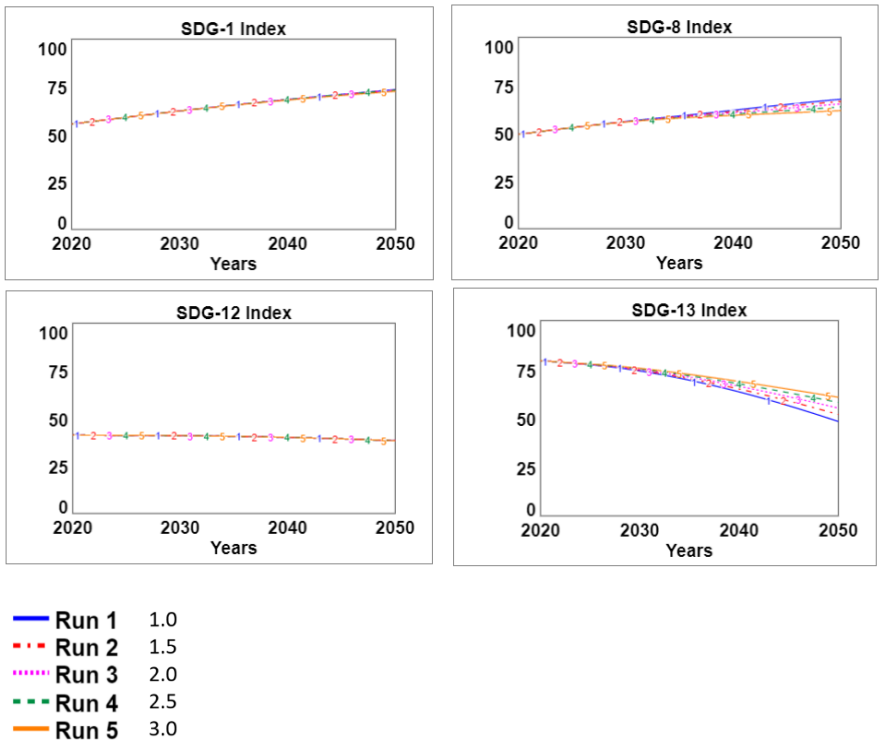

***Figure 19**: Sensitivity Analysis on fertility rate*

7.5. Sanctions

Economic sanctions on Iran affects different aspects of socio-economic and environmental. In this model sanctions are influencing on the model through directly affecting on exports. As a result of sanctions exports are reduced to

13% and 100% of its value in base year with incremental distribution in 5 runs in the scenario of Inclusive Growth. Therefore, in Figure 20, in the highest level of sanctions exports are reduced to 13% of their value, while when sanctions are lifted exports remains as 100% of its value. Sensitivity analysis of sanctions on the outputs of the model (SDGs indexes) shows that it has different effects on each SDGs. If sanctions increase, then GDP decreases which declines SDG-1 and SDG-8 indexes as well. This means that sanctions weaken achieving SDG-1 and SDG-8 indexes. In the sensitivity analysis, the difference in SDG-1 is very small and therefore, it is not very visible in the Figure 20. On the other hand, if sanctions increases then SDG-12 and SDG-13 indexes increases, *ceteris paribus*. This increase in SDG-12 and SDG-13 is happening because sanctions reduce GDP, then CO2 emissions decrease, and finally it increases SDG-12 and SDG-13. In the sensitivity analysis, the difference in SDG-12 is very small and therefore, it is not very visible in the Figure 20.

