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Master of Science in Economics (Applied Economic Modelling)

System Dynamics Modeling of Green Employment Outcomes Driven by Climate Finance in Ethiopia's Green Economy Transition

Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Science in Economics (Applied Economic Modelling)

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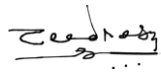
Internal Examiner: Tewodros Negash (PhD) Signature  Date 19/06/2025

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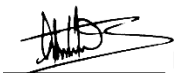
Advisor: Dr. Zerayehu Sime Eshete Signature  Date 19/06/2025

Declaration

I, **Eyuel Sahlu Ayele**, hereby declare that this thesis proposal, entitled "System Dynamics Modeling of Green Employment Outcomes Driven by Climate Finance in Ethiopia's Green Economy Transition," is my original work and has not been submitted for any degree or academic award at any university or institution. This thesis is submitted in partial fulfillment of the requirements for the degree of **Master of Science in Economics (Applied Economic Modelling)** at the **Department of Economics, Addis Ababa University**.

I affirm that all sources of materials used for this work have been properly acknowledged.

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Abstract

This study examines the changing interaction between climate finance, green job market, and labor productivity as a result of Ethiopia's green economy transition. The research adopts a system dynamics modeling technique to establish a consolidated structure for running various simulations of the climate finance sources—public, private, foreign, and green bonds—which co-exist with TVET, labor market, and GHG emissions. The simulation not only examines possible scenarios of policy but also explores the extent to which interventions have been targeted that include the growth of public-private partnerships, issuing of green bonds in phases, and the allocation of funds for skill development, thus helping the creation of green jobs and the development of low-carbon economy. The findings show that a well-timed and well-managed climate fund can provide employment opportunities on a large scale while still meeting the goals of emission reduction. Still, the degree of success of these events depends largely on the changes in productivity and the power of institutions to absorb investments in a proper manner.

Keywords: System Dynamics; Green Employment; Climate Finance; Ethiopia; Green Economy Transition; Labor Productivity; Green Bonds; TVET Investment; GHG Emissions; Policy Simulation

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Contents

List of Abbreviations

SD - System Dynamics

CRGE - Climate-Resilient Green Economy

GLI - Green Legacy Initiative

VKT - Vehicle Kilometers Traveled

GEM - Green Economy Model

NZE - Net-Zero Emissions

BAU - Business-As-Usual

ILO - International Labour Organization

CSA - Central Statistical Agency

FDRE - Federal Democratic Republic of Ethiopia

OECD - Organization for Economic Cooperation and Development

FSD - FSD Africa

BCG - Boston Consulting Group

EV - Electric Vehicles

E2W - Electric Two-Wheelers

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Chapter 1: Introduction

1.1. Background

Climate change has become a significant issue in the 21st century, which has a great impact on the ecosystems, global economies, and people's lives. The main reason is the rapid growth of the world temperature which is and still driven overwhelmingly by human activities like fossil fuel burning, removing forests, and performing industrial processes. Such an increase in temperature has caused the melting of the polar ice caps, strong weather changes, and a decrease in animal and plant species (Masson-Delmotte et al., 2021). The problem is beyond one country's boundaries and thus it needs a global concerted effort to solve it and also to be able to adjust to the new changes in the environment. The fact that climate change is accepted as a global issue is clearly identified in agreements such as the Paris Accord, which is an endeavor to bring together countries in pursuit of limiting global warming to below 2°C compared to the times before the industrial revolution(United Nations Framework Convention on Climate Change (United Nations Framework Convention on Climate Change (UNFCCC), 2015).

It is quite incredible that Africa is a continent with just 3% contribution to the global carbon emissions but has a unique chance to lead the world in decarbonization efforts and at the same time make a fortune from the green sectors that are just emerging. Africa is blessed with natural resources and there is a huge potential for renewable energy. The situation is further complemented with the largest growing labor force in the world; Africa can bypass the carbon-intensive infrastructure and go directly to renewable energy. Going by the green economy, it could potentially create up to 100 million new and improved jobs and livelihoods in Africa by 2050 according to some expert groups(FSD Africa, & BCG, 2024).

Ethiopia has somewhat emerged as a leading proponent of the green economy (Death, 2015). The government has made significant steps towards sustainable utilization of resources through the Climate-Resilient Green Economy (CRGE) strategy they have launched in 2011. That strategy is targeted at becoming a middle-income country by 2025 without increasing carbon emissions and at the same time being able to adapt to climate change. The CRGE mainly concentrates on improving agriculture, increasing renewable energy, and managing forests more efficiently.

The Green Legacy Initiative (GLI), which was started in Ethiopia in 2019, has helped the environment a lot and also empowered the local people economically. The initiative has carried out a massive exercise that involved more than 25 million citizens nationwide. The program has thus been able to create about 767,000 jobs, the majority of which are for women and young people. The types of work are, for example, in the development of nurseries, tree planting, and reforestation. Besides job creation, GLI has also improved the capacities of the community in sustainable land management, agroforestry, and conservation, thus leading to resilience against environmental challenges and at the same time providing solutions to socio-economic needs. (Beyene & Shumetie, 2023)

The shift towards a green economy has a major impact on Ethiopia's labor market. Labor market analysis is one of the key factors in grasping employment trends during economic changes, as stated by a World Bank (World Bank, 2021) report. The report goes on to explain that green growth measures may bring about the generation of new jobs as well as the elimination of some, with sectors such as agriculture and energy being particularly vulnerable.

Climate change and its consequences as well as the efforts to mitigate and adapt to it affect employment, incomes, and poverty reduction in a very complex way. Moving to a green economy will probably cause changes of a great scale in employment markets, with some jobs disappearing, but on the other hand, new jobs will be created, especially in such sectors as renewable energy, energy efficiency, and sustainable resource management. This process, which is often policy-driven, demonstrates the necessity of understanding the feedback loops and non-linear connections among economic systems for making correct policies that create the largest employment gains while reducing the negative effects. Strategies for green jobs, which embrace not only the creation of new roles, but also the "greening" of existing jobs, are crucial for the provision of sustainable growth and decent work opportunities in the context of the transition. Meeting these pressures and tendencies needs a systems approach in order to grasp the complex interrelationships between economic activities, population growth, and labor market changes (International Labour Office (ILO), 2008)

Although Ethiopia has set high goals to shift into a climate-resilient and green economy, the problem of climate finance availability is still the main thing that restricts the country. According to (UNDP, 2025), the country will need more than USD 275 billion until 2050 for the full implementation of its CRGE strategy. But the funds spent on climate-related activities now are far from this target. This lack of funding does not just slow down the implementation of environmental programs—it also changes

the labor market significantly. Many green economy projects, for instance, sustainable agriculture, renewable energy, and reforestation, are all very labor-heavy. If the money is not enough or comes late, it limits the job creation scale and speed, it makes it difficult to upgrade the skills, and it also stops productivity improvements that could have been used for the broader workforce. The issue is not only about raising resources but also about making sure that the climate money is used for inclusive and employment-rich development results.

1.2. Problem statement

The worldwide move to a green economy is necessary to combat climate change and support sustainable development. This change is expected to result in a large number of new jobs; for example, the International Labour Organization (ILO) predicts that the green economy can create up to 24 million jobs globally by 203 0(International Labor Office, 2018). On the other hand, this change also brings quite a lot of problems, such as the possible loss of jobs in the traditional sectors and the need for a considerable number of workers to be retrained(Noubissi Domguia et al., 2022).

In Ethiopia, the government has shown a firm and clear commitment to the construction of a climate-resilient green economy. The Climate-Resilient Green Economy (CRGE) strategy, launched in 2011, has a goal to reach a middle-income level by 2025 while at the same time developing a green economy (Federal Democratic Republic of Ethiopia, 2011). Ethiopia's shift to a green economy can be the driving force behind the creation of a multitude of job opportunities, where studies indicate that just renewable energy sectors, such as solar power technology, may lead to about 190,000 jobs in high-impact areas like horticulture, wheat processing, and milk storage. Besides that, other green economy ventures, for instance, sustainable agriculture and forestry, should further increase the number of jobs. (Jobs Creation Commission, 2021)

Despite these initiatives, Ethiopia is still grappling with various issues concerning the green transition. The economy is hugely dependent on the agriculture sector which is responsible for about 80% of employment in total (Dawid & Mohammed, 2021a). Moving towards sustainable practices means that this sector needs to make huge changes which may end up resulting in the loss of jobs if it is not handled in a proper way. In addition to that, green jobs creation is not only limited to the availability of jobs but it also entails the provision of skills to the workforce in order to successfully utilize the green work. Nonetheless, a skills gap is very obvious particularly among women and young people,

thus, the lack of access to education and training is the main reason why these groups cannot catch up with the rest(ILO, 2019).

Yet still a noticeable gap is evident between country requirements and resources activated. An evaluation of existing financing sources and their contributions to climate-related investments (adaptation and mitigation activities) by the Ethiopian Government discloses that the NDC faces a financing gap of around $197.94 billion. This sum is equal to $19.7 billion per year. The gap remains the same, although there have been policy reforms and initiatives to implement greener investment frameworks, pointing to the deep-rooted barriers in the system, such as institutional fragmentation, limited involvement of the private sector, and low capacity for the preparation of green projects that are suitable for banks(UNDP, 2025).

Globally, other countries' experiences really drive home the point that it's a must to solve these problems. The European Union's financial backing of clean energy ventures has resulted in a robust economic upturn and the creation of new jobs in Southern Europe (European Commission, 2018). On the other hand, the shift to greener energy systems accelerates the danger of job losses in sectors that consume a lot of energy and are mainly fossil-fuel-based, thus causing economic stagnation in areas that are not able to adapt efficiently to structural changes. (OECD, 2024)

In spite of greater attention to environmentally friendly growth and sustainability, the term Green TVET is still limited in understanding and is being implemented in a shallow manner in most of the training institutions. The majority of the colleges target only green activities such as tree planting, and they do not go beyond that to implement sustainability goals in the primary functions of the institutions such as curriculum design, research, and community engagement. Most importantly, the necessary institutional culture that is the foundation for the sustainability of these colleges, i.e., the integration of the vision, mission, and long-term strategies for sustainability, is still highly underdeveloped. (Bahri, 2023)

As Ethiopia implements its green economy strategy to create employment, the job-creating potential of climate-friendly investments is still not fully tapped. Green sectors such as renewable energy, ecosystem restoration, and public transit not only emit less carbon but also create far more jobs per unit of investment than fossil fuels(Jaeger et al., 2021). However, if the country lacks targeted policy design and enough climate finance, Ethiopia will still be on the verge of missing out on this opportunity. The main issue that still stands between financial flows and labor market planning

connections is the gap which is the main roadblock that prevents the green employment outcomes to be at larger scale and also more inclusive.

1.3. Research Objectives

General Research Objective:

To develop a system dynamics model that explores how climate finance affects green employment outcomes, labor productivity, and greenhouse gas emissions in Ethiopia's transition toward a green economy.

Specific Research Objectives:

- To examine the causal relationships among climate finance flows (public, private, and foreign), green job creation, and productivity within the Ethiopian context.
- To construct a system dynamics model that captures the interactions between employment, climate investment, education and skill development (TVET), and environmental outcomes.
- To simulate policy scenarios that assess the impact of alternative climate financing strategies—such as public-private partnerships, green bonds, and foreign aid—on employment generation and emission reduction.
- To analyze the role of productivity and institutional capacity in mediating the labor market effects of climate-related investments.
- To generate policy-relevant insights that support the design of employment-intensive, climate-aligned development strategies in line with Ethiopia's CRGE objectives.

1.4. Significance of the study

Ethiopia is located at a crucial point in its development journey which is focused on attaining climate-resilient economic growth that also takes care of the issues of the increasing unemployment and environmental pollution. Unfortunately, the intricate and changeable interconnections among climate finance, labor markets, and environmental results are still not clear to both policy makers and academics. This paper is of utmost importance in its endeavor to connect those differents by employing a system dynamics modeling approach which represents the feedback-relations among the climate investment flows, green employment generation, skill improvement, productivity, and greenhouse gas emissions.

Through emphasizing on the various sources and mechanisms of climate finance like public administration, private sector involvement, and the use of green bonds that can influence situations in the job market, the paper gives hints of possible actions to implement by the decision-makers who are looking for the designing of the green transition strategies that are inclusive and employment-intensive. The use of policy scenario simulations additionally increases its hands-on importance, allowing the searching of the trade-offs, delays, and leverage points in the actual decision-making process.

This research in academic terms is an addition to the literature on system dynamics which is used for sustainability transitions in low-income countries. The author of the paper has come up with a model specific to Ethiopia which not only incorporates employment variables but also covers the environmental and financial spheres—a factor that still remains mostly uncharted. The results of the work are on the one hand likely to serve as a reference for national policy, and on the other hand to significantly contribute to the work of other researchers in green economy planning, labor economics, and sustainable development.

1.5. Limitations of the study

While this study provides some important lessons on the impact of climate finance on green jobs in Ethiopia's green transition, it is still limited in many ways. On the one hand, the system dynamics model is based on very basic assumptions and data at the national level because there is no detailed information for green jobs, investment flows, and labor market changes in time series. On the other hand, the model identifies positive employment results from climate-friendly investments, however, it does not include any possible negative effects such as job losses in the sectors that use fossil fuels intensely or the unemployment of the period of the transition during the changes of the structure of the economy. The model also comprises the major financial means and the productivity conditions, but it does not reveal fully the role of institutions and politics which may delay or change the implementation of the decision. Finally, the simulation results are not influenced by the external shocks like inflation, excessive climate, or political unrest because in the simulations these factors are not explicitly represented.

1.6. Outline of the study

The design of the research is definitely an organized effort to methodically examine the effects of Ethiopia's switch to a green economy on the labor market through a system dynamics approach. The introductory Chapter 1 acquaints the reader with the background, problem statement, research objectives, and significance of the study. In Chapter 2, the literature review is outlined with the theoretical framework, employment dynamics in Ethiopia, the concept of green jobs, and a review of empirical studies of the current situation. Chapter 3 discusses the research method that employs the system dynamics approach, provides the data sources, dynamic hypothesis, and describes how to construct a causal loop diagram (CLD). Chapter 4 is dedicated to the model development stage when the system dynamics model expresses the relations between economic activities, population growth, and labor market dynamics in Ethiopia. At last, Chapter 5 gives the space to the results and discussions, interprets the findings, and points out the long-term employment challenges of green economic policies in Ethiopia.

