

Refugee Integration in Norway: A System Dynamics Modeling Approach

by

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Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of
Master of Philosophy in System Dynamics

November 2022



Acknowledgements

First and foremost, I would like to express my sincere gratitude to my advisor, Christina Gkini. She has been a great mentor and a great advisor, and I have learnt so much from her. Thank you also for putting up with my emotional break down at the very last phase of my thesis. My words cannot describe enough of my appreciation for all your help.

I also would like to also express my gratitude to Birgit. Without her encouragement, I probably would have dropped out since 304 and miss out on the opportunity to know how much I can accomplish.

To all my classmate, thank you for such a unique journey when we all got to know each other over zoom link and help each other through all the courses. I remember one of us said, “It’s really strange to know that you have legs!” That was funny! Thank you to Pei Shan, Kat and Peyman for your friendship and a wonderful experience working with you. Thank you so much to Furkan, who has been there, mostly at Starbuck, where I know I can find him when I need support and for all your help throughout this journey. I sincerely appreciate it.

To Java, who probably does not understand what I am doing and why I am stress out from time to time, thank you for adapting so well in Norway and always be there for me. Your persistently begging for food has managed to distract me from my own problems.

To my friend Jon, thank you for letting me work remotely while I am in Norway and for your understanding when I need to have full concentration in my thesis and pause my work.

To my friends back at home, Tahn, Pat and Kate, thank you for all the endless phone calls and your support for me in my journey to Norway. I am lucky to have you guys.

To my family back at home, maybe it is not your first choice to have your only daughter lives so far away, yet you have supported me every ways you could. I am truly grateful.

Last but not least, to Torbjorn, thank you for being my rock. Thank you to you and your family for such a warm welcome. I know you try to make my experience in Norway comfortable as much as possible, I really appreciate it. You are my inspiration to embark on the new journey here.

Rujirin

28th November 2022

Abstract

In the past decade, there has been a continuous rise of a number of refugees globally. Many countries are therefore expected to help and welcome more refugees. However, many studies have shown that among the immigrants, the refugees face the most challenges in term of integrating into their new host society. The most popular indicator to measure the integration that has been used thus far is the employment rate. The problem that Norway faces is that the employment rate of refugees is the lowest among other immigration population and almost 30% lower than the national employment rate. The purpose of this research is therefore to integrate the knowledge about the refugee integration and explore other indicators besides employment rate and the dynamics between them in order to have a better understanding of how the refugees integrate in their host country. Furthermore, this research focuses on the mechanisms that trap the refugees in the vicious cycle which prevent them from a fulfilling life in the new country.

This research uses system dynamics to capture and quantify the dynamics of refugee integration. The literature review was conducted to form the dynamic hypothesis and the structure of the exploratory model was built based on it.

We have identified that the key indicators that contribute to refugee integration are the refugees' employment rate, their stress level, their social interaction to the local people, their social skill, their job performance, and the perception of local people towards refugees. These indicators are interconnected and form compounding reinforcing loops. Our analysis shows the "entry trap" where refugees is trapped in the unskilled worker job which has a relatively low income thus even when the perception towards refugees and social interactions are raised, these refugees still have a relatively higher stress than average due to the inequality of the income. Most importantly, since the perception towards refugee is not separated between the refugees in an entry level workforce and senior level workforce, the decrease in the perception when the entry refugees do not perform well will eventually have an impact to the senior level refugees who initially start off well.

The finding raises two potential helps to the refugee. First is to take measures to reduce the "entry trap", either by providing training or faster qualification of previous skills, or by providing incentives for businesses to hire refugees in more skilled positions. Secondly, our experiment shows that the increase in social interaction between local people and refugees can ultimately increase their job performance and social skill which increase the perception towards the refugee as well hence, better integration.

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1. Introduction

UNHCR Global Trends 2021 reports the number of people who forced to flee due to persecution, conflict, violence, human rights violations, and events seriously disturbing public order has reached 89.3 million at the end of 2021. The graph below shows the continuous rising trend in the past 10 years. It is also worth noting that when compares this figure to global population, it means that 1 in 88 people are forced to displaced from their home.

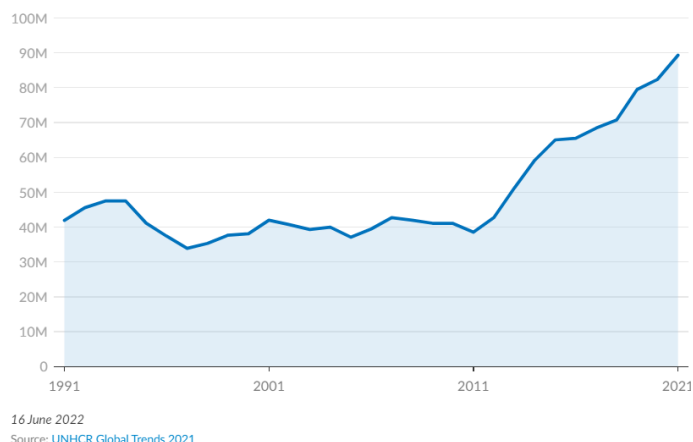


Figure 1: People forced to flee worldwide (UNHCR Global Trends 2021)

The most recent events that contributed to the rising number are the Taliban taking over in Afghanistan and the military taking over in Myanmar. However the report only includes the statistic up to the end of 2021, it is important to mention that the war between Russia and Ukraine has arisen in February 2022 and as of 30th September 2022, there are 7.5 million Ukrainian refugees across Europe. (UNHCR, 2022) In addition to the new events, there are many countries with on-going instability like Syria, Venezuela, South Sudan and Ethiopia that cause increasing number of refugees.

Beside the conflicts and political instability that drive people to flee from home, climate change is also recognized as a driver of migration (World Bank, 2021). The increased drought and desertification, rising sea levels, repeated crop failures, and more frequent and extreme weather events are likely to increase both internal and international migration, (Clement et al., 2021). Groundswell report, the report conducted by Worldbank, also estimates that in a pessimistic scenario, by 2050, 216 million people could become internal climate migrants. Although Groundswell report only mentioned the number of internal migrants, in the report UNHCR Global Trends 2021 (UNHCR, 2022) has stated that the climate change can increase

number of people in a poor country with the on-going conflict like Yemen, Syria, Somalia and Bangladesh to flee from their home countries.

Majority of the refugee landed on neighboring countries, which are mostly lower to middle income countries, while only 17% of refugees are hosted by high income countries. There are around 50,000 asylum applicants per month to EU countries before Corona pandemic and the applicant increases sharply in year 2021-2022 due to events in Afghanistan and Ukraine.

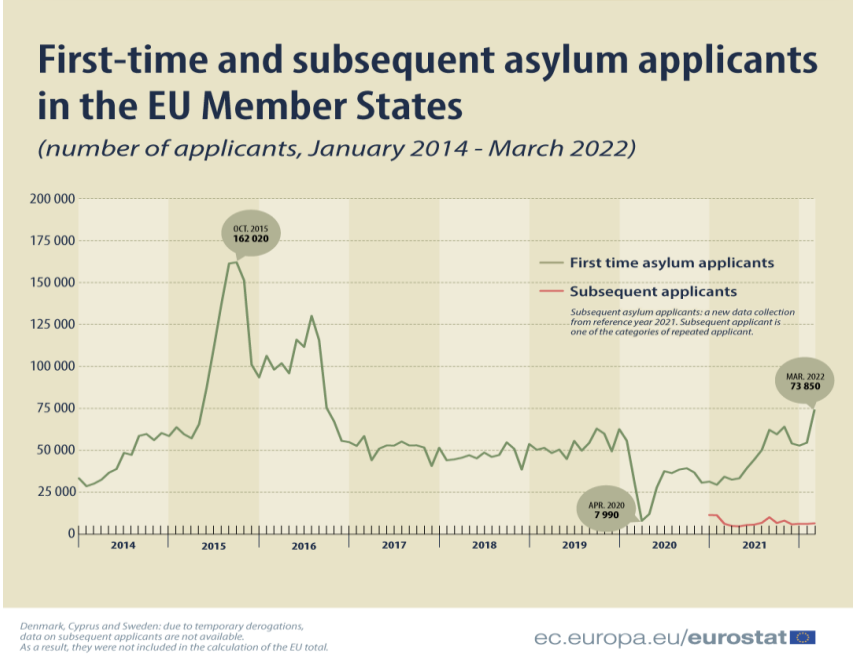


Figure 2: Asylum applicants in EU (Eurostat, 2022)

From the average of 50,000 applicants per month (600,000 applicants per year) to the EU from year 2017 to 2019 as shown in the graph above, Norway is receiving on average 4000 applicants per year in the corresponding time period which accounts for 0.7% of the total applicants to EU. The proportion of applicants that Norway received is not surprising due to the size of its population which is around 1% of the total population in EU. However in term of wealth and need for the labor workforce we do see the potential that Norway may be able to accept more refugees. Therefore in this research we would like to focus our study to Norway.

The graph below shows the asylum application to Norway from 2000 to 2021. Although the graph below shows a longer time period than that of EU, we can see that within the common timeframe 2014 to 2021, the trend for the number of applicants to Norway follow that of EU. We can also see that there is a change in the pattern before and after migration crisis in year 2015.

That is prior to 2015 there were many application to Norway and majorities are rejected hence large red area. While after 2015, the application to Norway decreases rapidly but there are less to zero rejected applications. This is due to the stricter border ID check across Europe. Of those applicants, Norway has granted the refugee status to 244,660 refugees, as of 1st January 2022. This number contributes to 4.5% of the total population in Norway. (Statistisk sentralbyrå, 2022)

Incoming asylum applications in Norway 2000 to 2021

The top line represents the total number of asylum applications (first applications + reviews). Below are the number of recognized refugees (green) and rejected applications (red).

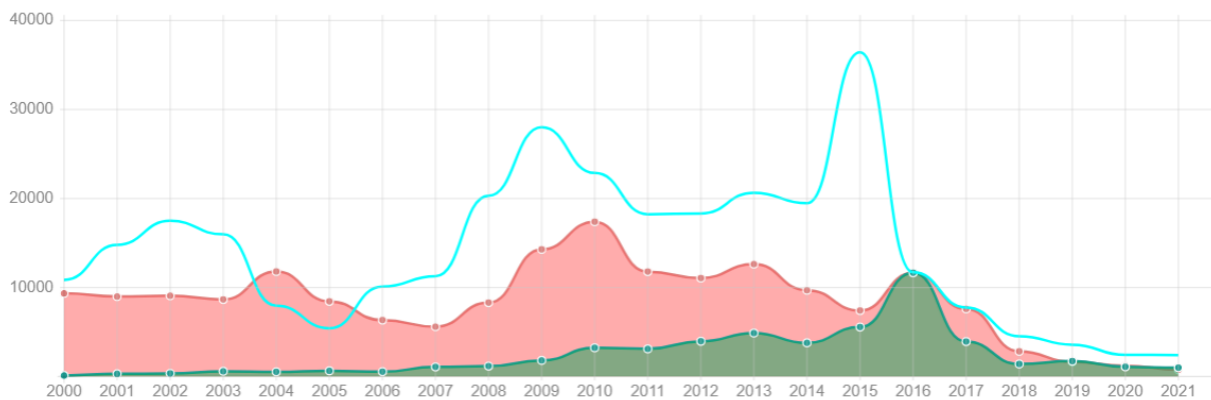


Figure 3: Incoming asylum application in Norway (World Data, 2021)

We can see from the statistic above that Europe had experienced refugee crisis in 2015 where there was an unusually large influx of refugee to Europe. At that time these refugees are mainly from Syria. The crisis divided the public opinion between being compassionate towards the refugee and being anxious towards such high number of them. (Kang, 2021) The crisis' short term implication was for the government to reshape policies related to refugee and to manage the proper accommodation for them. From here we learn that the local perception towards the refugee can have bias and this bias may contribute to the integration of the refugee. Furthermore in 2016, European Employment Policy Observatory (EEPO) has published a report "Challenges in the Labor Market Integration of Asylum Seekers and Refugees" stated the main challenges for refugee integration: legal barrier, poor institutional support, low labor market demand, lack of language skill, lack of recognition of existing qualification and lastly discrimination and social challenge. The mentioned factors contribute to the challenges for the refugees to get jobs.

The refugee's difficulties to get jobs means many of the refugees are not self-sufficient. This imposes burden to the government to continuously help them through unemployment benefit. It

also leads to local people having bad perception towards refugee and may not want to welcome more refugees to their country. As for the refugees themselves, it means poor living condition, poor health, stress and low self-esteem. The stress can lead to bad tragedy as reported on 19th December 2019 that the refugee woman from South Sudan died from drowning with her two daughters. NHIB, Norwegian Healthcare Investigation Board, has done further investigation of the incident and found that high demand and expectation of life in a new host country is one of the risks for poor health.

While we expect the rise in the refugee number in the country, statis shows that the employment for immigrants in Norway fluctuates around 60% to 65% over 20 years period which is 10% lower than the general population. Low employment rate means the more unemployment benefit that the government has to pay.

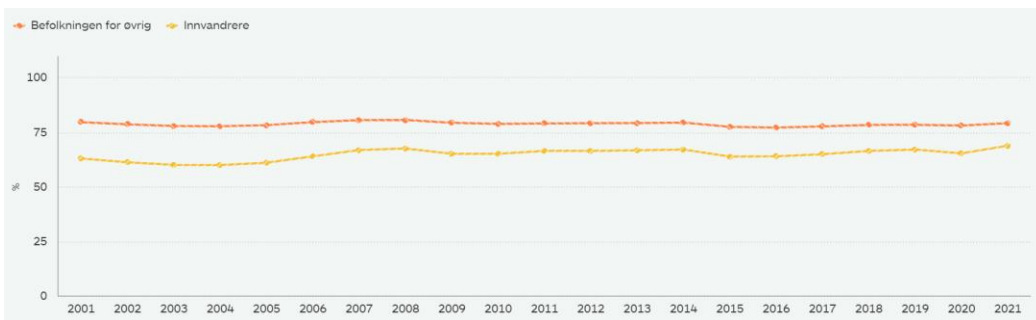


Figure 4: Employment rate among immigrants in Norway (Bufdir, 2022)

Among the immigrants, refugee is the group that has the lowest employment rate. The graph below shows the employment rate by immigrant type 2022 where the refugee and the family immigration through refugee only has 56% employment rate.

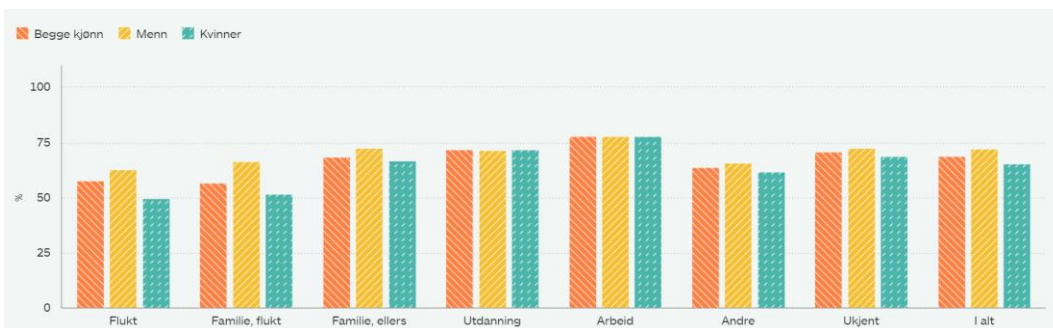


Figure 5: Employment rate by immigrant type in Norway (Bufdir, 2022)

From the statistic, we see that the employment rate for the refugees remain relatively low through out 20 years period, thus it is worth looking into the underlying reasons or dynamics of

many factors that contribute to the low employment rate for the refugees. In addition many studies use the employment rate as a main indicator for the refugee integration while in fact there could be many other factors that can be used as measurement to the integration. Thus our research objective are:

- To investigate the factors beside the employment rate that contribute to the refugee integration and the dynamic among them by using system dynamics model as an exploratory model to study such mechanism
- To explore in particular potential traps in refugee integration that is the reinforcing mechanisms that may not allow refugees to live a fulfilling life in a new country.
- To identify the potential help that can be offered to the refugees to help them integrate well in their host country

Our research aims to answer the following questions

1. What benefits can system dynamic approach bring in representing the dynamic behavior of the refugee integration in Norway?
2. What are the main indicators that contribute to the refugee integration and the dynamic between them especially the mechanism that makes refugees struggles in the new country?
3. What can potentially be the help that we can offer to the refugees to help easing them into the new host country?

2. Research Methodology

2.1 Research Methodology and Process

To answer the research questions, we need to develop a simulation model using System Dynamics modeling approach. System Dynamics was founded by Jay W Forrester in 1965. It is a method to enhance learning in complex systems and is fundamentally interdisciplinary (Sterman, 2000) “Because we are concerned with the behavior of complex systems, system dynamics is grounded in the theory of nonlinear dynamics and feedback control developed in mathematics, physics, and engineering.” (Sterman, 2002, p. 5) In addition, system dynamics seeks endogenous (arising from within) explanations for phenomena. (Sterman, 2000) Lastly, system dynamics allow for simulation of various scenarios. The simulation also makes us able to capture the complexity of our mental models and understand their implication. Especially when it is not possible to do the experiment in the real world, we can use the simulation as a main way to learn how complex system work. (Sterman, 2000) Therefore system dynamics is a good fit for our research.

We conducted this research based on the established guideline for the modeling process. Luna-Reyes & Andersen (2003) collects the system dynamic modeling process and summarize it into the Table 1 below. Although the grouping of the activity varies between different experts but the activities and stages are consistent among them. (Luna-Reyes & Andersen, 2003)

Randers (1980)	Richardson and Pugh (1981)	Roberts <i>et al.</i> (1983)	Wolstenholme (1990)	Sterman (2000)
Conceptualization	Problem definition	Problem definition	Diagram construction and analysis	Problem articulation
	System conceptualization	System conceptualization		Dynamic hypothesis
Formulation	Model formulation	Model representation	Simulation phase (stage 1)	Formulation
Testing	Analysis of model behavior	Model behavior		Simulation phase (stage 2)
	Model evaluation	Model evaluation	Policy formulation and evaluation	
Implementation	Policy analysis	Policy analysis and model use		
	Model use			

Table 1: The system dynamics modeling process across the classic literature (Luna-Reyes et.al, 2003)

We use qualitative research during model conceptualization phase. Through literature review, we familiarize ourselves with the research problem. We also find the framework for the integration of the refugee and employee performance. Through this method, we also find main

indicators of the system. We then use causal loop diagram (CLD) to capture the relationship between each variable in the system. CLD also allows us to come up with dynamic hypotheses which will be presented in the later chapter.

Next, for the model formulation step, we quantify the conceptual model using Stella Architect software. We formulate the equation based on our literature review. We also rely on public sources for example Statistisk sentralbyrå (SSB) and UDI for the statistic about refugee in Norway which will be used as a reference mode. Once the structure is in place, the model is undergone the tests according to (Sterman, 2000) and (Barlas, 1996) to ensure validity of our model. Finally the model behavior is analyzed thoroughly to understand the dynamics between each element in the system. This analysis enables us to identify leverage point in the system for policy recommendation.

2.2 Data Collection

We collect the numerical data from reliable data source: Statistisk sentralbyrå Statistics Norway (SSB) and The Norwegian Directorate of Immigration (UDI). The literatures are collected from reputable databases: Research Gate, ScienceDirect, IEEE, Springer, Google Scholar. These data are used as parameter value, equation formulation during the development of the model. However the focus of this research is to build an exploratory model thus the data is not used for model calibration and testing purposes.

2.3 Research Ethics

This research uses public anonymous data and does not require primary data collection therefore it does not require ethic approval. However in conducting the research we follow the guideline from the national research ethics committee for social sciences and humanities (NESH). Furthermore, we follow best practices to ensure transparency and validity of our model.

This research ensures transparency of the model by following the reporting guidelines for simulation based research in social science by (Rahmandad & Sterman, 2012). The transparency is necessary for reproducibility of the research and the growth of knowledge in the community. We have therefore provided the detail description of the model and thorough documentation for each variable.

“Causal-descriptive (whitebox) models are statements as to how real systems actually operate in some aspects.”(Barlas, 1996, p. 3) In this case, accuracy of the output generated from the model is not sufficient for validity of the model but it needs validity of internal structure of the

model as well (Barlas, 1996). Therefore to ensure credibility of our model, this research follows the model testing guideline from (Barlas, 1996) The test includes direct structure test and indirect structure test. Direct structure tests are structure confirmation, parameter confirmation, boundary adequacy and dimensional consistency. Indirect structure tests are extreme condition, integration error and sensitivity test.

3. Literature review

3.1 Refugee vs. Migrants

United Nations High Commissioner for Refugees (UNHCR) consolidated the definitions of refugee in the 1951 Convention to single definition as

“someone who is unable or unwilling to return to their country of origin owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group, or political opinion.” (UNHCR, 1951)

It is important that we distinct refugees from other types of migrants since in most cases refugee suffers from traumatic experiences and move to the destination country less prepared than other migrants. Such phenomenon is called a refugee entry effect. (Bakker et al., 2017) While refugee moves because of life threatening situation, according to UNHCR, migrants choose to move in order to improve their quality of life for example work, education, family reunion. Since refugee bring with them many disadvantages, this creates gap for them when entering into labor market and thus worth looking into.

Much research has been done on migration but the research on refugees has only been in focus in the past decade after the refugee crisis. In google scholar for example, the keyword “migration” provides the results of 5 million articles while the keyword “refugees” 2.2 million articles. Despite this, many studies have shown that the refugees are at the disadvantage than other migrants. L.Bakker et al studied the refugee gap in Netherland and found that the employment rate of refugees is significantly lower than those of family and labor migrants in the same cohort. This is mostly due to their mental health problem that prevents them from a smooth start. However the same study also shows that the refugee gap has become narrower over 15 years period for certain group of refugees. The factors that contribute to close the gap are the gender of refugees and the age of arrival. Female refugees from countries like Somalia, Afghanistan and Iraq are more likely to still be unemployed and this could be due to the culture.

Refugees who arrive during their adolescent period are more likely to obtain good language proficiency and qualification and therefore more likely to be employed. Organization for Economic Co-operation and Development (OECD) studied women refugees and found that the women refugees are vulnerable group and have the triple disadvantages as compared to women migrants and men refugees. The disadvantages are that they usually have lower education due to gender inequality to their home countries, lower language literacy and poorer health due to the nature of the forced migration. Furthermore, women refugees are likely to be pregnant once settle in the host countries which prevent them from participating in labor market. (Liebig & Tronstad, 2018)

Lastly, refugee is someone who has been granted refugee status and thus has legal right to work in their host countries. Asylum-seeker, on the other hand, is someone who is seeking protection but has not yet been granted the refugee status and thus has no legal right to work in their host countries. In Norway, a person can report themselves to the police and register his application as asylum-seeker. The person will be taken to asylum reception center, where he/she will be interviewed by Norwegian Directorate of Immigration (UDI). While waiting for the decision from UDI, the person can live in the reception center for free with economic support but is not allowed to work or is not entitled to Norwegian language course. The duration for waiting at the reception center can last months or even a year. There are many studies that show the negative correlation between the waiting duration and the refugee mental health i.e. the longer the waiting time the poorer the mental health. (Bakker et al., 2014; Phillimore, 2011) Only when UDI has made decision to accept the person as refugee, he/she will be transferred to a designated municipality and provided with Norwegian language and culture course. This project does not include the stage where a person is still asylum seeker since at that stage they have not yet been granted right to work and not yet integrated to the society.

3.2 Refugee Integration

In 2017, Michael Garkisch et.al performed a systematic literature review on refugees integration and propose a conceptual framework that provides a holistic view of the challenges that refugees are facing. The framework also maps the challenges to the group/organization in the society that can help address such challenges. This holistic view focus from the refugees themselves and outward to the environment and systems they are living in or interacting with. In the figure below, the challenges start with refugees basic need which are safety and health. The wellbeing of refugees which include quality of life, belonging, is also of important. The study

proposes programs to ensure their wellbeing such as get together programs, training programs, offering for sports and leisure activities. In addition, it also proposes that adjustment program should be included in the social welfare to ensure the integration of the refugees. For human development, language training, skill building program, education and information providers should be offered to the refugees. For the economic development and employment, the study found that not all economic counterparts participate in this area. Beside training the refugees for the labor market, the government can potentially compensate for companies to hire and train the refugees. (Garkisch et al., 2017)

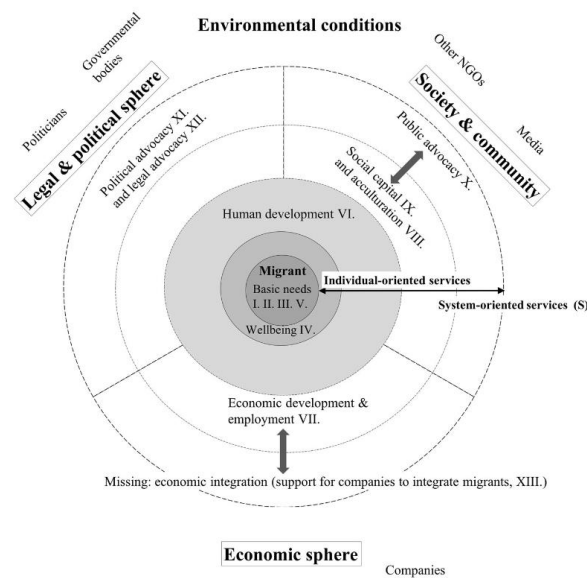


Figure 6: Conceptual model of different contribution (Garkisch et al., 2017 p.24)

Another most cited framework is by Alastair Ager and Alison Strang, 2018. They have proposed that employment, housing, education and health are the key indicators for the integration. Among these, employment forms the most researched area for refugees’ integration while health is the least cited as the core indicator for integration. The study believes that good health is an important component for active engagement in the refugee new society. In the framework that, on one hand, the refugees have the foundation right to stay in the host countries and on the other hand we have the main indicators for public outcome. The study proposes two categories of factors that can provide the link between the citizen right to a good public outcome: Social connection and Facilitators. (Ager & Strang, 2008)

Ager et al proposed that social connection should be use to “drive the process of integration at a local level” (Ager & Strang, 2008, p. 12) They have identify three types of social

connection. First one is the social bonds when the refugee connects to family, co-ethnic and co-religious group. The bond gives them a feeling of “settled”. This kind of bond also contribute to positive health state. The second one is the social bridges. This is the relationship between groups. It is reported that friendliness, greeting, smiles have large positive effect to the refugees, helping them to feel more secure and included. The third one is the social links which is the linkage between refugees and the government or the organization in the host country. This can be interpreted as the accessibility to the service provided by the government for example the health care, the interpreters.