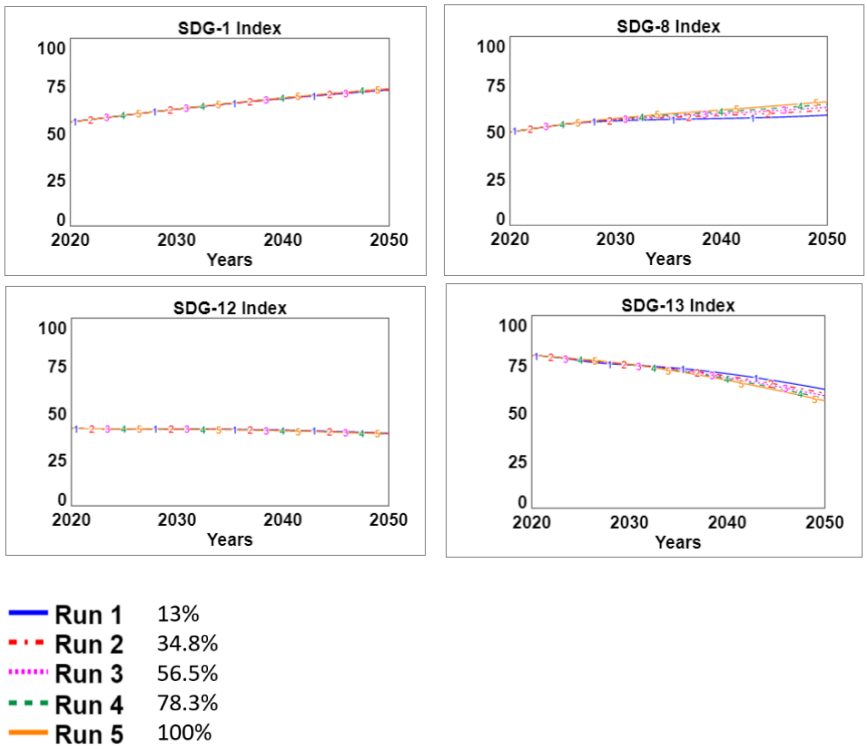

***Figure 20**: Sensitivity Analysis on sanctions*

7.6. Elasticity of demand on carbon tax

In this model, elasticity of demand on carbon tax is effective on CO2 emissions. In Figure 21, elasticity of demand on carbon tax varies from 0 to 1 with incremental distribution in 5 runs in the scenario of Well-being for People and Planet. Varying elasticity of demand on carbon tax does not influence on indexes of SDG-1 and SDG-8. If elasticity of demand on carbon tax increases, it reduces CO2 emissions, so SDG-13 index improves. Elasticity of demand on carbon tax can have more complex effect on SDG-12; in one hand, increasing in elasticity of demand on carbon tax reduces CO2 emissions which reduces ecological footprint of carbon, on the other hand, by increasing elasticity of demand on carbon tax, CO2 emissions declines and therefore, revenue on carbon tax declines as well. As Figure 21 shows the effect of declining in carbon tax revenue is more than ecological footprint reduction, therefore, SDG-12 has declined.

