An Endogenous Relationship between Wages, Job Opportunity, and Skilled Labor Shortage in Norway

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Abstract

Norway's economy has gone through unprecedented growth in the past decade. The strong growth in GDP, employment, labor productivity, real wage, and labor immigration combines with increasing outflows from the labor force, such as early retirement scheme, sickness and disability, and old age retirement implies that Norway's labor market is tight. We hypothesize demographic changes and skilled and unskilled job composition affects tertiary education participation through wage premium and job opportunities. Motivation to pursue tertiary education is determined by perceived wage premium, expected foregone earnings, expected relative lifetime earnings, and ease of finding jobs. Among the four elements, expected foregone earnings have the most weight when individuals decide whether to pursue tertiary education or not. Thus, we propose policies to minimize individuals' expected foregone earnings, such as voluntary-base internship to tertiary students and online tertiary education for the mature students in age group 30-35. On the other hand, we propose the government to establish agencies in countries that have high skilled labor reserve with lower living stand than Norway. These agencies will disseminate information labor market and regulatory issues of Norway and to market the attractiveness of Norway as a migration destination. Lastly, we propose the government to further entice foreign students to come to the country. These students can be a potential skilled labor supply after they graduate.

Keywords: skilled labor, labor supply, labor demand, skilled wage premium, tertiary education, labor immigrant

Acknowledgment

The bittersweet experience here in Bergen and the entire master's program has once again changed my perspective of life. Up until now, I have been spending one third of my life in a nomadic lifestyle as I believe that we should live life to the fullest by experiencing life and lives of others.

Three years ago, I came across Norway through my aimless online browsing one day. I became very curious about this country. So I came here. I was hoping to pursue a master's degree from this country. At the beginning I worked part-time in restaurants to make ends meet. One day, I discovered the System Dynamics program, it was in December 2007. I emailed Professor Pål Davidsen and he replied me promptly. So I met him in person to express my interest in this study. As it was in the middle of the academic year, Professor Davidsen helped me with the application as much as he could. Since I was a drop-in student, it was difficult for me to catch up, but I never gave up on learning. I think the most important thing is not what I get, but how I get to where I want to be.

Now that I have finally concluded the study, I have not only acquired new knowledge, this knowledge of System Dynamics also shapes my philosophical views in daily life. It solves many doubts I used to have because I have come to know that real systems are complex and there are feedback and delays involved.

I would like to extend my appreciation to Professor Davidsen for admitting me into the program. I particularly want to thank Professor David Wheat, my supervisor, for his incredible patience. I know I am a "problem-child", but he has always been enthusiastic and patient to help me solve my academic problems and answer my endless questions.

I am thankful to my parents and siblings, especially my mom, for their understanding as I am always away from home. I am honored to have the support from my best friend, Bei Durbin, who is always open-minded and supportive. Although we rarely see each other, our friendship grows stronger and stronger each day.

Finally, I am indebted to my husband, Ken Chin, for his unconditional love and support during my study. Without his emotional support and courage, I will not be able to reach higher and higher in every stage of life.

"Almost everything you do will seem insignificant, but it is important that you do it"

--Mahatma Gandhi

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1.0 Introduction

In the recent years, demand for skilled labor[1] in Norway is expected to increase (Bjørnstad,et.al., 2002, Salvanes & Førre, 2003). In their paper, Salvanes & Førre reveal that net job creation rate for the low-skilled labor was negative in the 1980s and 1990s whereas it was positive for the medium- and high-skilled workers. The net job creation rate for the low-educated labors was -4% annually; the net job creation rates for the medium- and high-skilled labors were 1% and 5% annually. They expect the trend to be continued into the future.

As there is no hard data on skilled labor demand, we infer the demand for skilled labor through several indicators such as skilled employment growth, skilled unemployment rate, and skilled wages. Norway has seen a strong productivity and economic growth at unprecedented rates. From 1948 to 2003, Norway's mainland GDP grew by an average of 3.3% annually. Since the past two decades, Norwegian labor demand has shifted from unskilled to skilled labors (Lindquist & Skjerpen, 2000). Due to rapid output growth, unemployment rate had remained low, between the range of 1.5% and 2.0% from 1997 to 2008. From *Figure 1-1*, it shows that the unemployment rate for skilled labors was almost half of the national unemployment rate. On the other hand, real wages for the tertiary educated also projected an increasing trend from 1993 to 2003 (*Figure 1-2*). The average annual real wages of a tertiary educated labor was slightly above NOK 300,000 in 1993. In 2007, the number approached NOK500, 000.

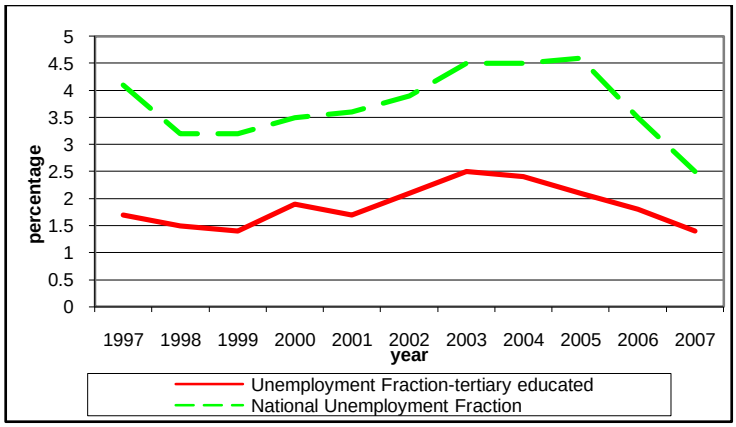


Figure 1-1 The Comparison of National Unemployment Fraction to Tertiary Educated Unemployment Fraction, 1997 to 2007

[1] Since skill is unobservable, we use education attainment as an indication of skills. In our paper, we refer skilled labor market as a labor market that is made up labors with education attainment of at least ISCED 5. Refer to Appendix E.

Source: Statistics Norway

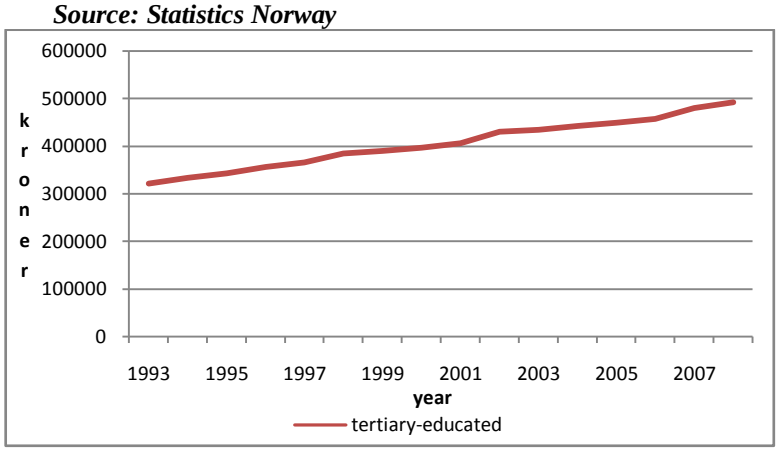


Figure 1-2 Average Annual Real Wages for Tertiary Educated Labor, 1993 to 2007
Source: Statistics Norway

Norway also has a high labor force participation rate[2], 73%, which is one of the highest among the OECD[3] countries. As a consequence of strong output growth, high participation rate, and low unemployment rate, Norway encounters a tight skilled labor market.

Lately, much attention was devoted to skilled labor supply in the media and politics. It was said that the skilled labor market was tight and some were concerned about the development of skilled labor shortage in the future. In a tight skilled labor market, Norway tries to ease the pressure by boosting tertiary education participation and attracting foreign skilled labors. Skilled labor immigration is a fast-track solution to ease the tight skilled labor market situation. This can be seen from the number of specialist permits being issued in the recent years. The number of skilled worker permits[4] issued had been increasing since 1997. In 1997, there were 1528 permits issued to foreign skilled labors; in 2009, 5605 permits were issued. This implies that the need for foreign skilled labor has increased over the years.

In order to encourage skilled labor immigration, as of 2010, foreign skilled labors who meet the requirements as skilled labors are granted the rights to start working as soon as the applications for permit are submitted. This modification is to let foreign skilled start work as

[2] Labor force participation rate in Norway is defined by the population in the age group of 15-74 in OECD StatsExtracts (http://www.oecd.org/home/0,2987,en_2649_201185_1_1_1_1_1,00.html)
[3] OECD (Organization for Economic Co-operation and Development) countries include: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.
[4] Skilled worker permits are granted to applicants with specialist training corresponding to upper-secondary education level, craft certificates or university or university college education. (http://www.udi.no)

soon as possible rather than making them wait until they are granted the permit. Another newly launched immigration policy is the skilled job seeker scheme. Under this scheme, foreign skilled job seekers who are either fresh graduates from Norwegian higher education institutions or potential skilled labors from oversea are granted this permit. With this permit, foreign skilled job seekers are able to remain in the country for up to two years to take Norwegian language course, to search for jobs, or to take courses relevant to their desired employment.

The other source of skilled labor comes from local tertiary education institutions. These institutions educate the locals in order to become skilled labors. In our paper, we define these skilled labors as "domestic skilled labors". From 1997 to 2007, Norway's tertiary education attainment among population 25 to 64 had been 5% higher than the OECD country average. The education attainment rate increased linearly from 25% to 34% (*Figure 1-3*).

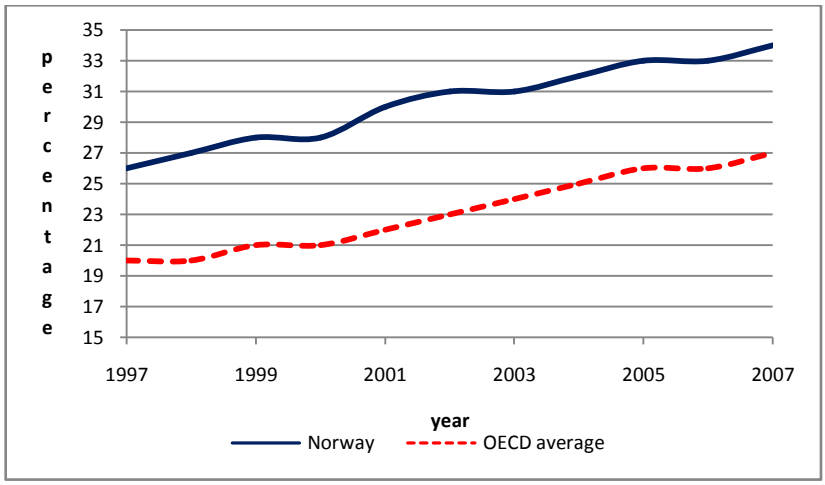


Figure 1-3 Tertiary Education Attainment of Population 25-64, 1997 to 2007
Source: OECD Education At a Glance (2009)

The Norwegian government has initiated several reforms in the past few years to boost skilled labor supply. These reforms include: The *Competence Reform 2000* and *Quality Reform of Higher Education 2003* (OECD, 2004). The *Competence Reform 2000* is an action plan targeted on those employed and unemployed adults who have little or low education. The reform plans to make it easier for adults who have not completed primary and secondary education by providing flexible schedule and location that work around their work schedule and live situation. *The Quality Reform of Higher Education 2003* is a

comprehensive reform aiming to improve the quality and efficiency of the tertiary education in Norway. By implementing this reform, the Norwegian government expects an educated population with better quality and international exposure. By shortening the duration of tertiary education, it is anticipated that larger proportion of the students will be willing to take up graduate studies.

Since the skilled labor market is considered to be tight, skilled labor supply merely meets the demand. If the development of skilled labor supply and demand continue as it is, skilled labor shortage will possible emerge in the near future. Trendle (2008) and Brigden and Thomas (2003) define labor market tightness as "*the disequilibrium state between supply and desired demand of labor at an agreeable price determine by the market*." In another word, the increase in skilled job demand or the lag in skilled labor supply, or the sluggish skilled wage growth are trends that will possibly lead to a tight skilled labor market. Skilled labor shortage will eventually appear if skilled labor demand keeps rising while skilled labor supply fails to increase marginally to match the demand. Also, according to them, wages of skilled labor affects the development of skilled job demand and skilled labor supply.

Our study intends to explore the causal relationship of job opportunities, labor supply, and wages in a closed feedback loop. Feedback loop is described as interactions between components in a closed chain of cause and effect. Since both skilled and unskilled labors come from a limited source—the working age population, individuals participate in the labor force are either skilled or unskilled. The development of skilled labor force will affect the unskilled labor force and vice versa. Thus, we will use a model to simulate and trace the causal effect of wages and job opportunities for skilled and unskilled labor on tertiary education participation rate in the country. Lastly, we will formulate feasible policies based on the findings from our analysis through simulations. We would like to find policies to prevent future skilled labor shortage from worsening.

We will discuss labor supply and demand theory in general in the literature review section. Then we will identify the knowledge gap we aim to fill. Next, in the hypothesis section, we will build a useful model to study the endogenous relationship of job opportunities, wages, and skilled labor supply. After which, we will analyze the system to identify policy leverage points. Through our study, we wish to propose policies that will increase skilled labor supply in order to keep up with skilled labor demand.

1.1 Literature Review

In traditional economics textbooks, labor shortage is characterized as imbalanced state due to the development of labor demand, labor supply, and wages. In fact, these market forces will push institutions to the direction to re-establish a new equilibrium in the long run (Brigden & Thomas, 2003). According to them, labor market can only be considered as tight or loose if the economic shocks move the labor market away from the equilibrium of supply and demand. In the standard labor market model, labor supply and demand will achieve its equilibrium state at an agreeable wages. Therefore, it is essential to gain an understanding how these three factors relate to each other and how they affect skilled labor supply. Trendles (2008) expressed labor shortages arise from three different shocks. In the following, we will present these three types of shortages briefly.