Chapter 2: Literature Review

2.1. Theoretical Review

2.1.1. Employment Dynamics in Ethiopia

The unemployment rate in Ethiopia has experienced tremendous fluctuations over time, indicative of its economic landscape. According to the World Bank statistics, unemployment rates rose exponentially after 2020, coupled with the devastation wrought by the COVID-19 pandemic, regional civil war, and international economic turmoil. Urban unemployment is highly debatable, particularly among young people, and research has indicated that urban youth unemployment has exceeded 25% in certain regions (Ulandssekretariatet, 2022).

The unemployment rate in Ethiopia experienced drastic oscillation in recent years, indicative of the intricacy of its economic system. The graph calculated by the World Bank indicates that the unemployment rates hit record-breaking heights in 2020, coincidentally the period when the pandemic caused by the novel coronavirus, local wars, and global economic disruptions were the buzzwords. The issue of urban unemployment continues to exist very seriously. The issue of urban unemployment continues to exist very seriously, especially in the youths' case. Even a study shows that for the urban youths, the unemployment already exceeds 25% in certain regions.

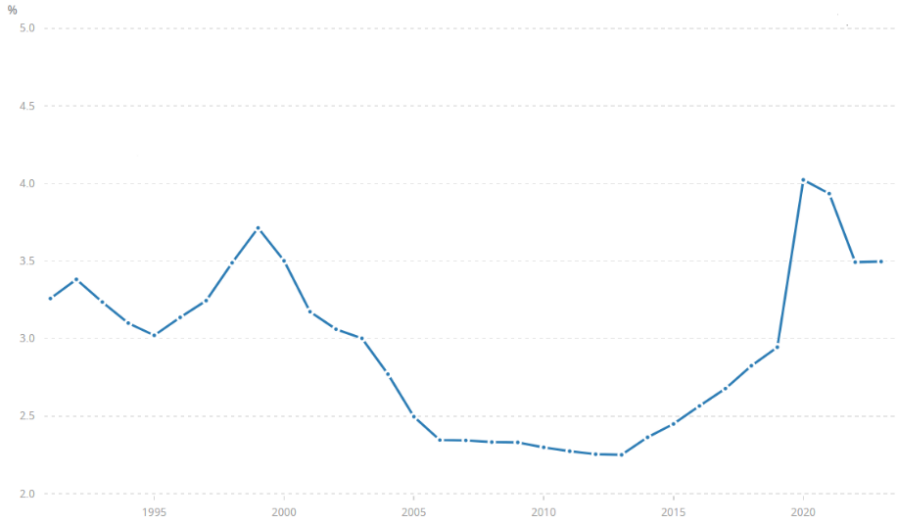

Figure 1: Unemployment (As a percentage of the total Labor force) in Ethiopia

(Source: World Bank, Unemployment, total (% of total labor force), retrieved from World Bank)

The pie graph breaks down parts of Ethiopia's labor force into three primary parts: agriculture, industry, and services. The World Bank indicates that agriculture dominated the employment sector with 73% of the workforce. The industry sector had about 6.5% of the employment, thus investment in industrialization persists. The sector of services accounted for some 20.5% of the total employment, and thus it can be referred to as the rising star in sectors of the economy. This can clearly illustrate the current situation in the economic structure of Ethiopia, whereby most people are engaged in agriculture, and industry and services are still growing at a mild pace.

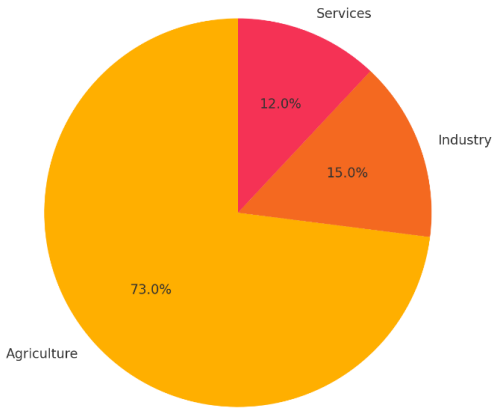

Figure 2: Sectoral employment in Ethiopia

(Source: World Bank)

The greening of the economy in Ethiopia is broadly anticipated to cause tremendous change to the nation's job market in the three principal sectors: agriculture, industry, and services. The agriculture sector, which has the mandate of ensuring 73% of the labor force is employed, will be the sector that will undergo the most change because green agriculture and climate-resilient crops technology will be the major drivers. These will involve reskilling and upskilling of labor in a bid to embrace modern methods. The industrial sector representing 6.5% of employment could experience job cuts as well as job creation, as energy-using industries are realigned towards new sources of energy and embrace less environmentally degrading production processes. Finally, the services sector, which provides employment to 20.5% of the working class, is the sector with the most potential when it comes to generating green jobs, particularly in renewable energy management, environmental consulting, and eco-tourism. (Akol, 2015)

The green jobs estimate for Ethiopia offers humongous job creation opportunities for the different sectors to the year 2030. Hydropower and solar will provide the greatest workforce, with each sector providing about 33,000 jobs, the figure reflects that Ethiopia is still pumping in enormous sums of money into renewable energy. Next, climate-smart agriculture has the highest share with an estimated 15,000 jobs, which shows the country is still on a track of modernizing the agricultural sector towards sustainability. Aquaculture and poultry and waste management can earn employment to the tune of about 1,000 and 6,000, respectively. These estimates are showing that Ethiopia's green economy plan is targeted at synchronizing with the sustainable growth of those key sectors that will be used to absorb the unemployed. (FSD Africa, & BCG, 2024)

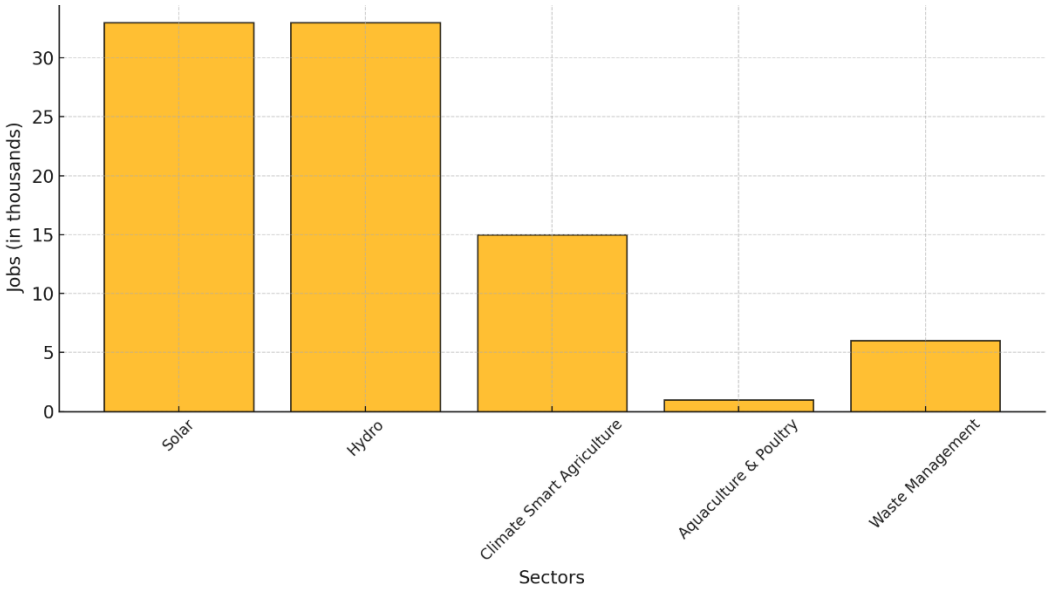

Figure 3: Green Jobs Forecast for Ethiopia by 2030

Source:(FSD Africa, & BCG, 2024)

In Ethiopia, the environmental energy revolution underlines the vital connection between the knowledgeable and untrained workforce that need to be kept in equilibrium for the efficient use of the economy of the country. Consequently, a report (FSD Africa, & BCG, 2024) points out that green sectors such as solar energy and hydropower are expected to be the source of about 33,000 new jobs each by 2030. Besides, it is highlighted that a majority of these jobs will be offered to unskilled labor. In addition to this, it is mentioned that workers with specialized skills, such as electricians and technicians, are very necessary to carry out the green technologies in a proper way and also to keep them in good condition.

Electric vehicles (EVs) will be a revolutionary force in Ethiopia, with massive employment opportunities, particularly in the assembling of vehicles and charging infrastructure. About 7,500 jobs will be created by the electric two-wheeler (E2W) industry alone by 2030, and an additional 4,600 jobs will be created by the development of charging infrastructure. With 40% of them being unskilled laborers, 35% being skilled workers like electricians and welders, and 10% being high-level specialists like electrical engineers, the industry has the potential to completely transform Ethiopia's labor force. (FSD Africa, & BCG, 2024)

2.1.2. Defining Green Jobs

Green jobs are typically described as employment in sectors and activities that have a key contribution to making or restoring the environment. According to the International Labour Organization(ILO, 2019), green jobs cross sectors such as renewable energy, energy efficiency, sustainable agriculture, and waste management. They aim to reduce the environmental footprint of economic activity but still provide decent work.

Green jobs can be broadly described as all the employment in the industries and the activities that contribute significantly to the maintenance or restoration of the environmental quality. The International Labour Organization (ILO, 2019) states that such industries as renewable energy, energy efficiency, sustainable agriculture, and waste management have been covered by these jobs. The initiative for green jobs is focused on reduction of the environmental effect of economic activities aside from promotion of decent work.

The definition of a "green job" is very liberally interpreted as those jobs that directly assist in environmental protection and those that indirectly assist in supporting such activities. For example, renewable energy jobs are not only technical jobs (e.g., the installation of solar panels) but also even administrative jobs (e.g., project management). (Beyene & Shumetie, 2023) Pot green jobs to be primary participants in offering green solutions to environmental and social issues.

The goal of the shift to a green economy is to balance environmental sustainability with economic growth by putting policies and initiatives in place that not only reduce emissions but also guarantee effective resource management and sustainable industries (Jacob et al., 2020). This idea is essentially related to the sectoral development of clean technologies and products as well as the application of macroeconomic techniques to enhance environmental performance.

The green job idea is crafted with the help of their positive contribution toward the environmentally sustainable state, the possibility of contribution toward social equity in the form of the diverse population, and the ability to remain economically sustainable in the long run. The International Labor Organization (ILO) estimates that a shift toward a green economy will create 24 million new jobs globally in 2030, if endowed with proper policies. Green transformation is no longer hence it simply has to do with facing the environmental issues but also takes into account taking the social dimension into perspective by giving the job industries a chance to generate new employment. And besides, the ILO reminds us that such a change can be the basis of sustainable economic development because investing in green technologies and good practices makes new innovation and efficiency happen. (Bureau international du travail, 2018)

The Ethiopian economy is agriculture-dominated, and it accounts for 80% of the whole working population (Dawid & Mohammed, 2021b).The transition to a green economy has, however, brought the drastic change in the employment situation. The Climate-Resilient Green Economy (CRGE) strategy (Federal Democratic Republic of Ethiopia, 2011) confirms that the above two industries green energy and sustainable agriculture are not only supplying green energy and sustainable agriculture they are also creating green jobs.

Greening TVET is a transforming process of norms that goes beyond current green jobs to examine how and why skills must alter for long-term environmental and social purposes, as opposed to short-term economic purposes. It involves restructuring competency standards and curricula, developing new training and assessment practices, refurbishing physical facilities, and internalizing environmental values in institutional culture. This holistic and systemic strategy makes sure that the vocational education accurately presents the existing situation and also contributes favourably towards changing to sustainability (Bahri, 2023).

2.1.3. Climate Finance Instruments in the Ethiopian Context

Climate finance as a field of economic theory has its background from a number of theoretical foundations that explain the justification for mobilization of finances to fight climate change. At the heart of this is theory in public goods and externalities, which identifies climate adaptation and mitigation as archetypal public goods—non-rival and non-excludable in consumption—likely to be underproduced by markets. Arrangements for climate finance are therefore justified by the need to

correct for these externalities and align private action with socially optimal levels of action. (Stern & Great Britain, 2007)

Green bonds, being one of the pivotal tools, trace their origin in information asymmetry theory as well as signaling models. These tools bridge the gap between the investors and the borrowers by categorizing the use of proceeds towards green purposes, thereby attracting environmentally conscious investors as well as reducing the cost of capital for green initiatives. This follows the belief that the labeling itself is valuable and credible, especially when endorsed by third-party verification (Alperovych et al., 2021).Green bonds have not yet been applied in Ethiopia but are planned under the CRGE national strategy to be applied in the future as a vehicle for scaling up green infrastructure investment scale.

Carbon pricing mechanisms, including carbon taxes and carbon markets, are based on Pigouvian theory that suggests imposing a tax or market price on pollution will internalize the external costs and bring the market in line with efficient outcomes. These tools yield revenue alongside providing behavioral incentives for emitters to limit carbon emissions. Ethiopia's involvement in carbon markets, primarily in REDD+ forest schemes, illustrates early-stage application of this theory in voluntary markets early-stage application of this theory in voluntary markets. (Newell et al., 2013)

Voluntary Sustainability Standards (VSS) are also referred to as privately governed standards, which ensure environmentally and socially sustainable production by establishing standards typically much higher than national law. Global momentum toward such standards as drivers toward inducing sustainable production in export-oriented industries such as agriculture, forestry, and manufacturing has been there. VSS can be employed as an instrument of climate-compliant investment mobilization and employment generation in the green economy transformation of Ethiopia through certification for markets of sustainable and ethical products. Not only do their application advance labor formalization and environmental regulatory adherence but also enhance the competitiveness of the country in global supply chains with demands for verified sustainability certifications. (Bhutani & Hoffmann, 2021)

In Ethiopia, the institutional infrastructure for climate financing is still at the stage of establishing and this has had an impact on the implementation of the theory in practice. Although the CRGE Facility acts as a single place to gather and coordinate funds, however, obstacles like fragmented planning, low openness, and weak monitoring systems still exist. These voids point out the restrictions of the

utilization of climate finance instruments in places where the institutional capacity is still in the process of development. (UNDP, 2025)

2.2. Empirical Review

Environmental regulation has demonstrated impacts on labor markets in different ways, which in turn were influenced by the nature of policies and sectoral dynamics. For instance, (Zheng et al., 2022) discovered that A decrease in SO2 emissions in China led to the loss of labor demand in polluting industries that were the most energy-intensive, which restricted low-skilled workers primarily. On the other hand, (Noubissi Domguia et al., 2022) investigated the effects of environment taxes and came out with expected positive correlation with employment, as they argued that adopting such policies contributes to the expansion of sectors, job types, and professions. Also, (Bezdek et al., 2008)pointed out that as expenditures on the environmental protection are done, they run in parallel with the creation and displace of jobs and that the net effect is positive. Furthermore (Pasnicu et al., 2020)got a similar result proving a direct relationship between environmental protection expenditure and new green jobs in Romania. At the same time, (Morgenstern et al., 2002) found a small impact but still there is a slight increase in jobs associated with environmental. They state, however, that an injection of $1 million in such spending could lead to up to 1.5 new positions. The examples above all illustrate different green economy scenarios on employment in various sectors, emphasizing the need for more thoughtful and sector-specific policies that can fully tap into labor market benefits as the green economy transitions.