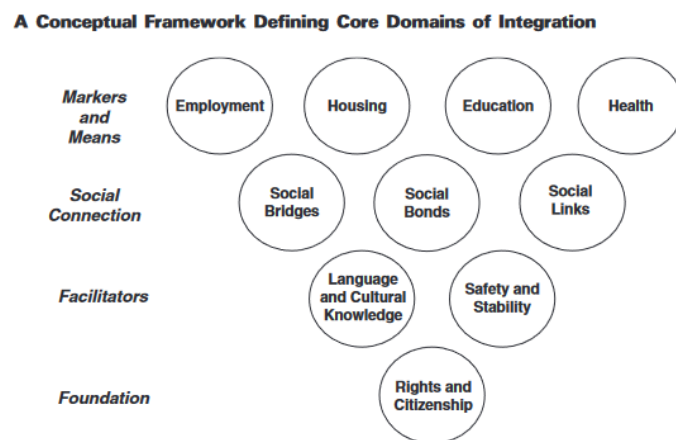


Figure 7: A conceptual framework defining core domains of integration (Ager & Strang, 2008)

The last component in the framework as illustrated above is the facilitators. The facilitator act as a mean to remove the barrier for the integration. The perception of the refugee toward the new community and neighborhood needs to be safe and stable in order for refugee to open for integration. The safety goes beyond physical violence but also verbal abuse as well. The refugees’ knowledge of language and culture of the host countries are perceived as the effective way to integrate to the new society. In this regard, many host countries put emphasis on providing introduction program that includes language and the way of living to the refugees. In Norway, once the refugee status is given to the refugees, they have the right and obligation to study Norwegian and social study up to 600 hours.

Even though it is important for refugees to learn the language and adapt to the culture of the host country, UNHCR and many studies define integration as two-way process:

“Integration requires that receiving States and civil society create a welcoming environment which supports refugees to achieve long-term economic stability and adjust

to the new society, including fostering a sense of belonging, and encouraging participation in their new communities.” (UNHCR, 2013)

Many refugees, especially the young one, find it difficult to balance their identity between the one from their home country, which is often reinforced by the family, and the new one from the host society, for example school, friends. Therefore the extent to which the host community accept the refugee culture and tradition and adapt it to the main culture plays important role in the integration process. (Brook & Ottemöller, 2020) (Berry, 1997) has developed range of acculturation from marginalization, separation, assimilation to integration. Marginalization is when the refugees neither want to maintain their own culture nor the new culture. Separation is when the refugees strongly want to maintain their culture but not adapting to host countries culture. Assimilation is when refugees adopt the new culture and reject their tradition. The integration happens when refugees develop cross-cultural identity, adapting to the new culture while maintaining their tradition. (Sam & Berry, 2010) While the government is promoting the integration, most society still adopt the assimilation approach. (Brook & Ottemöller, 2020)

3.3 Integration Indicators

We found from the literature review that most of the studies/reports use employment as indicator for integration. (Koirala, 2016) (Ager & Strang, 2008) (Valtonen, 2004) The employment is seen as a mean for refugee to be self-reliance, the concept that is promoted by many countries and organization. However there are also other indicators that is used in some studies to measure the integration: language (Brook & Ottemöller, 2020), (Koirala, 2016), education (Koirala, 2016) (Ager & Strang, 2008), housing (Koirala, 2016) (Ager & Strang, 2008), health (Koirala, 2016) (Ager & Strang, 2008). We find that another important indicator for integration is refugees’ social network. (Brook & Ottemöller, 2020), (Koirala, 2016) (Valtonen, 2004) The social network of the refugee is a significant factor to determine their psychology well-being which is also another indicator for good integration. (Brook & Ottemöller, 2020)

During our literature review, we have found some gaps in the literature that we would like to contribute to the research area. While we look into the refugee employment as well as the social connection as the indicators for integration, we will also look into soft indicators such as refugee psychology well-being and their job performance. Moreover, since the integration is a

two-way process, we will also look into local people toward refugee as one of our main indicators. Most importantly, the indicators to measure the refugee integration are studied separately while in reality there are interconnections between them. Therefore we will study the interplay between these indicators.

3.4 System dynamics contribution to refugee integration research

From our literature review, we found that in humanitarian area system dynamics are used to model operation and supply chain logistic. We are able to find few studies that use system dynamics to study the movement of the refugees in order to project the number of the refugees (Liang, 2017; Taylor & Masys, 2018) In the context of refugee integration, we only find two papers that use CLD to study refugee psychological well-being, the factors that contribute to it and its impact to employment and social connection. (Sederel, 2016; Werner et al., 2021) However there were no studies that attempt to do quantitative study on refugee integration using system dynamics.

4. Dynamic Hypotheses

This chapter presents our conceptual model through a causal loop diagram (CLD). Using the CLD, we will go through the main feedback loops which are our dynamic hypotheses of this research. Our research focuses on the reinforcing cycles around refugees' integration and how each cycle inter-play with each other.

Firstly, studies have shown that persistent poverty can affect the psychological well-being, causing people to stress out and often develop to other anxiety and depression. (Santiago et al., 2011) Study also shows that poverty and social isolation has a compounding negative effect to the refugee mental health. (Burnett, 2001) In the CLD below, the income and social interaction are main factors that contribute to refugee's stress. For now the income is treated as exogeneous factor, later on we will close the loop for income. In closing the inclusion loop, studies have shown that low income causes stress which in turn causes the social isolation. (Stewart et al., 2009) We now have the reinforcing loop where the increase in refugee's stress causes their willingness to socialize to decrease and thus they have less social interactions. Less social interaction then creates more stress which lower their social interaction even more. Although the example we just described is the vicious cycle, the same loop can be turned into virtuous cycle as well. An example of virtuous cycle is when there are more interactions between refugees and

local people, they would feel included, and also cause their stress level to become lower, which makes the refugees to become more open and willing to socialize more with other people.

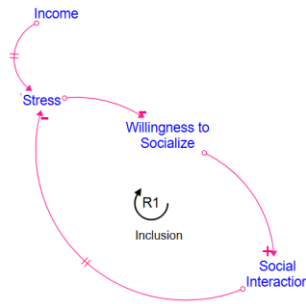


Figure 8: Inclusion reinforcing loop

However with any languages, it requires practice to be fluent and able to communicate. The next loop, R2, is the reinforcing loop where the more interaction the refugees have with the Norwegian, the more fluent in Norwegian they are as well as getting used to and accustomed to Norwegian culture. We use the term social skill to describe not just language aspect but also the culture and etiquette that the refugees need to have in order to communicate and interact with Norwegian. The better social skill gives refugees more capability and confidence in interacting with other people. As with any reinforcing loop, the loop can be both virtuous and vicious cycle. In this case the vicious cycle is when the social interaction decreases, which means less opportunities for refugees to socialize with the local people thus their social skill especially the language skill deteriorates and when they cannot communicate the social interaction decreases even more.

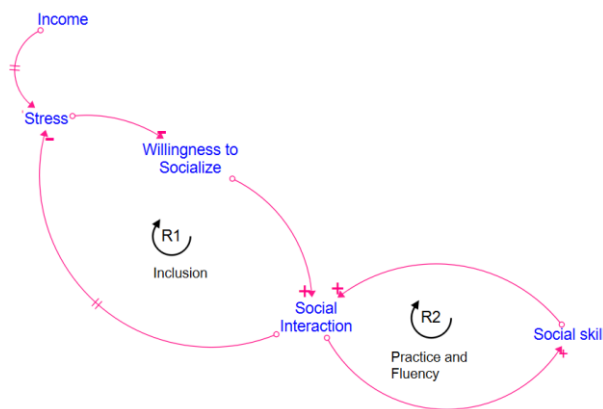


Figure 9: Practice and fluency reinforcing loop

The integration is a two-way process. (Strang & Ager, 2010) That is when the refugees adapt themselves to the host country and the host country is creating the friendly environment in

return. In reinforcing loop, R3, we assume that once the refugees acquire a necessary social skill to communicate to the local people, this will raise the perception of the local towards refugee. As Strang & Ager conceptual framework for refugee integration suggested that language and cultural knowledge acts as a facilitator for the refugees to build social bridges and social bonds. (Ager & Strang, 2008) Once the bond is established between refugees and local people, it is then likely that there will be more interaction between them for example more invitation to the community events, more interaction during work. Since the increase in perception drives the increase in social interaction, therefore it also impacts both R1 and R2 reinforcement loops, further reinforcing the direction that the loop go in i.e. vicious cycle or virtuous cycle.

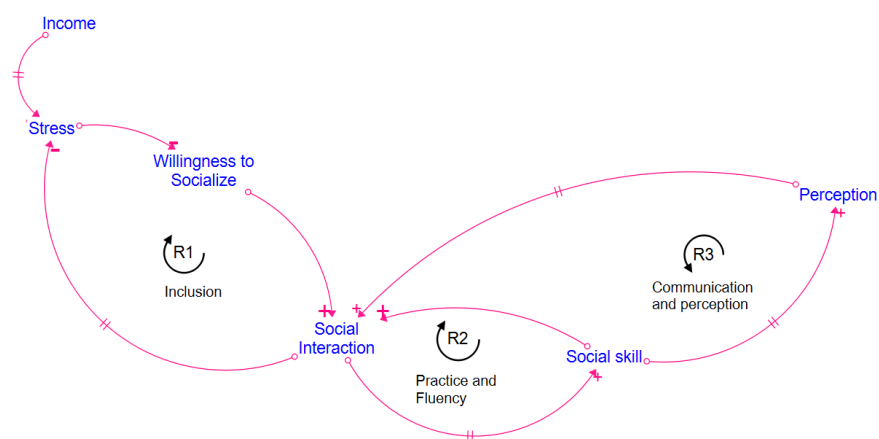


Figure 10: Communication and perception reinforcing loop

However the main factors that will raise the perception towards refugees is how well they perform at work. Statistics Norway, show that 80% agrees that most immigrants make an important contribution to Norwegian working life (Statistisk sentralbyrå, 2022). This reflects how Norwegian values the contribution towards society through working. Thus in the figure below we see the reinforcement loop R4 which describes the scenario when the better perception towards refugees come from their job performance. Work performance is in turn impacted by motivation and social interaction. Studies support that the working environment where the employee feels the sense of community increases the employees motivation and their job performance. (Jayaweera, 2015; Khan et al., 2012) Thus through good social interaction at work, the refugees are motivated and thus perform better at their job which makes the Norwegian sees the refugees' capabilities and that they contributes to the work and the society. In this way the local people open up more to the refugees and further increase the interaction. Again the same cycle can spiral in a negative direction and become a vicious cycle instead if the refugees do not

perform well, then the perception towards them decreases thus there is less interaction between them which makes the refugees unmotivated and perform poorly at work.

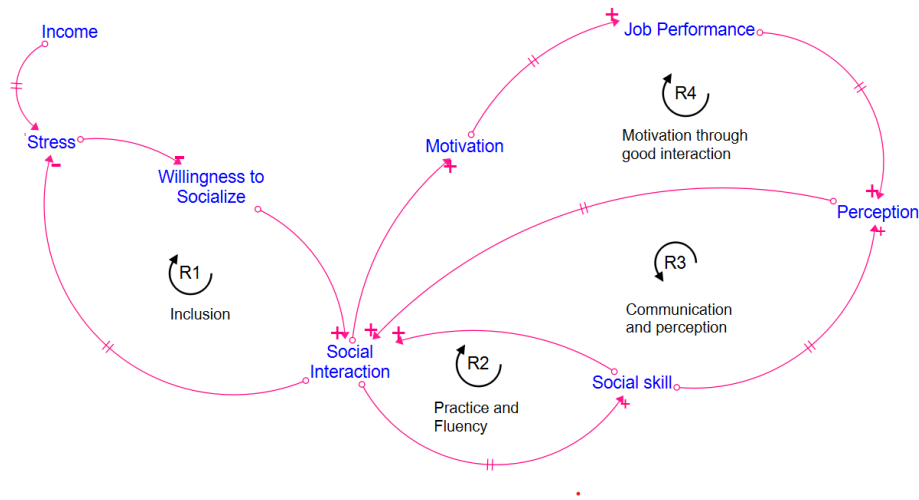


Figure 11: Motivation through good interaction reinforcing loop

Not only the working environment that affects the employee motivation but the rewards they receive also has a major positive impact to their motivation. (Khan et al., 2012; Shahzadi et al., 2014; Smith & Shields, 2013) The rewards do not have to necessarily be the money but they can be recognition and promotion as well. Thus in reinforcing loop R5, the better the refugees do their jobs, the more rewards they receive and thus result in higher motivation and better job performance.

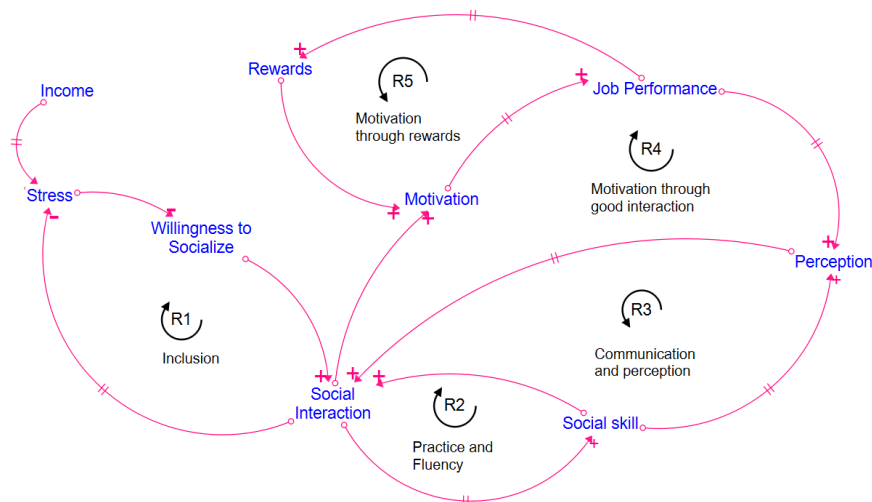


Figure 12: Motivation through rewards reinforcing loop

In addition to the motivation, one must not forget that the employee must have the ability to perform their tasks as well. Here the effect of ability and motivation to the job performance

are additive rather than multiplicative and they are both carry the same weight to the performance. (Van Iddekinge et al., 2018) The same study also shows that statelike measures of motivation are better indicators to employee performance than traitlike measure which means that the motivation of the person that changes over time depending on the state that they are in are a better indicator for their job performance than whether they are a motivated person or not. (Van Iddekinge et al., 2018)

Our model assumes that the increase in ability is the result from the increase in employment rate i.e. the ability accumulates through work. The employment rate is in turn impacted by the hiring rate and the hiring rate depends on the perception towards refugee which comes from their performance. This creates the reinforcing loop or a virtuous cycle, R6. The same cycle can also be a vicious cycle. This is when the refugees do not perform well at work which would bring down the perception towards refugees and would create bias in hiring them. Since the loop R6 impacts the perception which impacts the social aspect as well, it means that there is a ripple effect to all other loops that have been described as well.

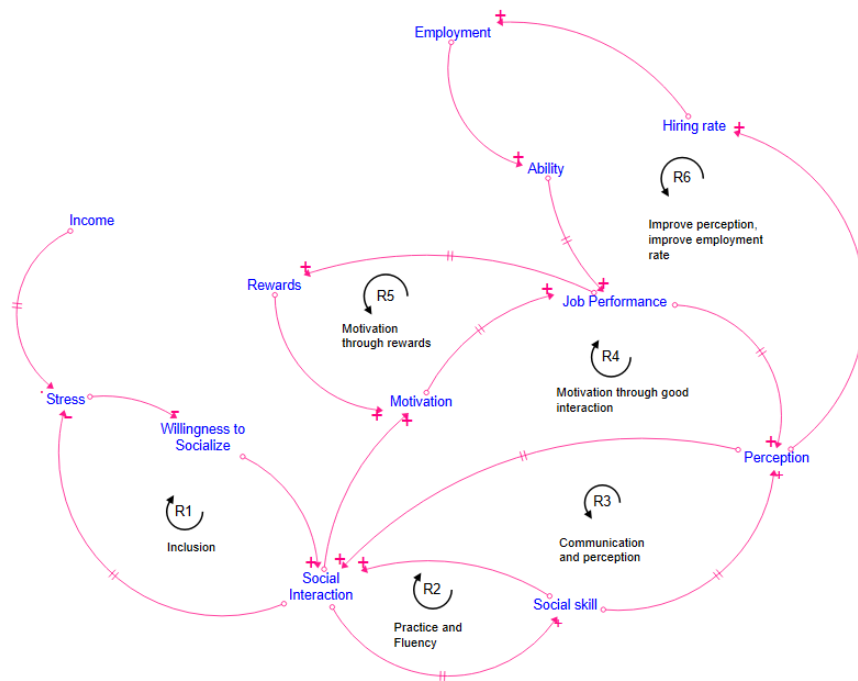


Figure 13: Improve perception, improve employment rate reinforcing loop

Finally the employment leads to income for the refugees and thus closing the big reinforcing loop, R7 and R8. Our model will be at aggregated level therefore the higher the employment rate for the refugees leads to increase in the average income than it would otherwise be if there was a low employment rate. Here, the virtuous cycle is when the increase of income

would decrease the refugee stress level which enable them to socialize more and thus improve the Norwegian’s perception towards them and result in a higher employment rate. The increase in the social interaction also motivates the refugee to perform well at work thus improves there job performance and in turn improve the Norwegian’s perception towards them which also increases the refugees’ employment rate. The reinforcing loop R7 and R8 are different in that R7 improves the perception and hiring rate through social aspect and R8 improves the perception and hiring rate through refugees’ performance at work.

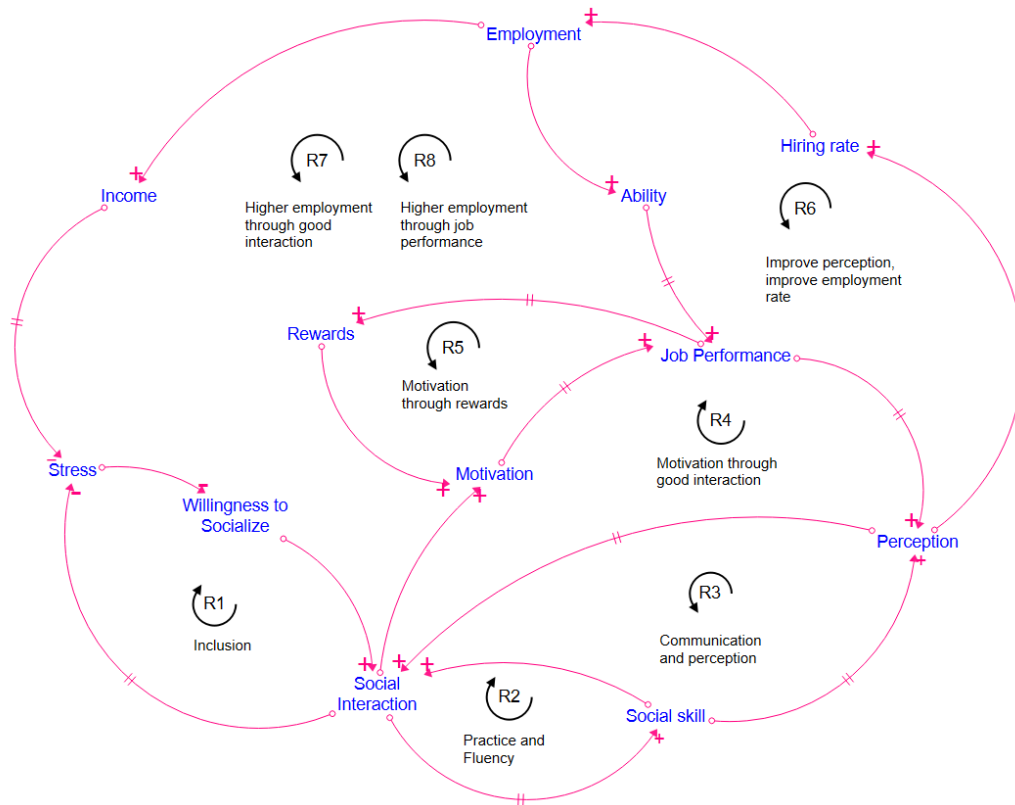


Figure 14: The completed CLD

The above CLD depicts the entire conceptual model of our research based on our literature review. Altogether we find 8 main reinforcing loop that contributes to the dynamic of refugee integration.

5. Model Description

5.1 Model Boundary

The following is the boundary of our model

- The boundary of this model starts after the asylum seekers received a confirmation status from UDI to have a refugee status and ends when the refugees retire and die. The model structure follows Norway's process i.e. after granting the status the refugees need to attend the mandatory course for one year.
- The model focus on working age refugee population and their integration. As such the refugee outside the working age is not considered.
- The model does not take into account the gender differences. Therefore in the model the male and female would behave similarly i.e. the way they respond to stress, the way they socialize and the way they can perform at work. In addition, other integration elements specific to the gender is not considered.
- Literacy and work skills of refugees are outside the model boundary. This means that refugees are considered to have same level of education and skills prior to migrating to Norway. Furthermore other education beside the introduction program is not considered in this model. This is because when the refugees arrive to Norway, most of them already have family and kids that they need to support, therefore they would like to work and earn money as soon as possible. Thus most of them only take the mandatory introduction program even though there are other specialization program that Norwegian government offer to them for example carpenter and plumber. In this way, all refugees start their career at entry level and their work ability is only influenced by the time they spend employed.
- Regarding the employment, refugees' job satisfaction and its effects to attrition are also outside the model boundary.

5.2 Assumptions

The general assumption for this model is that the refugees and Norwegians are considered equal in all aspect. That is if the refugees have the same income as the average income in Norwegian, their stress level will be the same as the Norwegians and hence socialize the same amount and have the same social skill. In this way their job performance is of the same level as the native population and hence same employment rate. This assumption is made since there is a lack of data hence makes it difficult to quantify the differences between the refugees and the

local people. Thus for all the soft indicators such as the stress level we use the relative term instead i.e. they are represented as relative to Norwegian population. Also, in this way we can understand the dynamic that can put the refugees into disadvantages even without the biases in the society. Nevertheless, where possible, the model has explicit variables to capture the biases and gap between the local people and the refugees.

5.3 Model Structure

5.3.1 Overview

The main objective of this research is to investigate the dynamics of refugee integration between the main indicators and to particularly explore the vicious cycles that may impede the integration. In the previous section we have identified dynamic hypotheses and the causal loop diagram. For the ease of understanding we organize the module in the model according to the main elements in the causal loop diagram. The figure below shows that the model is divided into 6 separate modules: Economic, Employment, Job Performance, Perception, Social Interaction and Stress. Each module is connected to other modules by taking the input from or provide the input to other modules. Each connection between the module will have the switch corresponding to it. The switch is used to switch on or off the connection between each module. This is useful when partially testing and analyzing the model. Where possible the model is normalized, and the relative value is used. The subsequent sections will briefly explain the structure of each module individually. The more detail of the module can be found in the appendix which contains model documentation.

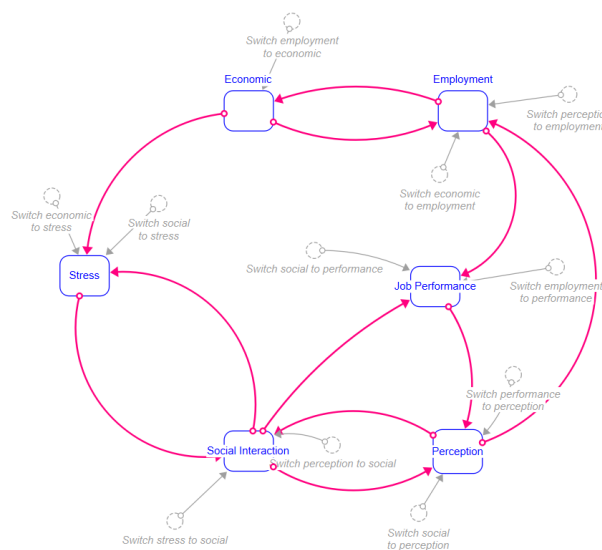


Figure 15: Model Overview

5.3.2 Economic Module

This module gives the model structure for the budget to help the refugee and calculate the refugees' income. First the module takes the number of refugees who work in an entry level and the number of refugees who work in a senior level and calculate the average income for the refugee in each workforce level. The average income is calculated from both employed and unemployed refugees in that level. Thus to make a fair comparison to Norwegian average income, which only takes into account the employed people, we multiply it by 0.75 which is a Norwegian employment fraction for total population. Then we calculate the refugee relative income which will be used in the stress module. For simplicity, we assume constant budget is provided to help refugees. Once the budget flows in yearly, the budget will be used first to help the current refugees. This comprises of the transition cost for the refugees that still has ongoing training and the cost for the unemployment benefit for those refugees who have completed the training but are still unemployed. The rest of the budget then will be used for helping new refugees. Thus the number of refugees that can be accepted each year is determined by how much budget is left from helping current refugees. If the employment rate for current refugees is high, then the government does not need to spend much money for unemployment benefit and thus more budget is left to help the new refugees. Once the refugee status is granted to the refugee then the refugee has to complete the mandatory training for language and social study, hence the stock "refugee in training". Usually it takes one year for refugees to have the training therefore the outflow of the stock "refugee in training" is determined by the duration for preparation. The refugees are transitioned out of the refugee in training stock and flow into the "refugees waiting to be employed" stock in the employment module. This module provides the output to employment module as we have just mentioned and also to the stress module. The output to the stress module is the refugee's relative income to the average Norwegian.

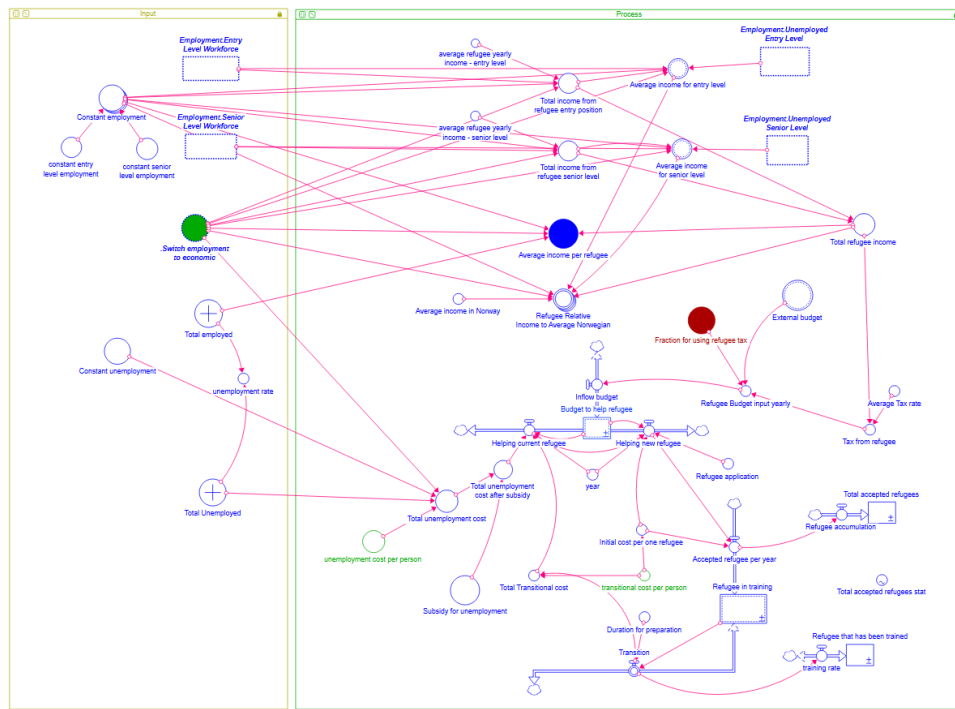


Figure 16: Economic Module

5.3.3 Employment Module

The employment module has the structure of aging chain and co-flow. The aging chain takes the refugee, from the economic module, who has finished their training to the stock “Ready refugees waiting to be employed” and when refugees are hired they will move to “Entry Level Workforce” stock and move to “Senior Level Workforce” when they are promoted.