In a demand-driven shortage situation, demand for skilled labors increases faster than the supply. Therefore, shortage occurs. The demand for labor comes from the increase in demand for goods and services and technical advancement.

The relationship can be illustrated through the following figure (*Figure 1-4)*. When wages and labor supply are held constant, the increase of labor demand will lead to labor shortage.

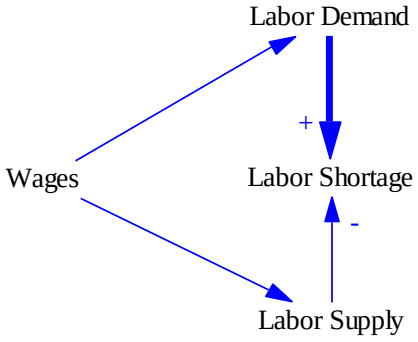


Figure 1-4 Demand-driven Labor Shortage
Source: Trendle, 2008

On the other hand, supply driven shortage denotes the labor shortage caused by a decrease or sluggish growth of labor supply at a given wage level. The slow growth or decrease in labor supply can be attributed to low incentives to participate in the labor market or the reduction in working age population growth. Incentives include monetary and non-

monetary returns. In our paper, we focus on economic returns, namely wages. This relationship is presented in the following figure.

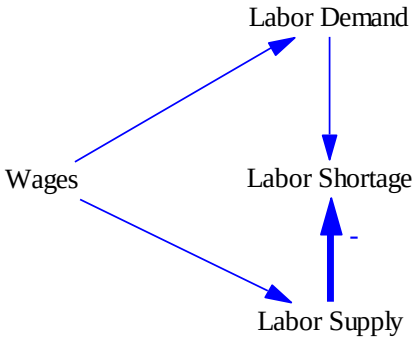


Figure 1-5 Supply-driven Labor Shortage
Source: Trendle, 2008

In the supply-driven labor shortage situation, while wages and demand are held constant, the reduction in labor supply will cause labor shortage.

The third factor that constitute to labor shortage is wages. When wages increases, it will reduce the labor demand, but it raises the incentives for labors to enter the market. Labor surplus takes place in this situation. On the contrary, when wages decreases, firms will be willing to take in additional labor input to increase production marginally. But labors will be unwilling to provide service at lower wages, so this will lead to labor shortage as illustrated in *Figure 1-6*. In this case, the unmatched wage level between firms and labors constitute to the mismatch of labor demand and supply. Therefore, shortage occurs.

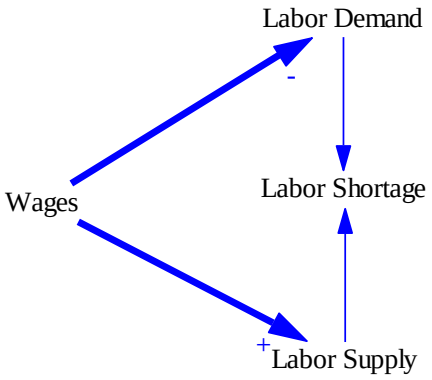


Figure 1-6 Wage-driven Labor Shortage
Source: Trendle, 2008

Up until this point, the causal relationship between the developments of labor demand, labor supply, and wages are assumed to be one-way. These relationship described by Trendle fails to take feedback into consideration. By that we mean Trendle omits the feedback of labor shortage to labor demand and labor supply and the effect of labor shortage on wages (*Figure 1-7)*.

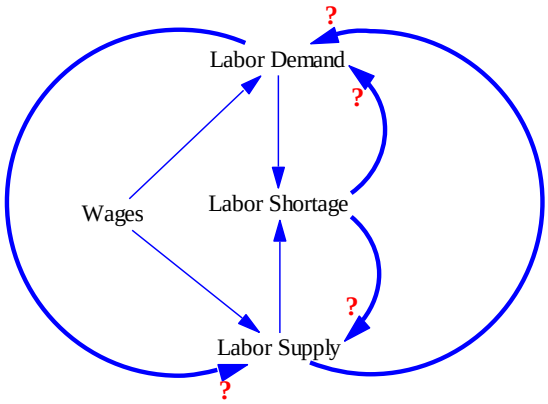


Figure 1-7 Links omitted in standard economic textbook explanation of the causes of labor shortage

The previously explained relationship between labor demand, labor supply, and wages can be further extended to explain the interaction between skilled[5] and unskilled labor[6] shortages.

In most OECD countries, the skill structure of labor demand has shifted in favor of skilled workers in the recent years. The shift is hypothesized to be caused by skilled-biased technological change and increased international competition (Linquist & Skjerpen, 2003). This emergence has significant impact on demand for skilled and unskilled labors. This is because skilled labors and technology are complements while unskilled labor and technology are substitutes. In another word, the demand for skilled labor will increase over time but the demand for unskilled labor will decrease over time (Lindquist & Skjerpen, 2003, Acemoglu, 1999).

[5] Since skill is unobservable, we use education attainment as an indication of skills. In our paper, we refer skilled labor market as a labor market that is made up labors with education attainment of at least ISCED 5. Refer to Appendix E

[6] Unskilled labors mean those who have not attained education at ISCED 5 level.

In his paper, Acemoglu (1999) claims that skilled labor demand comes from skilled labor supply—"supply creates its own demand". It is hypothesized that the increasing supply of skilled labor urges firms to take advantage of skill premium. Hence, firms' investment in more advance technology and replace unskilled labors with skilled labors to take advantage of technological advancement for profit- maximization purpose. Therefore, amidst the increasing skilled job demand, skilled labor supply falls short.

Next, we shall look at how wages play a role in skilled labor shortage formation. By and large, investment in education is considered as an investment in human capital from the economic perspective. Expected returns to tertiary education are the expected relative benefits of getting tertiary education. Individuals are assumed to weigh the relative benefits of investing in tertiary education when they are to decide whether to go to tertiary education to be skilled labors or remain unskilled. In our paper, we focus on economic returns to tertiary education. In skilled labor production, relative wages does not only affect labor force participation, it also determines the motivation for individual to invest in education. This is because motivation to tertiary education is a function of costs and future earnings.

Cost includes direct and indirect costs. Direct costs represent tuition fees and expected foregone earnings; foregone earning is considered as opportunity costs. Opportunity costs denote the earnings one gives up when he or she pursues tertiary education. On the other hand, indirect costs include living expenses, textbooks, and other educational-related expenses. When considering the cost for tertiary education, direct costs such as tuition are more important than expected foregone earnings to individuals' (Tannen, 1978). However, when weighing costs and future earnings, Tannen concluded that individuals give costs more weight than future financial returns in their consideration.

Opposite to Tannen's study, OECD reports that returns to education in OECD countries are mostly driven by earnings premium[7] (OECD, 2009). Earnings premium is the ratio between earnings of skilled labors and the unskilled. Individuals' assessment of the earnings premium can be analyzed in two ways: short-term and long-term. From short-term view, individuals concern the starting wages and the wages in the next few years; from the long-term perspective, individuals formulate expectation of their lifetime earnings.

[7] Earnings premium, wage premium, and wage differential are used interchangeably throughout the paper.

In the previously presented literature review, labor shortage caused by labor demand, labor supply, and wages are discussed in one-way links, not feedback loops. Most literature fails to assess the demand, supply, and wages with feedbacks to see how these three factors develop dynamically over time. The relationship between these three factors is not static; it is dynamic and it will change relatively to the changes within each factor. More specifically, we intend to study the changes in supply and demand of skilled and unskilled labor force to understand how relative wages and job opportunity affect tertiary education participation, which will eventually feedback to skilled labor supply. The following figure illustrates the knowledge gap we are intending to fill.

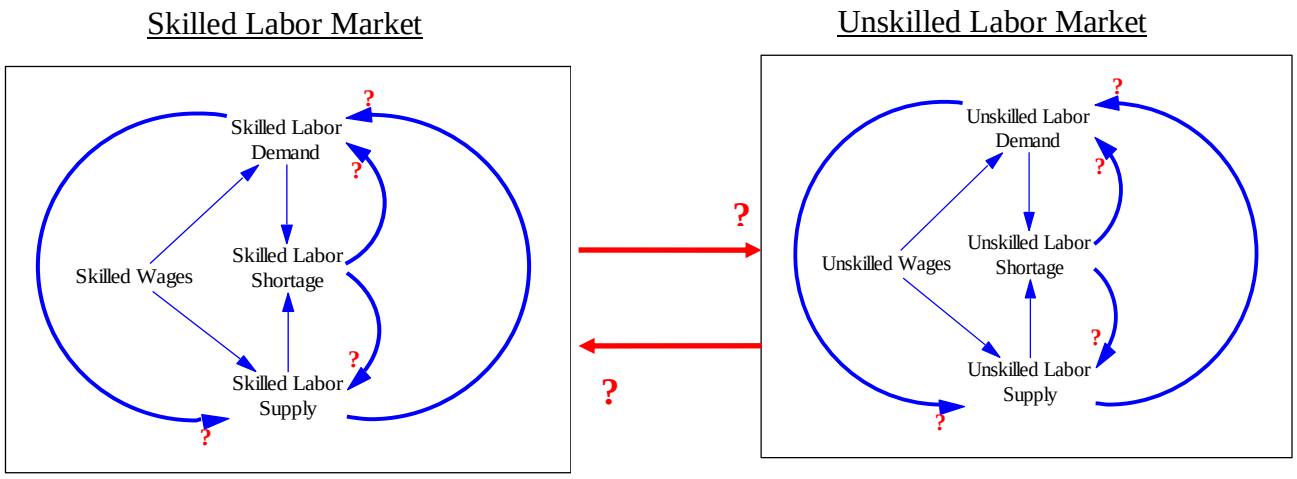


Figure 1-8 The Feedback Relationship Our Study Includes to the traditional labor shortage model
Note: red lines represent the feedback loops our study intends to investigate

We apply system dynamics methodology to study the endogenous relationship between wages, job opportunity, and skilled labor supply and how the endogenous relationship constitutes to skilled labor shortage. The central concept of this method is to study the persistent dynamic nature of a complex system from its causal structure internally rather than external disturbances or random events (Meadows, 1980). We will discuss the dynamic problem in the following section.

2.0 The Dynamic Problem

From indicators such as skilled employment growth, skilled unemployment rate, and skilled wages, the skilled labor market in Norway for the past 17 years is characterized to be tight. As the nation's economy is transforming to be knowledge and technology intensive, the demand for skilled labor will continue to rise. If skilled labor demand continues to rise faster than skilled labor supply, shortage will possibly occur. Depending on the growth rate of skilled labor force, the intensity of skilled labor shortage varies (*Figure 2-1*).

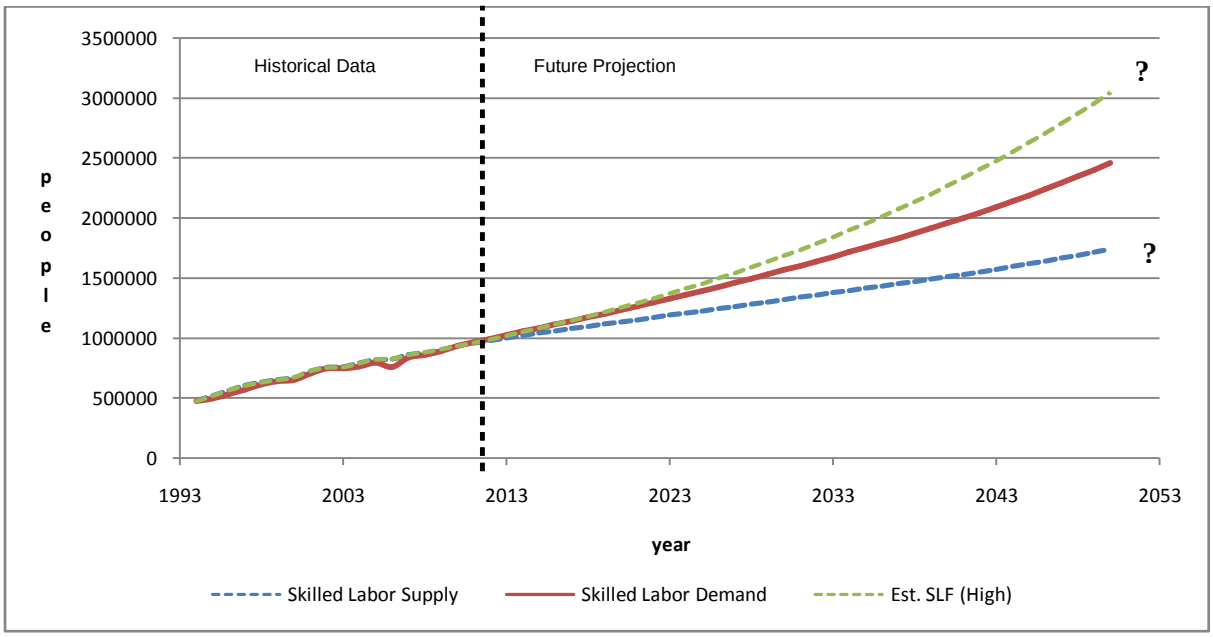


Figure 2-1 Reference Mode: Historical and Future Projection of Skilled Labor Supply, Skilled Labor Demand and Desired Demand
Source: Statistics Norway

Figure 2-1 demonstrates the historical development and future projection of the estimated skilled labor force and skilled labor demand. As there is no existing hard data on the supply of skilled labor force and skilled labor demand, skilled labor force is derived from the estimation of historical and future projection of labor force with the tertiary education attainment rate in the country over time; both statistics are obtained from Statistics Norway. Estimated skilled labor demand is calculated by estimating the gross domestic production (GDP), obtained from Statistics Norway, with tertiary education attainment rate to obtain an estimated fraction of GDP that requires skilled labor input. From there, GDP with skilled input divides by labor productivity to obtain skilled labor demand. The trend is extrapolated to the future.