Implementation of the Long-Term Low Emission and Climate Resilient Development Strategy (LT-LEDS) of Ethiopia will be expected to provide maximum employment benefits, namely the generation of green jobs. By 2050, the Green Economy Model (GEM) estimates green jobs will be a significant share of the country's labour force through investment in sustainable agriculture, renewable energy, and reforestation. Forestry and energy are set to lead this transition, opening up millions of job opportunities, as also in sustainable industrial activities and waste management in the provision of jobs. Policies, however, are what bridge skills gaps, especially among women, young people, and the vulnerable, in order to maximize the gains of such a transition and to buffer against its adverse effects on conventional labour markets. The LT-LEDS mentions the just transition framework in order to achieve economic transformation with equity and sustainable development(FDRE, 2020).

Between 2020 and 2025, an estimated 14 million new jobs will be needed by up to 2 million youth entering Ethiopia's labor market annually. TVET institutions can play a key role in closing the green

economy skills gap, but mainly in areas like renewable energy and climate-smart agriculture. TVET institutions are not yet doing this, though, as they struggle to match their training programs with the demands of the labor market. The new national TVET policy attempts to fill these shortcomings by establishing green skills as those that "minimize environmental footprints and enable economic transformation towards cleaner, climate resilient, and efficient economies"(Bahri, 2023)

Ethiopia reportedly mobilized about $400 million in grants from multilateral vertical funds like the Green Climate Fund (GCF), Global Environment Facility (GEF), and Adaptation Fund in the last decade, according to the study. It is one of the leading five African nations in climate finance procurement during 2011-2021. In 2024 alone, Ethiopia earned $139 million from exporting electricity to the region, exemplifying how renewable energy infrastructure investment can provide concrete economic gains while contributing to the fulfillment of mitigation targets(UNDP, 2025)

Empirical tests across different settings always confirm that climate finance can have the ability to directly influence the performance of labor markets, notably by producing additional green job opportunities. Through a system dynamics modeling method, (Guidolin & Guseo, 2014)confirmed that investment in renewable energy and green industries with specific emphasis in South Africa improved employment in the long run, particularly if combined with institutional coordination and worker training. Their simulations demonstrated that green investments at an early stage, in combination with proper skill formation and policy alignment with industry, can promote job creation while curbing environmental pressures, thus providing a twin dividend of environmental and labor market benefits. (Guidolin & Guseo, 2014)

Similarly, (Fu et al., 2025) examined the impact of green finance instruments on employment generation in China's pilot green finance areas. Using their econometric framework, they established that the issuance of green bonds and other associated sustainable investment products increased manufacturing scale of employment significantly, particularly in high-tech industries and non-state-owned sectors. Through the easing of credit bottlenecks and stimulation of private investment, green finance raised the scope of employment generation in emerging sectors such as clean energy, green building, and low-carbon technology.

As empirical research cited by the World Resources Institute (Jaeger et al., 2021) claims, green investment has proved to be a better creator of jobs in the same sectors and countries as fossil fuel investment. For example, energy efficiency building retrofits create 2.8 times as many jobs per dollar

as fossil fuels do, and solar and wind electricity generate 1.5 and 1.2 times as many jobs, respectively. In transport, investment in cycling and public transport infrastructure creates 1.4 to 2 times the number of jobs that investing in the building of roads and internal combustion vehicle manufacturing creates. Nature-based solutions such as ecosystem restoration can create up to 3.7 times the number of jobs the traditional oil and gas sector can create. Survey results imply the labor intensity and economic inclusiveness of the green industries, under the condition that climate finance will be targeted appropriately. This evidence underlies the relevance of green job impacts modeling in the context of Ethiopia, as employment generation is one of the most critical policy concerns with a limited fiscal environment.

Transition to a net-zero emissions (NZE) path in Ethiopia would likely bring enormous job gains, with a wide base in green jobs. The GEM initiatives for Ethiopia are projecting that, if the NZE scenario is to dominate, overall employment will reach 78.57 million jobs by the year 2050, a figure that is 11.9% more than the BAU scenario. It is estimated that land-related measures such as reforestation contribute two-thirds of the new green jobs, while the expansion of renewable energy generates about 27% of the green jobs produced. In spite of the net job creation, the transition is challenging, including labor loss in conventional industries such as fossil fuels and the retraining of workers to occupy new positions in renewable energy and sustainable agriculture. The policies for filling the skill gaps and for a just transition are critical to driving the employment advantages of the green economy transition to its potential (Dagne et al., 2024).

2.3. Conceptual framework

In the vision of Ethiopia's Climate Resilient Green Economy (CRGE), sustainable finance mobilization and coordination of labor policy with environmental objectives are necessary in order to achieve a fair transition. This study seeks to examine how inter-linkages between main interventions—climate finance mobilization, technical and vocational education and training (TVET), issuance of green bonds, and uptake of voluntary sustainability standards (VSS)—affect green job creation, labor productivity, and environmental performance. These policy levers operate in interconnected channels: e.g., green bonds and climate finance fund low-carbon industries, while TVET prepares workers for green jobs. The creation of green jobs then lowers emissions and compensates for climate labor productivity losses. These mechanisms, taken together, support the wider agenda of developing an inclusive, resilient, and low-carbon economy. The theoretical framework in this study is system

dynamics, which enables integrated comprehension of economic, labor, and environmental systems' co-evolution to policy intervention.

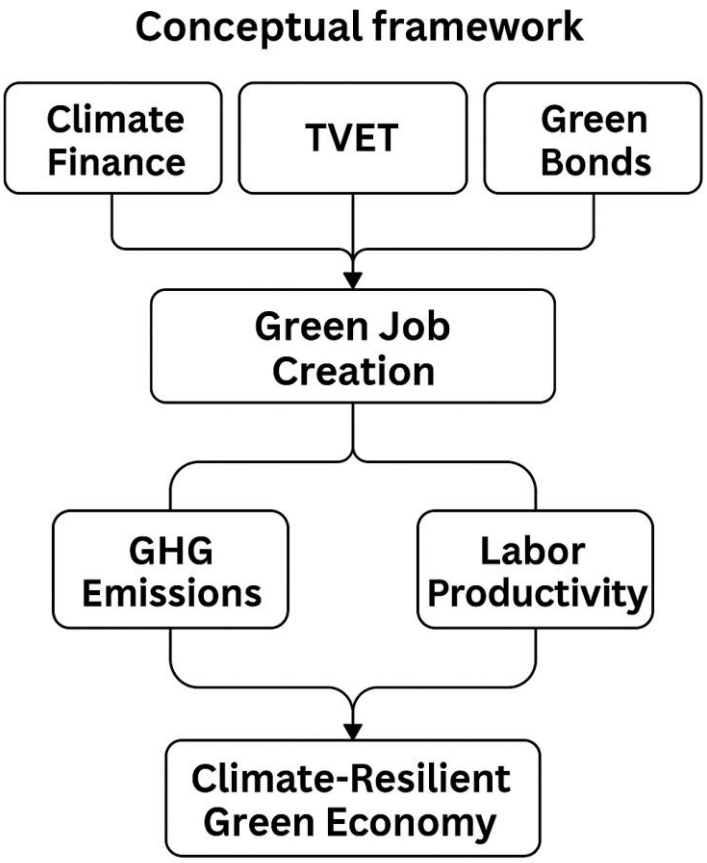

Figure 4: Framework of the study

Chapter 3: Research method

3.1. System Dynamics Modelling

System Dynamics (SD), which was invented by Jay Wright Forrester at MIT in 1956, is now the most suitable method to study the complex nature of the interconnected systems. Forrester's book Industrial Dynamics (1961) was the firsthand approach that recognized the nature of feedback loops and non-linear behaviors, thus providing the concepts for the application of the new paradigm in different fields. The professor extended the range of SD in social and environmental fields through these works Urban Dynamics and World Dynamics that were treating such problems as urban decay, population growth and resource depletion (Forrester, 1994; Meadows et al., 1974). These models claim the significant role of systemic structures, feedback mechanisms and accumulation effects, which are very important for the solution of the present problems such as the transition of Ethiopia to the green economy. System dynamics, by concentrating on the interactions between economic growth, environmental sustainability and employment dynamics, gives the possibility for policymakers to find and solve leverage points in such complicated systems.

As complexity in world problems increases, traditional analytical approaches struggle to cope with multi-dimensional challenges. The (OECD, 2017) emphasizes that governments effective at solving knotty issues find it challenging to manage complex systems as linear thought comes with limitations. This gap emphasizes the need for systemic methods like SD that are able to follow causal relationships and feedback loops, giving useful insights. For instance, SD has been at the center of environmental modeling, where it assists in understanding long-term consequences of greenhouse gas accumulations (Sterman, 2000). Additionally, (Gary & Wood, 2016) believe that decision-makers misunderstand feedback structures and discount non-linearity and this leads to second-best policies. With the integration of systems thinking concepts into simulation models, SD overcomes many of the said limitations and is therefore the ideal model to study the interrelationships between Ethiopia's labor market, green policies, and environmental boundaries.

SD's facility for simulating behavior over time is particularly well-suited to study complex phenomena such as employment trends in a changing economy.". Feedback loops and non-linearities, such as the creation of jobs, the use of resources, and population increase, often shift the dominance of system elements, drastically altering system behavior (Sterman, 2000). For example, the relationship between the demand for and supply of labor in green economic policy can create reinforcing or balancing

feedback loops, affecting long-run sustainability. In addition, the requirement to successfully balance complexity in an effort to derive meaningful insights is once again underscored by (Ackoff, 1981), who advocates for looking at how system components interact rather than attempting to deal with each variable. Synthesizing previous data, theoretical models, and empirical data, SD offers a strong methodology to guide Ethiopia's green economy transition from complexity without realizing unwanted unintended effects.

3.2. Approach and Data Sources

The intricate, non-linear relationships between climate finance, green investments, population growth, and labor market outcomes in Ethiopia's transition to a green economy are examined in this study using a system dynamics modeling approach. Because it accounts for time delays, threshold effects, and both reinforcing and balancing loops that are present in labor, economic, and environmental subsystems, system dynamics is especially well-suited for examining these feedback-rich systems. Within a feedback structure that replicates system behavior over time, the modeling framework incorporates policy-relevant variables like labor productivity, skill mismatches, green job creation, and climate finance flows.

To illustrate the interdependencies between population dynamics, green employment, and sectoral investment flows, the model uses a stock-and-flow structure backed by causal loop diagrams (CLDs). While flows like "Climate Investment," "TVET Output," and "Job Attrition" capture the rates of change, stocks like "Green Jobs," "Total Labor Force," and "GHG Concentration" build up over time. To account for realistic behavioral responses, such as the sensitivity of employment growth to public-private investment partnerships or the declining returns of labor productivity in the absence of targeted skill development, elasticity functions and nonlinear multipliers are included.

The Ministry of Planning and Development, the Ethiopian Central Statistical Agency (CSA), and globally renowned publications like the UNDP's Financing Ethiopia's Green Transition (2022) are the sources of data used for model parameterization. Sectoral employment statistics, labor force participation rates, trends in climate finance, estimates of spending on the green economy, and population projections are important datasets. When there is a lack of empirical data, key relationships are approximated using expert judgment and proxy variables, with sensitivity analysis used to test assumptions.

The model is calibrated using historical time-series data to match observed trends with simulated behaviors, ensuring both external validity and internal consistency. Extreme condition testing, reality checks, and the replication of past behavior are examples of validation techniques. The effects of alternative policy interventions, like more public climate investment, the issuance of green bonds, or increased technical and vocational training, on job creation and economic performance are then examined using scenario analysis.

In general, the system dynamics approach permits a more interactive investigation of Ethiopia's green economy shift, exposing how policy levers co-act during a period to mold labor market paths. The modeling framework goes beyond just enabling a profound appreciation of the interrelations between climate finance, human capital, and sustainability outcomes but also offers a decision-support tool for the design of employment-oriented policies over a considerable time span.

3.3. Dynamic Hypothesis

The interaction between climate finance, labor dynamics, and economic transformation in Ethiopia exhibits several reinforcing and balancing feedback mechanisms. As public and private climate-aligned investments increase, more funds are channeled toward green sectors such as renewable energy, waste management, and sustainable transport. These investments stimulate employment creation, particularly in labor-intensive and skill-sensitive green sectors, thereby reducing unemployment and underemployment. As employment rises, household incomes and aggregate demand also increase, which further boosts economic activity and government revenue. This, in turn, expands the fiscal space for continued climate investment, forming a reinforcing loop.

Improved access to technical and vocational education and training (TVET) raises workforce skill levels on the supply side of the labor market, minimizing the gap between the changing demands of a green economy and the labor supply. This increases overall labor productivity by facilitating a more effective labor absorption into green sectors. Additionally, by replacing jobs that rely heavily on fossil fuels with low-carbon alternatives, more green employment helps to reduce greenhouse gas emissions.

However, there are also balancing loops within the system. For instance, delayed climate finance disbursement, institutional inefficiency, or inadequate public-private coordination may constrain the investment rate and job creation rate. Likewise, a rate of high job creation places persistent pressure on the labor market, which may outpace the job creation rate and limit green investment benefits. Also,

the displacement of labor out of carbon-using industries—though not explicitly modeled here—is potentially a source of transitional unemployment and social resistance to change.