The model assumes that all refugees are accepted at cost around 30 years old. This determines the constant parameter that determines the time refugees stay in each stock for example time to retire, time to promote, years after retirement. Since other education besides the introduction program is not in the model boundary. We assume that refugees are not specializing in any skills, and they can only start off with the entry level work. We assume only two levels of workforce in our model: entry level and senior level. The assumption is that the entry level is unskilled job, and such jobs are temporary and unstable by nature hence parameter for duration of stay in the job is shorter than senior level. The definition of senior workforce in our model is the jobs that required skilled and are hired as permanent workers. Our assumption leads to entry level workforce with the unskilled job earn less than the average earning in Norway and the senior level workforce earns a little bit above the average.

The rate of which refugees are employed is determined by the hiring fraction which depends on the Norwegian’s perception to the refugee. When the relative perception is one, it means that

the refugees are perceived as equal to the Norwegian and as so the hiring fraction for employee is equal to national employment rate. The structure also includes attrition rates, in that case the refugee flows into “Unemployed Entry Level” and “Unemployed Senior Level” accordingly. The employee attrition rate in the model assumes the average stay in the job to be the same for all refugees and does not take into account for the refugees being fired due to their lack of capability or that the refugees are not satisfied with their job.

The unemployed refugees can be hired again and so they move back to the employed stock. Eventually both entry level refugees and senior level refugees are retired and so they move to “Retired Refugee” stock. Finally the retired refugees die and there is an outflow from the retired refugee. The model assumes average time for each event to determine how long the refugees stay in each stock for example average time the refugees quit their job, average time to promote the refugees from entry level to senior level, average time for the refugees to retire based on the assumption that the refugees enter the country at 30 years old.

We have also constructed the co-flow for the employee experience. As long as the refugees continue to work, they continue to gain more experience. Once the refugees quit their jobs, they stop collecting any more experience until they are hired again. When the refugees are promoted, the experience flow into senior level workforce experience. Finally we calculate the average workforce experience of both entry level workforce and senior level workforce, and we will use this in the job performance module, which will be described in the next section.

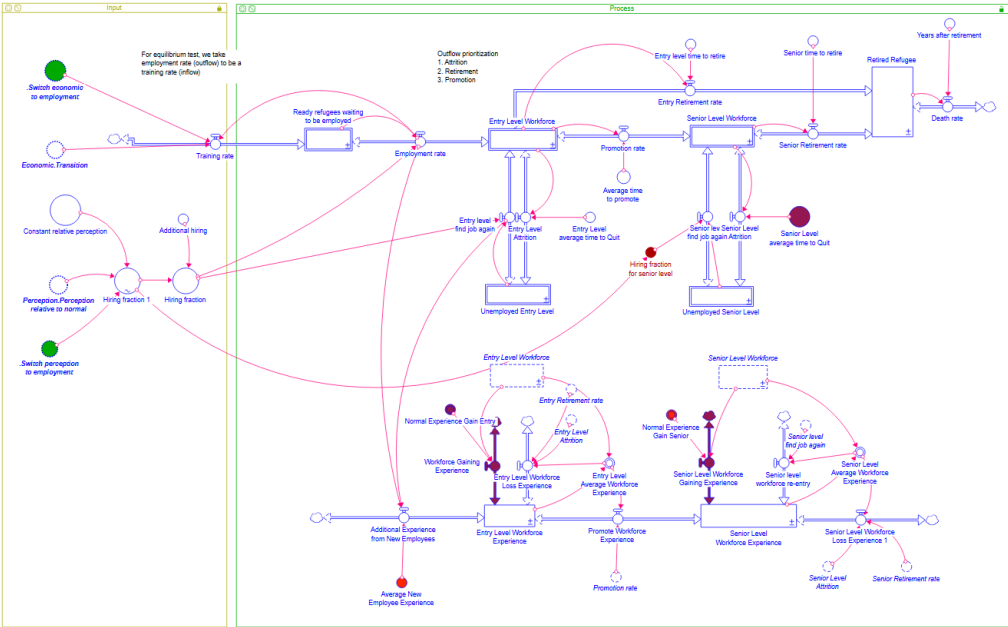


Figure 17: Employment Module

5.3.4 Job Performance Module

The job performance module determines refugees’ job performance in relation to average Norwegian. There are two contributors to the employee job performance: ability and motivation. The model assumes that the ability depends on the average experience of the employee. More years in the job means more experience and higher ability. If the average experience is relatively low, that is when there is high unemployment, the overall ability for the refugee will then decrease. We use graphical function to depict the effect of the average experience to the normal ability. Then we multiply the effect to the normal ability to find the actual ability. However the refugees’ ability at work does not change immediately thus we represent this change by using the inflow to the stock “Ability” and use the time to adjust to determine the rate of change.

Similarly, we construct the change of refugees’ motivation at work. For the motivation to perform, there are two factors that contribute to it: the frequency that the refugees interact to other people at work and the rewards. Although both of them affect the motivation to perform, rewards tend to be more impactful than the interaction and thus we assume rewards carry 0.7 weight. We can see small reinforcement loop in the diagram below where the better the performance relative to the average, the more rewards the refugee get, the more motivated they are at work and result in even better performance. We normalize the refugee performance with the average performance to get the relative performance value and refugee relative performance will be used in the perception module, which we will describe in the next section.

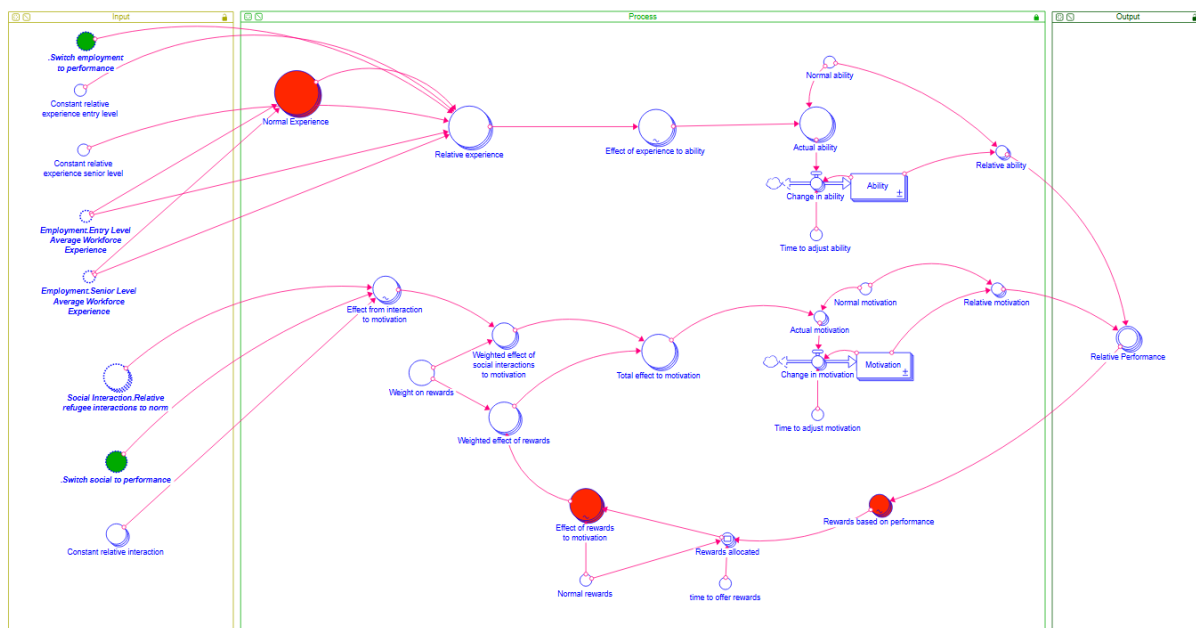


Figure 18: Job Performance Module

5.3.5 Perception Module

The perception module determines how are refugees being perceived by Norwegian in relation to how other Norwegians perceive each other. There are two factors that contribute to the perception: refugees’ performance at work and their social skill. We assume that people are mostly judged by how well they work hence job performance carries 0.6 weight. However it is also important that there is a good interaction between the refugees and Norwegian. Good interaction is determined by how well the refugees are able to communicate hence their social skill. The better skill the better the perception. Similarly, the better their performance the better perception people will have towards the refugees. The structure has a variable that allows in case there are any biases in the perception towards refugees, both positive and negative biases, hence the converter “Gap between normal and refugees”. In the analysis chapter, we will discuss on how the bias can affect the dynamics of the model. In addition, the perception does not change immediately, hence the rate of change is determined by the time to adjust the perception. Finally, in this module, we calculate the relative perception to the refugees, and this will be used to determine the hiring rate, in employment module, and it will also be used to determine the frequency of social events refugees are invited in the social interaction module, which will be described in the next section.

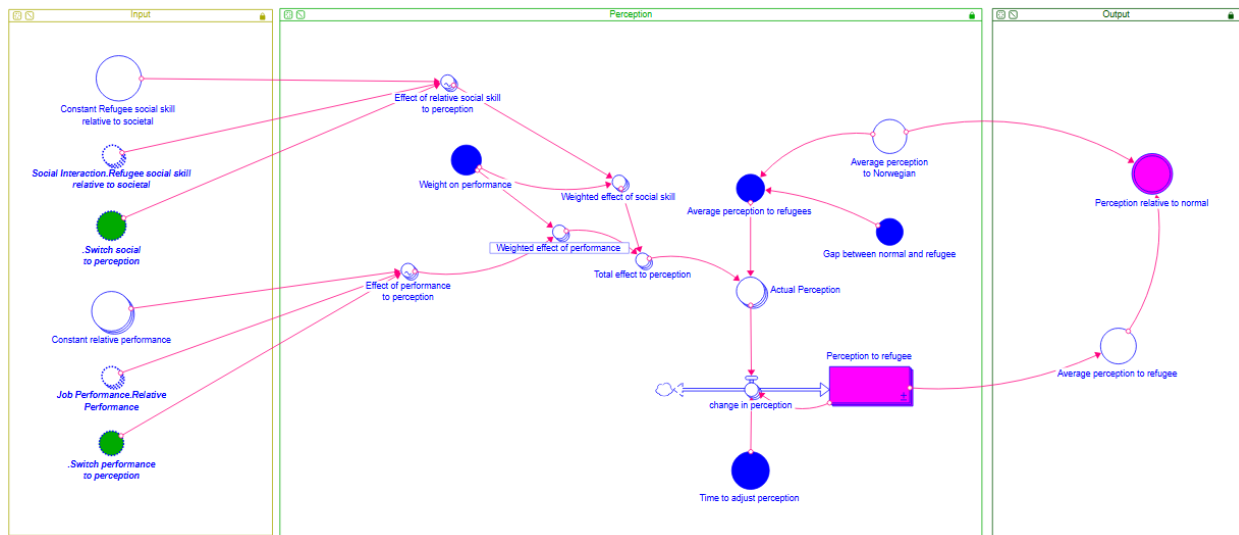


Figure 19: Perception Module

5.3.6 Social Interaction Module

The social interaction in this module focuses on the interaction between the refugees and Norwegian. There are two types of interaction, the interaction from the social event and the

interaction from the workplace. The number of social events that the refugees have depend on the invitation that the refugees received from local people and their willingness to attend the event. Unlike the total effects in other modules where it is the sum of all effects, here the total effects is multiplication of two effects. This is because for the refugee to attend the social events they need both the invitation and their own willingness to attend. The invitation is the effect of the perception towards refugee i.e. if the local people have good perception towards them, they would be more willing to include and invite the refugees to the social events. In addition, the refugee's willingness to attend the social events is the effect from the refugee's stress level. When people are highly stress, it is more likely for them to isolate themselves from the society.

The model also includes the interactions in the workplace, and this largely determined by how well the refugees can socialize. This skill includes mainly the language fluency and the understanding of the culture and the etiquettes. Here we have the reinforcement loop where the refugee social skill is improved with the more interactions they have with the Norwegians. The better the social skill, the more confident they are and thus even more interaction to the Norwegians. The model assumes that people do not always have long meaningful interaction with their colleague every day that they go to work. Thus we have the fraction of meaningful interactions, and the fraction would change according to the refugees' social skill. Finally this module provides the relative social skill that the refugees have which is used in the perception module, described in the previous section. The social interaction module also provides the refugees' relative interaction which will be used to determine their stress level which we will elaborate in the next section.

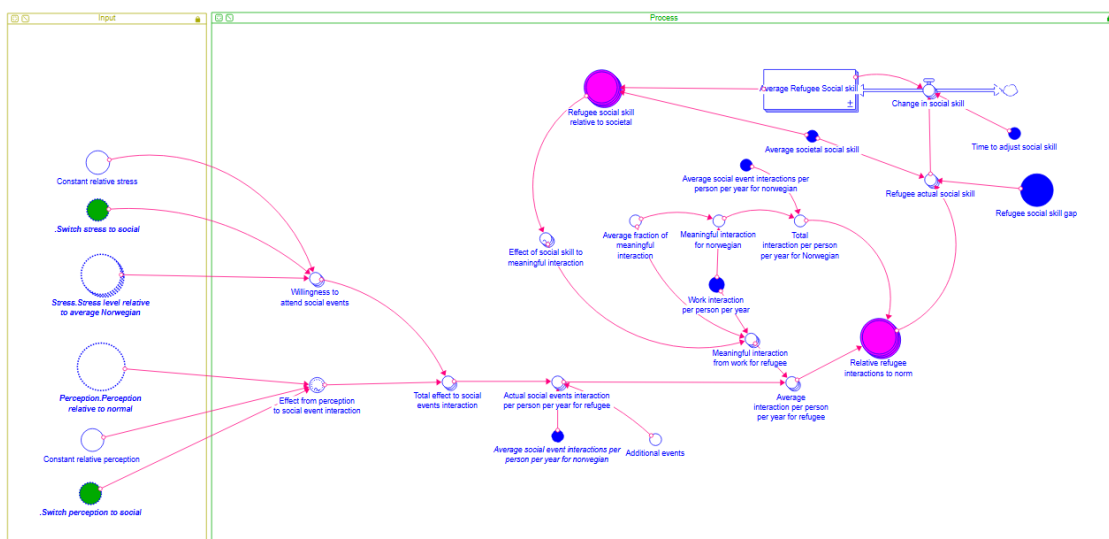


Figure 20: Social Interaction Module

5.3.7 Stress Module

There are two endogenous factors and one exogenous factor to the stress. The main effect to stress is the income since it directly determines the quality of living especially living in a high cost of living like Norway. Here we use the relative income that the refugees earn in relation to the average earning in Norway. When the relative income is equal to one, it means that the refugees earn as much as the average Norwegian and thus assume to have the same level of stress as the Norwegian. When the relative income is less than one, it means refugees earn less than the average Norwegian and thus has a higher stress. Another factor that contributes to the stress is the number of social interactions. The more social interactions the refugees have with the local people, the more included they feel and thus are happier hence less stress. There is one exogenous stress factor in the model since there can be other kind of stressors in people's life beside money and friendship. The model assumes 0.6 weight for income, 0.2 for social interaction and 0.2 for other stressors. Finally the stress does not change immediately but rather changes over time and the rate of change is determined by the adjust time for stress level.

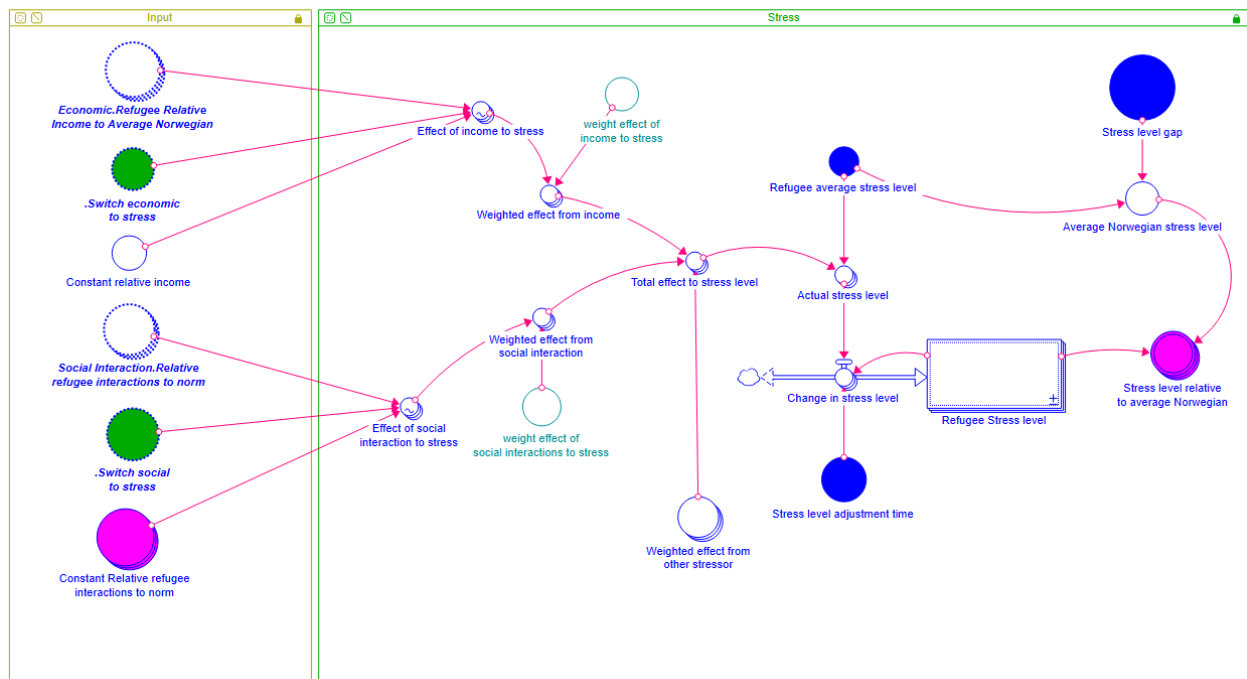


Figure 21: Stress Module

6 Model Validation and Testing

The purpose of model validation and testing is to build the confidence in the system dynamics model that we have created. (Senge & Forrester, 1980) In this research, we follow the validation and testing guideline provided by (Barlas, 1996; Senge & Forrester, 1980; Sterman, 2000). The validation and testing can be summarized into 3 major categories:

Direct structure test: structure confirmation test, parameter confirmation test, direct extreme condition test, dimensional consistency test

Structure-oriented behavior test: extreme condition test, integration test, behavior sensitivity test

Behavior pattern test: model pattern test

The next section discusses the result of these tests

6.1 Direct structure test

Structure confirmation test: This test ensures that the structure of the model follow the real-world knowledge. In our model, we ground our equations, links and structures from the literature review. The reference for the assumptions for each relationship and parameter values can be found in Dynamic Hypothesis (chapter 4), Model Description (chapter 5) and the model documentation (appendix). Thus the model is structured based on the reference to the real-world.

Parameter confirmation test: This test ensures that the constant parameter in the model reflects the real system both conceptually and numerically. Conceptual confirmation is when the parameter in the model exists in the real world. Numerically confirmation is when the value of constant parameter has enough accuracy. In our model, the parameter values are based on the literature review which provides conceptual confirmation. However since most of the parameters are soft variables for example average stress and average perception, there is high uncertainty for this type of variables. We therefore use sensitivity analysis to determine the impacts that this uncertainty has on our findings. The result for the sensitivity analysis can be found in section 6.2. Furthermore, due to the uncertainty and lack of the data for most parameters we choose to use the relative term instead of the absolute values where possible.

Direct extreme condition test: This test ensures the robustness of the model. We test this by replace the variables with the extreme value, although the value still needs to be meaningful in

the real-world. Where applicable we also apply min and max function to ensure the robustness. We have found that for all the variables the model can pass the extreme condition except for one condition that the refugee application per year cannot be zero at initial. This is due to how we initialize our stocks in equilibrium and the zero refugee application at initial would create error. The refugee application can be zero at other times.

Dimension consistency test: This test ensures that the dimensions in the models are consistent with each other and have meaning in the real world. The units we use in the model has the real world meaning. In addition all variables contain the measurement units, and the units are consistent across the model. Moreover, Stella Architect version 2.1, which is the software we use for the modelling, provides automatic check for unit consistency. Our model does not have unit error or unit warning.

6.2 Structure-oriented behavior test

Indirect extreme condition test: This test is to ensure that the model is able to produces the expected behavior under the extreme condition. Since our model cannot take zero refugee applicants at the beginning of time due to the equation to initialize stocks in equilibrium therefore we simulate the indirect extreme condition test by having 1 applicant at the first year and then zero applicants for the rest of years that the model runs. Our expectation is that eventually there will be no more refugees in the workforce as all of them will have to eventually retire. The figure on the left confirms that there is only 1 refugee accepted in year 2010 then the accepted refugee drops to zero for the rest of the time. The refugee in training follows the same pattern, which it supposed to be. The graph on the right shows that eventually all refugees are retired and that the number of unemployed and employed refugees go down to zero, respectively. It is worth noting that since we initialize the employed refugees stock in equilibrium, the equilibrium equation does not give zero employee as the initial.

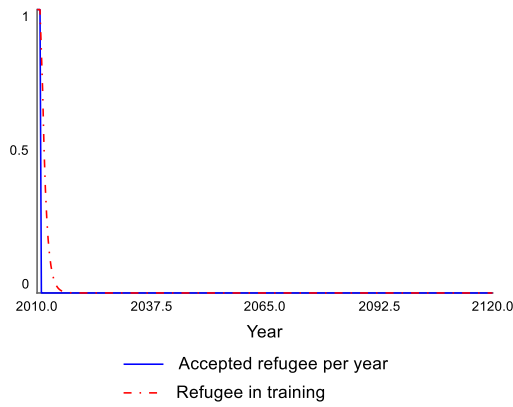


Figure 22: Result of accepted refugees per year

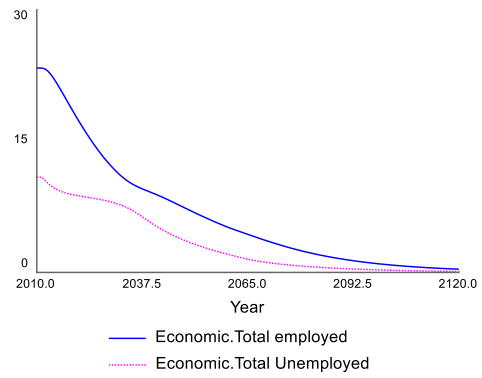


Figure 23: Result of total employed and unemployed refugees

In term of the behavior, we observe that the relative perception towards refugees has risen and stay in equilibrium at 1.6 after year 2080. This is because perception depends largely on the performance and the refugee performance increases since year 2030 for senior level and 2065 for entry level. This is due to how we structure the performance that base on the ability and the ability is based on the average workforce experience. Thus when the workforce decreases the average workforce experience increases hence the performance increases.

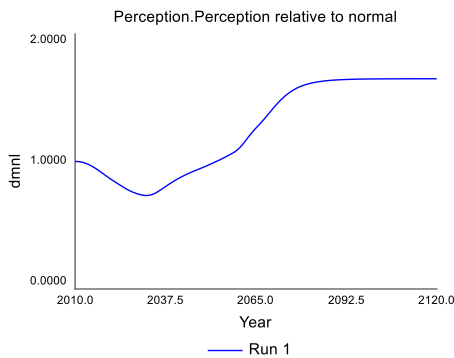


Figure 24: Relative Performance

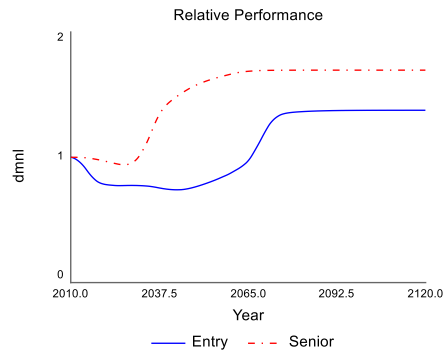


Figure 25: Relative perception

In addition as the refugees start to retire, the market become less competitive and the fraction for employed refugees start to increase from year 2030. Since most refugees are employed thus the average income increase thus we see the decline in refugees' stress level which also increases the social interaction and motivation to work, resulting in even better performance and perception. Thus in term of behavior, although the perception and job performance does not reflect the reality entirely but its trend still make sense.

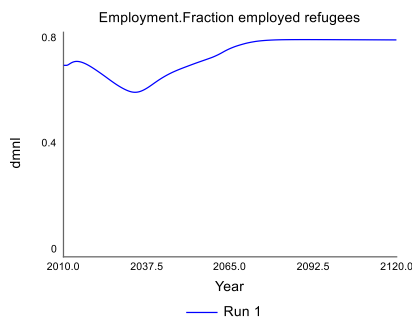


Figure 26: Fraction of employed refugees

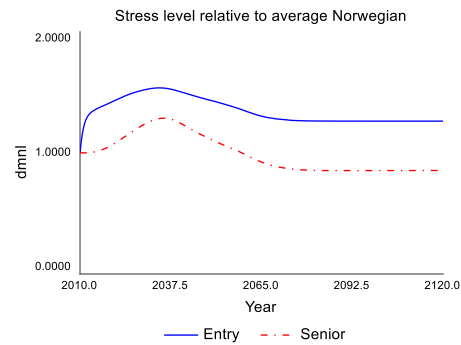


Figure 27: Refugees' relative stress level

Integration test: This test is to test whether model behaves differently with different integration method. We have tested with 3 integration methods provided by the software, Stella Architect 2.1, that we use to develop and run the mode. The three integration methods that we used to test are Euler method, Runge-Kutta 2nd order and Runge-Kutta 4th order. We have also tested the Euler method with half and double DT. All integration methods and DT provide the same model result.

Behavior sensitivity test: The sensitivity test determines the sensitivity of the model as the parameter value changes. We perform the sensitivity test by running the sensitivity analysis that provided by the software, Stella Architect 2.1, changing the parameter value within the range of -25% and +25%. We also perform the sensitivity test on all graphical function by increasing the curvature of the graph and decreasing the curvature of the graph and makes the graph linear instead of s-shape. From our sensitivity analysis, we have identified three categories of sensitivities: Sensitive, Limited sensitivity, Not sensitive. Sensitive is when there is a change is behavior pattern. The example of the variables that are sensitive and which require more data in the future work are the weight of income to stress, the effect of social skill to perception, the effect of perception to social event interaction. Limited sensitivity is when the behavior pattern does not change but the magnitude of the difference is wide. Not sensitive is when the behavior pattern does not change and the magnitude of the difference in the result is small. Figures below show the example of the result of each category. For the detail result, please refer to appendix B.