It is uncertain how the development of skilled labor force will be in the future. If the education attainment rate (34%) and skilled labor force participation rate (88%) remain at the current rate, the gap between skilled labor force supply and demand will be widening from 2013 onwards; if the skilled labor force is projected to be growing at 3% annually (Est. SLF High), skilled labor supply will exceed skilled labor demand from 2020 onwards. In this scenario, skilled labor supply outgrows skilled labor demand and skilled labor surplus will occur.

As mentioned previously, the two sources of skilled laborer are foreign skilled immigrant and local tertiary educated laborers. Foreign skilled immigration is on the rise. However, looking into the tertiary education entry patterns in the country shows different entry rates of various age cohorts. The new entrants to tertiary education of age group 19-24 were about 17,500 from 1998 to 2001 (*Figure 2-2*). From 2001 to 2003, the number of new entrants dropped to 10,000. Then it climbed back up and peaked at 22,500 in 2005. However, it started to head downward after 2005. In 2006 and 2007, the number of new entrants in age group 19 – 24 remained at 10,000 students and it seems that the trend took a gradual upturn again in 2007.

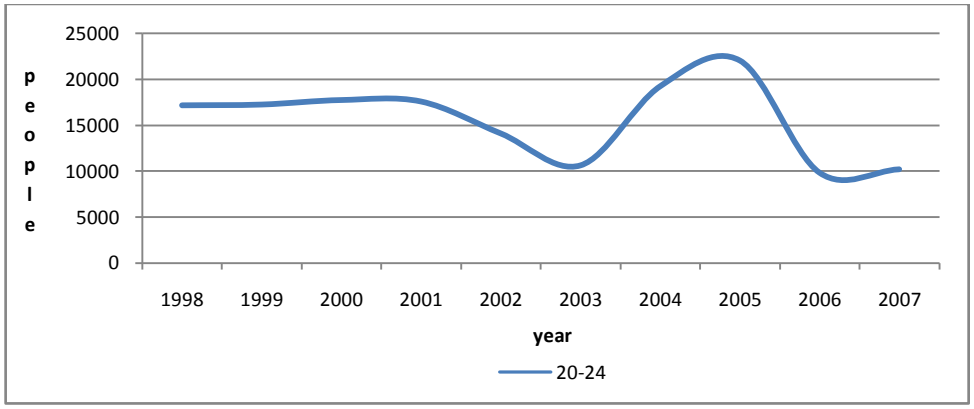


Figure 2-2 Number of New Entrants to Tertiary Education in Age Group 19-24, 1998 to 2007
Source: OECD StatExtract

The similar trend was also portrayed in *Figure 2-3* for age group 25-29. It shows that the number of students who entered tertiary education in age group 25 – 29 was relatively stable, around 3,500 from 1998 to 2002. After that it peaked at 3,700 in 2005. After which, the number of students entered tertiary education reduces to 2500 in 2006. The number was increasing again in 2007. However, the number of new entrants in age group 30-34 and 35 –

39 was increasing linearly from 1998 to 2003. After that both trends turned downward and stabilized at 2,000 students in 2007.

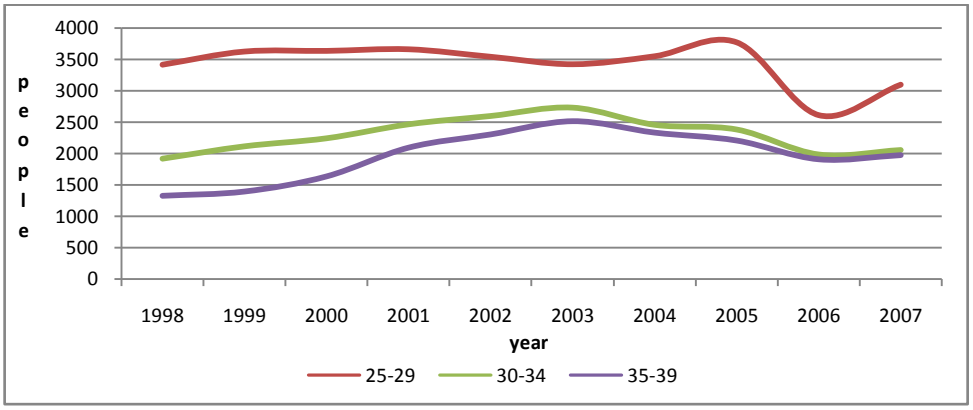


Figure 2-3 Number of New Entrants to Tertiary Education in Age Group 25-29, 30-34, and 35-39, 1998 to 2007
Source: OECD StatExtract

As tertiary education participation is vital to assure sufficient supply of domestic skilled laborer, this leads to the question of what motivates individuals to become skilled laborers? As the demand for skilled laborer is increasing, if the supply of skilled laborer falls short, shortage will follows. This becomes a concern for the policy makers.

Regardless, undersupply or oversupply of skilled laborers is not a desirable outcome from the government's perspective. Undersupply of skilled laborer will slow down Norway's transformation to a knowledge- and technology intensive economy; whereas oversupply of skilled laborer will bring forth skill mismatch or layoffs within industries. This may lead to unemployment and increases welfare expenditure. Therefore, the ideal condition is to be able to have a predictable and steady development of skilled labor supply and demand as pre-requisite and to close the gap as the secondary goal. Our study intends to gain an understanding in how wages and job opportunity affect skilled labor supply and how the system can be improved to achieve a desirable development of skilled labor supply and demand.

2.1 Research Questions

The purpose of this paper is to investigate the impact of wages and job opportunity on skilled labor market in an endogenous relationship and the causes of the possible future shortage. Thereafter, we formulate feasible policy to avoid the mismatch of skilled labor supply and demand that will lead to future shortage.

In short, our research questions are as of the following:

(1) What is the endogenous relationship between wages, job opportunities, and skilled labor supply in Norway?

(2) How does this endogenous relationship affect skilled labor shortage?

(3) What are the feasible policies to avoid skilled labor shortage?

We hypothesize that perceived wage premium and job opportunity have great impact on individuals' decision to pursue tertiary education. We simulate the decision-making of potential tertiary education students in relation to the development of skilled and unskilled labor forces and demand for skilled laborer. Finally, we identify the resilient dominating factors and design policies to alleviate the possible shortage in a long-run.

We will describe our hypothesis in the next section. Subsequently, we analyze the system through modeling and simulation, and then followed by model validation tests and result analysis. Lastly, we formulate feasible policies to avoid future skilled shortage in the country.

3.0 Dynamic Hypothesis

In the past twenty years, the demand for skilled labor in Norway has been increasing. However, due to slower population growth, it is projected by media and politicians that skilled labor supply will lag behind demand. We hypothesize that the sluggish skilled labor force growth is mainly caused by lower growth rate in tertiary entry rate in conjunction with slower population growth. We believe the motivation for individual to pursue tertiary education is responsible for the decreasing growth in domestic skilled labor force. The motivation for individual to pursue tertiary education encompasses four factors; these are perceived wage premium, expected foregone earnings, ease of finding job, and expected lifetime earnings. In this section, we will present our hypothesis in two ways: through **causal-loop diagrams** (CLD) and through **stock and flow diagrams** (SFD). CLD is used to demonstrate cause-and-effect relationships while SFD is useful in showing accumulation and delay in the system.

The following section exhibits our model boundary (*Figure 3-1*).

3.1 Model Boundary

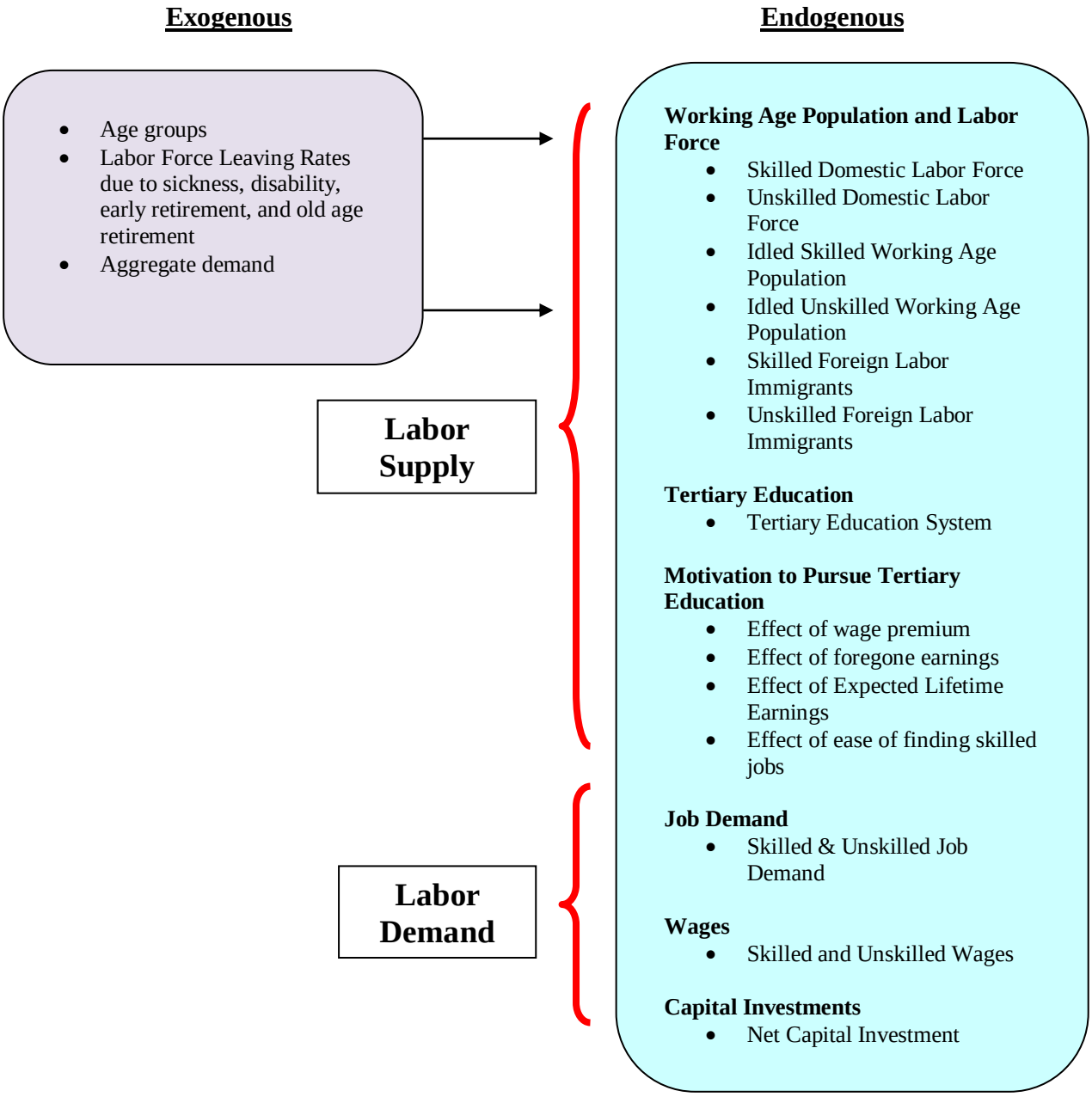


Figure 3-1 Model Boundary

Our cross-sector model consists of two major sections: labor supply and labor demand. These two sections consist of internal and cross sector feedback loops. The labor force section includes skilled and unskilled labor force, motivation to university, and tertiary education; whereas the labor demand section includes job demand, wages, and capital investments.

3.2 Causal Loop Diagram Explanation

Through CLDs, we present our hypothesis by studying the interdependencies and feedback processes that affect the development of skilled labor force in the country.

3.2.1 Skilled Job Density Loop (C2) and Foreign Skilled Labor Loop (C7)

Norway is facing the demographic ageing challenge just like other European countries due to declining fertility rate. According to Statistics Norway, the fertility rate, average number of children per woman, has fallen from 2.13 in 1974s to 1.96 in 2008. On the other hand, life expectancy has improved over the years. The life expectancy of men and women in 1951 was 71.11 and 74.7 respectively. However, in 2005, the number of years increases to 76.94 and 81.91 for men and women respectively.

Life expectancy and fertility rate are not sufficient to explain a growing population stock. A nation's population growth is determined by three factors, namely: births, deaths, and net migration. *Figure 3-2* outlines the trend of net births and net migration. In the recent years, net migration is the third force that contributes to the population growth in Norway. The number of total deaths is decreasing gradually since 1990. However the decrease in births and the increase in net migration are substantial. Total births started to decrease linearly since 1965 until 1985 and started to pick up again and remain stable. Net migration was insignificant during 1970s and early 1980s, but gradually increased considerably in late 1980s. The increment was more and more drastic since 1986 and continued to grow until 2008. It seems to decrease slightly in 2009. Amidst fewer deaths and staggering births, net migration is the dominating factor for the population growth in the last 10 years.