Therefore, the dynamic hypothesis of the research is that Ethiopian green economy transition can establish a long-lasting green employment generation cycle, enhance productivity, and deliver environmental dividends if climate finance is amplified and tied with human capital development. Alternatively, a failure in strategic coordination and investment in skills can trap structural unemployment and water down the inclusive prospects of the green transformation.

3.4. Causal Loop Diagram (CLD)

Causal loop diagrams (CLDs) are a central method to systems thinking and far reach are the implications of the systems being studied that are first mapped and later understood to carry out transformations. The present section deals with the application of CLDs to first recognize the dynamic relations among the main elements of the system under investigation. The visual representation of feedback loops—both reinforcing and balancing types—CLDs are a good analogy of the volitional factors that lead the system behavior. These diagrams illuminate the systemic causes of the existing problems and the opportunities for proper intervention, thus making them an ideal framework for complicated systems analysis. The sections that follow present the mechanics of building the diagrams, the rationale of the relations, and the consequences of the study.

A dynamic depiction of the relationships between climate finance, green employment, economic growth, and environmental outcomes in Ethiopia's shift to a green economy can be found in the causal loop diagram created for this study. The creation of green jobs is at the center of the system and is both a cause and an effect of a number of feedback loops that balance and reinforce one another and influence the long-term development trajectory of the nation.

A first impulse in climate finance triggers the development of green jobs in sectors like energy, industry, and agriculture. With the increase of jobs, GDP also grows, thus increasing the government’s ability to make public climate investments. These investments then drive the green job creation even more, thus creating a self-reinforcing cycle that connects employment growth with macroeconomic performance and institutional capacity.

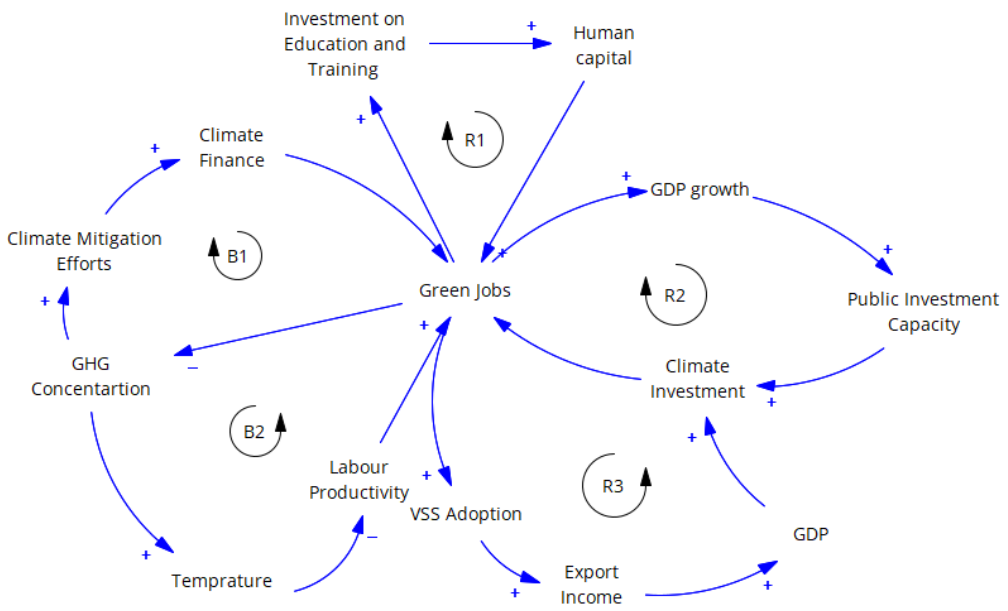

Figure 5: Causal Loop Diagram

Concurrently, the model incorporates the impact of human capital formation. Increased investment in education and training increases the quality of skilled labor supply, which facilitates the green jobs to expand. This cycle not only reinforces the mechanism of employment-growth but also addresses the issue of skill imbalances that can limit the labor market to be responsive to green investment. The resulting improvements in labor force quality contribute to higher productivity, which feeds back into GDP growth and reinforces the investment–employment nexus.

The export-driven feedbacks also strengthen the system further. With more green jobs, particularly in those sectors related to Voluntary Sustainability Standards (VSS), the diffusion and possibility of the latter become more real as well. This would make Ethiopian exports more competitive, raising the revenue from the exports and consequently GDP. This supple economic growth creates more fiscal room for the people's investment, and the cycle gets extremely virtuous as it connects labor market development, trade performance, and green finance.

Concurrently, the system is regulated by two primary balancing loops. As green employment grows, so does the role of green employment in climate mitigation by lowering greenhouse gas (GHG) levels. Reduced GHG levels stabilize temperature, which is important because there is feedback between heat stress and labor productivity. In the absence of intervention, increasing temperatures have the potential to undermine productivity, decelerating GDP growth and undermining the labor demand caused by

climate investment. This force introduces a inherent stabilizer, highlighting the critical role of environmental thresholds in supporting long-run employment improvements.

Altogether, the model depicted in the CLD signifies that Ethiopia's green transition has resulted from a confluence of multiple policy levers, not just one. In fact, it emanates from the interrelated endeavors in education, climate finance, trade reform, and institutional investment. The loops emphasize that the green jobs can be a base for re-energizing both sectors of the economy and environment, if only the climate risks are handled and human resources are developed in accordance with the policy.

3.5. Stock Flow Diagram (SFD)

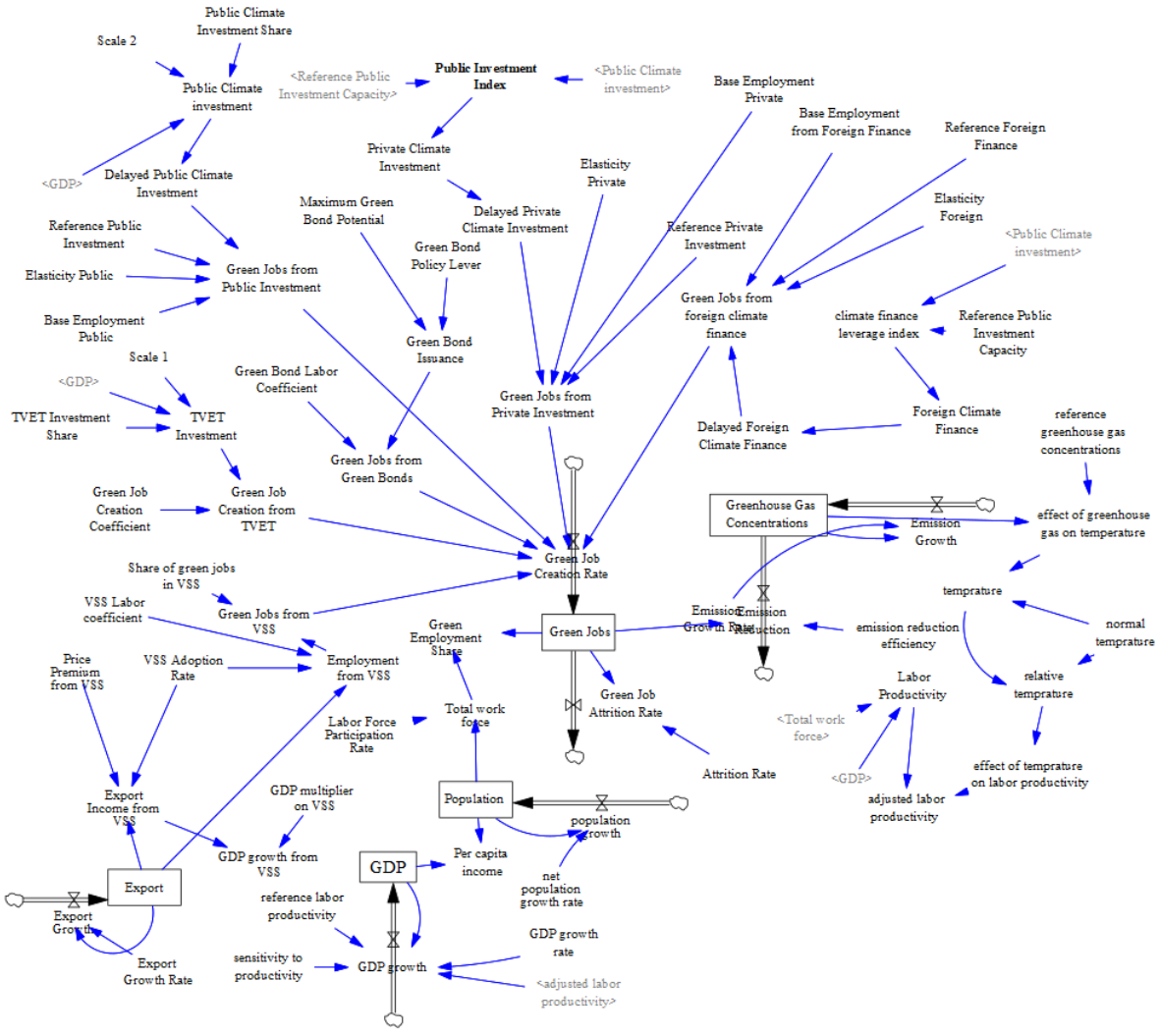

Figure 6: Stock Flow Diagram

The stock–flow architecture captures Ethiopia's green-transition story in terms of five core accumulations—Population, GDP, Export, Green Jobs, and Greenhouse-Gas (GHG) Concentrations—and a network of policy-sensitive flows that join climate finance, labour markets, productivity, and the environment. Population growth is due to a demographic inflow associated with birth and mortality assumptions; when multiplied by the labor-force-participation rate it produces the total workforce that underpins both conventional employment and the inflow into Green Jobs. The Green Jobs stock itself increases through a number of parallel channels of creation—public sector projects, private investment, overseas climate finance, green bonds, expansion in TVET, and take-up of voluntary sustainability standards (VSS)—each lagged to capture administrative or market resistance, and declines through an attrition channel that reflects job turnover. As green workers multiply, their salaries recycle into aggregate demand, further levering GDP growth and, as a consequence, increasing fiscal space for additional public climate expenditure and borrowing of additional private and external finance. This sets up a reinforcing process where effective mobilization of climate finance finds expression in job gains and increasingly larger investment capability.

GDP is treated as a level because the cumulative size of the economy, rather than the annual increment on its own, determines the extent of Ethiopian reserve mobilization toward the green transition. Its growth inflow is sensitive to (i) output from labour productivity and (ii) export income. Labour productivity itself is temperature-endogenously controlled: higher GHG concentrations raise mean temperatures, which decrease worker efficiency and decelerate GDP growth—a stabilizing feedback linking environmental deterioration to economic performance. Export, as a separate stock to capture capacity building in foreign-exchange earnings, is improved through VSS adoption; certification provides price premiums that enhance export revenues, which, in turn, propel GDP and strengthen the macro-fiscal underpinning for investment in climate change. Conversely, low productivity or slow export growth decelerates GDP accumulation, sharpening budget tightness and limiting room for future green-investment inflows.

The GHG Concentrations stock is the focus of the environmental subsystem, which has two opposing flows: Emission Growth, which is positively correlated with economic activity, and Emission-Reduction, which measures the technical effectiveness of climate finance-funded abatement measures. While effective abatement funded by green bonds, public investment, or foreign support slows the buildup of atmospheric carbon, rising concentrations raise temperature, which has a negative impact

on labor productivity and, consequently, GDP. A regulating loop is closed by this climate-economy feedback, whereby effective decarbonization protects long-term productivity and growth while inadequate mitigation triggers a self-reinforcing decline in efficiency and investment capacity.

The interrelations between the labour and finance modules definitely establish the model's policy influence. Public-investment share, elasticity parameters for private-sector response, green-bond issuance trajectories, and TVET-investment share are the carriages through which the analyst can pull employment-intensive or emission-focused strategies. Since each lever is a job-creation source, the effect of changes is like a ripple through the income–demand–GDP route, thus the changes in both fiscal headroom and the pace of emissions abatement. The schematic therefore offers a comprehensive base to investigate the conditions under which prudent sequencing of climate-finance devices and human-capital policies can lead Ethiopia to a low-carbon growth trajectory, at the same time being green-employment-friendly and maintaining macroeconomic stability.

3.5.1. Definition of Major Variables

Green Jobs: This stock variable represents the cumulative number of employment opportunities generated in environmentally sustainable sectors such as renewable energy, energy-efficient construction, green transport, and solid waste management. It increases with new green employment inflows and decreases with attrition or obsolescence.

Total Labor Force: A stock that reflects the total economically active population in the country, including both green and non-green sectors. It is influenced by population growth and labor force participation rates.

Climate Investment Rate: This flow variable captures the annual financial investment directed toward climate-resilient infrastructure and green economy programs. It includes public, private, and foreign climate finance contributions.

TVET Output: Represents the number of skilled individuals graduating from technical and vocational education and training programs annually. It influences the absorptive capacity of the labor force for green jobs.

Labor Productivity: An auxiliary variable denoting the average economic output per worker. It is affected by technological advancement, worker education, and the impact of environmental stressors such as rising temperatures.

Adjusted Labor Productivity: Reflects labor productivity after accounting for climate-related variables, particularly the negative effect of temperature rise. It is a critical determinant of employment efficiency and income generation.

Climate Finance Leverage Index: A dimensionless auxiliary variable showing the ability of public climate investment to attract additional private or external finance. It is calculated as the ratio of actual public climate investment to a benchmark reference capacity.

Green Bond Activation: A policy lever that simulates the introduction and scale-up of green bonds in the Ethiopian economy. It influences the availability of long-term, low-carbon investment capital.

TVET Investment Share: This policy variable determines the proportion of total climate finance allocated to technical and vocational training. It plays a central role in enhancing labor productivity and skill alignment in green sectors.

Job Attrition Rate: A flow variable representing the rate at which green jobs are lost due to factors such as retirement, emigration, or skill mismatch. It moderates the total stock of green jobs over time.

GHG Concentration: A stock variable reflecting the cumulative level of greenhouse gases in the atmosphere, driven by fossil fuel use, industrial activity, and mitigated by green investments and labor shifts.