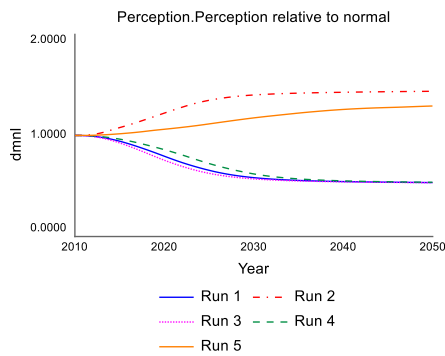


Figure 28: Example of result from sensitive parameters

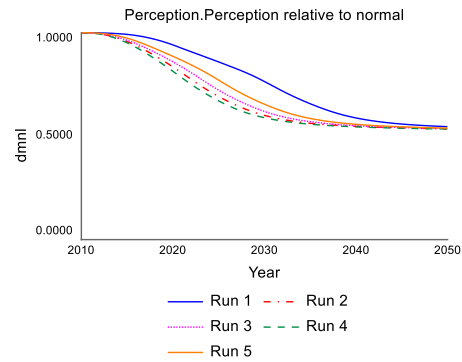


Figure 29: Example of result from limited sensitive parameter

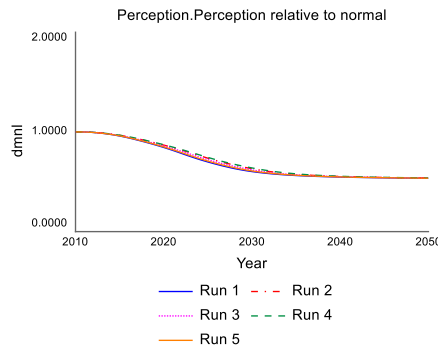


Figure 30: Example of result from non-sensitive parameter

6.3 Behavior pattern test

Since the main focus of this research is to develop an exploratory model in order to understand the mechanism of refugee integration and the dynamics between them, therefore the model is not developed to fit any data or behavior pattern. Rather, the model is developed based on the literature that we have found so far about the refugee integration, then we perform the analysis and learn the behavior of the system and the dynamic behind it. The detail behavior analysis is described in the next chapter.

7 Model Behavior and Analysis

Equilibrium

The model is initialized at equilibrium. The equilibrium means that refugees are equal to Norwegians in terms of salary and skill, they will be perceived and treated like other Norwegians. At equilibrium, the refugee earns as much as a Norwegian, thus their relative earning is 1. When they earn as much as a Norwegian, their stress is then equal to what a Norwegian has, therefore the relative stress is one. When relative stress is one, their relative social interaction is also one, which makes relative perception and relative performance equal to one, and in the end, the hiring rate is the same as a Norwegian (70% employment rate).

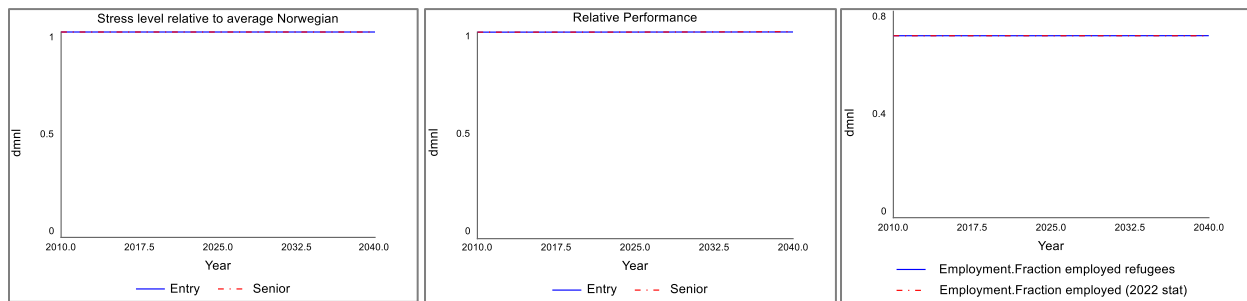


Figure 31: Sample results when the model is in equilibrium

Baseline Scenario

The following is the configuration for our baseline scenario

Time horizon	2010-2050
DT	1/30
Equilibrium switch	0
Refugee application per year	8000
External Budget to help refugees	29 billion NOK

Table 2: Configuration for baseline scenario

The model assumes 8000 applications per year according to the average of the previous 10 years' statistics. As a general trend, we observe that the employment fraction is stable in the first 5 years (2010-2015) then starts to decrease gradually from 2015 to 2030, then reaches a new equilibrium from 2030 onwards.

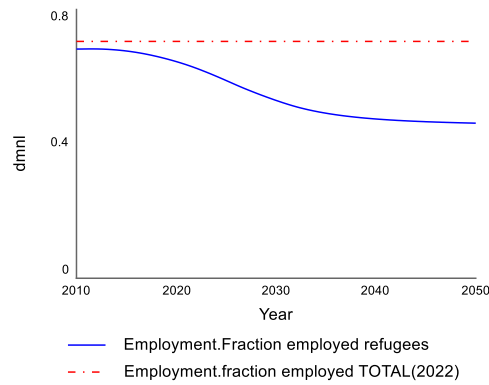


Figure 32: Refugees employment fraction

The following is the explanation of such dynamic. When the model is in equilibrium mode, we assume that the relative income of refugees is 1 (equal to the average Norwegian). When the model is not in equilibrium mode, the relative income for the entry level starts lower than the average Norwegian. Since we assume that the entry level job is unskilled job thus the annual income for entry level is around 30% lower than average. Nevertheless, the relative income for both entry and senior level is stable for the first 5 years. When the relative income is lower than average the stress level increases. As we can see from the graph on the right that the stress level for entry level refugee increases sharply in the first 2 years since the relative income for this level already starts off lower than average. The stress level for senior refugee on the other hand remains stable for the first 5 years.

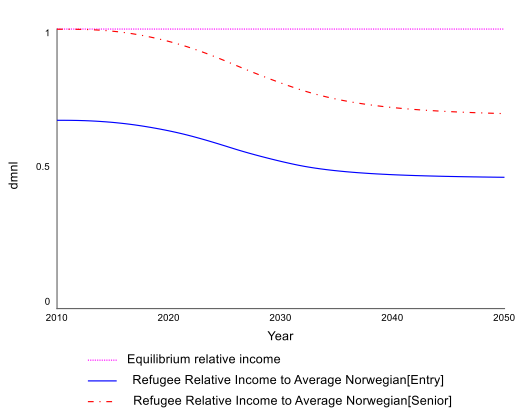


Figure 33: Refugee relative income

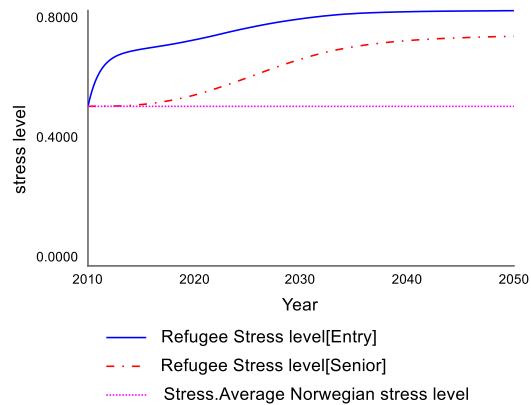


Figure 34: Refugee stress

The increase in the stress level for entry level refugee has an impact to willingness to socialization. Thus for the entry level refugee the relative interaction decreases rapidly. When the refugees do not socialize their social skill deteriorates as well. However for the senior level, the relative interaction and relative social skill still remains the same as the stress level does not

change. Here the reinforcing loop between interaction and stress level also working in a negative direction i.e. as the interaction decreases the stress level increases.

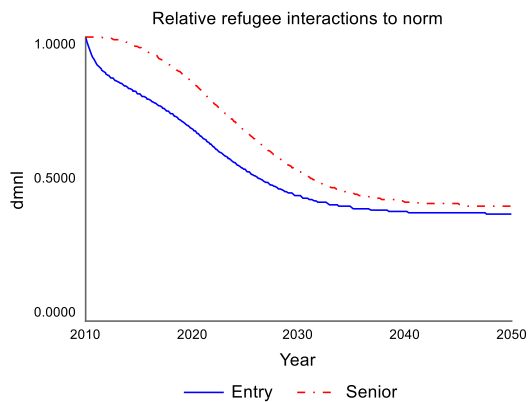


Figure 35: Refugee relative social interactions

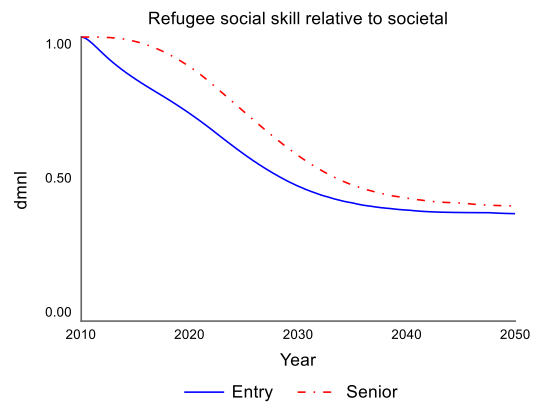


Figure 36: Refugee relative social skill

The decrease in social interaction also causes the motivation to drop. However this is not instantaneous, there is a delay for the motivation to change. Therefore we see that the motivation and performance decreases at a slower rate at first and then decrease decreasingly after the first 2 years.

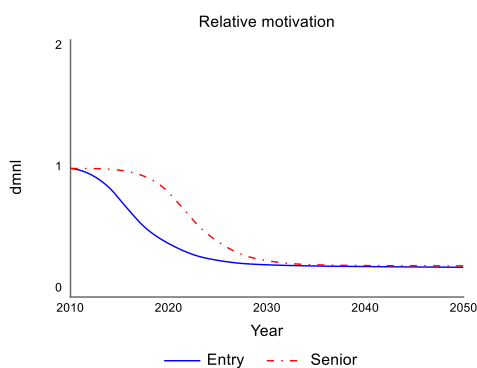


Figure 37: Refugee relative motivation

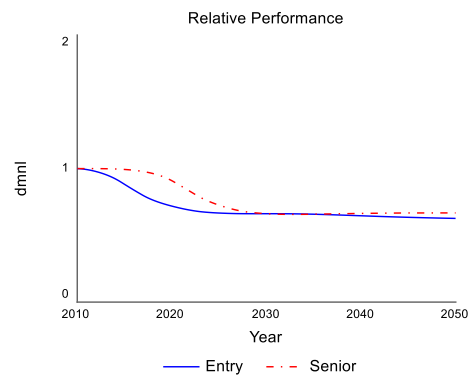


Figure 38: Refugee relative performance

Until now, we can see that the increase in stress level causes decrease in social interaction, motivation and performance for the entry level. These indicators remain stable around 1 for senior level refugees. However, the perception is an average of the entry level and senior level thus initially the perception slowly decreases in the first 5 years.

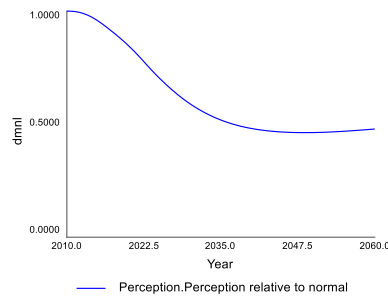


Figure 39: Perception toward refugee relative to normal

It is important to mention that, for senior workforce, their income is closer to the average at the beginning hence their stress is relatively equal to the Norwegian in the first 5 years. Though, the perception to the refugees is not separated by the employment level therefore the challenges that the entry level faces has an impact to senior level refugee as well. This means, when the decreasing of perception impacts both entry level and senior level in term of social interactions i.e. when the local people start to doubt the refugees they do not distinguish between entry level and senior level but they start to doubt refugees as a whole. The impact is that the local people socialize with refugee less and this is when the social interaction for senior level starts to drop in year 6th. Again, a decrease in social interaction causes increase in stress level. So we start to see the same pattern for the senior level refugees where the stress level increases which impact interaction, social skill, motivation and job performance. Thus for the next 15 years, 2015-2030, the vicious cycle goes on for both refugee at entry level and senior level.

In addition, the decrease in perception causes the hiring rate to decrease, as such the employment rate decreases which in turn impact average income of the refugees. When the relative income decreases, this causes more stress and add to the vicious cycle mentioned above.

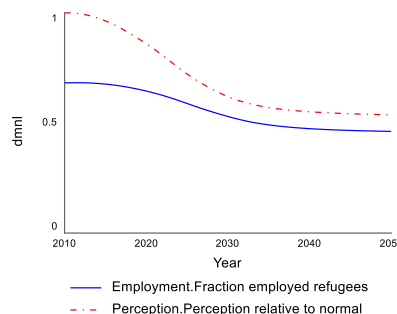


Figure 40: Refugee employment fraction and relative perception

Since the model assumes that the interaction between Norwegian and the refugees cannot go down to zero, once the relative interaction is at its lowest around 2030, the behavior stabilize at the new equilibrium. This equilibrium also represents the worst case scenario.

Bias in perception

This scenario uses the following configuration

Time horizon	2010-2050
DT	1/30
Equilibrium switch	0
Refugee application per year	8000
External Budget to help refugees	29 billion NOK
Gap between normal and refugee	0, -0.10, 0.10

Table 3: Configuration for bias in perception scenario

The baseline scenario assumes that there is no bias in perception towards refugees. However we have found that perception plays a vital role therefore we would like to explore the scenario when refugees are not perceived as equal to other people in the society both positively and negatively. Perception influence directly to the hiring rate and to the social interaction therefore even with the small gap it can worsen vicious cycle when start off negatively or amplify virtuous cycle when start off with positive gap. The positive gap does not necessarily have to mean that the refugees are perceived as being more capable than the Norwegian but can be seen as someone that is hard working and thrive to success in their new host country or someone who needs help and in this way that Norwegian try a bit more to reach out to them to invite them to the events or accept them to work.

The graph below shows that when we increase the perception by 10% the pattern of the behavior changes to a virtuous cycle i.e. the perception increases increasingly in the first 10 years. However when the perception decreases by 10% the pattern of a vicious cycle from the baseline scenario is amplified i.e. the perception keeps decreasing in the first 10 years.

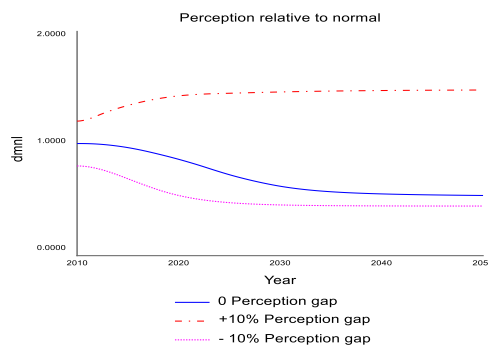


Figure 41: Different in relative perception

We examine the dynamic of the main indicators closely for each refugee level and found that the behavior is different for each level of the workforce. It is known from the baseline scenario analysis that as the perception increases the social interaction also increases. However, since the senior level refugees start off with a better position in term of stress level therefore when the perception increases, the relative social interaction is able to increase above 1 and the relative stress level decreases to less than 1. More interaction also means better working atmosphere and less stress and thus improve the overall working performance and perception accordingly.

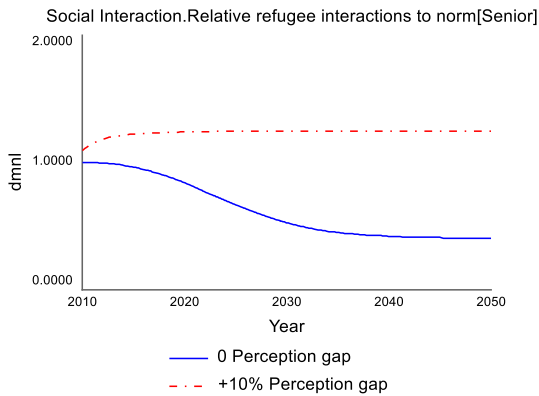


Figure 42: Refugee relative social interaction for senior level

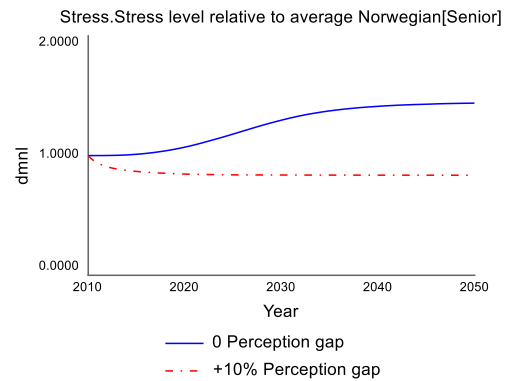


Figure 43: Refugee relative stress for senior level

For entry level workforce however, when the perception increases their social interaction increases from the baseline scenario and become equal to average Norwegian. However their stress level although decreases but does not completely disappear since their relative income is still lower than average. And the relative income contributes more to the stress level than the social interaction.

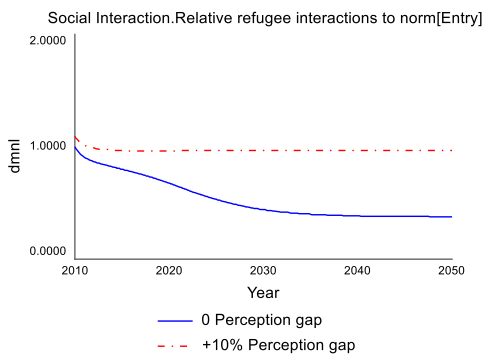


Figure 44: Refugee relative social interaction for entry level

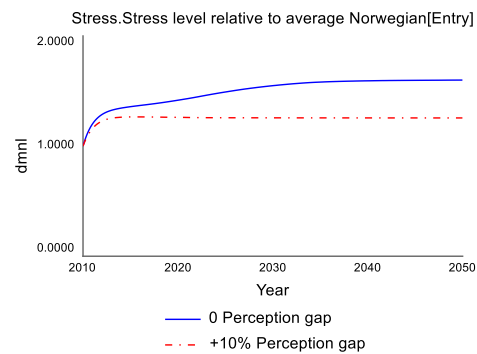


Figure 45: Refugee relative stress for entry level

On the other hand, when the society start off with negative perception that average (-10%), we see the same pattern as the baseline scenario but with a larger magnitude i.e. more stress, less interaction, less performance.

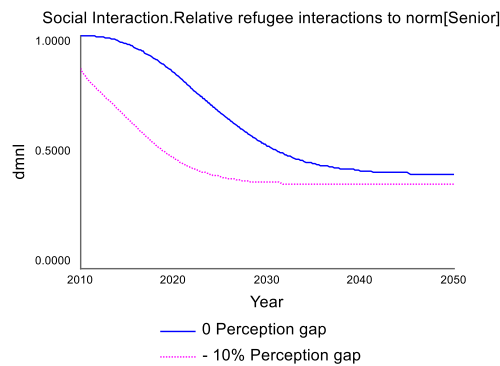


Figure 46: Refugee relative social interaction for senior level

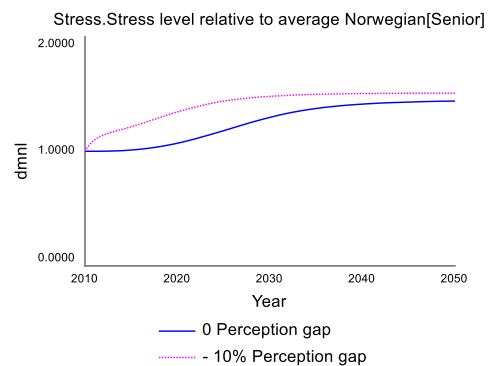


Figure 47: Refugee relative stress for senior level

The same is also true for the entry level workforce refugee i.e. less perception, less social interaction, more stress.

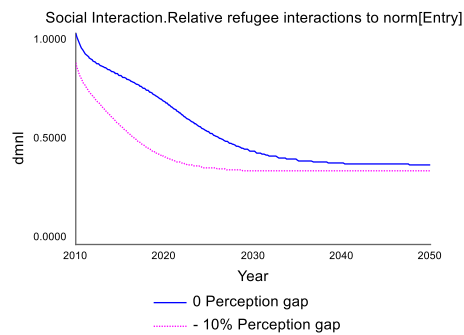


Figure 48: Refugee relative social interaction for entry level

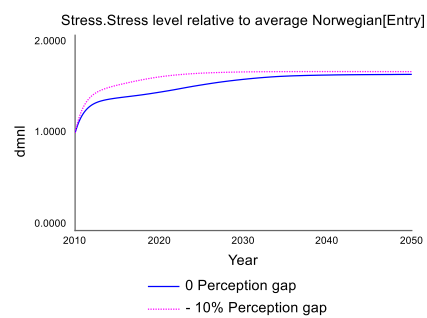


Figure 49: Refugee relative stress for entry level

In addition the gap is closer in term of relative social interaction between entry level and senior level as can be seen in below graph due to the negative perception sets the refugee in both entry and senior level at the disadvantage and thus the impact to the senior workforce happen faster than the baseline scenario with 0 bias gap.

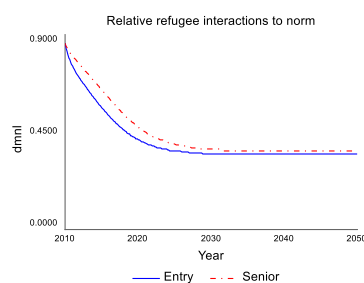


Figure 50: Comparative graph of relative social interaction by workforce level

Impact of social interaction

This scenario uses the following configuration

	Baseline	Scenario 1	Scenario 2	Scenario 3
Time horizon	2010-2050			
DT	1/30			
Equilibrium switch	0			
Refugee application per year	8000			
External Budget to help refugees	29 Billion NOK			
Bias gap between normal and refugee	0			
Additional events	0	12	12	48
Refugee social skill gap	0	0	-0.25	-0.25

Table 4: Configuration for each scenario

One can argue that the perception is difficult and slow to change. More importantly, the perception is influenced by the social interaction therefore we would like to explore the social interaction aspect of the model. First we run the baseline scenario as benchmark. Here we assume that there is no social skill gap between refugee and Norwegian. Then in scenario 1 we assume that there is one event per month that arrange for refugee to do activity with the local people, this results in the interaction and social skill is almost similar to Norwegian for entry level and even a little bit higher than average for senior level. However in reality, refugees have to learn new language like Norwegian and therefore do not have similar fluency and are not accustomed to the new culture hence there is a social skill gap. In scenario 2 we simulate that there is -25% gap, then we observe that the social interaction decreases at a much steeper rate than 0 gap. This is due to the reinforce loop through the social skill where the language is a barrier for refugees to have a meaningful interaction with the local people. Without meaningful interactions, they do not practice their social skill and so it deteriorates. In order to compensate for skill gap, in scenario 3, we arrange for more social events per month so that refugees can have more practice in their social skill since the social skill is a link to a good public outcome. (Ager & Strang, 2008) This sort of activities is already organized in some municipalities for example language café, group hiking.

As can be seen in the graph below for entry level, 4 additional events per month can compensate for their social skill gap and maintain the relative social interaction to 1 and as such their social skill is maintained at a higher level than the baseline scenario.

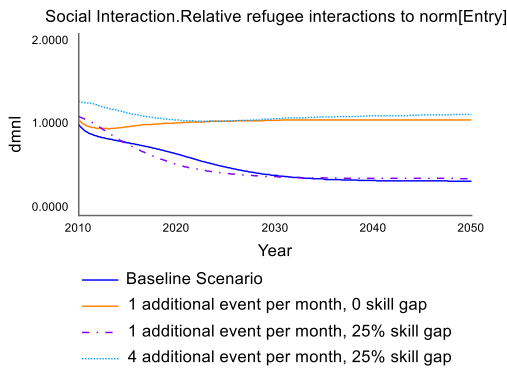


Figure 51: Refugee relative social interaction for entry level

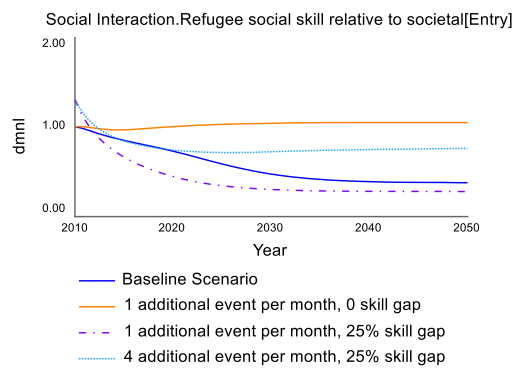


Figure 52: Refugee relative skill for entry level

For senior level refugee, since they have a better start due to better income and so less stress, even with the skill gap but 4 additional events per month can maintain their relative social skill to around 1.

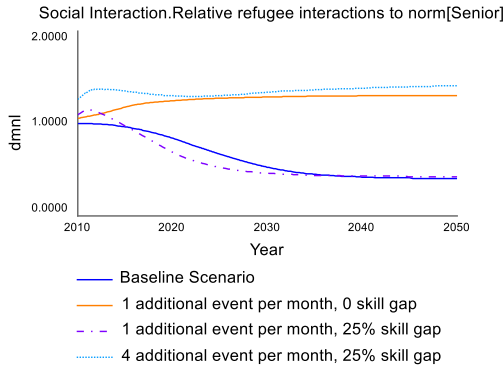


Figure 53: Refugee relative social interaction for senior level

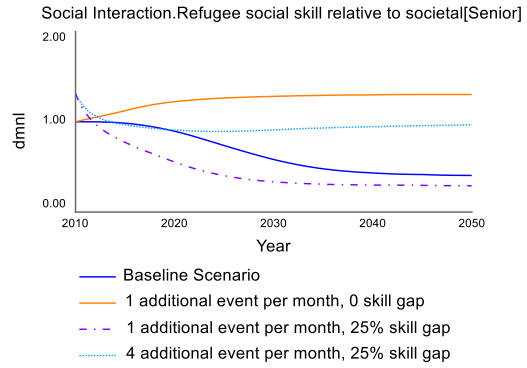


Figure 54: Refugee relative skill for senior level

It is also worth noting that, the extra activities/events when done right can add to much better perception that the local will have towards the refugee as can be seen in the graph below.

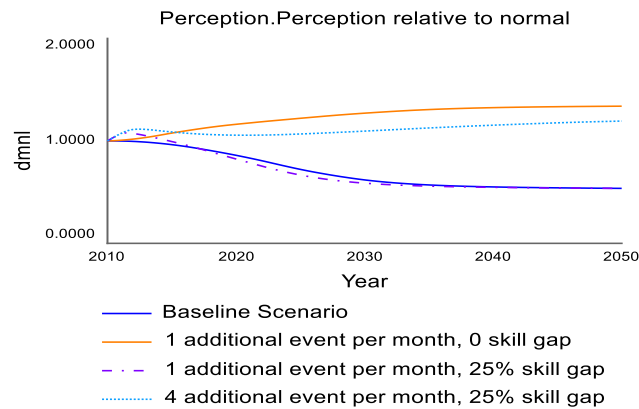


Figure 55: Perception towards refugee

Furthermore, for the refugees who have reached senior level, additional social events is sufficient to bring them to equal to average Norwegian, as we can see from the relative social interaction and social skill graph previously. Because the social aspects are relatively equal, this lowers their stress level and brings their job performance up to above average.