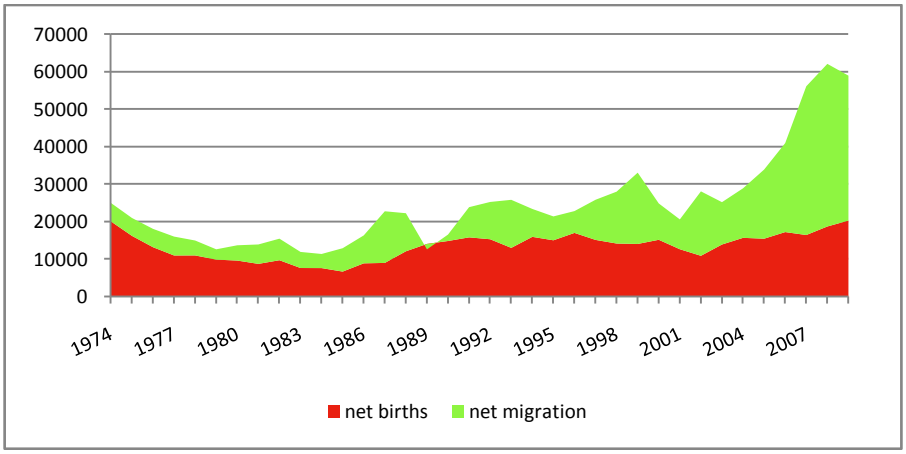


Figure 3-2 Population Net Flow broken down by Net Births and Net Migration, 1974 – 2009
Source: Statistics Norway

Albeit the population is expected to grow, it is estimated that by 2050, almost 25% of the total population will be aged 65 and over as opposed to 14% only in 2000 (OECD, 2004a).

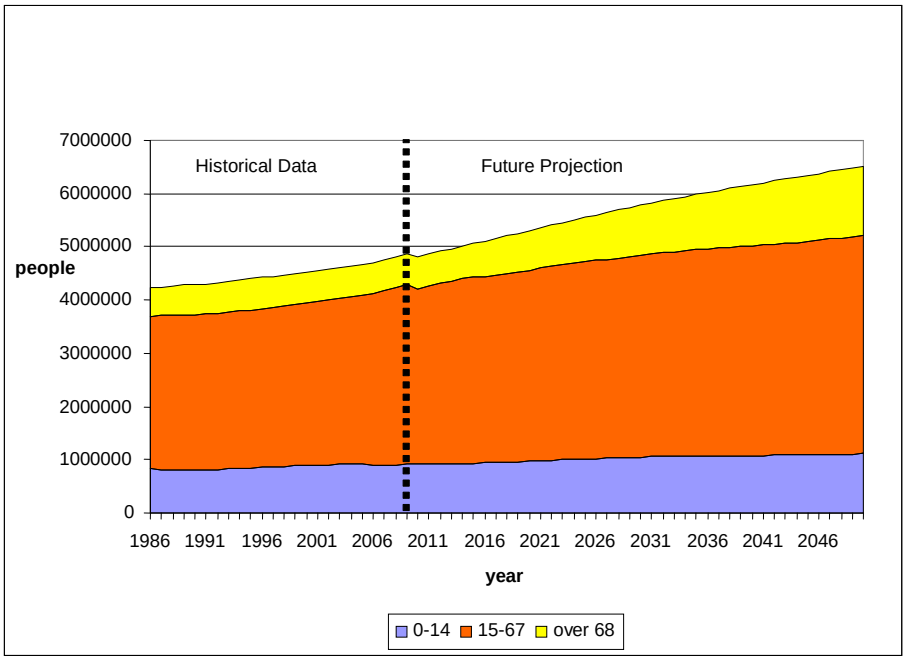


Figure 3-3 Historical Developments and Future Projection of the Population of Three Different Age Groups, 1986 – 2009
Source: Statistics Norway

Figure 3-3 provides an overview of the historical development and future projections of three age groups, namely: the Young (0-14 years old), the Working Age (15-67 years old), and the Elderly (over 68 years old). Up until 2010, the number of Young and the Elderly has been quite stable. Only the Working Age grew somewhat linearly. However, after 2010, the

number of Elderly will grow at a higher rate than the Working Age; meanwhile there will be not much increment in the Young.

The changes in demography indicate that the working age population will grow at a decreasing rate while the elderly population will grow linearly. Without immigration, the population net growth will become negative eventually. Therefore, the development of the population will have direct impact on the inflows and outflows of the labor force stocks.

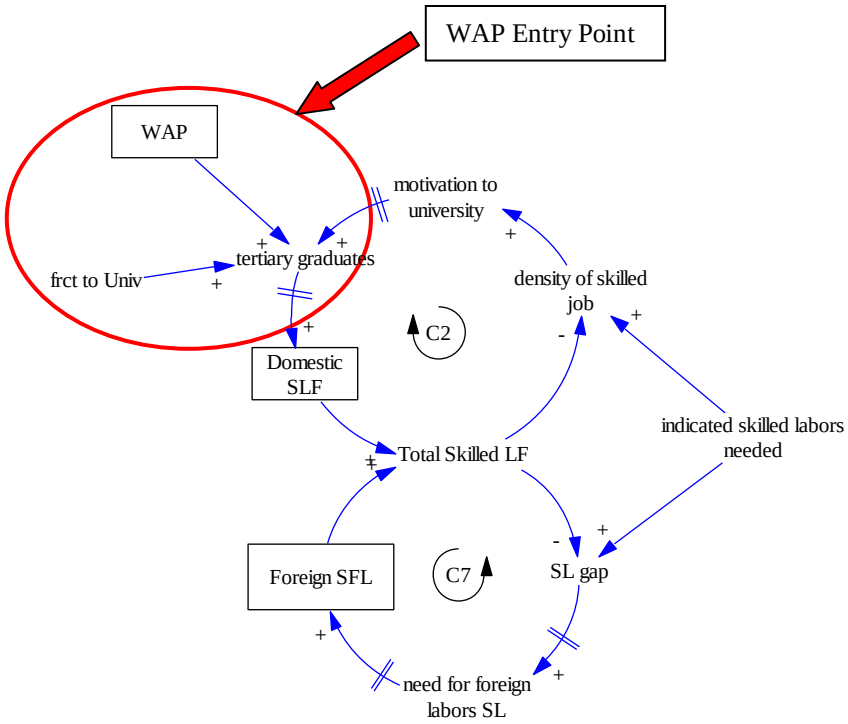


Figure 3-4 Skilled Job Density Loop[8] (C2) and Foreign Skilled Labor Loop (C7)

In our model, Total Skilled Labor Force consists of locally educated skilled laborers and foreign skilled immigrants (*Figure 3-4*). Tertiary graduates participate in domestic skilled labor force once they obtain employment or intend to seek employment. As the rate of locally educated and foreign skilled laborers enter the skilled labor force exceeds the rate of leaving, the skilled labor force has been increasing from 1994 to 2008. However, the population is growing at a decreasing rate due to lower fertility rate. Nevertheless, the fraction of young working age population who participate in tertiary education is increasing, skilled labor supply is still sufficient to meet the demand (C2). But the gap between skilled

[8] We label CLD presented in this section with names for communication purpose. Later in the paper, we will frequently refer to corresponding loop by name.

labor supply and demand is projected to be enlarging as the growth of skilled labor force is presumed to be slower than the growth of skilled labor demand. If the supply of local tertiary graduate persistently falls shorts the demand, more foreign skilled laborers will have to be brought into the country to fill the void (C7).

The increase in skilled labor force will reduce the gap (SL gap) between skilled labor demand (indicated skilled labor needed) and supply (Total Skilled LF). As the gap reduces, two consequences will be brought forth: reduction in the need for foreign skilled labor and skilled job opportunities. Fewer skilled jobs represent lower skilled job density (C2). Individuals formulate their perception on skilled job density through job postings, media, or word-of-mouth. In our model, we use the ratio between skilled labor demand and skilled labor supply to represent this perception of individuals at large. If the ratio equals to one, it means the skilled labor supply is enough to meet the demand and the skilled labor market is in equilibrium; if the ratio is less than one, that means skilled labor supply falls short the demand. This relationship is characterized as a counteracting loop. Counteracting loop is described as a self-correcting process that opposes change and will seek balance and eventually lead to balance in the system (Sterman, 2000). Lower skilled job density will reduce the incentives for individuals to participate in tertiary education as it symbolizes the difficulty of landing jobs after graduation. Individuals are assumed to take the historical development of skilled job density into consideration and adjust their perception gradually, and then they project the probable development for the next few years when they assess the benefits to pursue tertiary education. Hence, lower skilled job density will lead to fewer skilled laborers produced locally.

The red circle in *Figure 3-4* summarizes the inflows to tertiary education submodel. We will discuss the tertiary education submodel in the later section. Here, we shall explain the entry point to our model. The following flow chart (*Figure 3*-5) indicates that when age group 18 turns 19, the individuals in this age group will either enter tertiary education or remain to be non-tertiary students (Potential Students). Once they are in the tertiary education system, they will either finish tertiary education or to be dropouts (Incompletes) and enter unskilled labor force. In Education at a Glance (OECD, 2009), data shows that in 2007, the percentage of age group 15-29 who are neither in education nor labor force was only 0.8%. Since the fraction is relatively small, we consider that all the Incompletes who leave tertiary education will join the labor force. The potential students will either obtain jobs and be

unskilled laborers or remain idle. These potential students will enter tertiary education system if the opt to do so in the future. A more detailed view of the SFD will be presented in the SFD Explanation section.

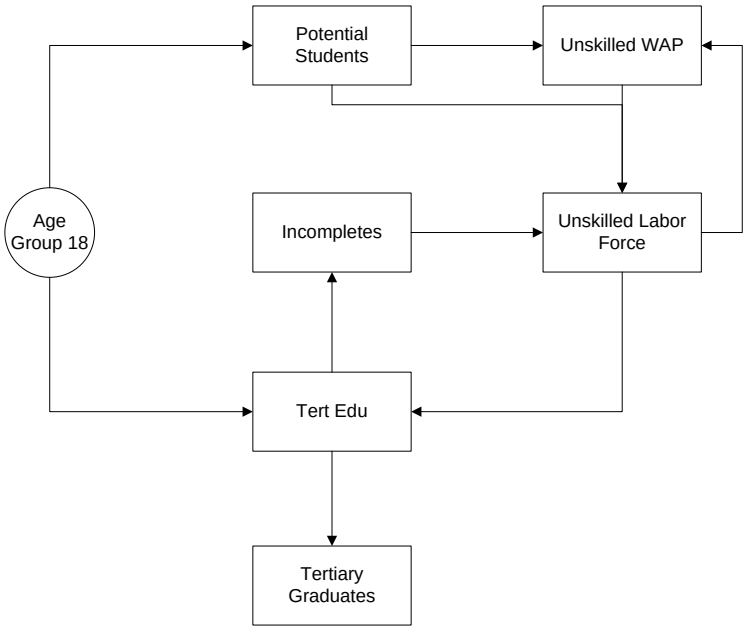


Figure 3-5 Flow Chart – Transitional paths of Age Cohort 18 and Future Possible transitions

3.2.2 Capital Investment and Skilled Wages Loop (R2) and Capital Investment and Skilled Labor Gap Loop (C9)

As skilled labor shortage increases, skilled job vacancies outnumber skilled job seekers; wages for skilled labor increases due to low unemployment rate. The growing wage rate encourages firms to raise capital investment to boost labor productivity. As wages grows proportionally to labor productivity, higher labor productivity will result in higher wages for skilled laborer (R2, *Figure 3-6*). So, this causal relationship will lead to higher capital investments from firms. This loop is characterized as a reinforcing loop. Reinforcing loop is a process that amplifies the growth of the system itself to produce exponential growth (Meadows, 1980).

In neoclassical economic growth theory, economic growth originates from technological progress and labor supply. Solow-Swan neo-classical growth model shows that the economic growth rate increased by capital investment is only temporary. Even though there is more capital available for each laborer to use, the marginal product of additional units

of capital is assumed to decline and the economy will converge to a steady growth path. As output, capital, and labor are growing at the same rate, output per labor and capital per labor are constant. Hence, it is hypothesized by neoclassical economists that long-term economic growth requires increase in labor supply and improvement in labor and capital productivity through technology.

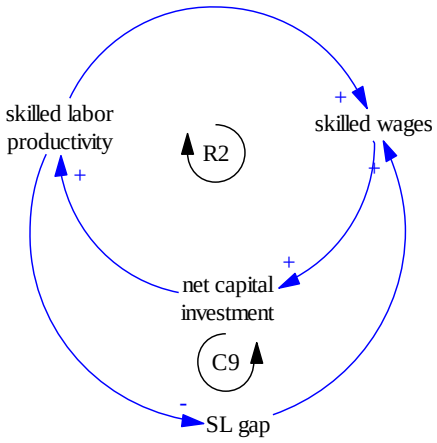


Figure 3-6 Skilled Labor Productivity and Wages Loop (R2) and Skilled Labor Productivity and Skilled Labor Gap Loop (C9)

Nevertheless, higher skilled labor productivity will also lead to the reduction of skilled labor demand (C9), a development termed capital-augment technological process. As skilled labor market relaxes, wage growth is dampened. Thus, firms find fewer incentives to invest in capital as human input is relatively less expensive at this stage. This counteracting loop becomes dominant; it will eventually curb the exponential growth of R2. Thus, sufficient skilled labor supply and persistent capital investment in technology to raise productivity are vital to economic growth.

3.2.3 Motivation to University Loops (C1, C3, C13, C14, and C15)

As discussed in section 1.1, Motivation to University is individual's expected relative benefits and opportunity costs to tertiary education. In our paper, we focus on private financial returns to education and leave out the psychological and social returns. Opportunity costs include direct and indirect costs. Tuition and education related spending are direct costs; expected foregone earnings are indirect costs. Benefits represent the expected lifetime earnings: the accumulated earning stream of an individual.