Emission Reduction: An auxiliary variable indicating the annual reduction in greenhouse gas emissions attributable to climate investment and transitions to green employment sectors.

Chapter 4: Results and Discussion

4.1. Model Validation

In system dynamics modeling, extensive validation is necessary to ensure the validity and pertinence of simulation results. In the theses examined, model validation usually involves structural tests (e.g., dimensional consistency and boundary sufficiency), behavioral tests (e.g., reproduction of behavior and sensitivity analysis), and tests of extreme conditions. These approaches try to ascertain whether the model structure represents real systems correctly and whether it can reliably reproduce historical trends across various situations. As (Sterman, 2000) states, "Model validation is not about proving a model to be true or false but about building confidence in the model's usefulness for decision-making," with the all-important insistence being that validation should be an iterative process supplemented by qualitative and quantitative analysis. This multi-step process of validation guarantees that the models are stable, transparent, and capable of supporting well-informed policy analysis.

4.1.1. Model Structure Test

Before any simulation is conducted, model structure testing is a very important first step for getting confidence in a system dynamics model. Structure tests are geared towards establishing whether the model is conceptually and logically correct (Bala et al., 2017). These covers ensuring that the units are of the correct dimension, all the equations are a true representation of the real-world system that is being modeled, and the parameter values are based on reliable empirical data or sound hypotheses. In addition, in order to be sure that all the relevant variables and feedback loops are present, the part of the system that has been modeled is also checked to see if it is suitable. These tests as one unit help the model's use in scenario and policy analysis by making sure that it is internally consistent and it sufficiently represents the system being studied.

4.1.1.1. Structure verification test

To build trust in the internal consistency and reliability of the model, a structure verification test was conducted. This pre-simulation test is essential to determine that the structure of the model accurately represents the underlying system which it is supposed to simulate. Structure testing,(Bala et al., 2017) explains, involves checking for dimensional consistency of the equations, verification of the adequacy of parameter values, and ensuring conceptual appropriateness of model boundaries. In the present model, unit consistency of all equations was checked using Vensim's built-in unit-checking feature to

ensure consistency among inputs, intermediate variables, and outputs. Parameters were either calibrated from national statistics—GDP, labor force participation rates, and population growth from the Central Statistical Agency of Ethiopia—or based on reputable sources like the (UNDP, 2025) and the Green Jobs Report(FSD Africa, & BCG, 2024). The model boundary was appropriately established to include core stocks and flows of green job creation, climate investment, technical and vocational education (TVET), labor productivity, and greenhouse gas emissions—without unnecessary complexity to ensure systemic integrity. This test for structural verification ensures the model's grounding in reality and fitness for policy simulation and scenario analysis.

4.1.1.2. Parameter verification test

To make sure the values assigned to important model parameters were correct and pertinent, parameter verification was carried out. Values were selected on the basis of their compatibility with related studies, logical coherence within the system, and empirical consistency with national trends. To ensure that the model behaved plausibly under a range of plausible parameter values, estimates were cross-checked using sensitivity analysis and expert-informed assumptions in cases where direct data was not available. The system dynamics model's contextual alignment and internal validity were strengthened by this procedure.

4.1.1.3. Boundary adequacy test

To find out if the model includes all the pertinent sectors, variables, and feedback loops required to meet the study goals, the boundary adequacy test was conducted. The test made sure that the major variables influencing the dynamics of the shift to a green economy—such as investment, labor, education, and emissions—were included without needlessly adding extraneous details to the model. In order to communicate the key interactions without losing sight of the policy levers that have the greatest influence on the system's behavior, the model's simplicity and analytical detail are compromised.

4.1.1.4. Dimensional Consistency Test

A dimensional consistency test was carried out to guarantee the system dynamics model's structural integrity. This required confirming that the equations connecting the stocks, flows, and auxiliaries were dimensionally coherent and that each variable was given a suitable and significant unit. Because it protects against logical mistakes that could result from incompatible unit operations, ensuring unit

consistency is an essential step in validating a system dynamics model. Vensim's built-in unit checking function was used to implement the test, methodically identifying and fixing any discrepancies. Dimensional consistency checks are crucial for model validation, as noted by (Schwaninger & Groesser, 2018), as they guarantee that the mathematical formulations in the model are solid both conceptually and technically.

To ensure the structural integrity of the system dynamics model, a dimensional consistency test was conducted. This necessitated verifying that each variable was assigned a suitable and meaningful unit and that the equations relating the stocks, flows, and auxiliaries were dimensionally coherent. Because it protects against logical mistakes that could result from incompatible unit operations, ensuring unit consistency is an essential step in validating a system dynamics model. The test was carried out using Vensim's integrated unit checking feature, which systematically found and corrected any inconsistencies. According to (Schwaninger & Groesser, 2018), dimensional consistency checks are essential for model validation because they ensure that the mathematical formulations in the model are sound from a conceptual and technical standpoint.

4.1.1.5. Extreme condition test

To test the structural validity of the model with respect to extreme conditions, an extreme condition test was conducted by setting the TVET Investment Share equal to zero. This variable directly affects TVET Investment, which in turn influences TVET Enrollment and ultimately Green Job Creation from TVET. The reason for conducting this test was to see whether the model behaves sensibly when the investment mechanism for vocational education is completely absent. As expected, when TVET Investment Share was set to zero, Green Job Creation from TVET also dropped to zero, confirming that the model accurately represents the dependence of green employment outcomes on public spending on technical and vocational education and training. This result confirms the model's internal consistency and structural validity in simulating the education-to-employment pipeline.

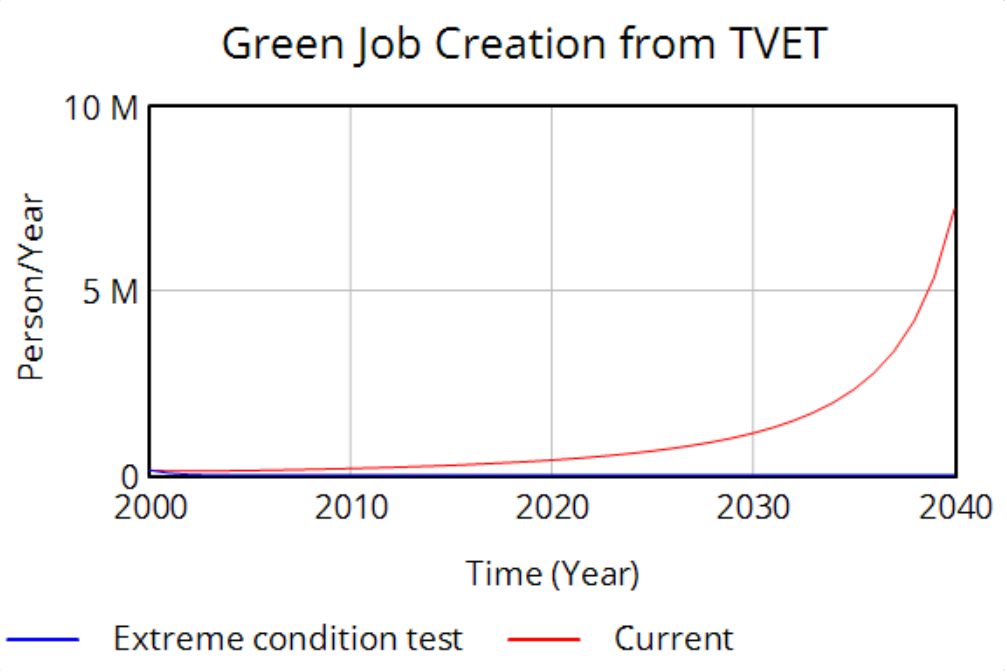

Figure 7: Extreme Condition Test

4.1.2. Model Behavior Test

To assess the model's capacity to reproduce real historical trends for important labor and demographic variables—specifically, the total population and workforce—the behavior reproduction test was performed. Because they support the labor dynamics and economic transition pathways under Ethiopia's green growth agenda, these variables are essential to the system dynamics model. Both workforce and population variables were based on historical data from 2000 to 2020, which was used as a standard to evaluate the simulation's accuracy.

During the validation period, the simulated trajectories show a strong agreement with historical trends, as shown in the figures below. The total workforce graph indicates that, up until about 2017, the simulated values (blue line) closely resemble the real data (red line). After that, there is a slight divergence. This discrepancy is probably the result of how the model's underlying assumptions—such as those about labor force participation, fertility rates, and migration flows—differ from actual events, such as unforeseen policy changes or economic shocks in later years.

The population simulation also shows a steady and realistic growth pattern that closely resembles historical data. The general pattern is still valid and believable even though the simulated curve slightly overestimates the population growth after 2020. The model's forward-looking assumptions, which might not accurately account for recent demographic changes or advancements in public health that have an impact on population dynamics, are another reason for this behavior.

Overall, the model's structural validity and behavioral soundness are supported by its capacity to replicate the historical behavior of both workforce and population variables. The model's ability to perform scenario analysis and policy simulations in the future is validated by the growth trends' consistency, particularly when evaluating Ethiopia's transition to a green economy and its effects on the growth of the labor market.

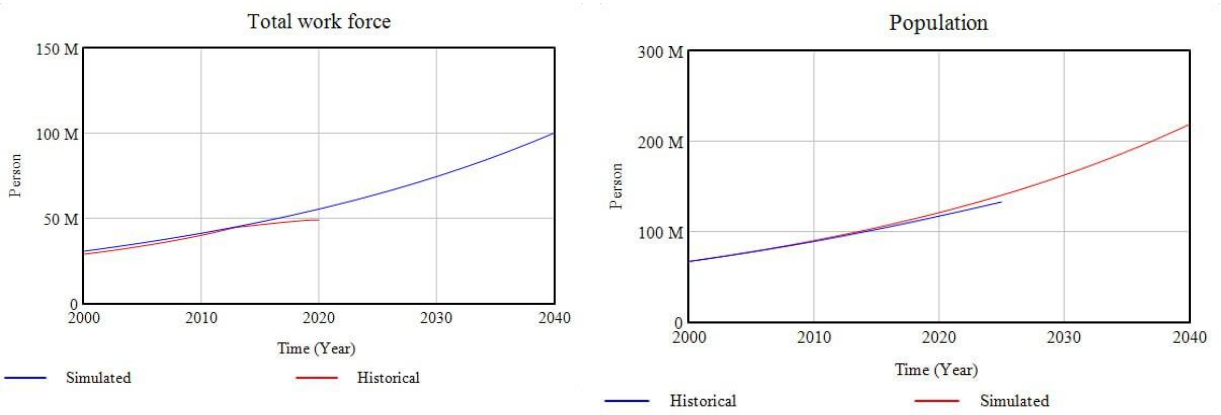

Figure 8: Simulated and Historical Behavior of Total work force and Population

4.1.3. Sensitivity Analysis

To test the sensitivity of the model, a set of policy-relevant variables were systematically altered within plausible ranges to test their impact on key results such as green job creation, greenhouse gas emissions, and labor productivity. The intention of this test is to see how system behavior is influenced by changes in policy levers and climate investment mix composition and which variables have the most impact on labor dynamics. The test examined five key variables: TVET investment proportion, introduction of green bond policy, elasticity of private climate investment response, green job creation factor, and price of carbon credits. Each variable was varied independently while others were held constant to isolate its effect on system performance. This kind of approach allows for the evaluation

of the robustness of the model and permits the determination of strategic intervention points that can lead Ethiopia's green economy transition to inclusive job creation.

The first test assesses the impact on employment and environmental outcomes of changing the percentage of climate finance allotted to technical and vocational education and training (TVET). The TVET investment share was raised and lowered by 50% in comparison to the base case in this sensitivity analysis. As a result of improved labor absorption in industries like sustainable agriculture, waste management, and renewable energy, the results show that increased TVET investment significantly increases the creation of green jobs, especially after 2025. Conversely, a smaller investment share leads to a slower growth in green jobs and a growing skill gap, with employment levels lagging behind the base case starting in the 2030s.

Secondary effects on greenhouse gas emissions are also a result of changes in TVET investment. The adoption of climate-resilient practices accelerates with improved skilled labor availability, resulting in a slight but significant decrease in cumulative GHG concentrations under the +50% scenario. The slightly higher emissions trajectory in the –50% case suggests that labor market structural changes have been delayed. Overall, the findings support the importance of skill development in facilitating the green transition and imply that policies that increase TVET investment can have a positive impact on both the environment and employment.