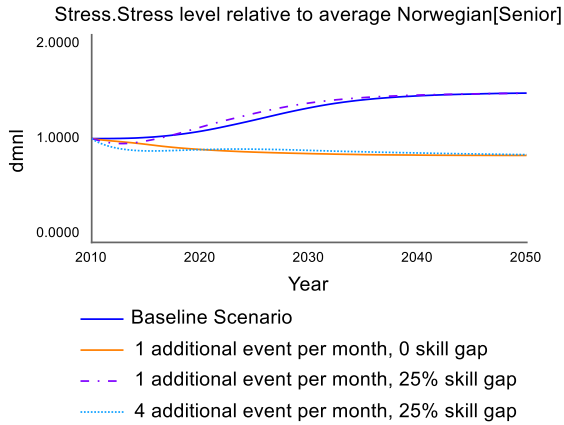


Figure 56: Refugee relative stress for senior level

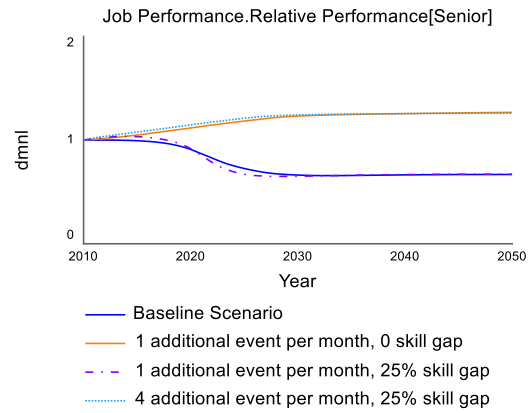


Figure 57: Refugee relative performance for senior level

For entry level refugee however, social interaction alone is not enough to bring their stress level down to average level as can be seen in the graph below. This is because they still have relatively low income job, and the income contributes more to the stress level than the social interaction.

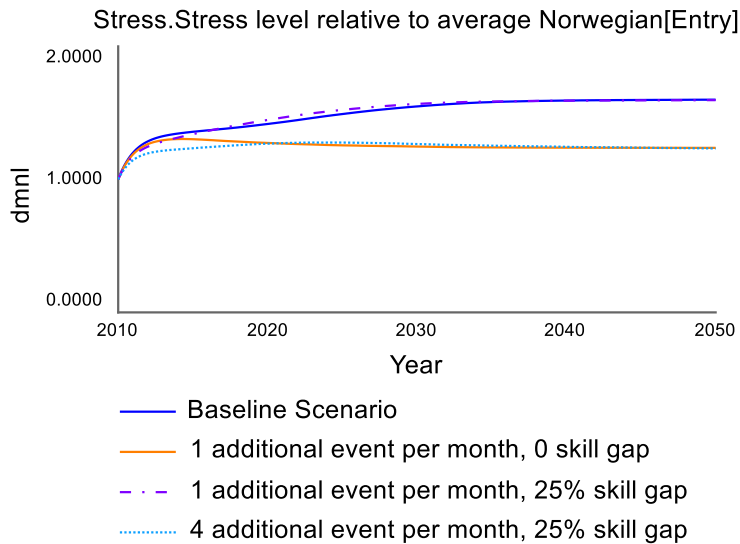


Figure 58: Refugee relative stress for entry level

Hiring more refugees

So far, we have found no mechanism to help the entry level refugee to be as equal to the Norwegian. This is due to 2 factors, their relatively low income, and the increase in unemployment. The average income decreases when unemployment rate is high. Since the average income for each level is calculated by taking into account the unemployed refugee as well.

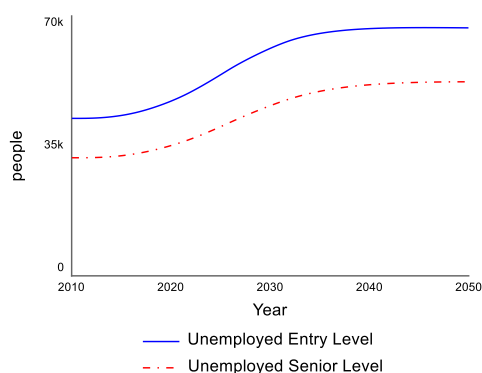


Figure 59: Unemployed refugees by level

As proposed by Garkish et.al, besides training refugees the government can potentially compensate for companies to hire the refugees as well. (Garkisch et al., 2017) We therefore explore the scenario where there are incentives for the employer to hire entry level refugees. We choose to focus only the entry level since for the senior refugee there are already other mechanism that can potentially help them. The configuration for this scenario is as below:

	Baseline	Scenario 1	Scenario 2
Time horizon	2010-2050		
DT	1/30		
Equilibrium switch	0		
Refugee application per year	8000		
External Budget to help refugees	29 billion NOK		
Bias gap between normal and refugee	0		
Additional events	0		
Refugee social skill gap	0		
Additional hiring	0	0.10	0.50

Table 5: Configuration for each scenario

Here we assume the hiring rate for refugee to have additional 10% for the entry level workforce. We found that the stress level is no different from the BAU scenario. Even if we raise the additional hiring to 50% the stress for the entry level is still 50% higher than the average

Norwegian. This is due to the limitation of the how the model is construct in which the entry level workforce is assumed to be non-skilled worker such as cleaner and thus have a lower paid than the average. Therefore the stress will still be there as long as they are still struggle financially.

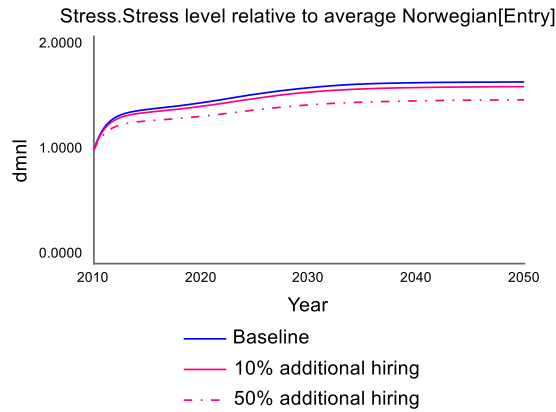


Figure 60: Refugee relative stress for entry level

This phenomenon also replicates what happen in reality where many of the refugees found themselves in a trap of low paid, temporary, non-skilled job. It is therefore crucial that the refugees are trained and educated so that they are able to have at least an average paid job (senior level in the model) and are able to thrive and integrate well in the society.

Many of the studies use the employment percentage as an indicator of how well the refugees are integrated into the society. The incentive to hire the refugees would increase the employment fraction in this case but it does not help with the refugees' stress level therefore the number of social interactions, social skill and perception still remains low. Since these factors for integration still remain low, we can see from the graph that the fraction of employment remains in the downward trend.

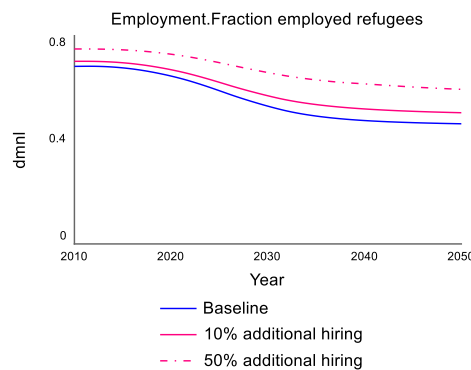


Figure 61: Fraction of employed refugees

Combination of help

Previously we have explored each factor and its impact to refugee integration individually. In this section, we would like to explore the impact of the combination of help that we can provide to the refugee and their impacts. Below is configuration for each scenario

	Baseline	Scenario 1	Scenario 2
Time horizon	2010-2050		
DT	1/30		
Equilibrium switch	0		
Refugee application per year	8000		
External Budget to help refugees	29 billion NOK		
Bias gap between normal and refugee	0		
Additional events (per year)	0	24	24
Refugee social skill gap	0		
Additional hiring	0	0	0.3

Table 6: Configuration for each scenario

First scenario, we assume that there are 2 additional events per month for the refugee to meet with the local. We also assume that there is no social skill gap between Norwegian and refugee since this factor can be covered by providing more rigorous language training to them. We found that for the entry level, the stress level has significantly decrease although not to 1 but the increase in social interaction has impact in increasing their social skill and their job performance.

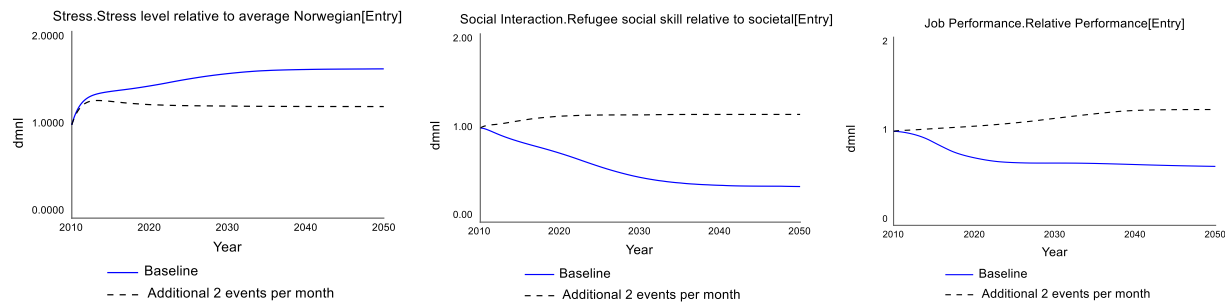


Figure 62: Result for refugee entry level

For the senior level refugees, the increase in social interaction is able to bring their stress level down to below average and thus their social skill and job performance increase to above average

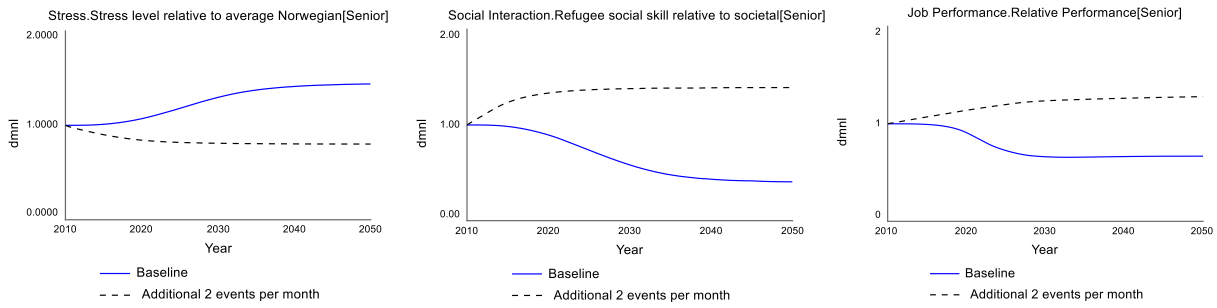


Figure 63: Result for refugee senior level

The overall perception towards refugee is then raised through the increase in social interaction and the increase in the refugees' job performance, as represented in the graph below.

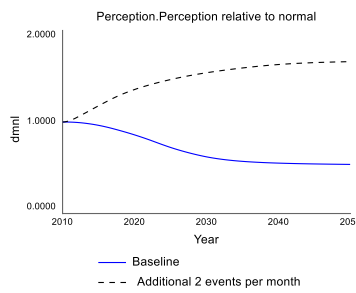


Figure 64: Perception towards refugee

Furthermore, we see the opportunity to increase the hiring rate for entry level in order to reduce the cost of helping unemployed refugees. Therefore in scenario 2, we assume that there is incentive to hire entry level refugee and there is additional 30% hiring rate for that group. We found that this does not have an impact on the perception from scenario 1 however it has an impact on the budget to help refugee. When hiring rate increase, the employment rate increases, in other word the unemployment decreases.

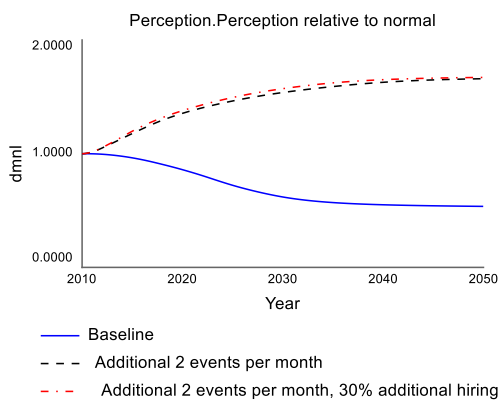


Figure 65: Perception towards refugee

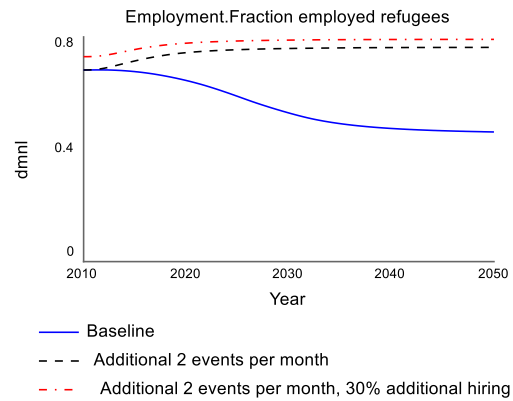


Figure 66: Refugee employment fraction

When unemployment decreases therefore the cost of helping unemployed refugee decreases. As the cost of helping current refugee decreases the total budget to help refugee increases. Of course, this does not take into the account of the cost for implementing policy to help current refugees. However we do see the potential in accepting more refugees to the country.

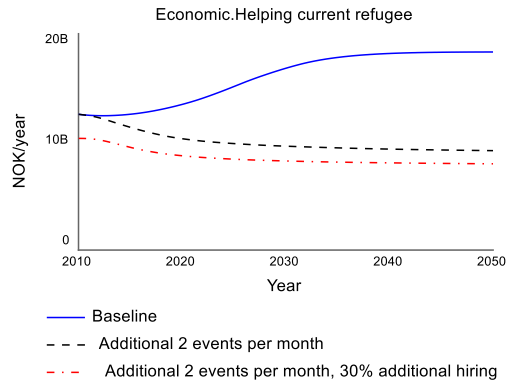


Figure 67: Budget used to help current refugees

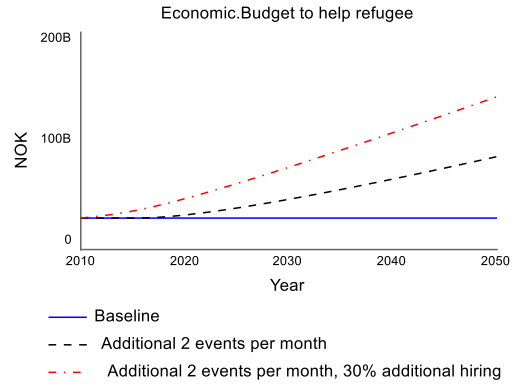


Figure 68: Total budgets to help both current and new refugees

8 Discussion and Conclusion

The purpose of this research is to understand the mechanism and dynamic of how refugees integrate by looking beyond just the employment rate but rather taking into account their psychological well-being aspect, their social aspect, the perception towards the refugee and how the refugees are able to perform their job. Our focus is on the reinforcing mechanism of these indicators and its compounding effect. The followings are our key insights and answer to our research questions.

1. What benefits can system dynamic approach bring in representing the dynamic behavior of the refugee integration in Norway?

We are able to use system dynamics to build exploratory model that represent and help us understand the dynamics of refugee integration. In addition, we have successfully attempted to quantify the model. Although there is lack of data on many “soft” variables, we normalize the model and use relative term to compensate for the limitation. The modelling allows us to integrate the elements that are usually discussed separately and understand the feedback loops that prevent refugees to integrate to the new country.

2. What are the main indicators that contribute to the refugee integration and the dynamic between them especially the mechanism that makes refugees struggles in the new country?

From our literature review, we have identified key indicators for refugee integration as follow: employment rate, stress level, social interaction, social skill, job performance, perception towards refugee. We have identified eight major reinforcing loops in our dynamic hypothesis. These loops are interconnected and thus have compounding effects.

The model categorizes refugee workforce into two levels: entry level and senior level. The entry level work is an unskilled, relatively low paid and unstable job. Where the senior level work requires skill and thus it is a higher paid and permanent job. With the assumption that entry level workers have lower income relatively to the average Norwegian income, we expect their average stress level to be higher than the average Norwegian since income is an important contributor to stress. We find that higher stress due to income impacts refugees willingness to socialize, their motivation to work and thus their job performance. As those elements can lead to the local population having a more negative perception towards refugees, refugees can get “trapped” in having fewer opportunities to participate to situations that can help their integration and stress for example social events or advancing to better paid jobs. In addition, since the

perception is not separated by the level of worker therefore the decrease in perception will eventually impact the senior refugee who has start off well in the beginning.

3. What can potentially be the help that we can offer to the refugees to help easing them into the new host country?

Since the entry level workforce is trapped in the unskilled and relatively low income job, it is therefore important to ensure that the refugees are trained and acquire necessary skills needed in the labor market. This is to move the refugee out of the entry level workforce trap to senior workforce where they are able to live like an average Norwegian.

Furthermore, we found that the local perception towards the refugee has a major impact to the integration. However the perception in itself takes a long time and is difficult to change thus the increase in number of interactions between local and refugees can be used as a mean for refugee to improve their social skill, raise the perception of local people and reduce the refugees' stress. Some municipalities already organize such events for the refugees to meet local people for example walk and talk, where they go hiking together and language café where foreigner can practice Norwegian with the local. Our insight recommends that these activities should be done in a regular basis.

Lastly, our analysis has shown that the refugees employment rate can be increased through increasing the refugees social interaction and provide the incentive for the company to hire more refugee. This will result in less cost for helping unemployed refugees and there is potentially enough budget left to accept more refugees.

Limitation

This research is the first attempt to use system dynamics model to quantify refugee integration. Thus the model is an exploratory model that has an objective to explain the dynamic of refugee integration and theoretical insight and does not have the objective to fit the model result into the real-world data. Plugging and fitting in the data is therefore a future work of this research. In addition, there is limitation of data for many parameters especially the soft variables. Therefore where possible we use relative term in the model to avoid the absolute number.

Due to the limitation of time, the model structure does not separate the refugee by age, gender and education background. Thus it assumes the same behavior from the different groups while in fact the literature review shows that the stress level is different between age group and gender. In addition the refugees with higher education background will start off with better footing than the one with low to zero education. In addition, this research focus is on the trap

that prevents the refugees to have a fulfilling life in the new host country, hence many reinforcing loops. The balancing mechanism should be added as future work.

Lastly this research does not cover the policy structure. The policy recommendation is based on the intervention points, but the policy structure has not yet been developed. Thus the future work of this research is to ensure the fitting of the result to the real-world data and development of the policy implementation structure.

Appendix A: Reference

- Ager, A., & Strang, A. (2008). Understanding Integration: A Conceptual Framework. *Journal of Refugee Studies*, 21(2), 166–191. <https://doi.org/10.1093/jrs/fen016>
- Bakker, L., Dagevos, J., & Engbersen, G. (2014). The Importance of Resources and Security in the Socio-Economic Integration of Refugees. A Study on the Impact of Length of Stay in Asylum Accommodation and Residence Status on Socio-Economic Integration for the Four Largest Refugee Groups in the Netherlands. *Journal of International Migration and Integration*, 15(3), 431–448. <https://doi.org/10.1007/s12134-013-0296-2>
- Bakker, L., Dagevos, J., & Engbersen, G. (2017). Explaining the refugee gap: A longitudinal study on labour market participation of refugees in the Netherlands. *Journal of Ethnic and Migration Studies*, 43(11), 1775–1791.
<https://doi.org/10.1080/1369183X.2016.1251835>
- Barlas, Y. (1996). Formal aspects of model validity and validation in system dynamics. *System Dynamics Review*, 12(3), 183–210. [https://doi.org/10.1002/\(SICI\)1099-1727\(199623\)12:3<183::AID-SDR103>3.0.CO;2-4](https://doi.org/10.1002/(SICI)1099-1727(199623)12:3<183::AID-SDR103>3.0.CO;2-4)
- Berry, J. W. (1997). Immigration, Acculturation, and Adaptation. *Applied Psychology*, 46(1), 5–34. <https://doi.org/10.1111/j.1464-0597.1997.tb01087.x>
- Brook, M. I., & Ottemöller, F. G. (2020). A new life in Norway: The adaptation experiences of unaccompanied refugee minor girls. *Children and Youth Services Review*, 117, 105287. <https://doi.org/10.1016/j.childyouth.2020.105287>
- Bufdir. (2022). *The employment rate for immigrants in Norway* [Data Set] https://www.bufdir.no/Statistikk_og_analyse/Etnisitet/arbeidsliv/deltakelse_i_arbeidslivet/_blant_samer_nasjonale_minoriteter_og_personer_med_innvandrerbakgrunn/

- Burnett, A. (2001). Asylum seekers and refugees in Britain: Health needs of asylum seekers and refugees. *BMJ*, 322(7285), 544–547. <https://doi.org/10.1136/bmj.322.7285.544>
- Clement, V., Kanta, R., & Alex, S. (2021). *Groundswell Part II: Acting on Internal Climate Migration*. The World Bank.
- Garkisch, M., Heidingsfelder, J., & Beckmann, M. (2017). Third Sector Organizations and Migration: A Systematic Literature Review on the Contribution of Third Sector Organizations in View of Flight, Migration and Refugee Crises. *VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations*, 28(5), 1839–1880. <https://doi.org/10.1007/s11266-017-9895-4>
- Jayaweera, T. (2015). Impact of Work Environmental Factors on Job Performance, Mediating Role of Work Motivation: A Study of Hotel Sector in England. *International Journal of Business and Management*, 10(3), p271. <https://doi.org/10.5539/ijbm.v10n3p271>
- Kang, Y.-D. (2021). Refugee crisis in Europe: Determinants of asylum seeking in European countries from 2008–2014. *Journal of European Integration*, 43(1), 33–48. <https://doi.org/10.1080/07036337.2020.1718673>
- Khan, A. H., Nawaz, M. M., Aleem, M., & Hamed, W. (2012). *Impact of job satisfaction on employee performance: An empirical study of autonomous Medical Institutions of Pakistan*. 9.
- Koirala, S. (2016). Refugee Settlement in Australia and the Challenges for Integration. In S. Fan & J. Fielding-Wells (Eds.), *What is Next in Educational Research?* (pp. 119–129). SensePublishers. https://doi.org/10.1007/978-94-6300-524-1_12
- Liang, B. (2017). Real-time Response Model to Optimize Refugee Flow. *Proceedings of the 2017 5th International Conference on Frontiers of Manufacturing Science and Measuring Technology (FMSMT 2017)*. 2017 5th International Conference on Frontiers

- of Manufacturing Science and Measuring Technology (FMSMT 2017), Taiyuan, China.
<https://doi.org/10.2991/fmsmt-17.2017.187>
- Liebig, T., & Tronstad, K. (2018). *Triple Disadvantage?: A first overview of the integration of refugee women* (OECD Social, Employment and Migration Working Papers No. 216; OECD Social, Employment and Migration Working Papers, Vol. 216).
<https://doi.org/10.1787/3f3a9612-en>
- Luna-Reyes, L. F., & Andersen, D. L. (2003). Collecting and analyzing qualitative data for system dynamics: Methods and models: Collecting and Analyzing Qualitative Data. *System Dynamics Review*, 19(4), 271–296. <https://doi.org/10.1002/sdr.280>
- Phillimore, J. (2011). Refugees, Acculturation Strategies, Stress and Integration. *Journal of Social Policy*, 40(3), 575–593. <https://doi.org/10.1017/S0047279410000929>
- Rahmandad, H., & Sterman, J. D. (2012). Reporting guidelines for simulation-based research in social sciences: Reporting Guidelines for Simulation-Based Research. *System Dynamics Review*, 28(4), 396–411. <https://doi.org/10.1002/sdr.1481>
- Sam, D. L., & Berry, J. W. (2010). Acculturation: When Individuals and Groups of Different Cultural Backgrounds Meet. *Perspectives on Psychological Science*, 5(4), 472–481.
<https://doi.org/10.1177/1745691610373075>
- Santiago, C. D., Wadsworth, M. E., & Stump, J. (2011). Socioeconomic status, neighborhood disadvantage, and poverty-related stress: Prospective effects on psychological syndromes among diverse low-income families. *Journal of Economic Psychology*, 32(2), 218–230.
<https://doi.org/10.1016/j.joep.2009.10.008>
- Sederel, C. (2016). *No wellbeing – no integration. A qualitative system dynamics model of the relationship between refugees’ psychological wellbeing and their integration into the Netherlands*. <https://doi.org/10.13140/RG.2.2.10078.64325>

- Senge, P. M., & Forrester, J. W. (1980). Tests for building confidence in system dynamics models. *System Dynamics, TIMS Studies in Management Sciences*, 14, 209–228.
- Shahzadi, I., Javed, A., Pirzada, S. S., Nasreen, S., & Khanam, F. (2014). Impact of Employee Motivation on Employee Performance. *European Journal of Business and Management*, 9.
- Smith, D. B., & Shields, J. (2013). Factors Related to Social Service Workers' Job Satisfaction: Revisiting Herzberg's Motivation to Work. *Administration in Social Work*, 37(2), 189–198. <https://doi.org/10.1080/03643107.2012.673217>
- Statistisk sentralbyrå Statistics Norway. (2022), *Attitudes towards immigrants and immigration* [Data Set] <https://www.ssb.no/en/befolkning/innvandrere/statistikk/personer-med-flyktningbakgrunn>
- Statistisk sentralbyrå Statistics Norway. (2022), *Person with Refugee Background* [Data Set] <https://www.ssb.no/en/befolkning/innvandrere/statistikk/personer-med-flyktningbakgrunn>
- Sterman, J. D. (2000). *Business dynamics: Systems thinking and modeling for a complex world*. Irwin/McGraw-Hill.
- Sterman, J. D. (2002). *System Dynamics: Systems Thinking and Modeling for a Complex World*. 31.
- Stewart, M. J., Makwarimba, E., Reutter, L. I., Veenstra, G., Raphael, D., & Love, R. (2009). Poverty, Sense of Belonging and Experiences of Social Isolation. *Journal of Poverty*, 13(2), 173–195. <https://doi.org/10.1080/10875540902841762>
- Strang, A., & Ager, A. (2010). Refugee Integration: Emerging Trends and Remaining Agendas. *Journal of Refugee Studies*, 23(4), 589–607. <https://doi.org/10.1093/jrs/feq046>
- Taylor, I., & Masys, A. J. (2018). Complexity and Unintended Consequences in a Human Security Crisis: A System Dynamic Model of the Refugee Migration to Europe. In A. J.