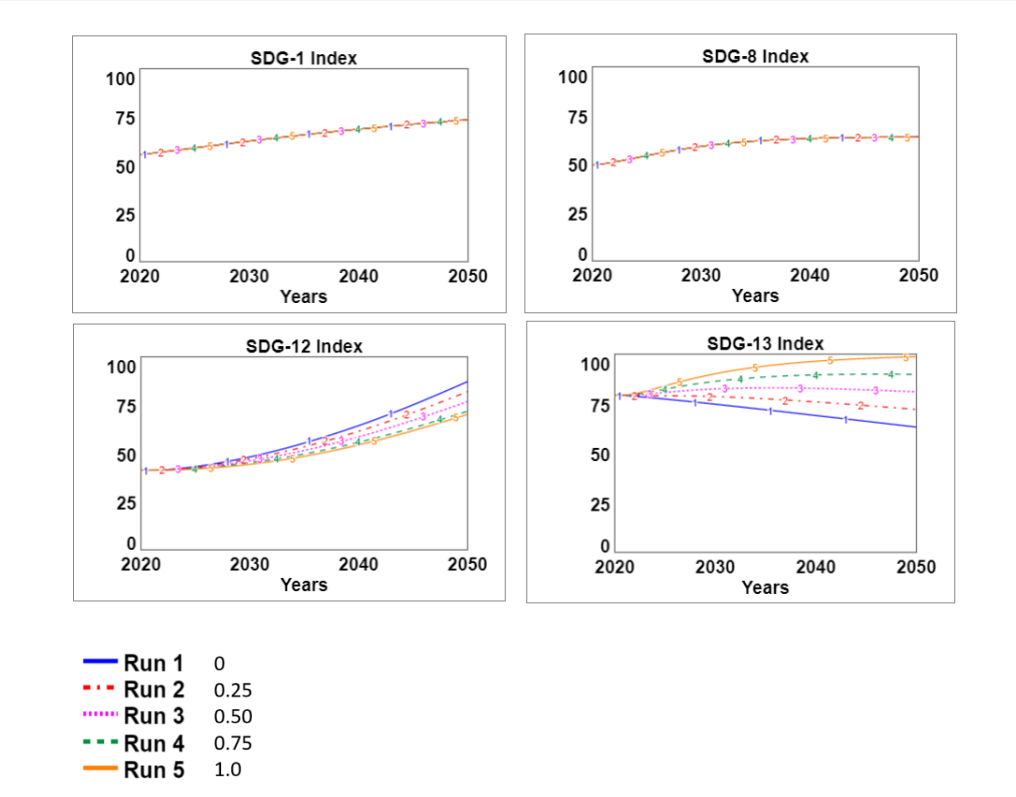

***Figure 21**: Sensitivity Analysis on elasticity of demand on carbon tax*

7.7. Carbon Tax

Figure 22 shows the sensitivity of carbon tax on SDGs indexes. Here, carbon tax varies between 0 and 80$ with incremental distribution in 5 runs in the scenario of Well-being for People and Planet. Changing carbon tax only has effect on SDG-12. In scenario of Well-being for People and Planet, carbon tax revenue is redirected to renewable energy investment. Figure 22 shows that if carbon tax increases, then renewable energy investment increases which finally SDG-12 improves.