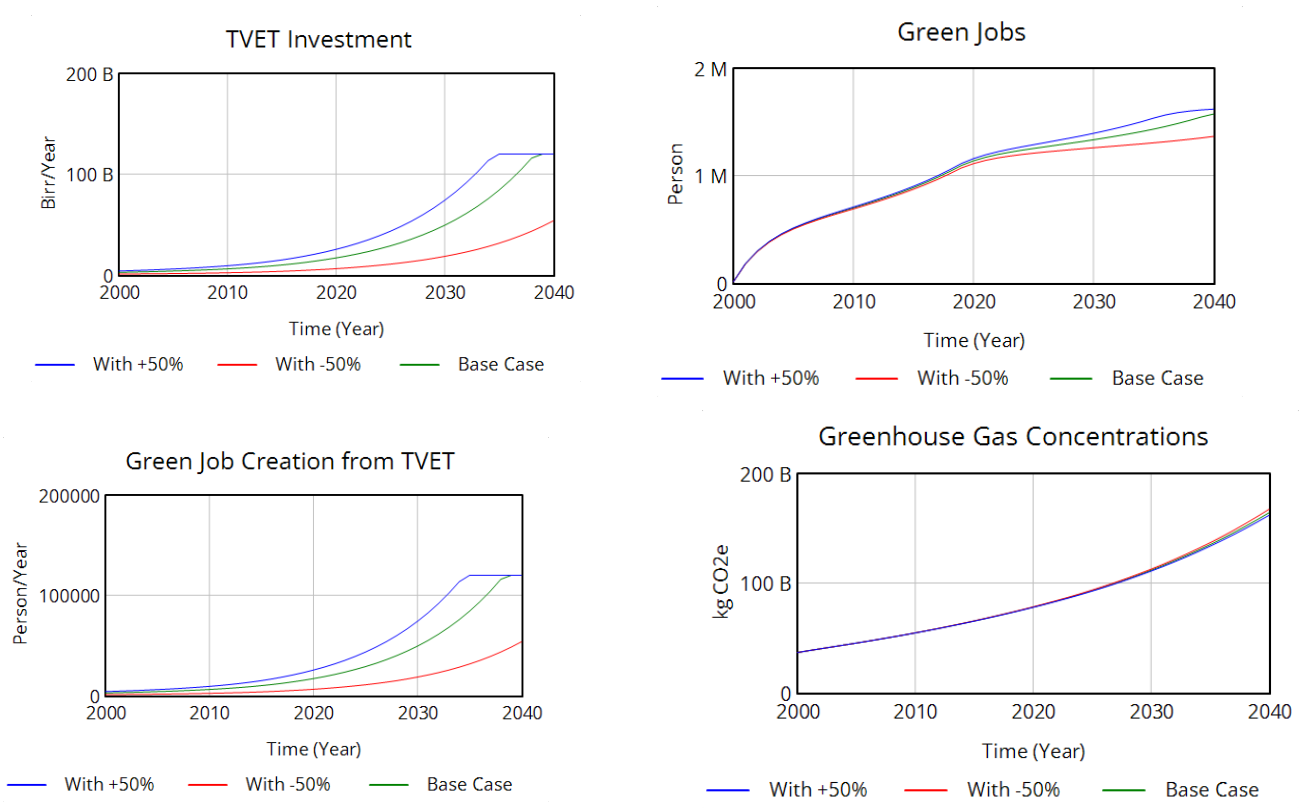

Figure 9: Sensitivity analysis of TVET Investment, Green Jobs, Green Job Creation from TVET and GHG concentration to TVET investment share

This sensitivity analysis investigates the effect of changing emission reduction efficiency on greenhouse gas (GHG) concentrations and temperature. When the efficiency is increased by 50%, the model shows a drastic cut in GHG accumulation compared to the base case, leading to a slower rise in temperature over time. Conversely, when the efficiency is reduced by 50%, the GHG levels are exceedingly higher and the rise in temperature is sharper. Although the changes in temperature appear modest, the consistent divergence across scenarios highlights the importance of emission efficiency in shaping long-term climate outcomes. The results emphasize that even small increases in mitigation performance can have real environmental benefits in the long term.

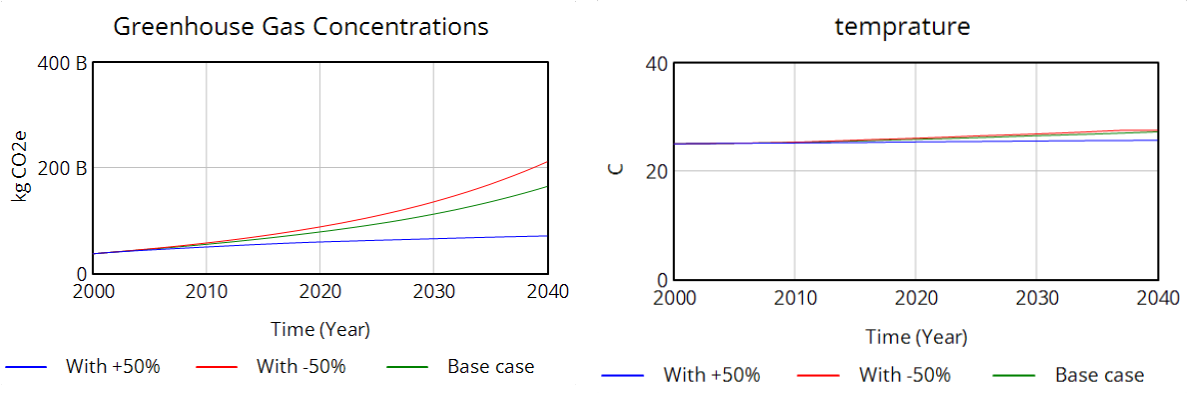

Figure 10: Sensitivity of GHG emission and temprature to different emission reduction efficiencies

4.2. Scenario Design

4.2.1. Base Case

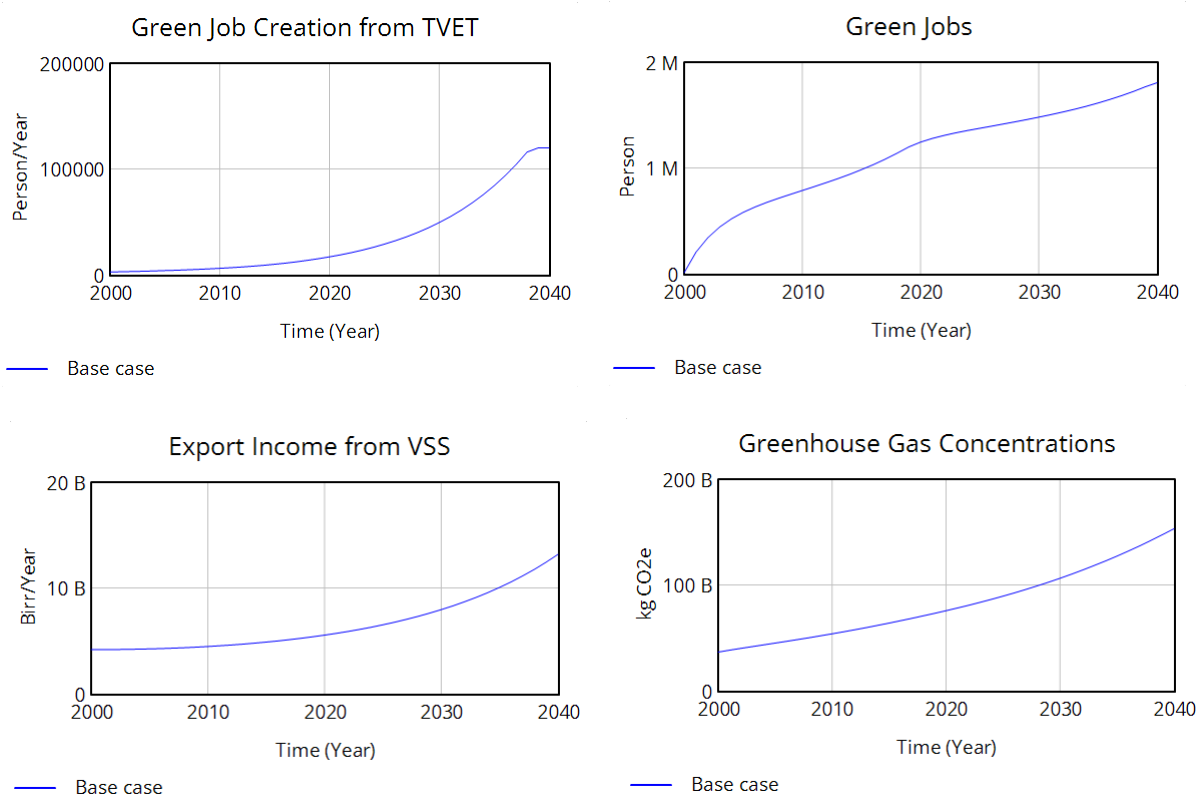

Figure 11: Values of Green Job creation from TVET, Green Jobs, Export Income from VSS and Greenhouse Gas Concertation under the base case

In the base case scenario, all policy variables were kept at their reference values and no additional interventions or scale ups were introduced. The simulation shows a gradual increase in green job

creation from TVET, which commenced gently in the 2020s and gained momentum toward 2040 as more skilled workers entered the labor market. Such a rise in TVET-driven employment leads to a steady increase in the total number of green jobs, which reaches almost two million at the end of the simulation period. The path of green jobs indicates that even without policy improvements, Ethiopia's current green investment and workforce training programs can still provide a moderate growth of environmentally sustainable employment, although not at the pace needed to absorb the expanding labor force.

As Ethiopia gradually enters climate-conscious markets, its export revenue from Voluntary Sustainability Standards (VSS) also increases over time. But under the base case, this growth is still modest, suggesting that VSS's contribution to employment and foreign exchange will remain limited in the absence of proactive measures to increase its adoption. With no significant difference from past trends, greenhouse gas concentrations are still rising steadily, suggesting that current institutional capacity and investment levels are not enough to counteract the growth in emissions. All things considered, the base case offers a reference path that emphasizes the necessity of more aggressive and focused policy interventions to improve the creation of green jobs and the reduction of emissions.

4.2.2. Scenario 1: Green Skills Expansion Scenario

This scenario is a model of a mild increment in the proportion of GDP devoted to Technical and Vocational Education and Training (TVET), that is aimed at extending green skills to enable the green transition of Ethiopia. The policy decision increases the TVET investment share from an initial value of 0.0008 to 0.0012 (or 0.12% of GDP), which is a fiscally sustainable and significant step that is consistent with national education investment trends. This figure was picked to show both the budget and the policy given that Ethiopia currently allocates less than 1% of its education budget to TVET (Bahri, 2023), although it is very important in training the workforce for the green sectors. The case further believes that more TVET investment results in the improvement of institutional capacity, hence, increasing the number of students who enroll and graduate and also green job creation through better placement rates and labor market needs continuity.

4.2.3. Scenario 2: Phased Green Bond Adoption Scenario

This scenario replicates the phased release of green bond financing in Ethiopia between 2025 and through a linear increase in the Green Bond Policy Lever. The lever grows uniformly after 2035, after following an ambitious policy trajectory where the issuance of bonds keeps rising with growing

institutional maturity and market absorption capacity. For simulation purposes, the assumption is made that the green bond instrument finances climate-resilient industries and directly finances the creation of green employment.

4.2.4. Scenario 3: Enhanced Green Job Effectiveness Scenario

This scenario looks at the effects of increasing the emission mitigation capability of green jobs by changing the emission reduction efficiency factor from 1000 to 1300 kg CO_2e per worker per year. It represents a 30% improvement, based on reasonable increments from the better matching of green job training with climate change results, the utilization of cleaner tech, and the more effective focus of the project. The scenario is set to find out if the improvement of the quality of green employment—apart from its increase in number—can provide some environmental benefits.

4.2.5. Scenario 4: Accelerated VSS Adoption Scenario

This scenario mimics the effect of a deliberate policy intervention to increase the adoption of Voluntary Sustainability Standards (VSS) across Ethiopia's export sectors from 2026. VSS schemes such as Fairtrade, Organic, and Global G.A.P. offer producers cleaner market access and, in general, command price premiums. The intervention forecasts that policy, donor, and market factors collectively propel the adoption rate higher, most significantly in employment-intensive sectors such as agriculture and floriculture. The scenario is designed to examine whether boosting VSS participation has the potential to be a double stimulus of export revenue and green job creation that is inclusive.

4.2.6. Scenario 5: Enhanced Public-Private Climate Partnership Scenario

This scenario illustrates the effect of improving public-private climate investment partnerships by raising the elasticity of private investment in relation to public climate investment from 0.4 to 0.6. This change imitates a private sector that is more reactive to a policy environment that has clearer regulations, better risk-sharing mechanisms, and stronger incentives for investment in green infrastructure. The idea is to find out if using more private money can significantly accelerate the creation of green jobs and help public spending have a greater impact.

4.2.7. Scenario 6: All scenarios combined

This last scenario represents a coordinated green economy strategy by simulating the combined impact of the five previous policy interventions. It includes: (1) better elasticity of private investment in response to public climate spending; (2) phased rollout of green bond financing; (3) improved emission reduction efficiency of green jobs; (4) accelerated adoption of Voluntary Sustainability

Standards (VSS); and (5) increased TVET investment for green skill development. Together, these policy adjustments seek to mitigate climate-related productivity losses, including those brought on by heat stress, while concurrently addressing employment and environmental issues.

4.3. Scenario Analysis

4.3.1. Scenario 1: Green Skills Expansion Scenario

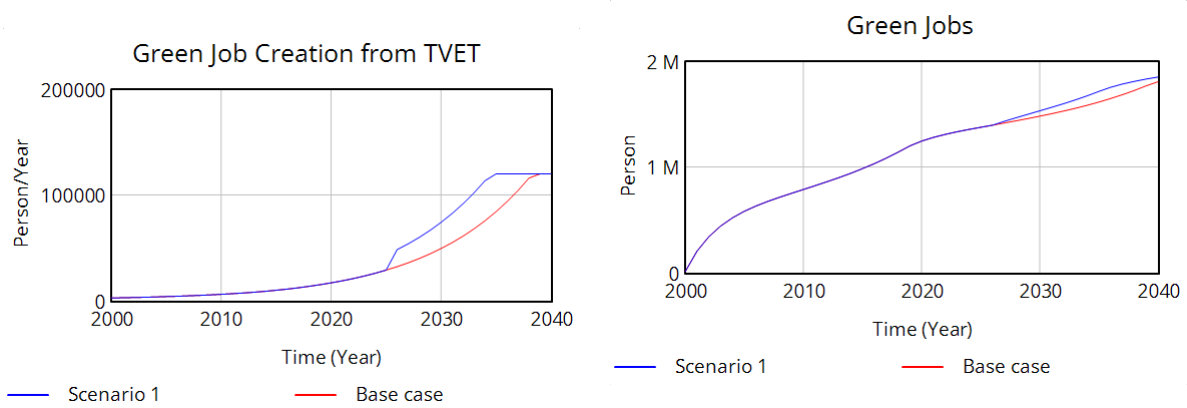

Figure 12: Green Job Creation from TVET and Green Jobs under Scenario 1

The results of the simulation demonstrate that as TVET investment rises, the number of green jobs created increases steadily. By the late 2020s, the stock of green jobs surpassed the base case, and by 2040, it had surpassed 2 million. The effect is more apparent in the creation of green jobs from TVET, where the annual flow after 2025 deviates significantly from the base case, reaching over 120,000 new jobs annually by the middle of the 1930s. This demonstrates how responsive the system is to investments in vocational training. The growth of a green-skilled workforce supports larger emission reduction initiatives, even though the environmental impact is indirect. All things considered, the scenario demonstrates that small, focused increases in TVET funding can result in significant and long-lasting job benefits during Ethiopia's green transition.

4.3.2. Scenario 2: Phased Green Bond Adoption Scenario

The results exhibit a linear growth with high intensity in both green bond policy lever and green bond issue per year, reaching nearly 6 billion Birr by 2040. This generates a huge growth in green jobs through bond financing, reaching nearly 100,000 new jobs per year by the end year of the simulation. The green job stock also exceeds the base case by a big margin. However, greenhouse gas levels remain high with limited deviation from the base case path. This suggests that while green bond expansion is highly effective in creating jobs, its abatement impact is modest unless supported by stronger targeting of the projects. The overall picture presents the potential of unlimited green bond expansion as an exceptionally powerful job policy tool, but with modest climate impact unless supported by emissions-focused measures.