- Masys (Ed.), *Security by Design* (pp. 93–136). Springer International Publishing.
https://doi.org/10.1007/978-3-319-78021-4_6
- UNHCR. (2010). *Convention and Protocol Relating to the Status of Refugees*.
- UNHCR. (2013). *The Integration of resettled refugees*.
- UNHCR. (2022). *Global Trends 2021*.
- UNHCR. (2022). *Ukraine Refugee Situation* [Data Set].
<https://data.unhcr.org/en/situations/ukraine/location?secret=unhcrrestricted>
- Valtonen, K. (2004). From the Margin to the Mainstream: Conceptualizing Refugee Settlement Processes. *Journal of Refugee Studies*, 17(1), 70–96. <https://doi.org/10.1093/jrs/17.1.70>
- Van Iddekinge, C. H., Aguinis, H., Mackey, J. D., & DeOrtentiis, P. S. (2018). A Meta-Analysis of the Interactive, Additive, and Relative Effects of Cognitive Ability and Motivation on Performance. *Journal of Management*, 44(1), 249–279.
<https://doi.org/10.1177/0149206317702220>
- Werner, K., St. Arnold, G., & Crea, T. M. (2021). Using a community-based system dynamics approach for understanding inclusion and wellbeing: A case study of special needs education in an eastern African refugee camp. *Conflict and Health*, 15(1), 58.
<https://doi.org/10.1186/s13031-021-00390-5>
- World Data (2021). *Incoming Asylum to Norway 2000-2021* [Data Set].
<https://www.worlddata.info/europe/norway/asylum.php#:~:text=A%20total%20of%201%2C076%20decisions,Turkey%20and%20from%20the%20Congo.>

Appendix B: Sensitivity Analysis Result

Below table is the summary for the result from our sensitivity analysis. The range is between -25% and +25% of the value. We have categorized the sensitivity into 3 categories:

- **Not sensitive:** There is no change in behavioral pattern and the magnitude of the model result is small.

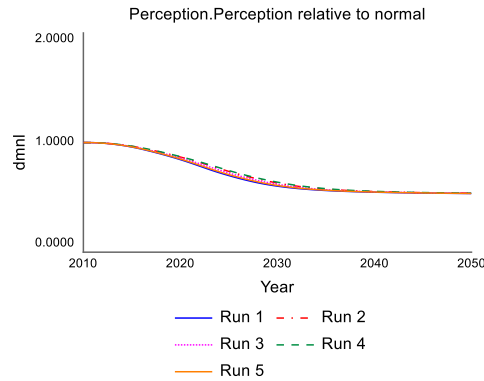


Figure 69: Example of result from non-sensitive parameter

- **Limited sensitivity:** There is no change in behavioral pattern however the magnitude of the model result is relatively noticeable.

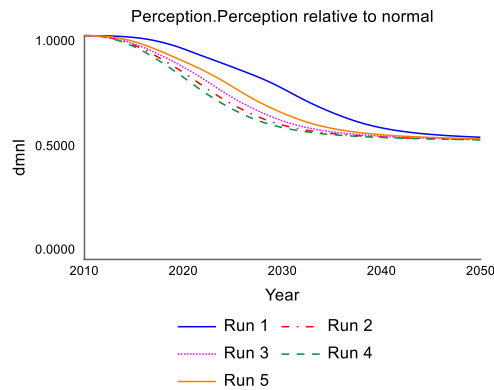


Figure 70: Example of result from limited sensitive parameter

- **Sensitive:** There is change in behavior pattern.

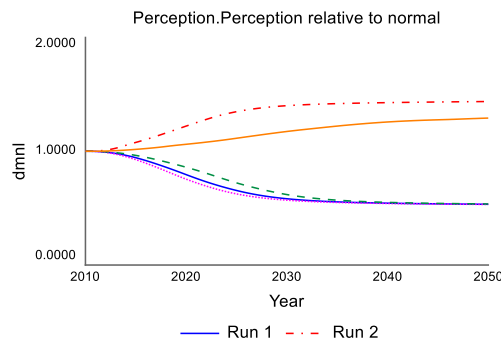


Figure 71: Example of result from sensitive parameter

For the sensitivity analysis of graphical function, we simulate 5 runs where each run has different curvature. For example, the figure below shows different graphical function for effect of income to stress. We have applied the same concept with all the graphical functions in the model.

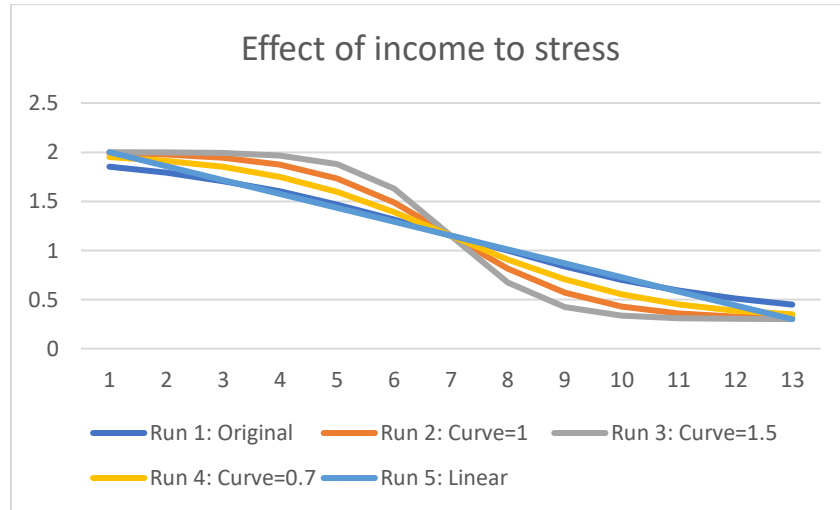


Figure 72: Example of different graphical function

In this case, the original graph is although an s-shape but it is close to linear, thus we found that the behavior changes as the curvature of the s-shape for effect of income to stress increases.

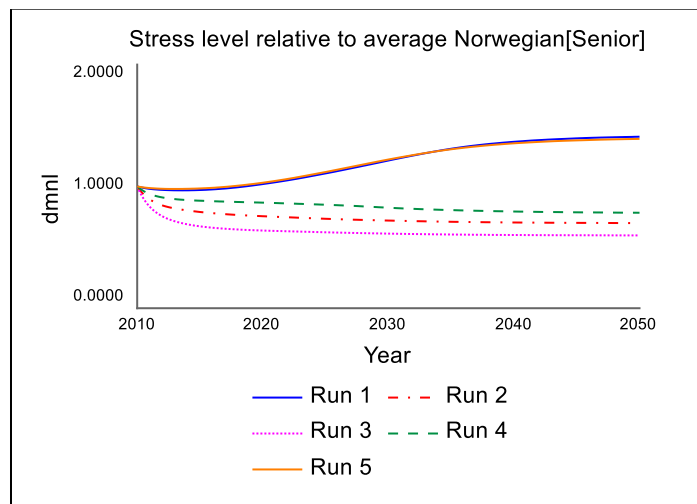


Figure 73: Example of the result from sensitive graphical function

Below table contains the summary of all the variables in the model with the sensitivity result.

Variable	Value	Range	Sensitivity	Comments
Time				
Stress level adjustment time	1	0.75-1.25	Not sensitive	
Time to adjust social skill	2	1.5-2.5	Not sensitive	
Time to adjust perception	5	3.75-6.25	Not sensitive	
Time to adjust ability	5	3.75-6.25	Not sensitive	
Time to adjust motivation	1	0.75-1.25	Not sensitive	
time to offer rewards	1	0.75-1.25	Not sensitive	
Duration for preparation	1	0.75-1.25	Not sensitive	
Entry Level average time to Quit	4	3-5	Not sensitive	
Average time to promote	20	15-25	Limited sensitivity	
Entry level time to retire	40	30-50	Not sensitive	
Senior time to retire	15	11.25-18.75	Limited sensitivity	
Senior Level average time to Quit	8	6-10	Not sensitive	
Years after retirement	13	9.75-16.25	Not sensitive	
Weight				
weight effect of income to stress	0.6	0.45-0.75	Sensitive	Pattern of stress changes to decline when the weight is 0.45
weight effect of social interactions to stress	0.2	0.15-0.25	Limited sensitivity	
Weighted effect from other stressor (Entry)	0.2	0.15-0.25	Not sensitive	
Weighted effect from other stressor (Senior)	0.2	0.15-0.25	Limited sensitivity	
Weight on performance	0.6	0.45-0.75	Not sensitive	
Weight on rewards	0.7	0.525-0.875	Not sensitive	
Average Level				
Refugee average stress level	0.5	0.375-0.625	Not sensitive	
Average social event interactions per person per year for Norwegian	106	79.5-132.5	Not sensitive	
Average fraction of meaningful interaction	0.5	0.375-0.625	Not sensitive	
Average societal social skill	0.8	0.6-1	Not sensitive	
Average perception to Norwegian	0.5	0.375-0.625	Not sensitive	
Normal ability	0.5	0.375-0.625	Not sensitive	
Normal motivation	0.5	0.375-0.625	Not sensitive	
Normal rewards	0.25	0.1875-0.3125	Not sensitive	
average refugee yearly income - entry level	430320	322740-537900	Sensitive	

Variable	Value	Range	Sensitivity	Comments
average refugee yearly income - senior level	638472	478854-798090	Sensitive	
average income in Norway	457110	342833-571388	Sensitive	
Average Tax rate	0.3	0.225-0.375	Not sensitive	
Average new employee experience	3	2.25-3.75	Not sensitive	
Normal Experience Gain Entry	1	0.75-1.25	Not sensitive	
Normal Experience Gain Senior	1.2	0.9-1.5	Not sensitive	
Other Parameter				
External budget	29000000000	21750000000-36250000000	Not sensitive	
Unemployment cost per person	125000	93750-156250	Not sensitive	
Transition cost per person	21000	157500-262500	Not sensitive	
Refugee application	8000	6000-10000	Not sensitive	
Graphical function				
Hiring fraction			Not sensitive	
Effect of income to stress			Sensitive	The pattern for stress level for senior changes when curvature is more than 0.7
Effect of social to stress			Not sensitive	
Effect from perception to social event interaction			Sensitive	The pattern for perception changes when curvature is more than 0.8
Effect of social skill to meaningful interaction			Sensitive	The pattern for perception changes when curvature is more than 0.8
Effect of relative social skill to perception			Sensitive	The pattern for social skill changes when curvature is more than 0.8
Effect of performance to perception			Not sensitive	
Effect of experience to ability			Not sensitive	
Effect from interaction to motivation			Sensitive	The pattern for senior level performance changes when curvature is more than 1.25
Effect of rewards to motivation			Not sensitive	
Rewards based on performance			Not sensitive	

Appendix C: Model Documentation

Top-Level Model:
Equilibrium_switch = 0
UNITS: dmn1
DOCUMENT: This is the switch to turn the model into equilibrium. When the switch is 1 the model is in equilibrium. When running other scenario this switch should be set to zero.
Input_1 = 1
UNITS: dmn1
DOCUMENT: Input to switch economic to stress. The input only takes value of 0 and 1.
Input_10 = 1
UNITS: dmn1
DOCUMENT: Input to switch economic to employment. The input only takes value of 0 and 1.
Input_11 = 1
UNITS: dmn1
DOCUMENT: Input to switch employment to economic. The input only takes value of 0 and 1.
Input_2 = 1
UNITS: dmn1
DOCUMENT: Input to switch social to stress. The input only takes value of 0 and 1.
Input_3 = 1
UNITS: dmn1
DOCUMENT: Input to switch stress to social. The input only takes value of 0 and 1.
Input_4 = 1
UNITS: dmn1
DOCUMENT: Input to switch perception to social. The input only takes value of 0 and 1.
Input_5 = 1
UNITS: dmn1
DOCUMENT: Input to switch social to perception. The input only takes value of 0 and 1.
Input_6 = 1

UNITS: dmn1
DOCUMENT: Input to switch performance to perception. The input only takes value of 0 and 1.
Input_7 = 1
UNITS: dmn1
DOCUMENT: Input to switch social to performance. The input only takes value of 0 and 1.
Input_8 = 1
UNITS: dmn1
DOCUMENT: Input to switch employment to performance. The input only takes value of 0 and 1.
Input_9 = 1
UNITS: dmn1
DOCUMENT: Input to switch perception to employment. The input only takes value of 0 and 1.
Switch_economic_to_employment = IF Equilibrium_switch = 1 THEN 1 ELSE Input_10
UNITS: dmn1
DOCUMENT: This is a switch to take input from the economic module to employment module. When the switch is 0, it will take the employment rate as input, for equilibrium purposes. When the switch is 1, it will take the transition rate from economic module as an input to this module i.e. training rate
Switch_economic_to_stress = IF Equilibrium_switch = 1 THEN 1 ELSE Input_1
UNITS: dmn1
DOCUMENT: This is switch to link output from economic module to stress module. 1 means the stress module will take the refugee relative income to norwegian from economic module as input, while 0 means it will take constant relative income.
Switch_employment_to_economic = IF Equilibrium_switch = 1 THEN 1 ELSE Input_11
UNITS: dmn1
DOCUMENT: This is a switch to take input from the economic module to employment module. When the switch is 0, it will take the employment rate as input, for equilibrium purposes. When the switch is 1, it will take the transition rate from economic module as an input to this module i.e. training rate

Switch_employment_to_performance = IF Equilibrium_switch = 1 THEN 1 ELSE Input_8
UNITS: dmn1
DOCUMENT: This is the switch to connect the employment module to performance module. When the switch is 1 it takes the relative experience from the employment module. When the switch is 0 it takes the constant relative experience. This is useful for testing the module individually.
Switch_perception_to_employment = IF Equilibrium_switch = 1 THEN 1 ELSE Input_9
UNITS: dmn1
DOCUMENT: This is a switch whether or not to take the input from the perception module or from a constant number. When switch is 0, the module takes constant relative perception. When switch is 1, the module takes input from perception module.
Switch_perception_to_social = IF Equilibrium_switch = 1 THEN 1 ELSE Input_4
UNITS: dmn1
DOCUMENT: This is switch to link output from perception module module to social interaction. 1 means the social module will take the relative perception from perception module as input, while 0 means it will take constant number.
Switch_performance_to_perception = IF Equilibrium_switch = 1 THEN 1 ELSE Input_6
UNITS: dmn1
DOCUMENT: This is the switch whether to use the input from job performance module or not. When the switch is 0, the perception module will use the input from the constant number. When the switch is 1, the perception module will use the input from the job performance module.
Switch_social_to_perception = IF Equilibrium_switch = 1 THEN 1 ELSE Input_5
UNITS: dmn1
DOCUMENT: This is the switch whether to use the input from social interaction module or not. When the switch is 0, the perception module will use the input from the constant number. When the switch is 1, the perception module will use the input from the social interaction module.
Switch_social_to_performance = IF Equilibrium_switch = 1 THEN 1 ELSE Input_7
UNITS: dmn1

DOCUMENT: This is the switch to connect the social interaction module to performance module. When the switch is 1 it takes the relative social interaction from the social module. When the switch is 0 it takes the constant relative social interaction. This is useful for testing the module individually.
Switch_social_to_stress = IF Equilibrium_switch = 1 THEN 1 ELSE Input_2
UNITS: dmn1
DOCUMENT: This is switch to link output from social interaction module to stress module. 1 means the stress module will take the relative refugee interactions to norm from social interaction module as input, while 0 means it will take constant number.
Switch_stress_to_social = IF Equilibrium_switch = 1 THEN 1 ELSE Input_3
UNITS: dmn1
DOCUMENT: This is switch to link output from stress module module to social interaction. 1 means the social module will take the relative stress from stress module as input, while 0 means it will take constant number.
Economic:
Budget_to_help_refugee(t) = Budget_to_help_refugee(t - dt) + (Inflow_budget - Helping_current_refugee - Helping_new_refugee) * dt
INIT Budget_to_help_refugee = Refugee_Budget_input_yearly*year
UNITS: NOK
DOCUMENT: This is the accumulation of the budget that is available for helping refugee both current refugees and new refugees.
INFLOWS:
Inflow_budget = Refugee_Budget_input_yearly
UNITS: NOK/year
DOCUMENT: This is the budget set for helping the refugee each year.
OUTFLOWS:
Helping_current_refugee = IF Total_unemployment_cost_after_subsidy+Total_Transitional_cost > (Budget_to_help_refugee/year) THEN Budget_to_help_refugee/year ELSE (Total_unemployment_cost_after_subsidy+Total_Transitional_cost) {UNIFLOW}

UNITS: NOK/year
<p>DOCUMENT: This is the outflow of the budget to help the current refugee in Norway. This comprises of two costs. First is the cost of helping the unemployment refugee since the refugee is entitle to unemployment benefit like other residence. Second is transition cost which is the cost that government has to pay to support refugee introduction program i.e. language class, social study class, personnel to help the refugees through transition period.</p> <p>The model makes helping current refugee as first priority, the rest of the budget then used for helping new refugee.</p>
$\text{Helping_new_refugee} = \text{IF Helping_current_refugee} = \text{Budget_to_help_refugee/year}$ $\text{THEN } 0 \text{ ELSE } \text{MIN}(\text{Budget_to_help_refugee/year} - \text{Helping_current_refugee},$ $\text{Initial_cost_per_one_refugee} * \text{Refugee_application}) \{ \text{UNIFLOW} \}$
UNITS: NOK/year
<p>DOCUMENT: The model makes helping current refugee as first priority, the rest of the budget then used for helping new refugee. The outflow choose the minimum number of the budget that is left from helping current refugee and the amount of money that is needed to help refugees that year.</p>
$\text{Refugee_in_training}(t) = \text{Refugee_in_training}(t - dt) + (\text{Accepted_refugee_per_year} -$ $\text{Transition}) * dt$
$\text{INIT Refugee_in_training} = \text{Refugee_application} * \text{year}$
UNITS: people
<p>DOCUMENT: Norway offer the introduction program for immigrants, refugees included. The objective of the program is to prepared refugees for labor market and also to have the refugees learn the new way of life and culture in the new country.</p> <p>This stock is the number of refugees who are still doing the introduction program i.e. language class, social class. These refugees are not working yet.</p>
INFLOWS:
$\text{Accepted_refugee_per_year} = \text{Helping_new_refugee} / \text{Initial_cost_per_one_refugee}$ $\{ \text{UNIFLOW} \}$
UNITS: person/year

DOCUMENT: This is rate of number of refugees that has been accepted each year. This depends on what is left of helping current refugees and initial cost to accept one refugee.
OUTFLOWS:
$Transition = \text{Refugee_in_training} / \text{Duration_for_preparation}$
UNITS: people/year
DOCUMENT: The transition rate is the rate that refugees are trained and be prepared for the labor market. When the transition period is over for the refugees the refugees move from the refugee in training stock to the refugee waiting to be employed stock (in the employment module)
$\text{Refugee_that_has_been_trained}(t) = \text{Refugee_that_has_been_trained}(t - dt) + (\text{training_rate}) * dt$
INIT $\text{Refugee_that_has_been_trained} = 0$
UNITS: people
DOCUMENT: This is the total number of refugees that has been trained over the period of time the model is run.
INFLOWS:
$\text{training_rate} = \text{Transition}$
UNITS: people/year
DOCUMENT: The training rate is equal to the transition rate because we assume that once the refugees are finished with the training they finish with the transition period also and ready to be employed.
$\text{Total_accepted_refugees}(t) = \text{Total_accepted_refugees}(t - dt) + (\text{Refugee_accumulation}) * dt$
INIT $\text{Total_accepted_refugees} = 151066$
UNITS: people
DOCUMENT: This is the total number of refugees being accepted to Norway over the period of time the model is run.
INFLOWS:
$\text{Refugee_accumulation} = \text{Accepted_refugee_per_year} \{ \text{UNIFLOW} \}$
UNITS: people/year
DOCUMENT: This is the inflow to the stock that accumulate total refugees being accepted during the time the model is run.

<p>Average_income_for_entry_level = IF .Switch_employment_to_economic = 1 THEN Total_income_from_refugee_entry_position//(Employment.Entry_Level_Workforce+Employment.Unemployed_Entry_Level) ELSE Total_income_from_refugee_entry_position//Constant_employment[Entry]</p>
<p>UNITS: NOK/year/people</p>
<p>DOCUMENT: This is an average income for everyone in the entry level workforce, employed and unemployed. Thus if there are many unemployment the average income will be low.</p>
<p>Average_income_for_senior_level = IF .Switch_employment_to_economic = 1 THEN Total_income_from_refugee_senior_level//(Employment.Senior_Level_Workforce+Employment.Unemployed_Senior_Level) ELSE Total_income_from_refugee_senior_level//Constant_employment[Senior]</p>
<p>UNITS: NOK/year/people</p>
<p>DOCUMENT: This is an average income for everyone in the senior level workforce, employed and unemployed. Thus if there are many unemployment the average income will be low.</p>
<p>Average_income_in_Norway = (50790*12)*0.75</p>
<p>UNITS: NOK/Year/people</p>
<p>DOCUMENT: This is the average income of individual in Norway in 2021 from SSB. However we multiply this number by 0.75 since this number is calculated not taking account for the unemployed people. We need to be able to compare this number to average income of entry and senior workforce in this model which incorporate the unemployed people therefore the number needs to be reduced.</p> <p>Ref: https://www.ssb.no/en/arbeid-og-lonn/lonn-og-arbeidskraftkostnader/statistikk/lonn</p>
<p>Average_income_per_refugee = IF .Switch_employment_to_economic = 1 THEN Total_refugee_income//Total_employed ELSE Total_refugee_income//(Constant_employment[Entry]+Constant_employment[Senior])</p>
<p>UNITS: NOK/year/people</p>
<p>DOCUMENT: The average income of the refugee is calculated by total refugee income divided by number of refugee being employed at that time.</p>

"average_refugee_yearly_income_-_entry_level" = 35860*12
UNITS: NOK/person/year
DOCUMENT: According to SSB statistic, the average monthly earning for elementary occupation for all industry is 35860 NOK per month Ref: https://www.ssb.no/en/arbeid-og-lonn/lonn-og-arbeidskraftkostnader/statistikk/lonn
"average_refugee_yearly_income_-_senior_level" = 53206*12
UNITS: NOK/person/year
DOCUMENT: According to SSB statistic, the average monthly earning for all occupation except elementary level is 53206 NOK per month Ref: https://www.ssb.no/en/arbeid-og-lonn/lonn-og-arbeidskraftkostnader/statistikk/lonn
Average_Tax_rate = 0.3
UNITS: dmn1
DOCUMENT: General income is taxed at a flat rate of 22%. Personal income between NOK 190,350 and NOK 267,900 is subject to a bracket tax of 1.7%. For personal income between NOK 267,900 and NOK 643,800, the bracket tax rate is 4.0%. The model assume senior level employee earns around 600K per year thus it is conservative to assume that average tax rate is 30% per year. Ref: https://taxsummaries.pwc.com/norway/individual/taxes-on-personal-income
Constant_employment[Entry] = constant_entry_level_employment
UNITS: people
DOCUMENT: This is a constant input variable for employment rate for both entry and senior level. Depending on the switch the variable takes the constant number or employment ratio. The variable is used for testing economic module.
Constant_employment[Senior] = constant_senior_level_employment
UNITS: people

DOCUMENT: This is a constant input variable for employment rate for both entry and senior level. Depending on the switch the variable takes the constant number or employment ratio. The variable is used for testing economic module.
$\text{constant_entry_level_employment} = 5 * 1000$
UNITS: people
DOCUMENT: This is a constant input variable for entry level employment rate. The variable is used for testing economic module.
$\text{constant_senior_level_employment} = 30.9 * 1000$
UNITS: people
DOCUMENT: This is a constant input variable for senior level employment rate. The variable is used for testing economic module.
$\text{Constant_unemployment} = 2.78 * 1000$
UNITS: people
DOCUMENT: This is a constant input variable for number of people who are unemployed. The variable is used for testing economic module.
$\text{Duration_for_preparation} = 1$
UNITS: year
DOCUMENT: Usually it takes around 6 months to 1 year, for refugee to finish the introduction course and ready to be in the work market.
$\text{Equilibrium_relative_income} = 1$
UNITS: dmnl
DOCUMENT: Equilibrium relative income is 1. This means that at the equilibrium the model assumes that the refugee has the same income as local people.
$\text{External_budget} = 29000000000$
UNITS: NOK/year
DOCUMENT: This is the variable for the fix external budget to help the refugee.
$\text{Fraction_for_using_refugee_tax} = 0$
UNITS: dmnl
DOCUMENT: This depends on the policy whether to use all tax from refugee to help funded the refugee budget or only fraction of it.
$\text{Initial_cost_per_one_refugee} = 2000000 + \text{transitional_cost_per_person}$

UNITS: NOK/people
DOCUMENT: This is the initial cost when accept the refugees plus the transition cost.
Initial_refugee_in_training = { 1470 } 8000
UNITS: People
DOCUMENT: This variable is used to intialized stock of refugee in training since this stock cannot be in the formula due to circular problem.
Refugee_application = 8000
UNITS: people/year
DOCUMENT: The model assumes large static number of application of refugees to be helped. This is because the focus of the model is to test how much we can help the refugees.
Refugee_Budget_input_yearly = (Fraction_for_using_refugee_tax*Tax_from_refugee)+External_budget
UNITS: NOK/year
DOCUMENT: This variable is the budget set aside each year to help both current refugee (training, unemployment benefit) and new refugee. The model assume that the budget only comes from the tax that Norway receive from refugee income and not from other funding. The budget also depend on the policy whether to use all tax from refugee to help funding the refugee or only fraction of it. Thus the refugee budget each year is calculated by tax from refugee multiply by fraction of budget to help refugee.
Refugee_Relative_Income_to_Average_Norwegian[Entry] = IF .Equilibrium_switch = 1 THEN Equilibrium_relative_income ELSE IF .Switch_employment_to_economic = 1 THEN Average_income_for_entry_level//Average_income_in_Norway ELSE Total_refugee_income//(Constant_employment[Entry]+Constant_employment[Senior])//Average_income_in_Norway
UNITS: dmnl
DOCUMENT: This is the relative of refugee average income to the norwegian average income. One means on average refugee earns as much as average norwegian.
Refugee_Relative_Income_to_Average_Norwegian[Senior] = IF .Equilibrium_switch = 1 THEN Equilibrium_relative_income ELSE IF .Switch_employment_to_economic = 1 THEN Average_income_for_senior_level//Average_income_in_Norway ELSE

Total_refugee_income//((Constant_employment[Entry]+Constant_employment[Senior])//Average_income_in_Norway
UNITS: dmnrl
DOCUMENT: This is the relative of refugee average income to the norwegian average income. One means on average refugee earns as much as average norwegian.
Subsidy_for_unemployment = IF TIME<2023 THEN 0000000000 ELSE 0000000000
UNITS: NOK/year
DOCUMENT: This is the variable to explicitly separate the budget for helping the unemployment cost if any.
Tax_from_refugee = Total_refugee_income*Average_Tax_rate
UNITS: NOK/year
DOCUMENT: Tax from refugee is calculated by total income from refugee multiply by average tax rate.
Total_accepted_refugees_stat = GRAPH(TIME)
Points: (2010.00, 151066), (2011.00, 157692), (2012.00, 163480), (2013.00, 171648), (2014.00, 179534), (2015.00, 188130), (2016.00, 199393), (2017.00, 217241), (2018.00, 228161), (2019.00, 233794), (2020.00, 238281), (2021.00, 240239), (2022.00, 244660)
UNITS: people
DOCUMENT: This is the statistic of the refugees being granted the refugee status in Norway Ref: https://www.ssb.no/en/statbank/table/08381/tableViewLayout1//
Total_employed = Employment.Entry_Level_Workforce + Employment.Senior_Level_Workforce {SUMMING CONVERTER}
UNITS: People
DOCUMENT: This is the total number of refugees who are employed at both entry level and senior level.
Total_income_from_refugee_entry_position = IF .Switch_employment_to_economic = 1 THEN "average_refugee_yearly_income_-_entry_level"*Employment.Entry_Level_Workforce ELSE "average_refugee_yearly_income_-_entry_level"*Constant_employment[Entry]
UNITS: NOK/year