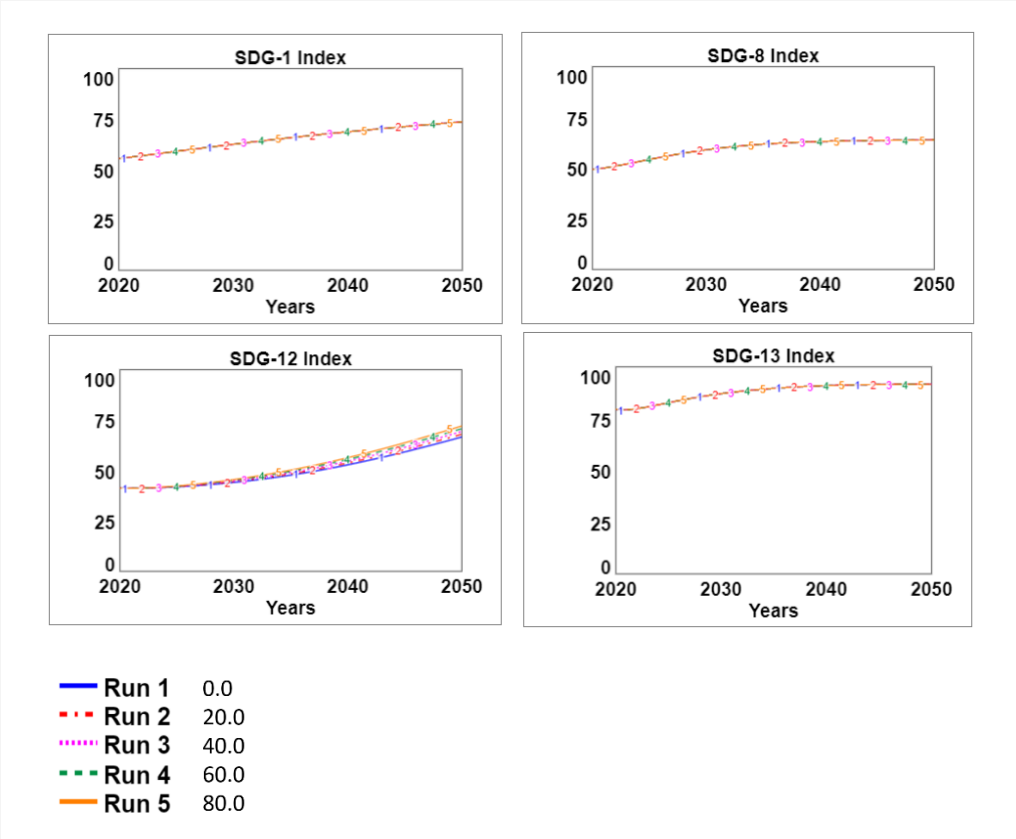

***Figure 22**: Sensitivity Analysis on carbon tax*

7.8. Oil Prices

In the SDGs model of Iran, fossil fuel prices influence on fossil fuel revenue which comes from exporting to other countries. Therefore, if fossil fuel prices decrease as a policy for supporting climate action, then it declines fossil fuel revenue. Fossil fuel revenue has positive influence on the amount of renewable energy investment. In Figure 23, oil prices vary between 0 and $110 per barrel with incremental distribution in 5 runs in the scenario of Steady State Economy. As it is show in Figure 23, if oil price increases then SDG-12 increases. But it does not have effect on the other SDGs indexes.