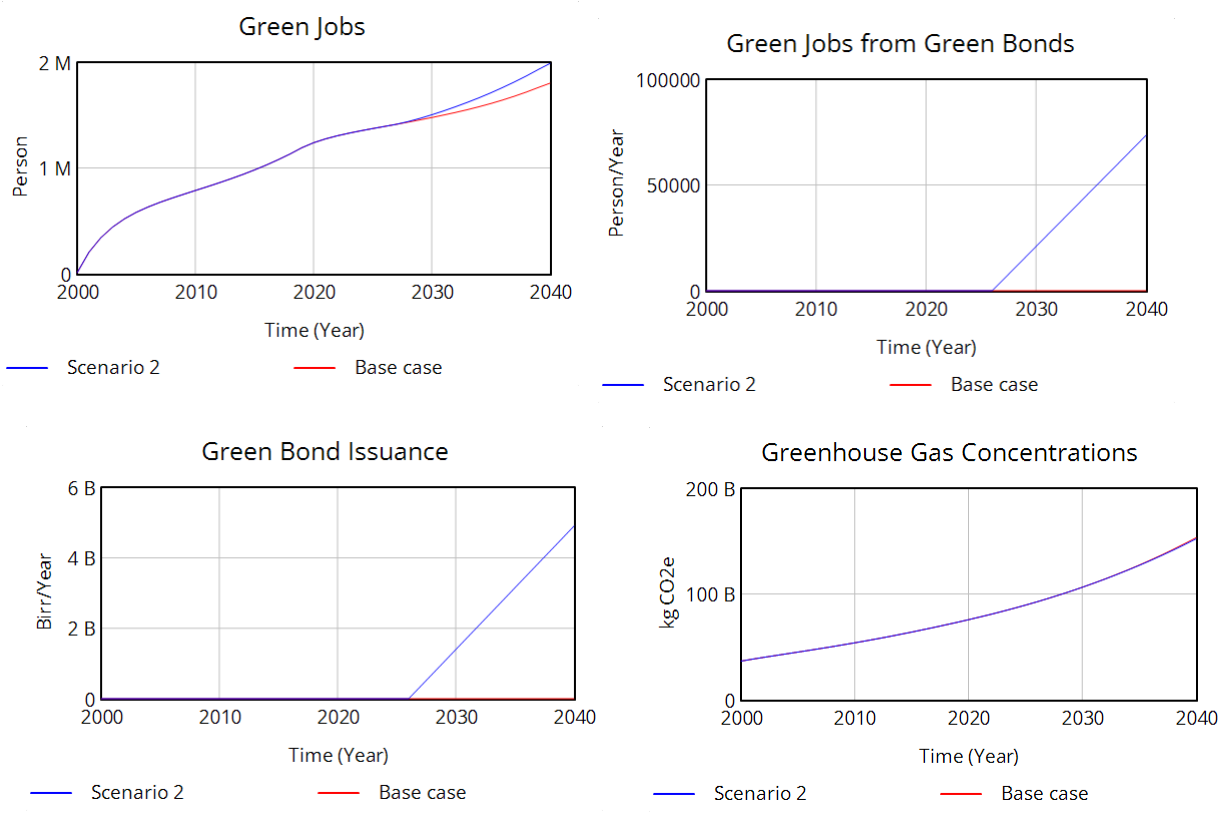

Figure 13: Values for Green Jobs, Green Jobs from Green Bonds, Green bond Issuance and GHG Concentration under scenario 2

4.3.3. Scenario 3: Enhanced Green Job Effectiveness Scenario

Scenario 3 illustrates the influence of raising the emission mitigation efficiency of green employment from 1,000 to 1,300 kg CO_2e per worker annually. The energy-efficient job improvement represents

the possible effect of more accurate job matching with the clean energy sector, better technologies, or more focused projects that bring the climate benefits of each green job to a higher level. The policy is launched in 2026 with a step function that represents a conscious move in workforce efficiency.

The outcomes of the simulation demonstrate a discernible variation in environmental performance. Shortly after the policy goes into effect, greenhouse gas concentrations start to deviate from the base case, and the difference keeps growing until 2040. In contrast to the steady upward trend seen in the base case, this decrease results in a slower rise in the average temperature, which levels off slightly under Scenario 3. Despite the slight difference in absolute temperature, the trajectory shift has significant long-term climate implications.

This situation highlights the importance of green job productivity over only expansion. While the employment impact is modest, the mitigation contribution is large and strategically relevant. Further, stabilization of temperature rise prevents curtailments of productivity because of heat stress, particularly in sectors like agriculture and construction. Scenario 3 reiterates the importance of not only the number of green jobs produced, but also their performance on climate and economic co-benefits.

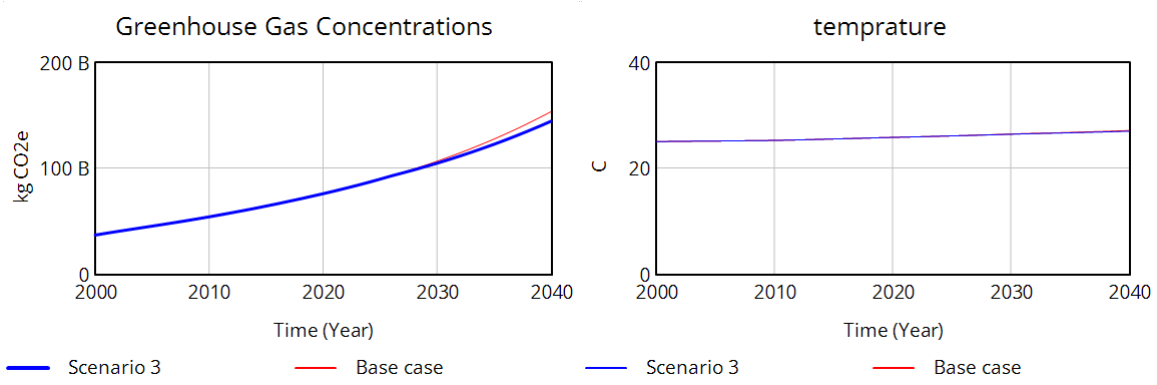

Figure 14: Values for GHG Concentration and Temprature under scenario 3

4.3.4. Scenario 4: Accelerated VSS Adoption Scenario

The result is a sharp increase in both jobs and export revenues following the start of VSS expansion in 2026. Gross yearly green job creation because of VSS adoption rises steadily, reaching close to 140,000 jobs per year by 2040—well beyond the base case. This expansion reflects the intensity of compliance of certified production systems as well as the overall institutional environment supporting

them. Overall stock of green jobs also rises more rapidly under this case, implying spillover effects across the economy.

After the policy is put into effect, export revenue from VSS-certified goods rises significantly, reaching nearly 20 billion Birr yearly by 2040 as opposed to less than 13 billion in the base case. This illustrates how export competitiveness and revenue growth can be unlocked through sustainability-linked certification. Strong responsiveness to policy support is indicated by the immediate uplift following 2026, especially when certification makes it easier to access premium markets.

In general, Scenario 4 illustrates the possible use of sustainability standards in Africa not only for ensuring compliance, but also as drivers of job creation and economic diversification. The VSS expansion in Ethiopia is also compatible with the country's green industrial policy and trade strategy.

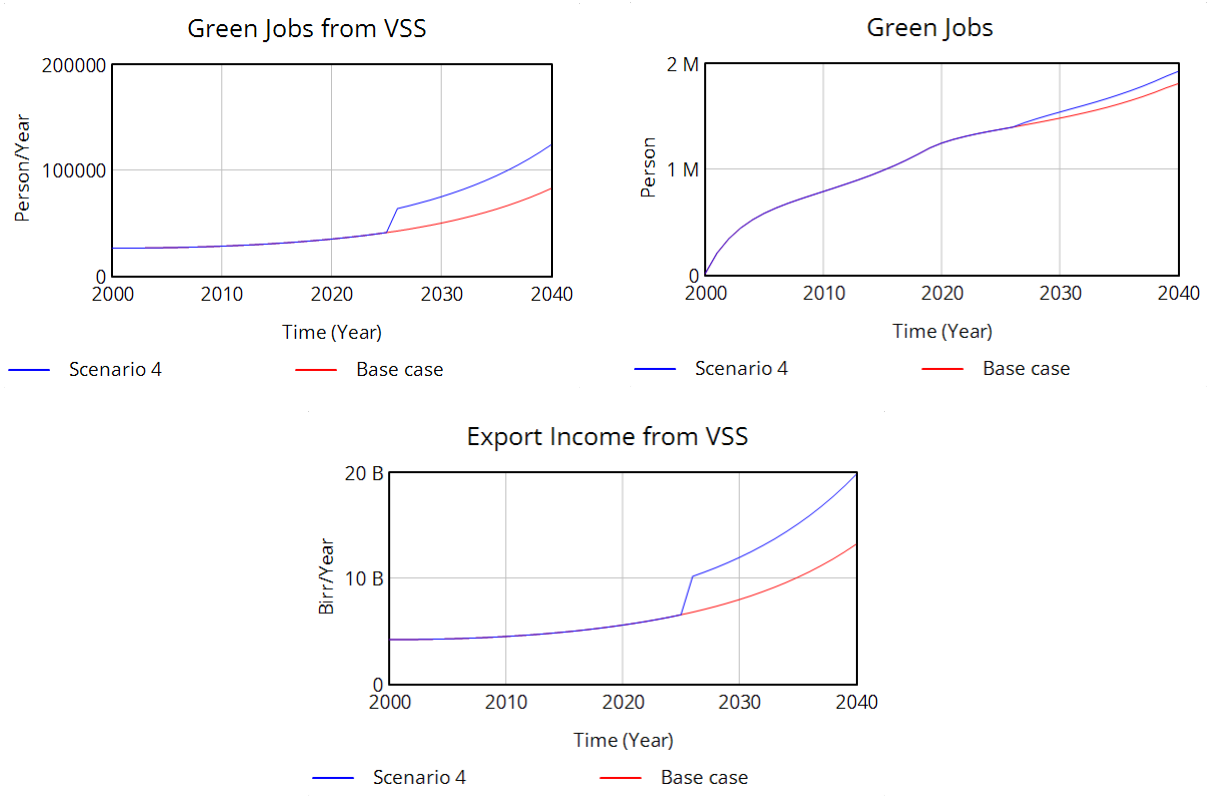

Figure 15: Values for GHG Emission, Green Jobs and Export Income from VSS under scenario 5

4.3.5. Scenario 5: Enhanced Public-Private Climate Partnership Scenario

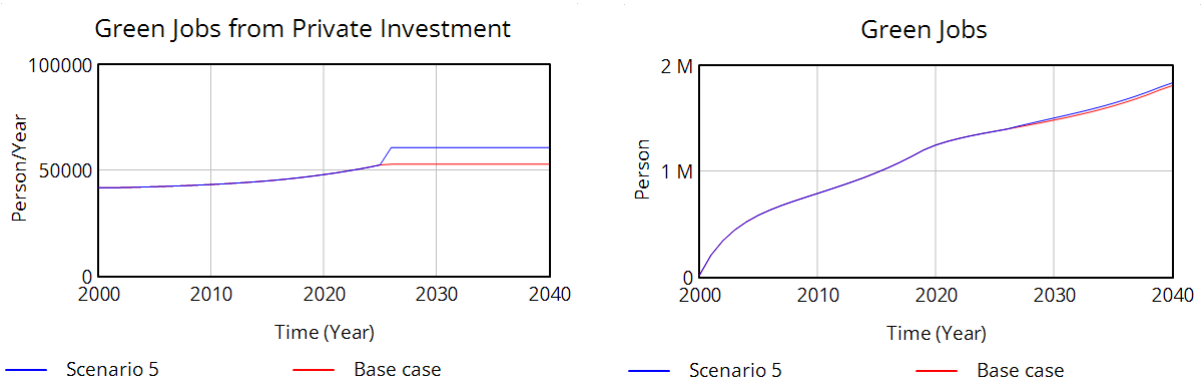

Figure 16: Values for Green Jobs and Green Jobs from Private Investment under Scenario 5

The simulation results capture a gradual but modest increase in private-investment-sustained green employment after the legislation passes the time it takes for the elasticity to respond. From 2026, annual job creation from private origins becomes higher and more comparable with the base case than previously, increasing to around 60,000 jobs annually by 2040. The increase is modest but indicates a clear labour market response enhancement to public investment impulses.

At the aggregate level, the aggregate stock of green jobs also rises above the base case, although with fairly moderate divergence. This suggests that although private sector engagement will support public investment projects, its addition to employment performance is small without complementing broader structural change. Nevertheless, the scenario reaffirms the utilization of private finance as part of Ethiopia's green transformation, particularly in renewable energy, sustainable agriculture, and transport.

Overall, Scenario 5 adds credibility to the strategic worth of creating a more conducive setting for private climate finance. Even a modest increase in responsiveness can generate steady employment benefits over time and is therefore a useful policy lever in pursuing the scaling up of green economic change.

4.3.6. Scenario 6: All scenarios combined

Scenario 6 reflects the combined effect of a fully integrated green transition strategy with more TVET investment, green bond finance, more productive green jobs, accelerated use of voluntary sustainability standards, and increased responsiveness of private investment. The combined effect of

these levers achieves the highest employment and environmental performance gains in all the scenarios.

Starting in the late 2020s, the number of green jobs created shows a notable and growing advantage over the base case, reaching over 2.5 million by 2040. This illustrates the combined effects of expanded training capabilities, funding for green industries, and more extensive institutional support systems. Scenario 6's employment trajectory shows that integrated policy actions can create more green jobs and maintain their growth over time.

Environmental effects also increase substantially. Greenhouse gas concentrations keep rising in both scenarios, but the path in Scenario 6 begins to diverge from the base case after 2026 and by 2040 becomes steeper. What this implies is that the joint interventions slow the growth of emissions, leading to a large mitigation effect in the long run. The difference between concentration levels in 2040 is large enough to make an impact on temperature moderation and long-term climate risk.