DOCUMENT: This is total income of refugee who are in entry level. It is calculated by the number of refugee in the entry level workforce multiply by average income for entry level in Norway.
Total_income_from_refugee_senior_level = IF .Switch_employment_to_economic = 1 THEN "average_refugee_yearly_income_-_senior_level"*Employment.Senior_Level_Workforce ELSE "average_refugee_yearly_income_-_senior_level"*Constant_employment[Senior]
UNITS: NOK/year
DOCUMENT: This is total income of refugee who are in senior level. It is calculated by the number of refugee in the senior level workforce multiply by average income for senior level in Norway.
Total_refugee_income = Total_income_from_refugee_senior_level+Total_income_from_refugee_entry_position
UNITS: NOK/year
DOCUMENT: This is the total income that all refugees earn per year. It is a summation of total income of refugee in entry level and senior level.
Total_Transitional_cost = transitional_cost_per_person*Transition
UNITS: NOK/year
DOCUMENT: Total transition cost is calculated by transition cost per one person multiplied by transition rate.
Total_Unemployed = Employment.Ready_refugees_waiting_to_be_employed + Employment.Unemployed_Entry_Level + Employment.Unemployed_Senior_Level {SUMMING CONVERTER }
UNITS: people
DOCUMENT: This is the total number of refugees who are unemployed. This number includes refugees who just finished their training and finding the jobs, refugees who quit their job and finding the new jobs at both entry and senior level.
Total_unemployment_cost = IF .Switch_employment_to_economic = 1 THEN Total_Unemployed*unemployment_cost_per_person ELSE Constant_unemployment*unemployment_cost_per_person
UNITS: NOK/year

DOCUMENT: This is the number of unemployed refugee multiplied by unemployment benefit per year.
$\text{Total_unemployment_cost_after_subsidy} = \text{MAX}(\text{Total_unemployment_cost} - \text{Subsidy_for_unemployment}, 0)$
UNITS: NOK/year
DOCUMENT: This is the cost of unemployment after the government has subsidized this cost, if any.
$\text{transitional_cost_per_person} = 210000$
UNITS: NOK/people
DOCUMENT: Transition cost is the cost that government has to pay to support refugee introduction program i.e. language class, social study class, personel to help the refugees through transition period. This cost is incurred while refugees are in the transition period and not yet employed.
$\text{unemployment_cost_per_person} = 125000$
UNITS: NOK/person/year
DOCUMENT: This figure (125K NOK per year) assume lowest based of salary to calculate for the unemployment benefit.
Ref: https://ec.europa.eu/social/main.jsp?catId=1123&langId=en&intPageId=4715#:~:text=What%20am%20I%20entitled%20to,parental%20benefit%20and%20unemployment%20benefit.
$\text{year} = 1$
UNITS: year
DOCUMENT: This is a number of year in which the budget is used. Here we assume the budget will come every year and will be used each year.
Employment:
$\text{Entry_Level_Workforce}(t) = \text{Entry_Level_Workforce}(t - dt) + (\text{Employment_rate} + \text{Entry_level_find_job_again} - \text{Entry_Level_Attrition} - \text{Entry_Retirement_rate} - \text{Promotion_rate}) * dt$

<p>INIT Entry_Level_Workforce = (Ready_refugees_waiting_to_be_employed*Hiring_fraction) /(1/Entry_level_time_to_retire+1/Average_time_to_promote)</p>
<p>UNITS: people</p>
<p>DOCUMENT: This stock is number of refugees who are employed in entry level at one point in time. The entry level is mostly unskilled work. The stock is initialized at equilibrium.</p> <p>The inflow to this stock are the employment rate, the reentry of the unemployed.</p> <p>The outflow to this stock take the following priorities: attrition, retirement and promotion to the senior level.</p>
<p>INFLOWS:</p>
<p>Employment_rate = Ready_refugees_waiting_to_be_employed*Hiring_fraction</p>
<p>UNITS: People/Years</p>
<p>DOCUMENT: The employment rate depends upon the hiring fraction.</p>
<p>Entry_level_find_job_again = Unemployed_Entry_Level*Hiring_fraction</p>
<p>UNITS: People/Years</p>
<p>DOCUMENT: Since this is for an entry level so we assume the same fraction of hiring with the employment rate.</p>
<p>OUTFLOWS:</p>
<p>Entry_Level_Attrition = (Entry_Level_Workforce/Entry_Level_average_time_to_Quit)</p>
<p>UNITS: People/Years</p>
<p>DOCUMENT: The attrition rate depends on the average time to quit.</p>
<p>Entry_Retirement_rate = Entry_Level_Workforce/Entry_level_time_to_retire</p>
<p>UNITS: People/Years</p>
<p>DOCUMENT: This is the retirement rate of the people in entry level to retirement.</p>
<p>Promotion_rate = Entry_Level_Workforce/Average_time_to_promote</p>
<p>UNITS: People/Years</p>
<p>DOCUMENT: The promotion rate moves workforce from entry level to senior level. The rate depend on the average time to promote.</p>

$\text{Entry_Level_Workforce_Experience}(t) = \text{Entry_Level_Workforce_Experience}(t - dt) + (\text{Additional_Experience_from_New_Employees} + \text{Workforce_Gaining_Experience} - \text{Entry_Level_Workforce_Loss_Experience} - \text{Promote_Workforce_Experience}) * dt$
$\text{INIT Entry_Level_Workforce_Experience} = \frac{((\text{Average_New_Employee_Experience} * (\text{Employment_rate} + \text{Entry_level_find_job_again})) + (\text{Entry_Level_Workforce} * \text{Normal_Experience_Gain_Entry}))}{((\text{Entry_Level_Attrition} + \text{Entry_Retirement_rate} + \text{Promotion_rate}) / \text{Entry_Level_Workforce})}$
UNITS: year/people
DOCUMENT: This is the total of experience in year for entry level workforce.
INFLOWS:
$\text{Additional_Experience_from_New_Employees} = \text{Average_New_Employee_Experience} * (\text{Employment_rate} + \text{Entry_level_find_job_again})$
UNITS: year/people/year
DOCUMENT: This is the inflow as the refugee enter the job market they bring with them few years of experience from training.
$\text{Workforce_Gaining_Experience} = \text{Entry_Level_Workforce} * \text{Normal_Experience_Gain_Entry}$
UNITS: year/people/year
DOCUMENT: As the refugee continue to work they gain more experience.
OUTFLOWS:
$\text{Entry_Level_Workforce_Loss_Experience} = \text{Entry_Level_Average_Workforce_Experience} * (\text{Entry_Level_Attrition} + \text{Entry_Retirement_rate})$
UNITS: year/people/year
DOCUMENT: This is the outflow of entry level workforce experience stock i.e. as people quit their job or retire they stop gaining work experience.
$\text{Promote_Workforce_Experience} = \text{Promotion_rate} * \text{Entry_Level_Average_Workforce_Experience}$
UNITS: year/people/year
DOCUMENT: The experience of entry workforce moves from entry level to senior level as the worker get promoted their experience move with them.

Ready_refugees_waiting_to_be_employed(t) = Ready_refugees_waiting_to_be_employed(t - dt) + (Training_rate - Employment_rate) * dt
INIT Ready_refugees_waiting_to_be_employed = Economic.Transition/Hiring_fraction
UNITS: people
DOCUMENT: These are the refugees who have completed the training and finding a job.
INFLOWS:
Training_rate = IF .Switch_economic_to_employment = 1 THEN Economic.Transition ELSE Employment_rate
UNITS: People/Years
DOCUMENT: The training rate is the rate that refugees are trained and be prepared for the labor market. The training rate takes the transition rate from economic module.
OUTFLOWS:
Employment_rate = Ready_refugees_waiting_to_be_employed*Hiring_fraction
UNITS: People/Years
DOCUMENT: The employment rate depends upon the hiring fraction.
Retired_Refugee(t) = Retired_Refugee(t - dt) + (Senior_Retirement_rate + Entry_Retirement_rate - Death_rate) * dt
INIT Retired_Refugee = ((Entry_Level_Workforce/Entry_level_time_to_retire) + (Senior_Level_Workforce/Senior_time_to_retire)) *Years_after_retirement
UNITS: people
DOCUMENT: This is the number of refugees who are retired i.e. above 70 until they die.
INFLOWS:
Senior_Retirement_rate = Senior_Level_Workforce/Senior_time_to_retire
UNITS: People/Years
DOCUMENT: This is the retirement rate of the people in senior level to retirement.
Entry_Retirement_rate = Entry_Level_Workforce/Entry_level_time_to_retire
UNITS: People/Years
DOCUMENT: This is the retirement rate of the people in entry level to retirement.
OUTFLOWS:
Death_rate = Retired_Refugee/Years_after_retirement
UNITS: People/Years

DOCUMENT: Death rate is determined by the years after retirement
$\text{Senior_Level_Workforce}(t) = \text{Senior_Level_Workforce}(t - dt) + (\text{Promotion_rate} + \text{Senior_level_find_job_again} - \text{Senior_Level_Attrition} - \text{Senior_Retirement_rate}) * dt$
$\text{INIT Senior_Level_Workforce} = \text{Entry_Level_Workforce}/\text{Average_time_to_promote} * \text{Senior_time_to_retire}$
UNITS: people
<p>DOCUMENT: This stock is number of refugees who are promoted to senior level at one point in time. The stock is initialized at equilibrium.</p> <p>The inflow to this stock are the promotion, the reentry of the unemployed.</p> <p>The outflow to this stock take the following priorities: attrition and retirement.</p>
INFLOWS:
$\text{Promotion_rate} = \text{Entry_Level_Workforce}/\text{Average_time_to_promote}$
UNITS: People/Years
<p>DOCUMENT: The promotion rate moves workforce from entry level to senior level. The rate depend on the average time to promote.</p>
$\text{Senior_level_find_job_again} = \text{Unemployed_Senior_Level} * \text{Hiring_fraction_for_senior_level}$
UNITS: People/Years
DOCUMENT: The rate of which senior level will find job again is slower than the entry level.
OUTFLOWS:
$\text{Senior_Level_Attrition} = \text{Senior_Level_Workforce}/\text{Senior_Level_average_time_to_Quit}$
UNITS: People/Years
DOCUMENT: The attrition rate depends on the average time to quit.
$\text{Senior_Retirement_rate} = \text{Senior_Level_Workforce}/\text{Senior_time_to_retire}$
UNITS: People/Years
DOCUMENT: This is the retirement rate of the people in senior level to retirement.

$\text{Senior_Level_Workforce_Experience}(t) = \text{Senior_Level_Workforce_Experience}(t - dt) + (\text{Promote_Workforce_Experience} + \text{Senior_Level_Workforce_Gaining_Experience} + \text{"Senior_level_workforce_re-entry"} - \text{Senior_Level_Workforce_Loss_Experience}_1) * dt$
$\text{INIT Senior_Level_Workforce_Experience} = ((\text{Promotion_rate} * \text{Entry_Level_Average_Workforce_Experience}) + (\text{Senior_Level_Workforce} * \text{Normal_Experience_Gain_Senior})) / ((\text{Senior_Level_Attrition} + \text{Senior_Retirement_rate} - \text{Senior_level_find_job_again}) / \text{Senior_Level_Workforce})$
<p>UNITS: year/people</p>
<p>DOCUMENT: This is the total of experience in year for senior level workforce.</p>
<p>INFLOWS:</p>
$\text{Promote_Workforce_Experience} = \text{Promotion_rate} * \text{Entry_Level_Average_Workforce_Experience}$
<p>UNITS: year/people/year</p>
<p>DOCUMENT: The experience of entry workforce moves from entry level to senior level as the worker get promoted their experience move with them.</p>
$\text{Senior_Level_Workforce_Gaining_Experience} = \text{Senior_Level_Workforce} * \text{Normal_Experience_Gain_Senior}$
<p>UNITS: year/people/year</p>
<p>DOCUMENT: As the refugee continue to work they gain more experience.</p>
$\text{"Senior_level_workforce_re-entry"} = \text{Senior_level_find_job_again} * \text{Senior_Level_Average_Workforce_Experience}$
<p>UNITS: year/people/year</p>
<p>DOCUMENT: This is the inflow for the workforce that has been hired again and thus they start accumulating experience again.</p>
<p>OUTFLOWS:</p>
$\text{Senior_Level_Workforce_Loss_Experience}_1 = (\text{Senior_Level_Attrition} + \text{Senior_Retirement_rate}) * \text{Senior_Level_Average_Workforce_Experience}$
<p>UNITS: year/people/year</p>

DOCUMENT: This is the outflow of senior level workforce experience stock i.e. as people quit their job or retire they stop gaining work experience.
$\text{Unemployed_Entry_Level}(t) = \text{Unemployed_Entry_Level}(t - dt) + (\text{Entry_Level_Attrition} - \text{Entry_level_find_job_again}) * dt$
INIT Unemployed_Entry_Level = $(\text{Entry_Level_Workforce}/\text{Entry_Level_average_time_to_Quit})/\text{Hiring_fraction}$
UNITS: people
DOCUMENT: This is the number of refugee at entry level who quit their work and become unemployed and need the unemployment benefit from the government. The stock is initialized to equilibrium.
INFLOWS:
$\text{Entry_Level_Attrition} = (\text{Entry_Level_Workforce}/\text{Entry_Level_average_time_to_Quit})$
UNITS: People/Years
DOCUMENT: The attrition rate depends on the average time to quit.
OUTFLOWS:
$\text{Entry_level_find_job_again} = \text{Unemployed_Entry_Level} * \text{Hiring_fraction}$
UNITS: People/Years
DOCUMENT: Since this is for an entry level so we assume the same fraction of hiring with the employment rate.
$\text{Unemployed_Senior_Level}(t) = \text{Unemployed_Senior_Level}(t - dt) + (\text{Senior_Level_Attrition} - \text{Senior_level_find_job_again}) * dt$
INIT Unemployed_Senior_Level = $\text{Senior_Level_Workforce}/\text{Senior_Level_average_time_to_Quit}/\text{Hiring_fraction_for_senior_level}$
UNITS: people
DOCUMENT: This is the number of refugee at entry level who quit their work and become unemployed and need the unemployment benefit from the government. The stock is initialized to equilibrium.
INFLOWS:
$\text{Senior_Level_Attrition} = \text{Senior_Level_Workforce}/\text{Senior_Level_average_time_to_Quit}$
UNITS: People/Years

DOCUMENT: The attrition rate depends on the average time to quit.
OUTFLOWS:
Senior_level_find_job_again = Unemployed_Senior_Level*Hiring_fraction_for_senior_level
UNITS: People/Years
DOCUMENT: The rate of which senior level will find job again is slower than the entry level.
Additional_hiring = 0.3
UNITS: 1/year
DOCUMENT: This is the additional hiring rate for the policy to give incentive for the company to hire more refugees.
Average_New_Employee_Experience = 3
UNITS: year/people/people
DOCUMENT: This is the experience that the new employee has when they first hired
Average_stay_in_a_job_for_entry_level = Entry_Level_Workforce//((Promotion_rate+Entry_Level_Attrition+Entry_Retirement_rate)
UNITS: year
DOCUMENT: This is the average duration the entry level workforce stay in their job.
Average_stay_in_a_job_for_senior_level = Senior_Level_Workforce//((Senior_Retirement_rate+Senior_Level_Attrition)
UNITS: year
DOCUMENT: This is the average duration the senior level workforce stay in their job.
Average_time_to_promote = 20
UNITS: year
DOCUMENT: We assume it takes 15 years for people to move to senior level.
Constant_relative_perception = {.429 + .35*0} {0.785} 1
UNITS: dmnl
DOCUMENT: This is a constant relative perception that will be used when testing the employment module individually.
EMPLOYED = Entry_Level_Workforce + Senior_Level_Workforce {SUMMING CONVERTER}

UNITS: People
DOCUMENT: Total employment including entry level and senior level
Entry_Level_average_time_to_Quit = 4
UNITS: year
DOCUMENT: We assume that it takes on average 10 years before refugee quit their job. This is quite a long time since we assume that refugees will try their best to be in a job and earn money for their family.
Entry_Level_Average_Workforce_Experience = Entry_Level_Workforce_Experience//Entry_Level_Workforce
UNITS: year/people/people
DOCUMENT: The average workforce experience is calculated by total experience divided by number of workforce. It shows how many years of experience entry workforce has on average.
Entry_level_time_to_retire = 40
UNITS: year
DOCUMENT: We assume people work 40 years before they retire i.e. start working at 30 and retire at 40.
Fraction_employed_refugees = EMPLOYED/("TOTAL_(WORKING_AGE)")
UNITS: dmnl
DOCUMENT: The employment ratio relative to total working age.
"fraction_employed_TOTAL(2022)" = .705
UNITS: dmnl
DOCUMENT: This is thhe employment rate as of 2022 in Norway.
Ref: https://www.ssb.no/en/arbeid-og-lonn/sysselsetting/statistikk/arbeidskraftundersokelsen
fraction_Refugee_senior_worksforce = Senior_Level_Workforce/(Entry_Level_Workforce+Senior_Level_Workforce)
UNITS: dmnl
DOCUMENT: This is fraction of senior refugee relative to summation of entry level and senior level.
Fraction_RETIRED = Retired_Refugee/"TOTAL_(WITH_RETIRED)"

UNITS: dmnl
DOCUMENT: This is the fraction of refugee who is already retired relative to total refugee.
Fraction_Unemployed_Entry_Level = Unemployed_Entry_Level//Entry_Level_Workforce
UNITS: dmnl
DOCUMENT: This is the ratio of unemployment in entry level
Fraction_Unemployed_Senior_Level = Unemployed_Senior_Level//Senior_Level_Workforce
UNITS: dmnl
DOCUMENT: This is the ratio of unemployment in senior level
Hiring_fraction = Additional_hiring+Hiring_fraction_before_policy
UNITS: 1/year
DOCUMENT: The perception of Norwegian towards the refugee affect hiring fraction. This is represent in graphical function. When the relative perception is 1, then the hiring fraction is 0.7 which is equal to Norwegian employment rate. When the relative perception is less than 1 then the hiring fraction is lower than 0.7. When the relative perception is more than 1, it means that Norwegian look up to the refugee for their performance and ability and thus willing to hire more refugee so the hiring fraction is higher than average Norwegian.
Ref: https://www.ssb.no/en/arbeid-og-lonn/sysselsetting/statistikk/arbeidskraftundersokelsen
Hiring_fraction_before_policy = GRAPH(IF .Switch_perception_to_employment = 1 THEN Perception.Perception_relative_to_normal ELSE Constant_relative_perception)
Points: (0.100, 0.1255), (0.200, 0.1389), (0.300, 0.1588), (0.400, 0.1878), (0.500, 0.2288), (0.600, 0.2845), (0.700, 0.3560), (0.800, 0.4413), (0.900, 0.5350), (1.000, 0.6287), (1.100, 0.7140), (1.200, 0.7855), (1.300, 0.8412), (1.400, 0.8822), (1.500, 0.9112), (1.600, 0.9311), (1.700, 0.9445)
UNITS: 1/year
DOCUMENT: The perception of Norwegian towards the refugee affect hiring fraction. This is represent in graphical function. When the relative perception is 1, then the hiring fraction is 0.7 which is equal to Norwegian employment rate. When the relative perception is less than 1 then the hiring fraction is lower than 0.7. When the relative perception is more than 1, it means

that Norwegian look up to the refugee for their performance and ability and thus willing to hire more refugee so the hiring fraction is higher than average Norwegian.

Ref: <https://www.ssb.no/en/arbeid-og-lonn/sysselsetting/statistikk/arbeidskraftundersokelsen>

Hiring_fraction_for_senior_level = Hiring_fraction_before_policy*0.5

UNITS: 1/year

DOCUMENT: We assume that it will take more time for senior level to find a job than for entry level to find job therefore the hiring fraction is less i.e. multiplied by 0.8.

Normal_Experience_Gain_Entry = 1

UNITS: year/people/people/year

DOCUMENT: This is the average experience for entry level i.e. they work 1 year they gain 1 year of experience.

Normal_Experience_Gain_Senior = 1.2

UNITS: year/people/people/year

DOCUMENT: We assume here that the senior people will be more expertise in their work and thus gain more experience per year.

Senior_Level_average_time_to_Quit = 8

UNITS: year

DOCUMENT: We assume that it takes on average 10 years before refugee quit their job. This is quite a long time since we assume that refugees will try their best to be in a job and earn money for their family.

Senior_Level_Average_Workforce_Experience =
Senior_Level_Workforce_Experience//Senior_Level_Workforce

UNITS: year/people/people

DOCUMENT: The average workforce experience is calculated by total experience divided by number of workforce. It shows how many years of experience senior workforce has on average.

Senior_time_to_retire = 15

UNITS: year

DOCUMENT: We assume that people have 40 years to work, first 15 years in the entry level and the last 25 years in senior level.
"TOTAL_(WITH_RETIRED)" = "TOTAL_(WORKING_AGE)" + Retired_Refugee
UNITS: People
DOCUMENT: This is total number of refugee including the retired refugee as well.
"TOTAL_(WORKING_AGE)" = EMPLOYED + UNEMPLOYED {SUMMING CONVERTER}
UNITS: people
DOCUMENT: Total people at working age including both employed and unemployed.
UNEMPLOYED = Ready_refugees_waiting_to_be_employed + Unemployed_Entry_Level + Unemployed_Senior_Level {SUMMING CONVERTER}
UNITS: people
DOCUMENT: Total employment including entry level and senior level and the refugees just finished training
Years_after_retirement = 13
UNITS: years
DOCUMENT: We expect people live until 83 years old. Assume they retire at 70, they will live another 13 years. Ref: https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=NO
Job_Performance:
Ability[Level](t) = Ability[Level](t - dt) + (Change_in_ability[Level]) * dt
INIT Ability[Level] = Normal_ability
UNITS: ability
DOCUMENT: Since the ability does not change instantaneously it is a stock. This is the ability that the refugee can perform in their work.
INFLOWS:
Change_in_ability[Level] = (Actual_ability - Ability) / Time_to_adjust_ability
UNITS: ability/Years

DOCUMENT: There is a delay in the ability therefore the rate of change is determined by time to adjust the ability
$Motivation[Level](t) = Motivation[Level](t - dt) + (Change_in_motivation[Level]) * dt$
INIT Motivation[Level] = Normal_motivation
UNITS: motivation
DOCUMENT: Since the motivation does not change instantaneously it is a stock. This is the motivation that the refugee has to perform their work well.
INFLOWS:
$Change_in_motivation[Level] = (Actual_motivation - Motivation) / Time_to_adjust_motivation$
UNITS: motivation/Years
DOCUMENT: There is a delay in the motivation therefore the rate of change is determined by time to adjust the motivation
$Actual_ability[Level] = Normal_ability * Effect_of_experience_to_ability$
UNITS: ability
DOCUMENT: The actual ability is calculated from multiplying the normal ability and the effect.
$Actual_motivation[Level] = Normal_motivation * Total_effect_to_motivation$
UNITS: motivation
DOCUMENT: The actual motivation is a multiplication between normal motivation and the effect from interaction and rewards.
Constant_relative_experience_entry_level = 1
UNITS: dmn1
DOCUMENT: This is the constant number for relative experience at entry level, used for testing the performance module individually.
Constant_relative_experience_senior_level = 1
UNITS: dmn1
DOCUMENT: This is the constant number for relative experience at senior level, used for testing the performance module individually.
Constant_relative_interaction[Level] = 1
UNITS: dmn1

DOCUMENT: This is the constant number for relative social interaction at entry and senior level, used for testing the performance module individually.
Effect_from_interaction_to_motivation[Level] = GRAPH(IF .Switch_social_to_performance = 1 THEN Social_Interaction.Relative_refugee_interactions_to_norm ELSE Constant_relative_interaction)
Points: (0.200, 0.1074), (0.300, 0.1181), (0.400, 0.1438), (0.500, 0.2027), (0.600, 0.324), (0.700, 0.5271), (0.800, 0.730), (0.900, 0.885), (1.000, 1.000), (1.100, 1.113), (1.200, 1.182), (1.300, 1.193)
UNITS: dmn1
DOCUMENT: When the relative interaction is 1 then it means the working climate for the refugee is the same as that of Norwegian thus the effect to motivation is 1. This is a graphical function that takes an s-shape curve, where if the relative interaction is small the motivation is small i.e. employee does not feel included in the organization. If the working climate is good i.e. there are relatively high interaction people are more motivated.
Effect_of_experience_to_ability[Level] = GRAPH(Relative_experience)
Points: (0.200, 0.210708561), (0.360, 0.228777936), (0.520, 0.275881397), (0.680, 0.390724675), (0.840, 0.630306274), (1.000, 1.000), (1.160, 1.369693726), (1.320, 1.609275325), (1.480, 1.724118603), (1.640, 1.771222064), (1.800, 1.789291439)
UNITS: dmn1
DOCUMENT: This is the graphical function to represent the ability according the the relative experience. The graph is in an s-shape curve where relative low experience gives low ability. The s-shape curve represents the fact that one can learn and able to do so much for one job.
Effect_of_rewards_to_motivation[Level] = GRAPH(Rewards_allocated//Normal_rewards)
Points: (0.000, 0.210708561), (0.200, 0.236536389), (0.400, 0.303557189), (0.600, 0.44586356), (0.800, 0.685976427), (1.000, 1.000), (1.200, 1.314023573), (1.400, 1.55413644), (1.600, 1.696442811), (1.800, 1.763463611), (2.000, 1.789291439)
UNITS: dmn1
DOCUMENT: The effect of rewards is an s-shape where more rewards give more motivation however the motivation does not grow unlimited hence an s-shape
Normal_ability = 0.5

UNITS: ability
DOCUMENT: This is the average ability in the society.
Normal_Experience[Entry] = INIT(Employment.Entry_Level_Average_Workforce_Experience)
UNITS: year/people/people
DOCUMENT: The normal experience takes the initial value of the average workforce experience at each level.
Normal_Experience[Senior] = INIT(Employment.Senior_Level_Average_Workforce_Experience)
UNITS: year/people/people
DOCUMENT: The normal experience takes the initial value of the average workforce experience at each level.
Normal_motivation = 0.5
UNITS: motivation
DOCUMENT: This is the average motivation in the society for people to perform well at work.
Normal_rewards = 0.2500
UNITS: NOK
DOCUMENT: This is the average rewards given if the employee perform well.
Relative_ability[Level] = Ability//Normal_ability
UNITS: dmn1
DOCUMENT: This is a relative ability as compared to normal ability
Relative_experience[Entry] = IF .Switch_employment_to_performance = 0 THEN Constant_relative_experience_entry_level ELSE Employment.Entry_Level_Average_Workforce_Experience//Normal_Experience[Entry]
UNITS: dmn1
DOCUMENT: The relative experience is the relative of current experience as compared when they first start the job i.e. the more years they are employed the more relative experience.