However, tertiary education in Norway is free. So, if direct cost is not in the picture, why the tertiary education participation rate did not increase drastically? It is indicated that expected foregone earnings is the second most important factors (Tannen, 1978). In the recent years, the relative earnings of skilled and unskilled labor have been decreasing. This implies that the accumulated foregone earnings for individuals who pursue tertiary education rise higher.

We hypothesize that two more factors need to be included into the motivation to university: starting wage and relative ease of finding jobs. Human's cognitive map is very simplified and always fails to relate to the causal structure of system. People always tend to misperceive the effect of time and unable to refer to the dynamics of causal relationship because of "the many limitations of attention, memory, recall, information processing capability, and time constraint" (Sterman, 2000). Thus, individuals are more likely to focus on the wage premium that they might enjoy in the first few years after tertiary graduation, with the limited historical information. Wage premium development in a longer term may be difficult for individual to foresee, so they tend to discount the future rate of return sharply. The future discount rate of individual is fairly constant if they calculate the discount with subjective perception of time duration. Zauberman et al. (2008) concluded in their study that conceptualizing the future is very abstract and human is insensitive to time horizon if the time is perceived as a delay, for example in 10 years, rather than a point in time, i.e. year 2020. Corresponding to heavy discount of future lifetime earnings, it is likely that individuals consider future earnings as delayed benefit.

We believe that job availability affect individuals perception because individuals will be discouraged to invest in education if they believe it is difficult to find jobs after graduation. The skilled and unskilled labor market tightness, economic growth, and changing job composition in the country determines the relatively ease of finding jobs.

Wages for the skilled labor is compared to the unskilled labor when individuals weigh the economic benefits to tertiary education. Wage premium is the ratio of the skilled wages to the unskilled wages. Perceived wage premium symbolizes the attractiveness of skilled jobs. If wage premium is higher than one, it represents that skilled laborers are paid more than then unskilled as the returns to the additional education. The higher the perceived wage premium, the more attractive the skilled jobs are. Thus, working age population is more motivated to

take up tertiary education in order to become skilled laborers (C1, *Figure 3-7*). In the recent years, the increasing outflows from the unskilled labor force due to disability, early retirement, and official retirement have exerted upward pressure on wages for unskilled laborers (C3). Therefore, wage premium demonstrates a downward trend from 1994 to 2008.

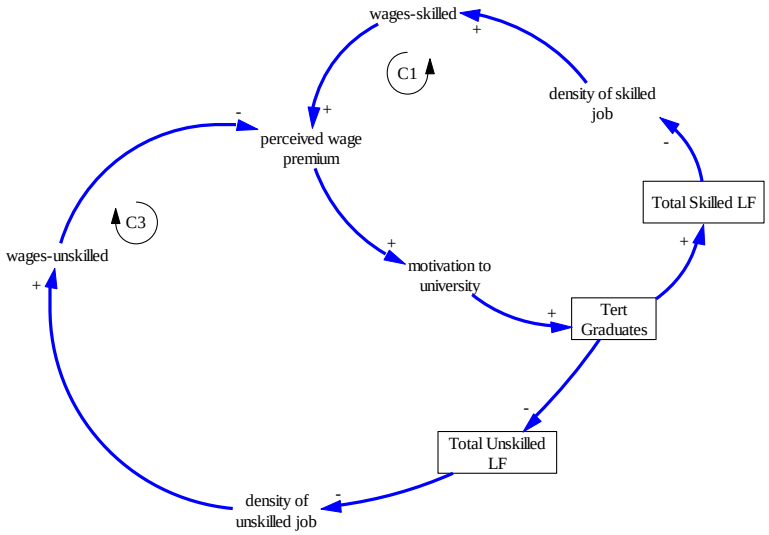


Figure 3-7 Perceived Wage Premium Loop (C1 & C3)

As more people become skilled laborers, the unskilled labor force is depressed. In conjunction with increasing outflow from unskilled labor force, this will lead to increasing unskilled labor shortage. Unskilled wages increases due to higher labor productivity and labor shortage, therefore expected foregone earnings of tertiary students increase (C15, *Figure 3-8*).

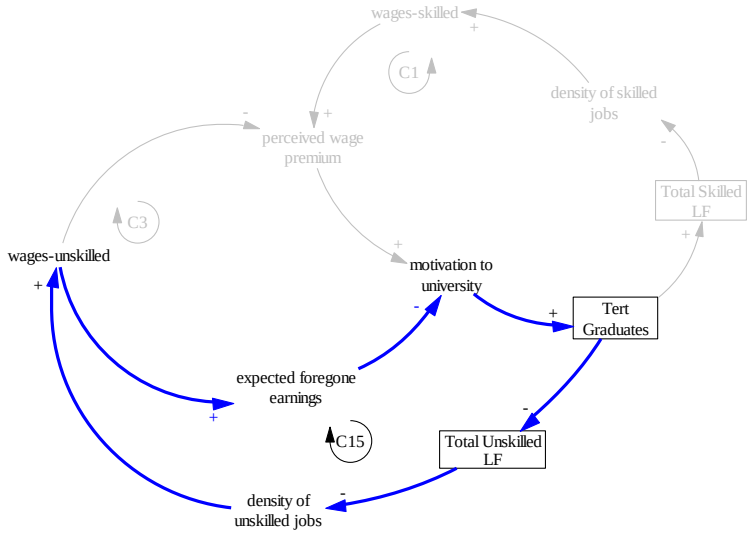


Figure 3-8 Expected Foregone Earnings Loop (C15)

Expected lifetime earnings are the accumulated stream of earnings of individuals expected. It consists of the expected stream of earnings during the working years minus foregone earnings should individuals pursue tertiary education and give up earnings during the study period. *Figure 3-9* exhibits the two causal loops that affect expected lifetime earnings (C13 and C14). If perceived wage premium heightens, the expected lifetime earnings skilled laborers swell; on the contrary, if wages for unskilled laborers rises, the inflated foregone earnings will reduce the cumulated stream of earnings of skilled laborers.

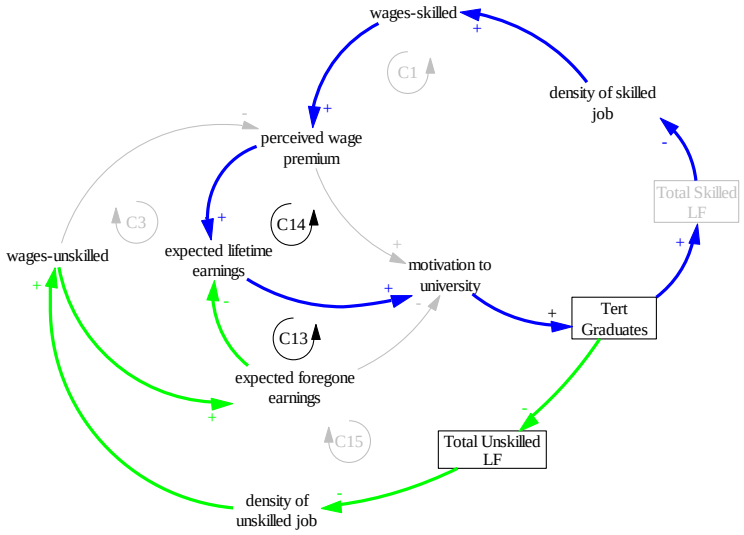


Figure 3-10 Expected Lifetime Earnings Loop (C13 & C14)

We hypothesize that motivation to university enrollment is a function of skilled job density loop (C2, *Figure 3-4*), Perceived Wage Premium Loop (C1 & C3), Expected Foregone Earnings Loop (C15), and Expected Lifetime Earnings Loop (C13 & C14).

As mentioned in section 1.1, individuals put different weighs on the factors that constitute motivation to pursue tertiary education. Thus, in our model the weight distribution of these elements is: Starting Wage (0.3), Expected Foregone Earnings (0.4), Expected Lifetime Earnings (0.1), and Ease of Finding Job (0.2). The total is 1.

3.2.4 Aggregate Demand with Skilled Input Loop (R1)

Finally, the growth of skilled labor force accounts for the growth in aggregate demand that requires skill input. If skilled labor supply is abundant, firms are encouraged to take advantage of the availability of skills. Therefore, firms have the human resource to venture

into sectors that required skilled labor input. The demand for skilled labor increases moderately within the past 15 years. This has prompted moderate growth of indicated skilled labor needed (R1, *Figure 3-10*). As a consequence, skilled labor gap widens and skilled job density increases and thus skilled labor market is tighten. The tighten labor market will lead to higher wages for skilled labor as firms compete for talents. This development will enhance the attractiveness of skilled jobs. Hence, more individuals take up tertiary education.

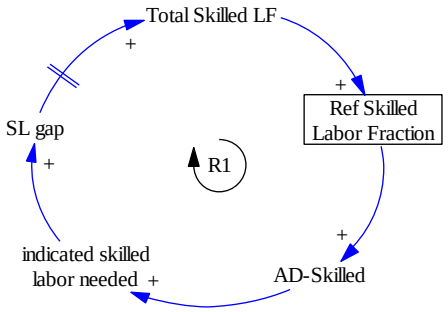


Figure 3-10 Aggregate Demand with Skilled Input Loop (R1)

As the result of increased cross-border trading, international competition, and labor scarcity, Norwegian economy has been shifting to more skilled based industries in the past two decades. In the early 90s, the fraction of aggregate demand that requires skilled input increased slowly, so skilled labor supply was able to catch up the demand. The growing skilled labor force also fueled the growth of aggregate demand that required skilled input. Even though the perceived wage premium has been decreasing from 1994 to 2008, the increasing skilled job density compensates for the lower wage premium and continues to attract individuals to tertiary education. As a result, skilled labor supply has been increasing from 1994 to 2008, so has the skilled labor demand.

In a nutshell, *Figure 3-11* demonstrates the overview of our dynamic hypothesis. The combination of the counteracting loops and reinforcing loop produces the behavior in the reference mode (*Figure 1-8*).

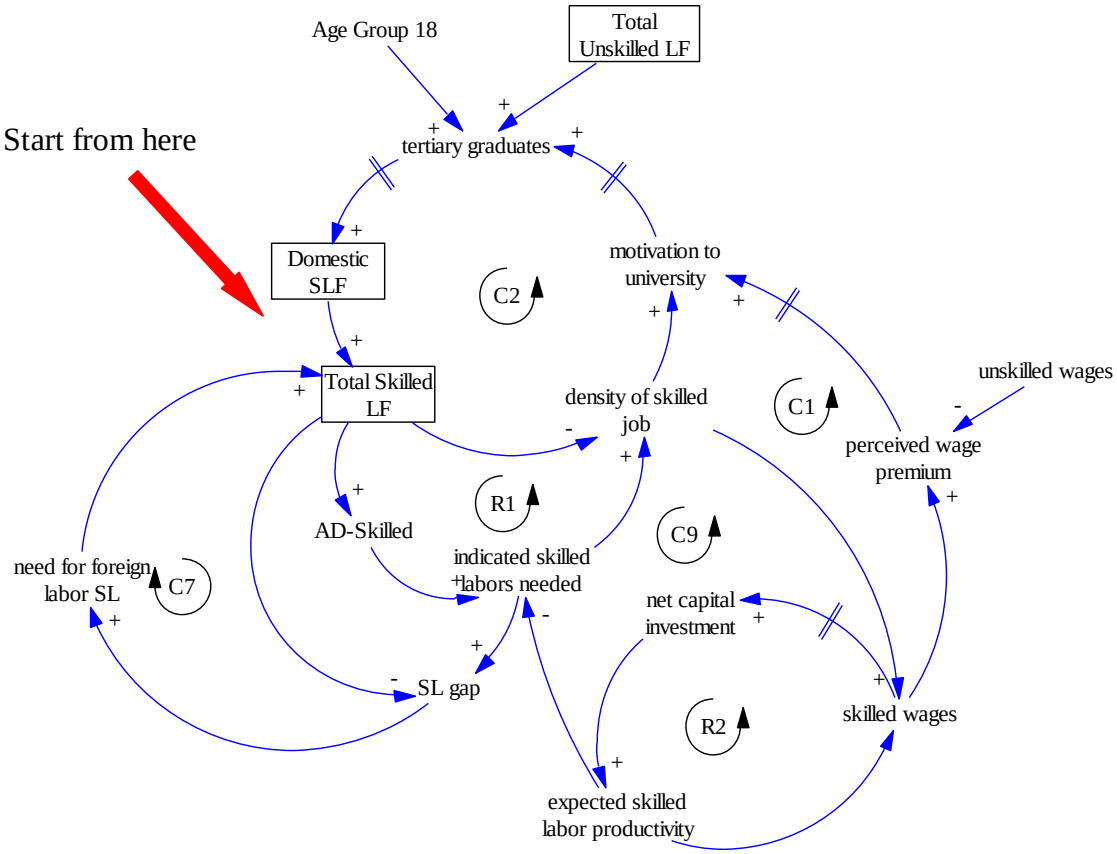


Figure 3-11 CLD-The Overview of Dynamic Hypothesis (C13 & C14 are omitted from the diagram for clarity purpose)

3.3 Stock and Flow Diagram Explanation

In this section, we present our hypothesis in a more detailed level by using stock and flow diagrams (SFD) to show accumulation and delays in the system.