Collectively, the outcomes of Scenario 6 emphasize the value of strategic consistency. Against the alternative single policy move, this collective approach demonstrates how simultaneous action in labor, finance, and institutional fields can yield synergistic effects — accelerating green jobs with equity, as well as with major environmental effect. Scenario 6 offers wide-ranging endorsement of a systems-based policy approach to Ethiopia's transition toward a green, climate-resilient economy.

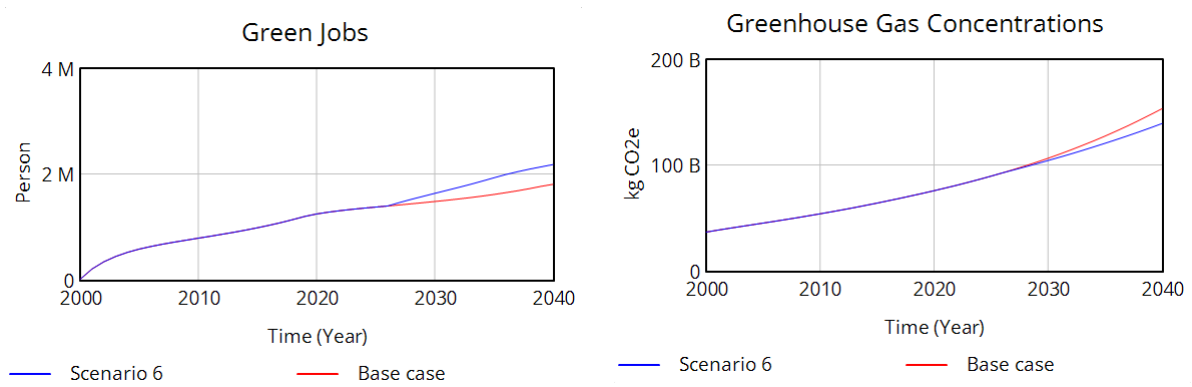

Figure 17: Values for Green Jobs and GHG Concentration under Scenario 6

	Years	Green Jobs (In millions)
Base Case	2020	1.28
	2030	1.48
	2040	1.80
Growth in relation to the base case (%)		
Scenario 6	2030	10.40
	2040	20.68

Table 1: Green Jobs Growth (% Change) – Scenario 6 vs. Base

The table contrasts green job forecasts in the base case and Scenario 6 for particular years. It indicates that whereas green jobs increase at a constant rate in the base case, Scenario 6 results in a 10.4% rise by 2030 and a 20.68% rise by 2040, thus underlining the influence of combined green policy measures.

Chapter 5: Conclusion and Policy Recommendations

5.1. Conclusion

This research investigated the complex connections between green economy initiatives and labor markets in Ethiopia through a system dynamics modeling approach. The study relied on the Climate Resilient Green Economy (CRGE) framework, including drivers such as climate finance, technical and vocational education and training (TVET), green job creation mechanisms, greenhouse gas emissions, and labor productivity. The findings indicate that the transition to a green economy opens up the various dimensions of employment generation, environmental sustainability, and economic resilience.

The scenario-based simulations of the model have demonstrated that while singular policy levers—such as increasing TVET investment or launching green bonds—generate measurable results, their combined application produces far more significant and synergistic effects. In particular, Scenario 6, which combines TVET improvement, the issue of green bonds, and the employment of institutional instruments such as the voluntary sustainability standards (VSS), revealed the highest number of green jobs to be created, a more moderate transition in the accumulation of greenhouse gases, and a real increase in labor productivity. Productivity improvements are mostly related to temperature stress relief as a result of emission reduction, thus co-benefits of economic action of the environmental sector are emphasized.

Furthermore, the findings underscore the role of institutional coordination and targeted financial mobilization in unlocking private and public investments for green employment sectors. The labor market response was found to be sensitive to the efficiency of job placement systems and the relevance of skills imparted. The study also illustrated that, beyond environmental necessity, climate action in Ethiopia represents a strategic opportunity to stimulate inclusive and sustainable employment.

5.2 Policy Recommendations

Policy leaders must consider developing investment strategies that strongly link climate finance—especially from new sources such as green bonds and carbon credit revenues—to human capital building. One possible pathway is to link these funds directly into expanding and upgrading Technical and Vocational Education and Training (TVET) networks. Focusing on green skill development in

sectors such as renewable energy, sustainable agriculture, and waste management has the potential to accelerate the building of a climate-resilient and future-ready workforce.

To make this transition possible, the government and the financial institutions must establish a credible and transparent green bond structure. This would entail a pipeline of well-developed, CRGE-conformant projects, third-party verification systems, and instruments to ensure transparency and accountability. These steps are essential in a bid to boost investor confidence and direct domestic as well as international climate finance to sustainable development projects.

Improving TVET placement arrangements' efficiency is also important. This requires further synchronization of training programs to the needs of the labor market, achieved through efficient labor demand forecasting systems, improved industry-training center collaboration, and the introduction of sustainability-oriented curricula. Such reforms will ensure graduates attain relevant and marketable skills in the emerging green economy.

The private sector can't be overlooked in the transition to the green economy. Applying tools like Voluntary Sustainability Standards (VSS) can play a crucial role in ensuring private sector action is aligned with environmental aims. Government support through certification schemes, awareness programs, and export promotion can encourage businesses to adopt sustainable production, become more competitive, and promote responsible investment.

Finally, an interlocked, cross-sectoral response is essential for effective implementation of the green economy. The ministries of labor, environment, finance, and education will need to work together through an inter-ministerial green transition taskforce. Institutional coordination of this type will help policy consistency, reduce duplication, and allow for synergistic interventions that advance both environmental and socio-economic objectives.

Finally, Ethiopia's green transition promises something unique not only to address pressing environmental issues but also to transform its job market. The findings of this research underscore the importance of systematic and well-financed policy strategies. With coordination between climate finance and skill development and institutional transformation, Ethiopia can generate significant jobs, enhance productivity, and realize long-term climate resilience. Scaling up these plans will be essential in ensuring that the transition to a green economy provides sustainable and inclusive benefits for all citizens.

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Appendix A: Model equations, values and units

(01) adjusted labor productivity=Labor Productivity*effect of temperature on labor productivity

Units: Birr/Person

(02) Attrition Rate=0.3

Units: 1/Year

(03) Base Employment from Foreign Finance=10000

Units: Person/Year

(04) Base Employment Private=40000

Units: Person/Year

(05) Base Employment Public=200000

Units: Person/Year

(06) climate finance leverage index=Public Climate investment/Reference Public Investment Capacity

Units: Dmnl

(07) Delayed Foreign Climate Finance=DELAY1(Foreign Climate Finance, 1)

Units: Birr/Year

(08) Delayed Private Climate Investment=DELAY1(Private Climate Investment, 1.5)

Units: C

(09) Delayed Public Climate Investment=DELAY1(Public Climate investment, 1)

Units: Birr/Year

(10) effect of greenhouse gas on temperature=WITH LOOKUP (Greenhouse Gas Concentrations / reference greenhouse gas concentrations,([(0,0)-(5,1.1)], (1,1), (1.5,1.01), (2,1.03), (3,1.06), (4,1.08),(5,1.1)))

Units: Dmnl

(11) effect of temprature on labor productivity = WITH LOOKUP (relative temperature, ([(0,0)-(1.6,1),(1,1),(1.05,0.95),(1.1,0.9),(1.15,0.8),(1.25,0.6),(1.4,0.4), (1.6,0.2)],(1,1),(1.05,0.95),(1.1,0.9),(1.15,0.8),(1.25,0.6),(1.4 ,0.4),(1.6,0.2)))

Units: Dmnl

(12) Elasticity Foreign=0.6

Units: Dmnl

(13) Elasticity Private=0.4

Units: Dmnl

(14) Elasticity Public=0.6

Units: Dmnl

(15) Emission Growth=Emission Growth Rate*Greenhouse Gas Concentrations

Units: kg CO2e/Year

(16) Emission Growth Rate=0.1

Units: 1/Year

(17) Emission Reduction=emission reduction efficiency*Green Jobs

Units: kg CO2e/Year

(18) emission reduction efficiency=1000

Units: kg CO2e / Person / Year

(19) Employment from VSS=Export*VSS Adoption Rate*VSS Labor coefficient

Units: Person

(20) Export= INTEG (Export Growth,1.82e+11)

Units: Birr

(21) Export Growth=Export*Export Growth Rate

Units: Birr/Year

(22) Export Growth Rate=RAMP(0.0015, 2000 , 2040)

Units: 1/Year

(23) Export Income from VSS=VSS Adoption Rate*Export*(1+Price Premium from VSS)

Units: Birr/Year

(24) FINAL TIME = 2040

Units: Year

The final time for the simulation.

(25) Foreign Climate Finance=

WITH LOOKUP(climate finance leverage index, ([(0,0)-(1,1.05e+11)], (0, 1.1e+10), (0.25, 3.1e+10), (0.4, 7e+10), (0.5, 8e+10), (0.65, 9e+10), (0.75, 9.5e+10), (0.9, 1e+11), (1, 1.05e+11)))

Units: Birr/Year

(26) GDP= INTEG (GDP growth,3.4e+12)

Units: Birr

(27) GDP growth=GDP * GDP growth rate *

MIN(1.5, MAX(0.5, (1 - sensitivity to productivity) + sensitivity to productivity * adjusted labor productivity / reference labor productivity))

Units: Birr/Year

(28) GDP growth from VSS=Export Income from VSS+GDP multiplier on VSS

Units: Birr/Year

(29) GDP growth rate=0.075

Units: 1/Year

(30) GDP multiplier on VSS=1.5

Units: Dmnl

(31) Green Bond Issuance=Green Bond Policy Lever*Maximum Green Bond Potential

Units: Birr/Year

(32) Green Bond Labor Coefficient=1.5e-05

Units: Person/Birr

(33) Green Bond Policy Lever=0

Units: Dmnl [0,1]

(34) Green Employment Share=Green Jobs/Total work force

Units: Dmnl

(35) Green Job Attrition Rate=Attrition Rate*Green Jobs

Units: Person/Year

(36) Green Job Creation Coefficient=1e-06

Units: Dmnl

(37) Green Job Creation from TVET=Green Job Creation Coefficient*TVET Investment
Units: Person/Year

(38) Green Job Creation Rate=
Green Jobs from foreign climate finance + Green Jobs from Private Investment + Green Jobs from Public Investment+ Green Jobs from Green Bonds+ Green Job Creation from TVET+ Green Jobs from VSS
Units: Person/Year

(39) Green Jobs= INTEG (Green Job Creation Rate-Green Job Attrition Rate,11201)
Units: Person

(40) Green Jobs from foreign climate finance=Base Employment from Foreign Finance * (MIN(2, MAX(0.2, Delayed Foreign Climate Finance/ Reference Foreign Finance))) ^ Elasticity Foreign
Units: Person/Year

(41) Green Jobs from Green Bonds=
Green Bond Issuance*Green Bond Labor Coefficient
Units: Person/Year

(42) Green Jobs from Private Investment=
Base Employment Private *(MIN(2, MAX(0.2, Delayed Private Climate Investment / Reference Private Investment))) ^ Elasticity Private
Units: Person/Year

(43) Green Jobs from Public Investment=
Base Employment Public * (MIN(2, MAX(0.2, Delayed Public Climate Investment / Reference Public Investment))) ^Elasticity Public
Units: Person/Year

(44) Green Jobs from VSS=Employment from VSS*Share of green jobs in VSS
Units: Person/Year

(45) Greenhouse Gas Concentrations= INTEG (Emission Growth-Emission Reduction, 3.66331e+10)
Units: kg CO2e

(46) INITIAL TIME = 2000

Units: Year

The initial time for the simulation

(47) Labor Force Participation Rate=0.4583

Units: Dmnl

(48) Labor Productivity=GDP/Total work force

Units: Birr/Person

(49) Maximum Green Bond Potential=7e+09

Units: Birr/Year

(50) net population growth rate=0.03

Units: Dmnl/Year

(51) normal temprature=25

Units: C

(52) Per capita income=GDP/Population

Units: Birr/Person

(53) Population= INTEG (population growth,6.70319e+07)

Units: Person

(54) population growth=net population growth rate*Population

Units: Person/Year

(55) Price Premium from VSS=0.15

Units: Birr

(56) Private Climate Investment= WITH LOOKUP (Public Investment Index, ([(0,3.5e+09)-(1,2.4e+10)], (0,3.5e+09), (0.25,7e+09), (0.5,1.2e+10), (0.75,1.8e+10), (1,2.4e+10)))

Units: Birr/Year

(57) Public Climate investment= MIN(GDP * Public Climate Investment Share * Scale 2, 7e+11)

Units: Birr/Year

(58) Public Climate Investment Share=0.0065

Units: Dmnl

(59) Public Investment Index=Public Climate investment/Reference Public Investment Capacity

Units: Dmnl

(60) Reference Foreign Finance=5e+10

Units: Birr/Year

(61) reference greenhouse gas concentrations=3.66331e+10

Units: kg CO2e

(62) reference labor productivity=88684

Units: Birr/Person

(63) Reference Private Investment=3.5e+09

Units: Birr/Year

(64) Reference Public Investment=5e+10

Units: Birr/Year

(65) Reference Public Investment Capacity=8.397e+11

Units: Birr/Year

(66) relative temprature=temprature/normal temprature

Units: Dmnl

(67) SAVEPER = TIME STEP

Units: Year [0,?]

The frequency with which output is stored.

(68) Scale 1=1

Units: 1/Year

(69) Scale 2=1

Units: 1/Year

(70) sensitivity to productivity=0.25

Units: Dmnl

(71) Share of green jobs in VSS=0.6

Units: Dmnl

(72) temprature=effect of greenhouse gas on temperature*normal temprature

Units: C

(73) TIME STEP = 1

Units: Year [0,?] The time step for the simulation.

(74) Total work force=Labor Force Participation Rate*Population

Units: Person

(75) TVET Investment=MIN (GDP * TVET Investment Share * Scale 1, 1.2e+11)

Units: Birr/Year

(76) TVET Investment Share=0.0008

Units: Dmnl

(77) VSS Adoption Rate=0.02

Units: Dmnl

(78) VSS Labor coefficient=1.2e-05

Units: Person/Birr