$\text{Relative_experience[Senior]} = \text{IF } .\text{Switch_employment_to_performance} = 0 \text{ THEN}$ $\text{Constant_relative_experience_senior_level} \text{ ELSE}$ $\text{Employment.Senior_Level_Average_Workforce_Experience//Normal_Experience[Senior]}$
UNITS: dmn1
DOCUMENT: The relative experience is the relative of current experience as compared when they first start the job i.e. the more years they are employed the more relative experience.
$\text{Relative_motivation[Level]} = \text{Motivation//Normal_motivation}$
UNITS: dmn1
DOCUMENT: This is a relative motivation as compared to the normal motivation in the society.
$\text{Relative_Performance[Level]} = (\text{Relative_ability} + \text{Relative_motivation}) / 2$
UNITS: dmn1
DOCUMENT: This is a relative performance as compared to the normal performance in the society.
$\text{Rewards_allocated[Level]} = \text{SMTH1}(\text{Rewards_based_on_performance} * \text{Normal_rewards},$ $\text{Time_to_offer_rewards}) \{ \text{DELAY CONVERTER} \}$
UNITS: NOK
DOCUMENT: The reward is given to the employee when they perform well however there is a delay for the rewards to be given.
$\text{Rewards_based_on_performance[Level]} = \text{GRAPH}(\text{Relative_Performance})$
Points: (0.100, 0.1127), (0.200, 0.124015789), (0.300, 0.137142105), (0.400, 0.166563158), (0.500, 0.204457895), (0.600, 0.276247368), (0.700, 0.371421053), (0.800, 0.521157895), (0.900, 0.703421053), (1.000, 1.000), (1.100, 1.180), (1.200, 1.396578947), (1.300, 1.579), (1.400, 1.729), (1.500, 1.824105263), (1.600, 1.895684211), (1.700, 1.933578947), (1.800, 1.963052632), (1.900, 1.975947368), (2.000, 1.987)
UNITS: dmn1
DOCUMENT: The rewards is given based on performance where higher performance employee get more rewards.
$\text{Time_to_adjust_ability} = 5$
UNITS: year

DOCUMENT: This is the time the ability required to change. We assume that there is a lot of learning in the job to be done before the ability changes.
Time_to_adjust_motivation = 1
UNITS: year
DOCUMENT: The time that the motivation of the employee changes, this is relatively short period of time.
Time_to_offer_rewards = 1
UNITS: years
Total_effect_to_motivation[Level] = Weighted_effect_of_social_interactions_to_motivation+Weighted_effect_of_rewards
UNITS: dmn1
DOCUMENT: The total effect to motivation is the sum of the effect from social interaction and the rewards.
Weight_on_rewards = 0.7
UNITS: dmn1
DOCUMENT: Here we assume that the rewards motivate the performance at work more than the working climate.
Weighted_effect_of_rewards[Level] = Weight_on_rewards*Effect_of_rewards_to_motivation
UNITS: dmn1
DOCUMENT: This is the effect of rewards to motivation after being weighted.
Weighted_effect_of_social_interactions_to_motivation[Level] = (1- Weight_on_rewards)*Effect_from_interaction_to_motivation
UNITS: dmn1
DOCUMENT: This is the effect of social interaction to motivation after being weighted.
Perception:
Perception_to_refugee[Level](t) = Perception_to_refugee[Level](t - dt) + (change_in_perception[Level]) * dt
INIT Perception_to_refugee[Level] = Average_perception_to_refugees
UNITS: Perception
DOCUMENT: This is the perception of Norwegian towards refugee.

INFLOWS:
$\text{change_in_perception}[\text{Level}] = (\text{Actual_Perception} - \text{Perception_to_refugee}) / \text{Time_to_adjust_perception}$
UNITS: Perception/Year
DOCUMENT: The rate of change in perception depend on time taken for Norwegian to adjust their perception towards refugee.
$\text{Actual_Perception}[\text{Level}] = \text{Average_perception_to_refugees} * \text{Total_effect_to_perception}$
UNITS: Perception
DOCUMENT: Actual perception is the product of average perception that Norwegian has towards refugee and the total effect that come from refugee social skill and job performance. The actual perception can range between 0 to 1.
$\text{Average_perception_to_Norwegian} = 0.50$
UNITS: Perception
DOCUMENT: This is the average perception among local people (Norwegian) towards each other. Currently it is set to 0.5 which is in the middle, neither good nor bad. The perception can range between 0.1 to 1 where 1 is when people completely trust each other and only think good things and 0.1 means that people don't trust each other and only think bad things.
$\text{Average_perception_to_refugee} = \text{MEAN}(\text{Perception_to_refugee})$
UNITS: Perception
DOCUMENT: This is the average perception between entry level refugee and senior level refugee.
$\text{Average_perception_to_refugees} = \text{Average_perception_to_Norwegian} + \text{Gap_between_normal_and_refugee}$
UNITS: Perception
DOCUMENT: This is the average perception of local people towards refugee. If there is no gap between how local people perceive each other and how local people perceive refugee then the average perception towards Norwegian and towards refugee are the same.
$\text{Constant_Refugee_social_skill_relative_to_societal} = 1$
UNITS: dmnl

DOCUMENT: This is a constant refugee social skill variable that will be used to test the perception module individually.
Constant_relative_performance[Entry] = 1
UNITS: dmn1
DOCUMENT: This is a constant refugee performance value that will be used when testing the perception module individually.
Constant_relative_performance[Senior] = 1
UNITS: dmn1
DOCUMENT: This is a constant refugee performance value that will be used when testing the perception module individually.
Effect_of_performance_to_perception[Level] = GRAPH(IF .Switch_performance_to_perception = 1 THEN Job_Performance.Relative_Performance ELSE Constant_relative_performance)
Points: (0.100, 0.142), (0.200, 0.167), (0.300, 0.226), (0.400, 0.318), (0.500, 0.385), (0.600, 0.493), (0.700, 0.619), (0.800, 0.719), (0.900, 0.853), (1.000, 1.000), (1.100, 1.238), (1.200, 1.439), (1.300, 1.568), (1.400, 1.710), (1.500, 1.811), (1.600, 1.879), (1.700, 1.924), (1.800, 1.953), (1.900, 1.971), (2.000, 2.000)
UNITS: dmn1
DOCUMENT: The effect is in the S-curve shape where the refugee performance at work increases as the social skill increases. When relative job performance is 1 it means the refugee performs equal to the norwegian hence they will likely be perceived equal to other in the society therefore the effect is 1. Since the average perception is 0.5 and the perception stock ranges between 0.1 to 1 therefore the effect range between 0.1 to 2.
Effect_of_relative_social_skill_to_perception[Level] = GRAPH(IF .Switch_social_to_perception = 1 THEN Social_Interaction.Refugee_social_skill_relative_to_societal ELSE Constant_Refugee_social_skill_relative_to_societal)
Points: (0.6000, 0.502), (0.7000, 0.602), (0.8000, 0.669), (0.9000, 0.803), (1.0000, 1.000), (1.1000, 1.824), (1.2000, 1.933)
UNITS: dmn1

<p>DOCUMENT: The effect is in the S-curve shape where the perception increases as the social skill increases. When refugee social skill is 1 it means the refugee has social skill equals to the norwegian hence they will likely be perceived equal to other in the society therefore the effect is 1. Since the average perception is 0.5 and the perception stock ranges between 0.1 to 1 therefore the effect range between 0.1 to 2.</p>
<p>Gap_between_normal_and_refugee = 0</p>
<p>UNITS: Perception</p>
<p>DOCUMENT: This variable makes the bias explicit. The bias is when the perception of Norwegian towards Norwegian is different than the perception of Norwegian towards refugee.</p>
<p>Perception_relative_to_normal = Average_perception_to_refugee/Average_perception_to_Norwegian</p>
<p>UNITS: dmnl</p>
<p>DOCUMENT: This is a norwegian's perception towards refugee relative to how they perceive other norwegian or other people in the society. When the relative perception is 1 it means that Norwegian perceive refugee equal to the rest of the society. If it is less than 1 , it means that Norwegian perceive refugee less than the rest of society i.e. some bad feeling, dislike etc.</p>
<p>Time_to_adjust_perception = 5</p>
<p>UNITS: year</p>
<p>DOCUMENT: This is the time taken for Norwegian to adjust their perception towards refugee. Currently it is set to 5 years since it takes a long time for the perception towards overall refugees to change.</p>
<p>Total_effect_to_perception[Level] = Weighted_effect_of_performance+Weighted_effect_of_social_skill</p>
<p>UNITS: dmnl</p>
<p>DOCUMENT: The total effect combines effect of social skill and effect of job performance by summation of these two effects. This number tells how the average perception towards refugee is changing. If the total effect is 1 it means that there is no change to the perception when the effect is less than 1 it means that the perception decreases i.e. local people do not see refugee to have equal ability or contribute to the society. If the effect is more than 1 it means</p>

that Norwegian perceive refugee better than towards other Norwegian i.e. more capable, nicer etc. The total effect range between 0.1 to 2 since the perception to refugee stock is from 0.1 to 1 and the average perception is 0.5.
Weight_on_performance = 0.6
UNITS: dmnl
DOCUMENT: This variable is from the assumption that performance and social skill do not contribute to the perception towards refugee equally. Here we assume that performance at work carry more weight than the social skill hence the weight on performance is 0.6. This makes the weight on social skill 0.4.
Weighted_effect_of_performance[Level] = Weight_on_performance*Effect_of_performance_to_perception
UNITS: dmnl
DOCUMENT: This variable is the weighted effect of performance to the perception towards refugee. This is calculated by weight on performance multiply by effect of performance to the perception toward refugees.
Weighted_effect_of_social_skill[Level] = (1- Weight_on_performance)*Effect_of_relative_social_skill_to_perception
UNITS: dmnl
DOCUMENT: This variable is the weighted effect of social skill which takes the effect of relative social skill to perception towards refugee multiplies by the weight of social skill. Since the total weight is 1 therefore it implies that the weight on social skill is one minus weight on performance.
Social Interaction:
Average_Refugee_Social_skill[Level](t) = Average_Refugee_Social_skill[Level](t - dt) + (Change_in_social_skill[Level]) * dt
INIT Average_Refugee_Social_skill[Level] = Average_societal_social_skill- Refugee_social_skill_gap
UNITS: social skill

DOCUMENT: This stock is the average social skill of refugee. The stock has a range from 0.1 to 1. The social skill is the skill to interact with other people in the society which requires the influence in language and understanding of the culture and the etiquette.

The social skill will not go down to zero since the refugee will have the introduction program for language and social study therefore they can communicate to some level.

To reach the societal social skill which is 1, refugee would require practice through social interactions.

INFLOWS:

$$\text{Change_in_social_skill[Level]} = (\text{Refugee_actual_social_skill} - \text{Average_Refugee_Social_skill}) / \text{Time_to_adjust_social_skill}$$

UNITS: social skill/Years

DOCUMENT: The refugee social skill change through their interaction with the Norwegian. The rate of change depends on the time to adjust the social skill.

$$\text{Actual_social_events_interaction_per_person_per_year_for_refugee[Level]} = (\text{Average_social_event_interactions_per_person_per_year_for_norwegian} * \text{Total_effect_to_social_events_interaction}) + \text{Additional_events}$$

UNITS: social interaction/people/year

DOCUMENT: This is the number of interaction from social event per refugee per year based on their willingness to participate (willingness comes from their confidence in social skill and their stress level) and the perception of Norwegian to refugee (better perception means more invitation to the social event)

$$\text{Additional_events} = 24$$

UNITS: social interaction/people/year

$$\text{Average_fraction_of_meaningful_interaction} = 0.5$$

UNITS: dmn1

DOCUMENT: We assume that half of the time at work is meaningful for average people i.e. every other day.

Average_interaction_per_person_per_year_for_refugee[Level] = (ROUND(Meaningful_interaction_from_work_for_refugee)+ROUND(Actual_social_events_interaction_per_person_per_year_for_refugee))
UNITS: social interaction/people/year
DOCUMENT: This is the average interaction of refugee. It comprises with meaningful interaction from work and interaction from social events.
Average_social_event_interactions_per_person_per_year_for_norwegian = 106
UNITS: social interaction/people/year
DOCUMENT: We assume social event twice a week. The social event can mean going to party to drink after work to having lunch during work.
Average_societal_social_skill = 0.8
UNITS: social skill
DOCUMENT: This is the amount of social skill on average for Norwegian.
Constant_relative_perception = 1
UNITS: dmnl
DOCUMENT: This is a perception toward refugee relative to other in the society. This is a constant number used for testing the social module individually.
Constant_relative_stress = 1
UNITS: dmnl
DOCUMENT: This is a relative stress of the refugee. This variable is used when we test the social module individually.
Effect_from_perception_to_social_event_interaction = GRAPH(IF .Switch_perception_to_social = 1 THEN Perception.Perception_relative_to_normal ELSE Constant_relative_perception)
Points: (0.200, 0.3515), (0.300, 0.3595), (0.400, 0.3952), (0.500, 0.4599), (0.600, 0.5374), (0.700, 0.6220), (0.800, 0.7137), (0.900, 0.8617), (1.000, 1.0000), (1.100, 1.1507), (1.200, 1.1870), (1.300, 1.1950)
UNITS: dmnl
DOCUMENT: Relative perception has an effect to the number of time refugees are invited to participate in a social event. The social event is when refugee feel included and integrate to society. The social event can range from small to large event for example lunch during work,

<p>drink after work, party, community gathering etc. If local people do not have good perception towards refugee then there will not be as much invitation.</p>
<p>Effect_of_social_skill_to_meaningful_interaction[Level] = GRAPH(Refugee_social_skill_relative_to_societal)</p>
<p>Points: (0.100, 0.3362), (0.200, 0.3609), (0.300, 0.4004), (0.400, 0.4600), (0.500, 0.5426), (0.600, 0.6449), (0.700, 0.7551), (0.800, 0.8574), (0.900, 0.9400), (1.000, 1.0000), (1.100, 1.0573), (1.200, 1.0731)</p>
<p>UNITS: dmn1</p>
<p>DOCUMENT: If the refugees social skill is not good then it is less likely that they can have a meaningful conversation with their colleague.</p>
<p>Meaningful_interaction_for_norwegian = Work_interaction_per_person_per_year*Average_fraction_of_meaningful_interaction</p>
<p>UNITS: social interaction/people/year</p>
<p>DOCUMENT: The meaning full interaction is calculated by the work interaction that a person has per year multiplied by the fraction. This is because we assume that not everyday at work we have meaningful interaction.</p>
<p>Meaningful_interaction_from_work_for_refugee[Level] = Work_interaction_per_person_per_year*Effect_of_social_skill_to_meaningful_interaction*Average_fraction_of_meaningful_interaction</p>
<p>UNITS: social interaction/people/year</p>
<p>DOCUMENT: This is from the assumption that we do not always have meaningful interaction at work i.e. long conversation. If the refugees social skill is not good then it is less likely that they can have a meaningful conversation with their colleague.</p>
<p>Refugee_actual_social_skill[Level] = Relative_refugee_interactions_to_norm*(Average_societal_social_skill+Refugee_social_skill_gap)</p>
<p>UNITS: social skill</p>
<p>DOCUMENT: Refugee social skill is determined by the amount of interactions that they have with Norwegian. The more interaction they have the better the social skill. We calculate this by using the amount of interaction that refugee has relative to what Norwegian has. If the relative interaction is 1 it means refugee has equal interaction with the Norwegian therefore</p>

they have same social skill as Norwegian. This is true if the social skill gap is zero meaning when everything is equal the refugee will have the same social skill as Norwegian.
Refugee_social_skill_gap = 0
UNITS: social skill
DOCUMENT: This is a variable to explicitly set the bias (if any) between Norwegian skill and the refugee skill i.e. the skill gap means, all things being equal the refugee still has lower social skill than the Norwegian.
Refugee_social_skill_relative_to_societal[Level] = Average_Refugee_Social_skill//Average_societal_social_skill
UNITS: dmnl
DOCUMENT: This is refugee social skill relative to Norwegian. If the refugee social skill is 1 then it means refugee has the same social skill as Norwegian.
Relative_refugee_interactions_to_norm[Level] = Average_interaction_per_person_per_year_for_refugee/Total_interaction_per_person_per_year_for_Norwegian
UNITS: dmnl
DOCUMENT: This is a relative number of interactions that refugee has compared to the number of interactions that Norwegian has.
Number of interactions is the interaction between refugee and Norwegian for example in the work place or in the social events with Norwegian. This number does not accounted for the number of interactions that refugee has among themselves. This is because we use this number to determine the integration with Norwegian in term of social skill and stress level.
Time_to_adjust_social_skill = 2
UNITS: year
DOCUMENT: This is the time taken for the social skill to improve or deteriorate. Currently it is assume to 2 years because the skill require lots of practice and for the refugee to familiarize themselves to the new language and culture.
Total_effect_to_social_events_interaction[Level] = Effect_from_perception_to_social_event_interaction*Willingness_to_attend_social_events
UNITS: dmnl

DOCUMENT: Social event is counted between norwegian and refugee only. It does not include the social interaction among refugees themselves since the model focus on the integration of refugee to Norwegian society.
This can come from willingness to socialize and invitation (good perception more invitation). We used multiplication here because the effect depends on each other i.e. no matter how much willingness refugee want to go to social event, they will not be able to if there is no invitation.
Total_interaction_per_person_per_year_for_Norwegian = Meaningful_interaction_for_norwegian+Average_social_event_interactions_per_person_per_year_for_norwegian
UNITS: social interaction/people/year
DOCUMENT: The total interaction includes interaction from work and interaction from social events for Norwegian
Willingness_to_attend_social_events[Level] = IF .Switch_stress_to_social = 1 THEN 1/Stress.Stress_level_relative_to_average_Norwegian ELSE 1/Constant_relative_stress { IF .Switch_stress_to_social = 1 THEN Stress.Stress_level_relative_to_average_Norwegian ELSE Constant_relative_stress }
UNITS: dmn
DOCUMENT: Refugees' stress affect the willingness for refugee to attend the social event. When a person is stressful, they are less likely to socialize.
Work_interaction_per_person_per_year = 218
UNITS: social interaction/people/year
DOCUMENT: Number of interaction at work calculate from how many days people work per year. The assumption is 22 working days per month, which gives 264 days. People have 5 weeks holiday (25 days) and 10 national holidays, therefore in total people have 229 days of working (264-35). Assume 11 sick leave day per year, then we are left with 229-11 = 218 days
Stress:
Refugee_Stress_level[Level](t) = Refugee_Stress_level[Level](t - dt) + (Change_in_stress_level[Level]) * dt
INIT Refugee_Stress_level[Level] = Refugee_average_stress_level
UNITS: stress level

DOCUMENT: This is the stress level of refugee. The model assumes that there are two factors that impact stress level: income and social interaction.
INFLOWS:
$\text{Change_in_stress_level[Level]} = (\text{Actual_stress_level} - \text{Refugee_Stress_level}) / \text{Stress_level_adjustment_time}$
UNITS: stress level/Year
DOCUMENT: This is an inflow to refugee stress level stock. The stress level will be adjusted according to the actual stress level through the adjustment time.
$\text{Actual_stress_level[Level]} = \text{Total_effect_to_stress_level} * \text{Refugee_average_stress_level}$
UNITS: stress level
DOCUMENT: Actual stress level is calculated by average stress level multiply by total effect to stress level. Actual stress level is between 0 to 1.
$\text{Average_Norwegian_stress_level} = \text{Refugee_average_stress_level} - \text{Stress_level_gap}$
UNITS: stress level
DOCUMENT: This value will be different from refugee average stress level if there is a stress level gap between Norwegian and refugee. The average norwegian stress level is calculated by refugee average stress level minus stress level gap.
$\text{Constant_relative_income} = 1$
UNITS: dmn1
DOCUMENT: This is the constant relative income variable. We use this variable when we want to test this module (stress) individually.
$\text{Constant_Relative_refugee_interactions_to_norm[Entry]} = 1$
UNITS: dmn1
DOCUMENT: This is a relative number of interactions that refugee has compared to the number of interactions that Norwegian has. This is a constant variable and will be used when testing stress module individually.
$\text{Constant_Relative_refugee_interactions_to_norm[Senior]} = 1$
UNITS: dmn1
DOCUMENT: This is a relative number of interactions that refugee has compared to the number of interactions that Norwegian has. This is a constant variable and will be used when testing stress module individually.

Effect_of_income_to_stress[Level] = GRAPH(IF .Switch_economic_to_stress = 1 THEN Economic.Refugee_Relative_Income_to_Average_Norwegian ELSE Constant_relative_income)
Points: (0.300, 1.852), (0.400, 1.790), (0.500, 1.706), (0.600, 1.599), (0.700, 1.467), (0.800, 1.314), (0.900, 1.150), (1.000, 1.000), (1.100, 0.8331), (1.200, 0.7011), (1.300, 0.5936), (1.400, 0.5102), (1.500, 0.448) {GF EXTRAPOLATED}
UNITS: dmn1
<p>DOCUMENT: Maximum effect can be up to 2</p> <p>The x axis is relative average income, this is the refugee income compare to average norwegian income, range from 0.1 to 1.5. When relative income is 1 it means refugee earns on average as much as average Norwegian.</p> <p>The y axis is the effect the relative average income cause to stress that the refugee usually have (refugee average stress level = 0.5)</p> <p>The shape of the curve is S-shaped, where the less the income refugee earn as compared to average Norwegian, the more stress they will be.</p> <p>If relative income is 1 it means the refugee earn as much as average norwegian therefore there is no change in average stress. If the relative income is much below 1 the stress level increases to almost double. The graph of the effect is drawn to depict that if refugee earn less than half of the average Norwegian the effect will be almost 2 which will make the stress level to go almost up to its maximum i.e. 1.</p>
Effect_of_social_interaction_to_stress[Level] = GRAPH(IF .Switch_social_to_stress = 1 THEN Social_Interaction.Relative_refugee_interactions_to_norm ELSE Constant_Relative_refugee_interactions_to_norm)
Points: (0.300, 1.852), (0.400, 1.790), (0.500, 1.706), (0.600, 1.599), (0.700, 1.467), (0.800, 1.314), (0.900, 1.150), (1.000, 1.000), (1.100, 0.8331), (1.200, 0.7011), (1.300, 0.5936), (1.400, 0.5102), (1.500, 0.448) {GF EXTRAPOLATED}

UNITS: dmn1
DOCUMENT: Maximum effect can be up to 2
<p>The x axis is relative social interaction, this is the refugee social interaction compare to average norwegian interaction, range from 0.1 to 1.5. When relative interaction is 1 it means refugee interacts to Norwegian as much as Norwegian interacts among themselves.</p> <p>The y axis is the effect the relative interaction cause to stress that the refugee usually have (refugee average stress level = 0.5)</p> <p>The shape of the curve is S-shaped, where the less the interaction refugee has as compared to average Norwegian, the more stress they will be.</p> <p>If relative interaction is 1 it means the refugee interact with Norwegian as much as average norwegian therefore there is no change in average stress. If the relative income is much below 1 the stress level increases to almost double.</p>
Refugee_average_stress_level = 0.5
UNITS: stress level
DOCUMENT: Stress level is from 0 to 1. 0 being no stress and 1 being very stress. Normal stress level is set to 0.5.
Stress_level_adjustment_time = 1
UNITS: year
DOCUMENT: We set the stress level adjustment time to 1 year. The assumption is that people can get stress quite quickly especially if the stressor is from the income
Stress_level_gap = 0
UNITS: stress level
DOCUMENT: This is the gap of stress between Norwegian and Refugee. We put the gap explicitly to study any bias or different between refugees and Norwegian.

$$\text{Stress_level_relative_to_average_Norwegian}[\text{Level}] = \frac{\text{Refugee_Stress_level}}{\text{Average_Norwegian_stress_level}}$$

UNITS: dmnl

DOCUMENT: This is refugee stress level relative to average Norwegian. When the relative stress equals one it means refugee has the same stress level as Norwegian.

$$\text{Total_effect_to_stress_level}[\text{Level}] = \text{Weighted_effect_from_social_interaction} + \text{Weighted_effect_from_income} + \text{Weighted_effect_from_other_stressor}$$

UNITS: dmnl

DOCUMENT: We determine that there are two factors that contribute to refugee stress level: income, social interaction. Each factor has different weight to stress level i.e. income tend to affect the stress level more than social interaction because it contributes directly to the well-being of the refugee. Therefore the total effect to stress level is an addition of weighted effect of income and weighted effect of social interaction. The total effect to stress level is from 0 to 2.

The rationale for the number formulation:

Actual stress level is between 0 to 1.

$$\text{Actual stress level} = \text{Total_effect_to_stress_level} * \text{Normal_stress_level}$$

$$\text{max(actual stress level)} = 1, \text{ normal stress level} = 0.5$$

Therefore

$$\text{max(Total_effect_to_stress_level)} = 1/0.5 = 2$$

total effect to stress level =

$$\text{Weighted_effect_from_social_interaction} + \text{Weighted_effect_from_income}$$

Assume the weight of income to stress level = 0.7 since that directly impact with their standard of living.

Therefore

$$\max(\text{Weighted_effect_from_income}) = 0.7 * 2 = 1.4$$

$$\max(\text{Weighted_effect_from_social_interaction}) = 0.3 * 2 = 0.6$$

$$\text{weight_effect_of_income_to_stress} = 0.6$$

UNITS: dmn1

$$\text{weight_effect_of_social_interactions_to_stress} = 0.2$$

UNITS: dmn1

$$\text{Weighted_effect_from_income}[\text{Level}] =$$

$$\text{Effect_of_income_to_stress} * \text{weight_effect_of_income_to_stress}$$

UNITS: dmn1

DOCUMENT: This is the effect of the income to refugee stress level that already incorporated the weight assumption. For example if the refugee relative income equal to 1, meaning refugee earn as much as norwegian thus there is no change in the stress level and the effect of income to stress in 1. But because income only contributes to 70% of the stress level so the weighted effect of income to stress is 0.7.

$$\text{Weighted_effect_from_other_stressor}[\text{Level}] = 0.2$$

UNITS: dmn1

DOCUMENT: This is the effect of the social interaction to refugee stress level that already incorporated the weight assumption. For example if the refugee relative social interaction equal to 1, meaning refugee interact to Norwegian as much as the norwegian among themselves thus there is no change in the stress level and the effect of social interaction to stress is 1. But because social interaction only contributes to 30% of the stress level so the weighted effect of social interaction to stress in this case is 0.3.

$$\text{Weighted_effect_from_social_interaction}[\text{Level}] =$$

$$\{\text{Effect_of_social_interaction_to_stress} * (1 - \text{Weight_of_income_to_stress_level})\}$$

$$\text{Effect_of_social_interaction_to_stress} * \text{weight_effect_of_social_interactions_to_stress}$$

UNITS: dmn1
DOCUMENT: This is the effect of the social interaction to refugee stress level that already incorporated the weight assumption. For example if the refugee relative social interaction equal to 1, meaning refugee interact to Norwegian as much as the norwegian among themselves thus there is no change in the stress level and the effect of social interaction to stress is 1. But because social interaction only contributes to 30% of the stress level so the weighted effect of social interaction to stress in this case is 0.3.
{ The model has 239 (298) variables (array expansion in parens).
In root model and 6 additional modules with 24 sectors.
Stocks: 17 (22) Flows: 29 (34) Converters: 193 (242)
Constants: 74 (78) Equations: 148 (198) Graphicals: 12 (21)
There are also 10 expanded macro variables.
}