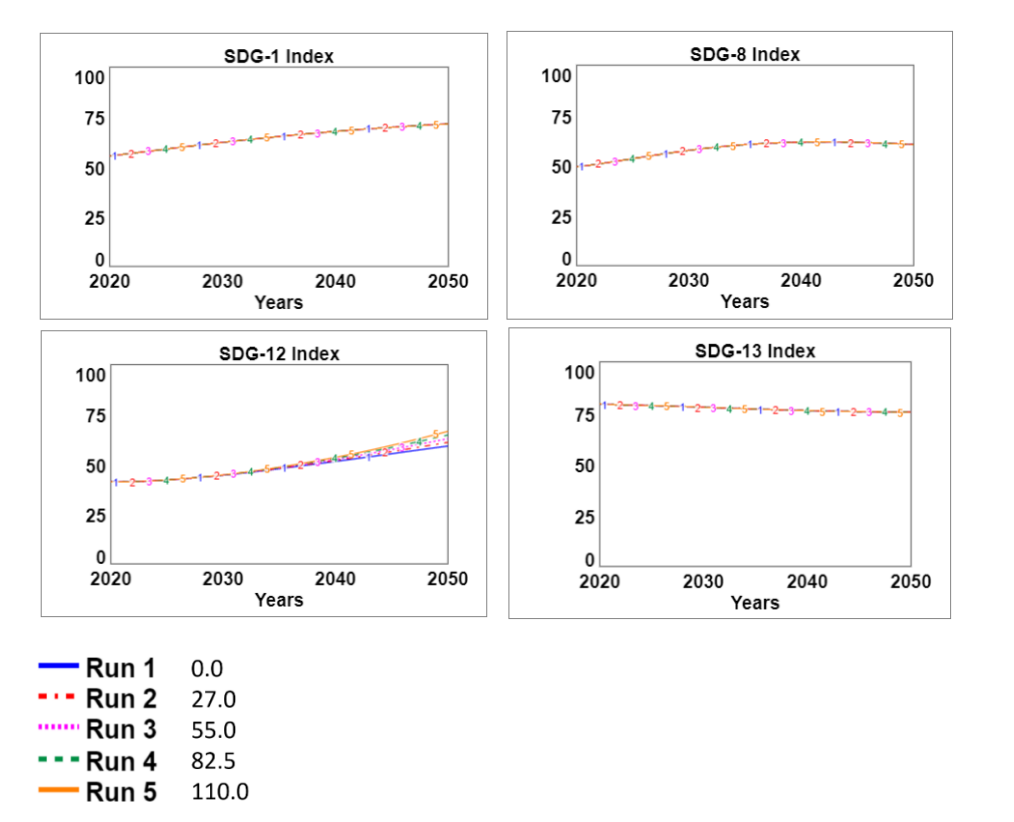

***Figure 23**: Sensitivity Analysis on Oil prices*

7.9. Redirecting Income to Renewable Energy

Figure 24 shows the sensitivity of the outputs of the model to changing amount of fossil fuel revenue which is redirected to renewable energy investment. In Figure 24, between 0 to 50% of fossil fuel revenue redirected to renewable energy investment with incremental distribution in 5 runs in scenario of Steady State Economy. Figure 24 shows that by increasing the amount of fossil fuel revenue redirected into renewable energy investment, SDG-12 index increases. The other SDGs indexes remain constant.

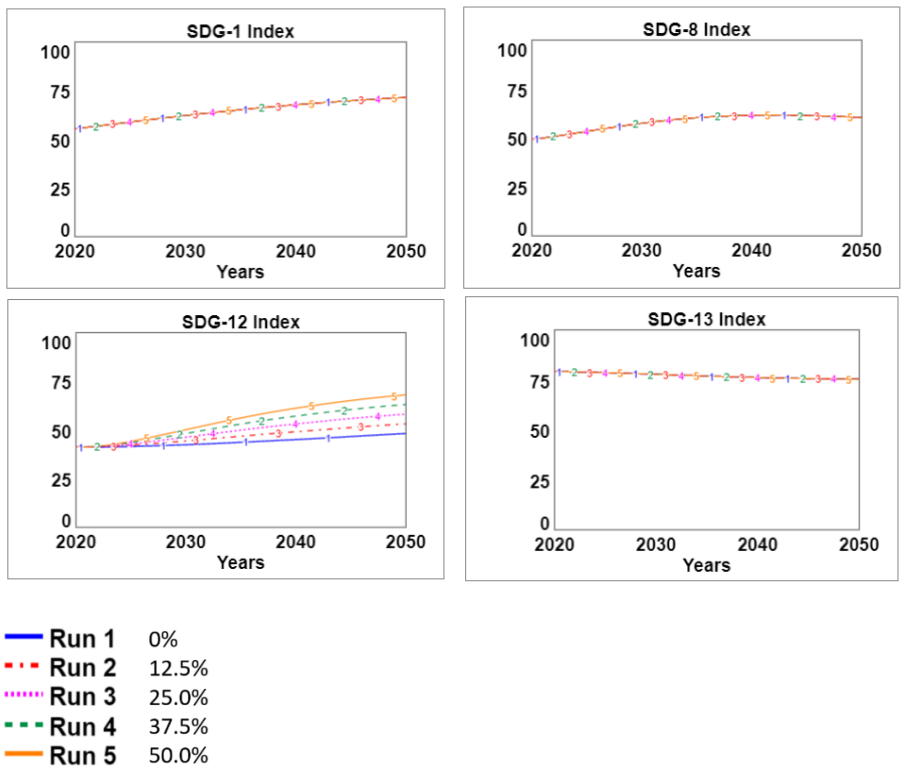

***Figure 24**: Sensitivity Analysis on redirecting fossil fuel income to renewable energy*

8. Discussions and Conclusion

The SDGs model simulates four progresses towards four goals of SDGs in the case of Iran. The model generates four different scenarios: Business as Usual, Inclusive Growth, Steady State, and Well-being for People and Planet for the

period of 2020 to 2050. Scenarios of Business as Usual, and Inclusive Growth are based on conventional efforts, while Steady State, and Well-being for People and Planet are based on transformational efforts.