3.3.1 WAP Entry Point

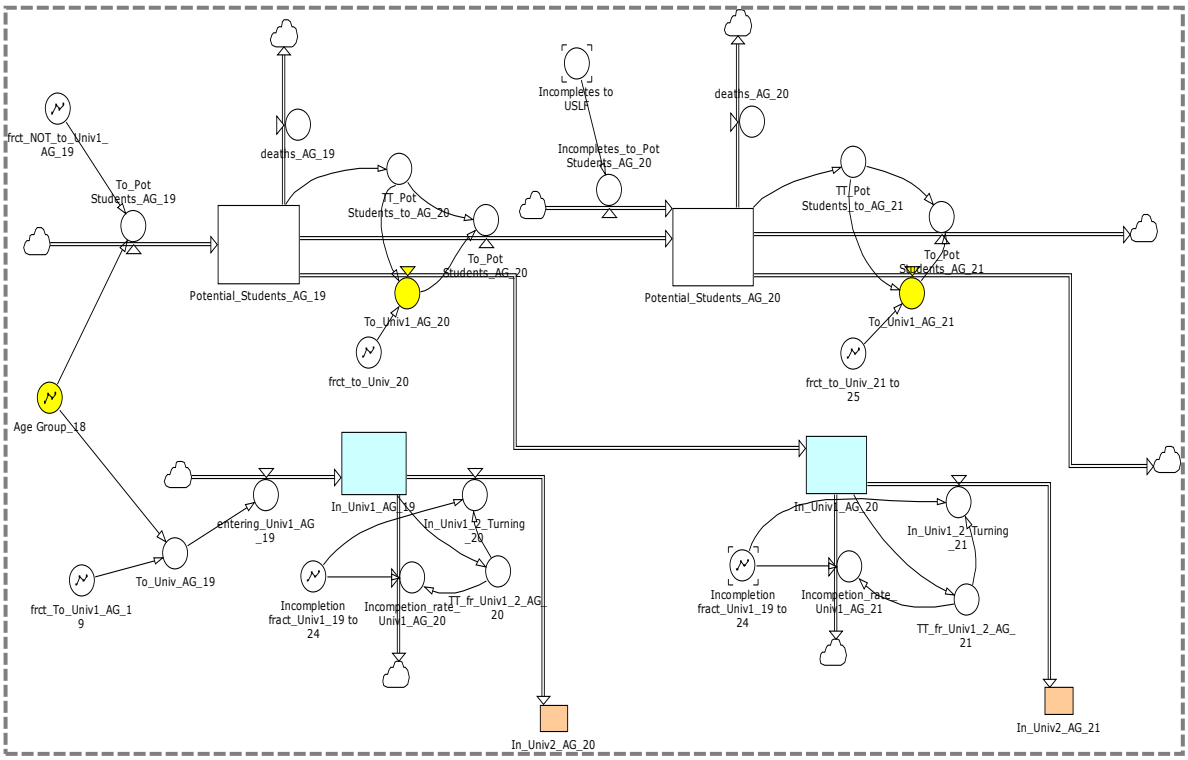


Figure 3-12 SFD – Partial View of Entry Points for Age Group 18

As the starting point to our model, individuals will enter the aging chain and move along either horizontally or vertically (*Figure 3-12*). Individuals in age group 18 who are turning 19 will either be the inflow to tertiary education or potential students if they are not in tertiary education. Once the fraction of individual is in tertiary education, they will move on to the next level of their studies year by year until they graduate. Certain fraction of these tertiary students will drop out and enter the potential students stocks, depending on their age. The individuals in potential student stocks will also age year by year. This SFD is a detailed illustration of the red circle in *Figure 3-4*.

The statistics of age cohort 18 from 1994 to 2008 is taken from the historical data from Statistics Norway. From 2008 to 2050, the age cohort is taken from the projection done

by Statistics Norway. The projection takes net migration, life expectancy, and fertility into consideration. Net migration is projected to be 8,000 people per year until 2050; life expectancy is projected to increase between 3 and 4 years until 2050; fertility rate is projected to be 1.89 until 2050.

The following table exhibits the transition to tertiary education rate of the age cohort of 19 and 20.

	Age 19	Age 20
2002	12	25
2003	14	28
2004	13	29
2005	14	29
2006	15	30
2007	15	29

Table 3-13 Percentage of Age Cohort entered Tertiary Education
Source: OECD Education at a Glance (2009)

Our model includes the tertiary education entry rate from 19 to 29. This is because the entry rate of these cohorts is more pronounced than individuals older than 30[9]. The fraction of age cohorts enter tertiary education varies. In general, most people continue to tertiary education after having completed videregående skole (high school), which is after 18 years old. Some individuals may also choose to participate in the unskilled labor force in their early twenties and go back to tertiary education few years later. However, the likelihood of individuals' tertiary education participation decreases drastically after 30 years old. Hence, the tertiary education sector in our model only consists of age cohorts from 19 to 29.

The detailed view of unskilled labor force submodel shows the corresponding flows of age group 18. The unskilled labor force stock is an array[10]. It consists of 49 individual age groups from 19 to 67. Circle A in *Figure 3-14* indicates the fraction of potential students entering domestic unskilled labor force. This co-flow consists of individuals who decide not to pursue tertiary education at age 19 as well as the dropouts from tertiary education (AG_18 and Incompletes entering_USLF). In Education at a Glance (OECD, 2009), data shows that in 2007, the percentage of age group 15-29 who are neither in education nor labor force was

[9] According to OECD Education at a Glance 2003-2007, the tertiary enrollment rate of age cohorts 30-39 and over 40 were between 6-7% and 2% respectively from 2001-2007. Refer to Appendix D.
[10] In Powersim, array can be structured in such a way as aging chain. The transition flow (TT_D_USLF) contains a pulse function that moves each age cohort to the next age group by the end of every year.

only 0.8%. Since the fraction is relatively small, we consider that all the Incompletes leave tertiary education to join the labor force. The remaining fraction of age group 18 which is neither in tertiary education nor unskilled labor force enters the domestic idle unskilled working age population (Circle C). Data shows that in the transition from 18 to 19 years old, the fraction of this age group which remains idle was between 7 – 8% on average from 1994 to 2009.

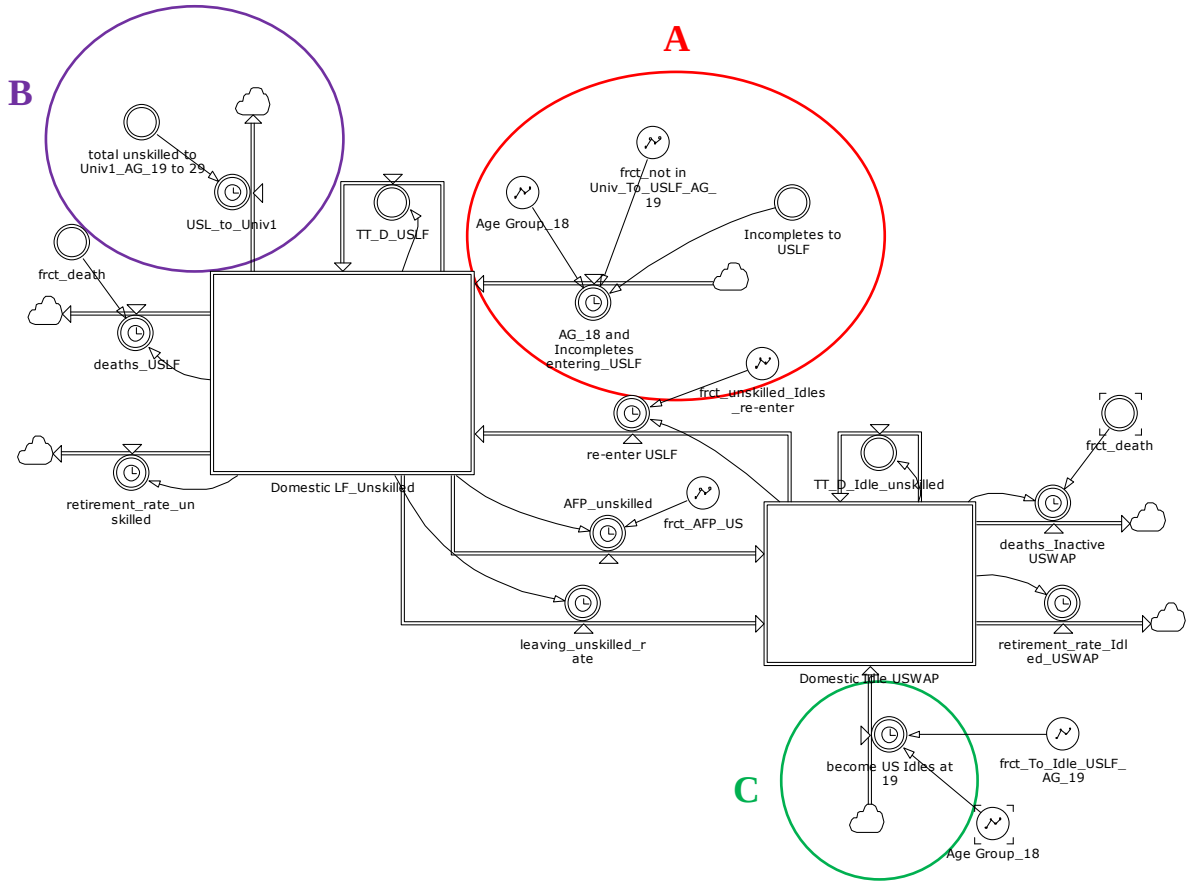


Figure 3-14 SFD – Detailed view of the Domestic Unskilled LF and Domestic Idled USWAP Submodel

In the course of their work life from 20 to 29, the fraction who decides to pursue tertiary education leaves the domestic unskilled labor force stock (Circle B). Even though individuals leave the unskilled labor force to participate in tertiary education, Jobs for Youth-Norway (OECD, 2008b) highlights that in 2006 50% to 60% of the students did work part time while they were studying. Therefore, the students who leave the unskilled labor force not only enter universities, but also enter the Students as PT USL stocks (*Figure 3-15*) as a co-flow if they hold part-time jobs. The fraction of tertiary students who leaves tertiary education before graduation enters the unskilled labor force. If students stay in the tertiary education for three years and graduate, they will leave Students as PT USL stock and enter

skilled labor force or idle working age population as co-flows to domestic skilled labor force and idle skilled working age population. The following SFD is the detailed view of the stocks and flows for students with part-time jobs.

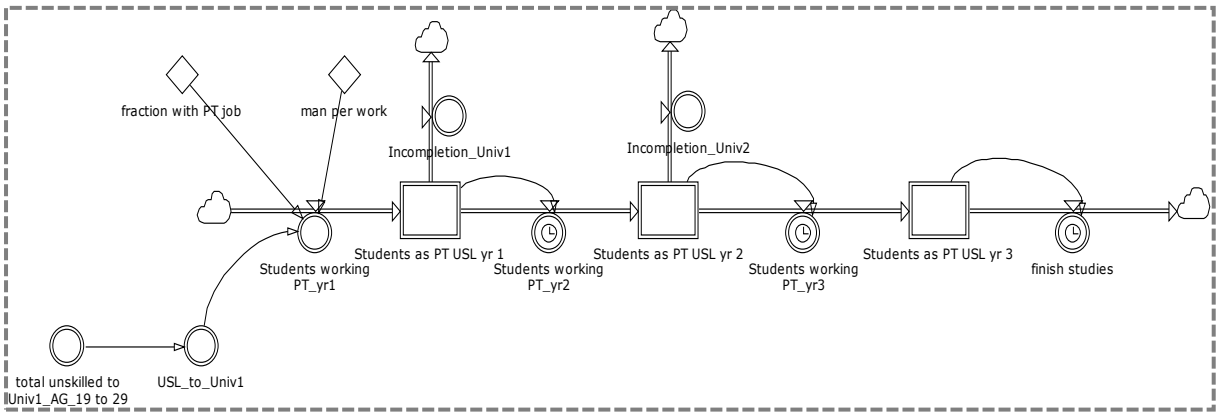


Figure 3-15 SFD – Detailed view of the Students as PT USL Submodel

The total unskilled labor force is made up of total domestic unskilled labor force, foreign unskilled labor force, and total students as part-time unskilled labor stocks. *Figure 3-16* shows that unskilled labor immigration has been increasing annually from 1999 to 2009. The inflow of unskilled labor immigrants is almost four times greater in 2009 than in 1999. The labor force participation rate of Norway, which is 76%, is one of the highest among the OECD countries. The already high labor force participation rate and low unemployment rate[11], leaves very few not-employed unskilled labor reserve. In addition, the increasing outflow due to disability and sickness, early retirement (AFP)[12], and old age retirement[13] intensify labor shortage. Therefore, more foreign unskilled laborers are needed to fill job vacancies.

[11] From 2000 to 2007, the annual national unemployment rate was about 3.06 on average. Refer to *Figure 1-1*.
[12] Early retirement – Due to high wage increase, an early retirement scheme (AFP), an agreement-based early retirement pension due to the wage settlement in 1988, was introduced in 1989. The age limit from 1988 to 1997 was 66, but it was reduced to 62 in 1998.
[13] Refer to the official retirement at the age of 67.

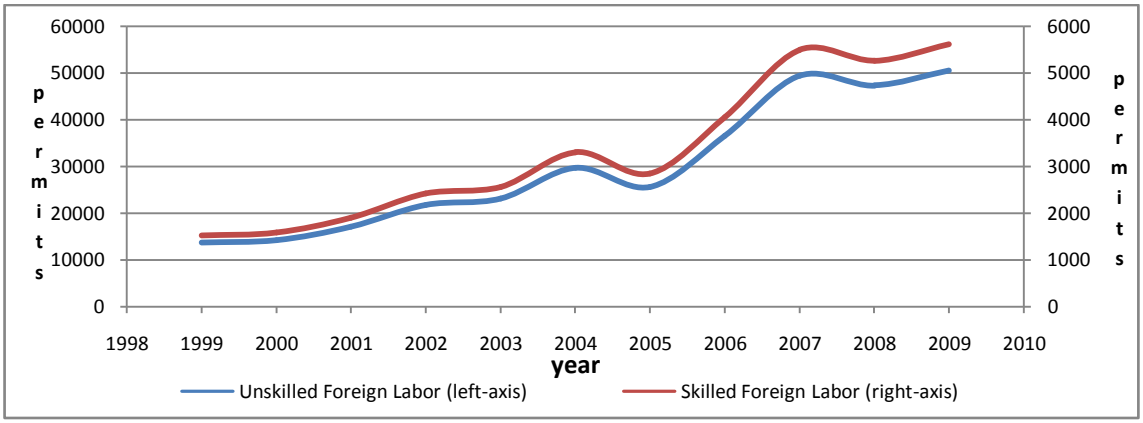
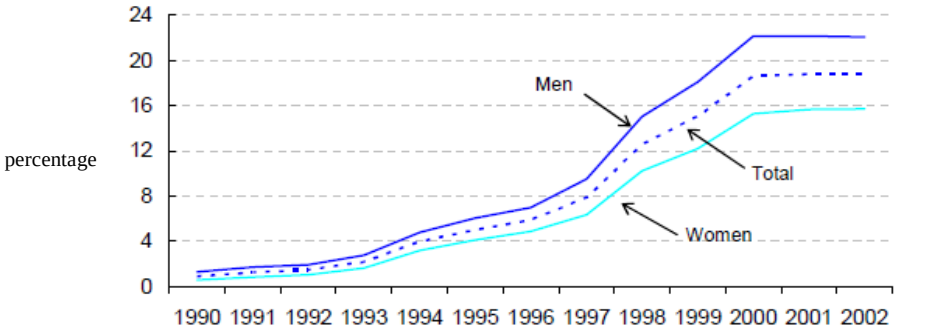


Figure 3-16 SFD – Number of permits granted to unskilled and skilled labor immigrants, 1999 -2009

According to Statistics Norway, GDP in Norway has grown 3% annually on average from 1948 to 2003. However, the unskilled labor leaving rate (leaving_unskilled rate, *Figure 3-14*) and early retirement rate (AFP_unskilled, *Figure 3-14*) deserve more detailed elaboration here. This is because "in Norway, the inflow into disability benefits is particularly high and with no sign of a turnaround in the trend, and sickness absence is twice the OECD average" (OECD, 2006a). In 2004, public spending on sickness and disability was 4.1% of GDP. But most of the spending is on benefits rather than encouraging the benefit-recipients to re-enter the work force. Therefore, the outflow from the disability-recipient stock is almost zero. The unemployed working age population in Norway is mainly due to health reasons (OECD, 2006a). This is serious because labor inactivity depresses the labor force stock.

In 2001, close to 19% of the working age population between 62 and 66 accepted the AFP scheme (early retirement scheme) as the exit path from the labor force. *Figure 3-17* shows the percentage of the population aged 62 to 66 who accepted the AFP-scheme from 1990 to 2002. It clearly shows that the number of people who selected to leave the labor force before they reach the official retirement age were increasing ever since AFP-scheme was introduced.



a) Prior to 1992, only those aged 65 and over were eligible for an AFP pension. In 1993, eligibility was extended also to those aged 64 and in 1997, this age level was further lowered to 63. Since 1998, the AFP scheme covers people in the age group 62-66.

Figure 3-17 Percentage of the population aged 62-66 who received the Contractual Early Retirement scheme, 1990 – 2002
Source: Extracted from Ageing and Employment Policies: Norway (OECD, 2004a)

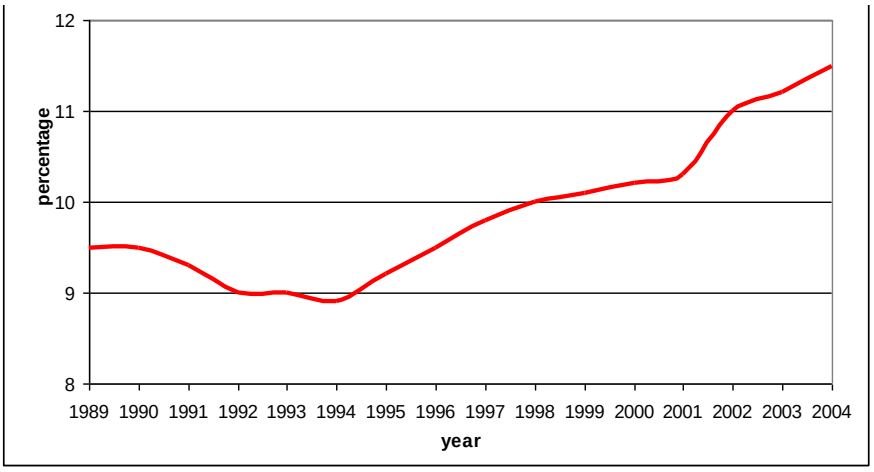


Figure 3-18 Disability Benefit Percipient as a Fraction of the Working Age Population , 1989 – 2004
Source: Recreated from "Sickness, Disability, and Work: Breaking the Barrier" (OECD, 2006a)

More than 11% of the working age population in Norway receives disability benefits since 2002 (OECD, 2006a, *Figure 3-18*). The annual inflow to the disability stock is 1% of the working age population. Disabled persons have lower employment rate and only about 3% to 4% are employed and mostly on part-time basis. Therefore, the overall outflow of unskilled disabled from the domestic idle unskilled working age population stock (Domestic Idle_USWAP) is merely 0.5%.

The generous welfare options provided to exit the labor force has negative impact on the labor force stock. The study conducted by Brinch, Hernoes and Strøm concluded that if AFP-scheme was abolished at the end of 1999, the labor force participation would have lifted 1.8% in 2005 among the population aged 16 to 74 (OECD, 2004a).

3.3.2 Skilled Labor Force

It is predicted by Statistics Norway that in the coming years, aggregate demand in Norway will grow by 3.3% to 3.9% from 2011 to 2013. This is due to the expected strong growth in household consumption (over 3%), moderate growth in export (average 1.1% annually until 2013), and resumed investment in capital after the economy downturn in 2008 (average 4.6% until 2013). So, between 2011 and 2050, aggregate demand is expected to grow at a constant growth fraction of 3.7%. Therefore, the demand for skilled laborers is also expected to increase from 2011 onwards.

Total skilled labor force is made up of domestic skilled labor force (Domestic LF_Skilled) and foreign skilled labor force (Foreign Labors_Skilled), as shown in *Figure 3-19*[14]. The first inflow to domestic skilled labor force is the fraction of tertiary graduates who enter the market to seek for job every year. The second inflow is the people who re-enter the labor force from Domestic Idle SWAP. Domestic Idle SWAP is the stock of skilled working age population who are inactive; they are neither employed nor looking for employment. The fraction of tertiary graduates who are not in the skilled labor force will enter Domestic Idle SWAP. The three outflows from domestic skilled labor force are deaths, leaving rate, and old age retirement. Leaving rate includes those who are leaving due to sickness, disability and early retirement scheme (AFP). The outflows from idle skilled working age population are deaths and old age retirement. Those who reach 67 years old leave the domestic skilled labor force and domestic idle skilled working age population stocks.

[14] This is a simplified SFD to show the stocks and flows of skilled labor force. For a detailed view, refer to Appendix C.

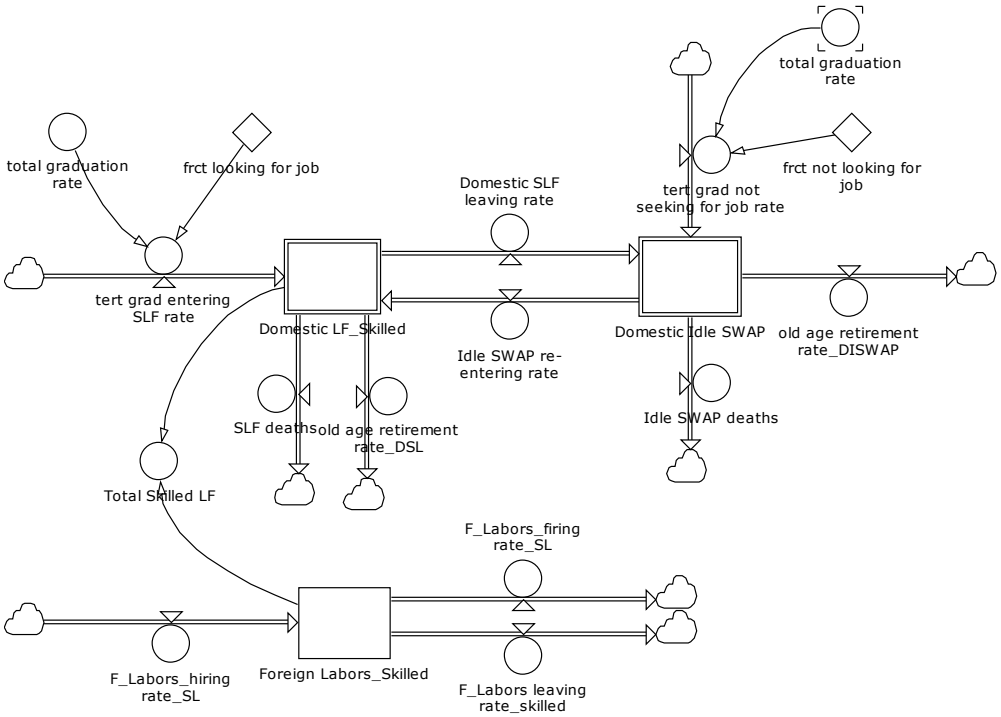


Figure 3-19 SFD – Simplified view of Domestic Skilled Labor Force, Domestic Idle SWAP, Foreign Skilled Labor Force and Total Skilled LF

Note that domestic skilled labor force and idle SWAP are stocks with arrays, meaning that these two stocks contain individual age group from 19 to 67. With transition flows, individual age group will age year by year throughout the entire simulation. Since our study focus on how the local population dynamics affect the total skilled labor force, so total Skilled LF is the sum of all individual age groups in domestic skilled labor force and foreign skilled labor force.

Foreign skilled labor force has one inflow, which is F_Labors_hiring rate_SL. This is the number of foreign skilled laborers being hired into the country. *Figure 3*-16 shows that the number of permits granted to foreign skilled labor has been increasing every year from 1999 to 2009. The number of permits approved in 2009 slightly more than 5,000 as compared to less than 1,500 in 1999. We assume that the foreign skilled laborers have obtained employment offers prior to their arrival because employment offer is the pre-condition for obtaining work permit in the country. The outflows from this stock are firing rate and leaving rate. When skilled labor force gap (SL gap) becomes negative when skilled labor supply is greater than demand, foreign laborers will possibly be retrenched. A fraction of the foreign skilled labor is assumed to be leaving the stock every year due to various

reasons. Most Nordic or European foreign labors usually stay in Norway on a temporary basis (OECD, 2004), only 60% of them stay more than 10 years.

The following submodel demonstrates the hiring and firing process of skilled labor force. In this sector, domestic skilled labor force is broken down into two stocks: employed domestic skilled labor force and unemployed domestic skilled labor force. This sector also shows the how skilled job demand affects the hiring of foreign skilled labor.