The scenario of Business as Usual continues historical trends, therefore, there are no policy changes considered in this scenario. The results of implementing SDGs through this scenario in the model illustrates that while SDG-1 is improving, the other goals of SDG-8, SDG-12, and SDG-13 are declining. Moreover, the combined index of SDGs is declining in the scenario of Business as Usual. Therefore, scenario of Business as Usual is not appropriate for achieving SDGs in Iran. This result is in line with the OECD (2020) which emphasizes that for meeting the needs of today's world, "Business as Usual" is not a solution (OECD 2020a).

The scenario of Inclusive Growth is mainly based on policies about the acceleration of economic growth and increasing income equality. The results of the scenario of Inclusive Growth illustrate improvements in achieving SDG-1 and SDG-8 in comparison to the base year of 2020, however, SDG-12, and SDG-13 are declining. In the scenario of Inclusive Growth, SDG-1 is improving over time. Additionally, value of SDG-1 in the scenario of Inclusive Growth is higher than scenario of Business as Usual. In the scenario of Inclusive Growth, because of considering income redistribution policies and faster economic growth, SDG-8 index is improved in comparison to the Business-as-Usual scenario. On the other hand, in the scenario of Inclusive Growth, SDG-12 and SDG-13 are declining from 2020 to 2050. In the scenario of Inclusive Growth, the combined index of SDGs declines in comparison with the base year of 2020. Therefore, it shows that the Scenario of Inclusive Growth does not provide a proper pathway for achieving SDGs.

The scenario of Steady State Economy shows how the role of the Steady State Economy as an alternative agenda for transitioning toward an economy based on human and ecological well-being. This scenario contributes to the discourse on a steady state economy in Iran. Steady State Economy Scenario is mainly based on managing GDP growth, while considering some socio-economic and environmental policies to improve human and ecological well-being. The results of the scenario of Steady State Economy shows that SDG-1, SDG-8, and SDG-12 has improved from 2020 to 2050. In this scenario, the value of the SDG-13 slightly declines. In the scenario of Steady State Economy, combined index of SDGs has improved in the period of 2020 to 2050.

The scenario of Well-being for People and Planet is designed in a way that promotes human and ecological well-being and makes a better contribution in achieving SDGs. This scenario is based on extreme policy changes and therefore, extraordinary efforts are needed to implement them. The results of this scenario contribute to analyzing transformational policy changes for achieving SDGs and improving human and ecological well-being in Iran. In the scenario of Well-being for People and Planet, SDG-1, SDG-8, SDG-12, and SDG-13 indexes are improving from 2020 to 2050. The results show that the combined index of SDGs in the scenario of Well-being for People and Planet provides a better pathway in comparison to the other scenarios.

Currently we are facing a series of linked and complex issues such as climate change, the COVID-19 pandemic, socio-economic inequalities, which for facing these issues we need to rethink the role of economy and the human and ecological well-being (OECD 2020a). This study illustrates that transformational policy changes in Iran are required for implementing the SDGs. A transformation of the economic system means bridging the gap between the three systems of economy, society, and environment and their interactions. Some of the policies that have been considered in the *transformational* scenarios of the model include reduction of working hours, a carbon tax, and redirecting fossil-fuel revenue into renewable energy investment. The results of the simulations show that the combined index of the four SDGs improved in the Well-being for People and Planet, and Steady State Economy scenarios; however, in the Inclusive Growth and Business as Usual scenarios it decreased. The results of the *transformational* scenarios show that the SDGs indexes are improving, however, they are not enough for fully achieving SDGs by 2050. *Transformational* scenarios provide better pathways for achieving SDGs in comparison to *conventional* scenarios.

To conclude, SDGs are ambitious goals and, therefore, achieving them by 2050 let alone by 2030 is very difficult, especially in developing countries. This has become even more challenging because of the COVID-19 pandemic which has been particularly hard on developing countries (Ahmed et al. 2020). Because of the COVID-19 pandemic, middle and low income economies will suffer from a more serious lack of international funds for achieving the SDGs (Barbier and Burgess 2020) than when they were first adopted. It remains to be seen whether developed countries will provide them.

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