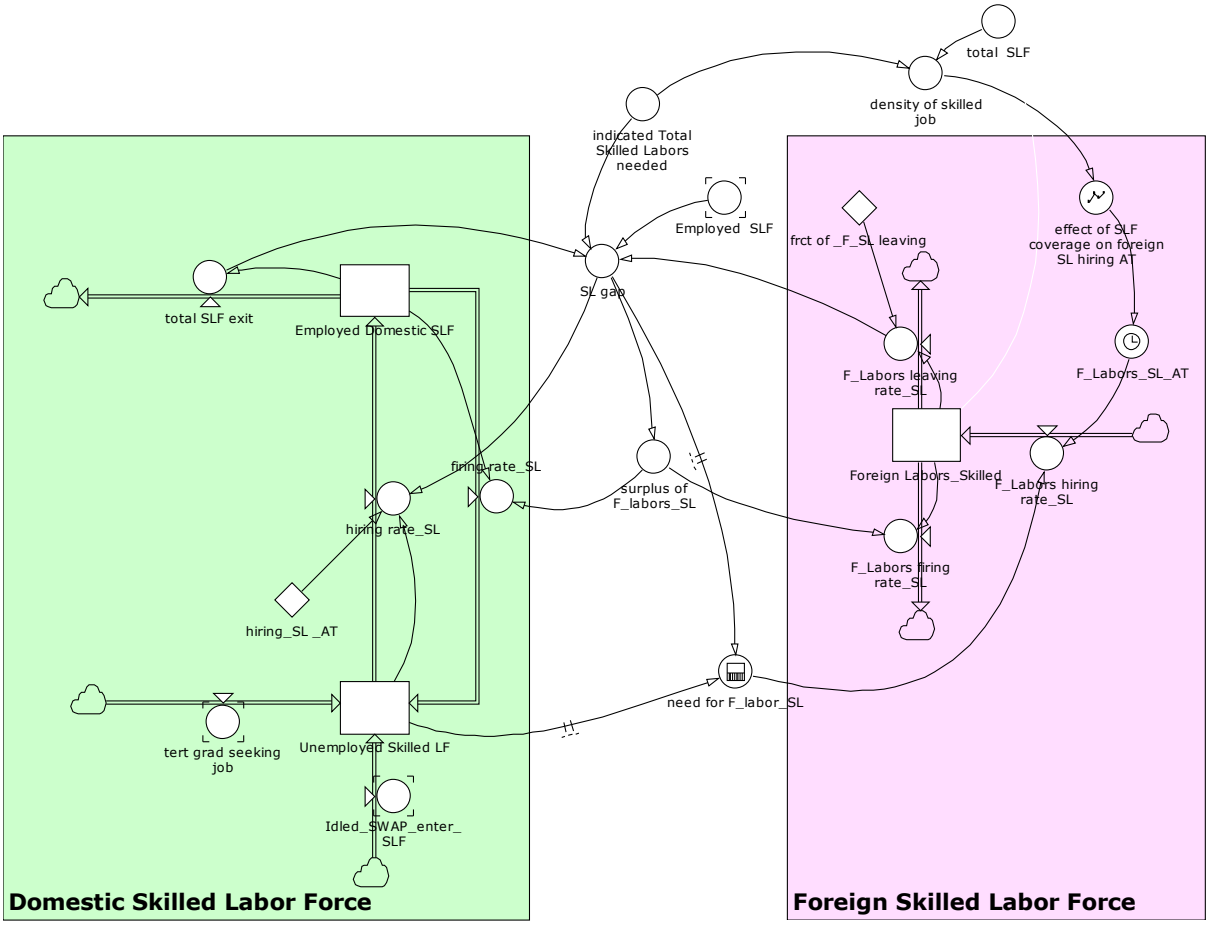


Figure 3-20 SFD – Simplified view of Employed Domestic Skilled Labor Force, Unemployed Domestic Skilled Labor Force, Foreign Skilled Labor Force for hiring and firing process illustration

Tert grad seeking job is a co-flow of tert grad entering SLF rate (*Figure 3-19*). When tertiary students graduate, the fraction of graduates who intends to obtain employment will enter the unemployed skilled labor force stock. Idle skilled laborers who decide to participate in labor force will also enter into unemployed skilled labor force stock. It is assumed that it will take 6 months for them to land a job. The hiring rate is determined by either SL gap or the unemployed skilled labor stock. If SL gap is larger than the unemployed skilled labor

stock, the maximum number of skilled labor to be hired only equals to the number of unemployed skilled labor waiting for jobs. On the flip side, if SL gap is smaller than the number skilled labor waiting to be hired, the maximum number of unemployed skilled labor to be hired only equals to the gap.

In the event of skilled labor supply exceeds demand, surplus of skilled labor occurs. Then, employed skilled labor will be laid off and become unemployed. This firing process will also take place in foreign skilled labor force stock.

If the stock of unemployed skilled labor is insufficient to meet skilled labor gap, firms will seek skilled laborers outside of the country (need for F_Labor_SL). It takes much longer time for firms to get foreign laborers because of delay in recognizing the need for foreign skilled labor, to advertise, to establish communication with potential employees, to negotiate, to deal with legal process, and so on. We assume it takes 2.5 years for the entire process. But starting from 2006, the immigration department simplified applications for skilled permits. Therefore, we reduce the foreign labor adjustment time to 2.0 years from 2006 onwards.

The tightness of the skilled labor market, density of skilled job, has an impact on the foreign labor hiring adjustment time. If the skilled labor market relaxes, the hiring time will be longer. This is because employers will be less aggressive in searching for foreign skilled labor if they believe there are locals who are available for the job vacancies. The nonlinear graphical function below (*Figure 3-21*) demonstrates the effect of SLF coverage on foreign skilled labor hiring adjustment time. In the recent years, as skilled labor shortage is intensifying, the immigration department simplified application procedures and grants rights to skilled laborers to start working as soon as they have submitted their applications. According to UDI[15], it takes at least 3 months to process skilled worker permits. In the event that density of skilled job falls below 1.0, we assume the hiring adjustment time will return to normal processing procedures. Thus the adjustment time will return to 2.5 years.

[15] Denotes Directorate of Immigration. The period taken to process a case is calculated from the day the job applicant submit your application to the police or at a Norwegian embassy or consulate until the day the UDI takes a decision on the case.

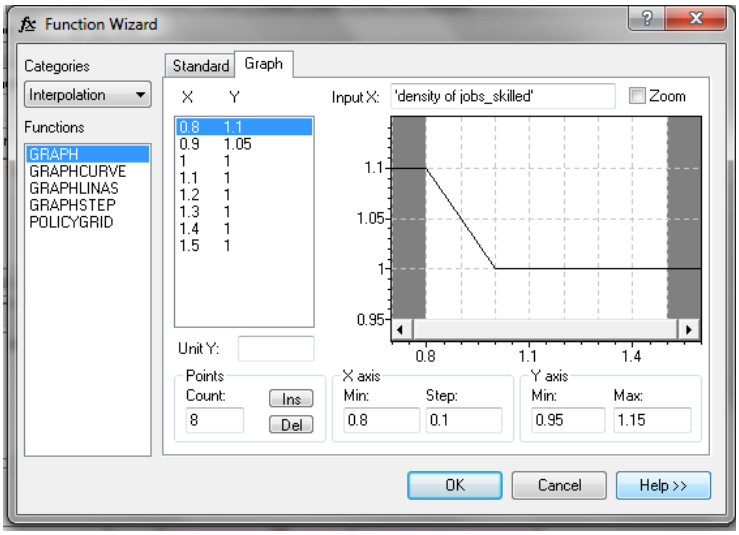


Figure 3-21 Nonlinear Graphical Function of the Effect of Skilled Labor Force Coverage on Foreign Skilled Labor Hiring Adjustment Time

In comparison to educating skilled laborers locally, which will take at least three years, hiring skilled laborers from abroad will reduce shortage faster. In our paper, we leave out the perceived attractiveness of working in Norway in the eyes of potential foreign skilled laborers and assume that Norway is as competitive as other countries in attracting foreign skilled laborers.

The hiring process in the unskilled labor force submodel is similar to the skilled labor force. The major differences are the hiring adjustment time. The domestic hiring adjustment time is 6 months and 1 year for foreign unskilled labor hiring.

3.3.3 University Enrollments

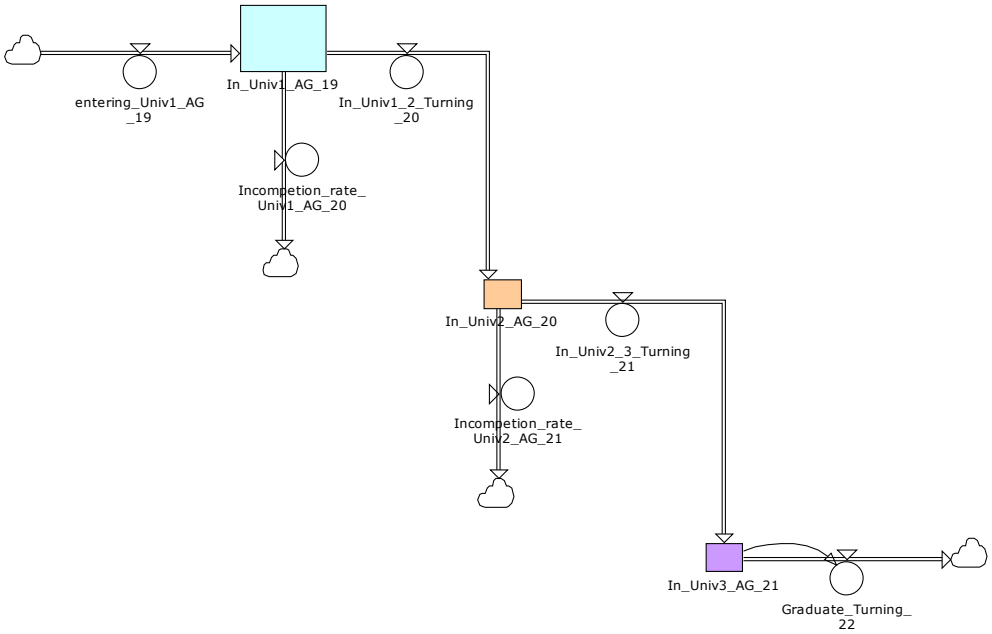


Figure 3-22 SFD-University Enrollments for Age Group 19 to 21

In the university enrollments submodel, the University stock symbolizes the tertiary education (*Figure 3-22*). The outflows consist of graduation rate and incompletion rate. The classification of the Norwegian tertiary education system was complicated. Some available data defines tertiary education in Norway by duration of education, for example tertiary education from 2 to less than 4 years is considered as lower university education while more than 4 years is considered as higher education. Thus, in our model we consider the duration of tertiary education as 3 years uniformly. However, after the implementation of Quality Reform of Higher Education 2003, Norwegian tertiary education has been restructured according to the Bologna's standard; most undergraduate program durations were standardized to 3 years.

3.3.4 Wages

From the neo-classical economic perspective, wages is expected to reflect labor productivity growth[16]. The increase in labor productivity leads to higher output. In Cobb-

[16] See Sharpe, Arsenault, & Harrison (2008) for the relationship of labor productivity, real wage growth, and labor share.

Douglas production function equation (***Equation 1***), output is a function of technology, capital, and labor input.

$$y = AK^{\alpha}L^{1-\alpha} \qquad \textbf{(1)}$$

y = real output
A - technology
K – capital
L – labor
1-α – share of output going to labor (labor share)
α - share of output going to capital

A, technological change is assumed to be exogenous. It can be influenced by the decreasing barrier to international competition and rapid technological revolution. Increasing capital (*K*) and labor (*L*) in equal proportion will increase an equivalent proportion in production. So, output will increase.

In **Equation (*1*)**, all the factors are characterized to have complimentary relationship. In order to achieve higher output, one of the factors on the right side of the equation has to increase if others are constant. But, if one of these factors declines, the other factors have to be increased marginally to keep the real output constant.

In this section, the relationship between capital and labor input is particularly important to illustrate wage development in Norway. Labor share (1-α) represents the total national wages as a proportion of real GDP. ***Equation (2)*** presents this relationship. The relationship between wages and labor share can be further illustrated through ***Equation (3)***. The increase of labor share comes from the higher increase in real wage than increase in labor productivity; the decrease of labor share comes from the higher increase in labor productivity than real wage.

Labor share = total real national wages / real GDP (2)

Labor share = real wage / labor productivity (3)

Guscina's (2006) study of the movement in labor share and confirmed that after 1985, the beginning of globalization and rapid-technological progress era in OECD countries, the

capital-rich or industrialized countries tend to specialize in production of capital-intensive goods where less human input was needed. This development led to the decreasing of labor share in national income. The regression result in her study presented that after 1985, the technological progress is capital-augmenting. This means that the technological progress tends to boost capital's return and share rather than returns to labor compensation. In a word, the increase of labor productivity will increase real wage for labor, but it will reduce the demand for labor. Therefore, fewer laborers are needed. This will lead to a decrease in Total Real National Wages (**Equation 2**). This is a significant contrast to the era prior to 1985 where labor productivity tended to compliment labor input and boost labor share through higher real wage growth. In the post-globalization era, one percentage point increase in labor productivity of the total economy, leads to a decline in labor share by 0.13 – 0.19 percentage point (Guscina, 2006).

Figure 3-23 below shows the development of labor share[17] in Norway over time.

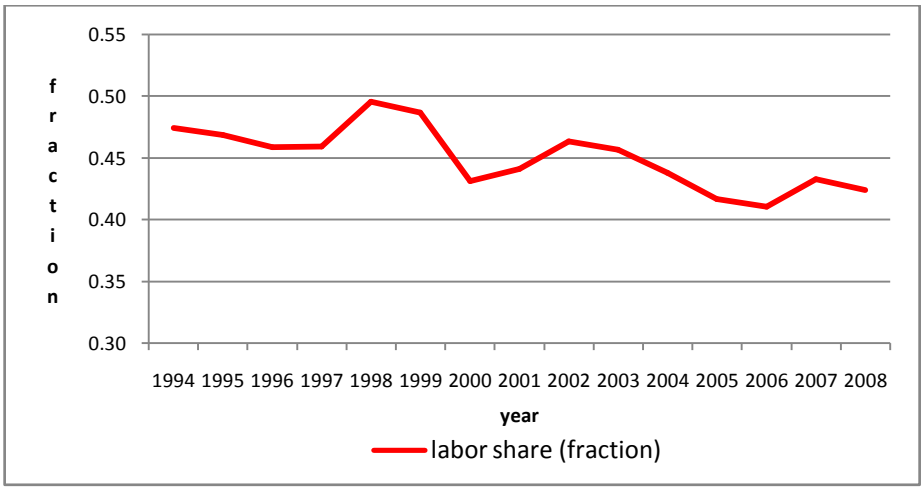


Figure 3-23 Labor Share Trend in Norway, 1994 – 2009
Source: Statistics Norway

[17] In Norway, labor compensation in the national account is defined by salary and wages plus employer's social contribution. Social contributions incurred by employers, paid to central government and to autonomous social security and pension funds as well as non-autonomous pension funds. They include the following sub-items: employers' contributions to National Insurance, employers' other actual social contributions (contributions to the Public Service Pension Fund, Municipal Pension Funds, other social security schemes, and other social contributions), and in addition, employers' imputed social contributions. The latter item coincides with social benefits actually paid through unfunded arrangements - from employers to present or former employees, for instance AFP-pensions. See Statistics Norway (http://www.ssb.no)

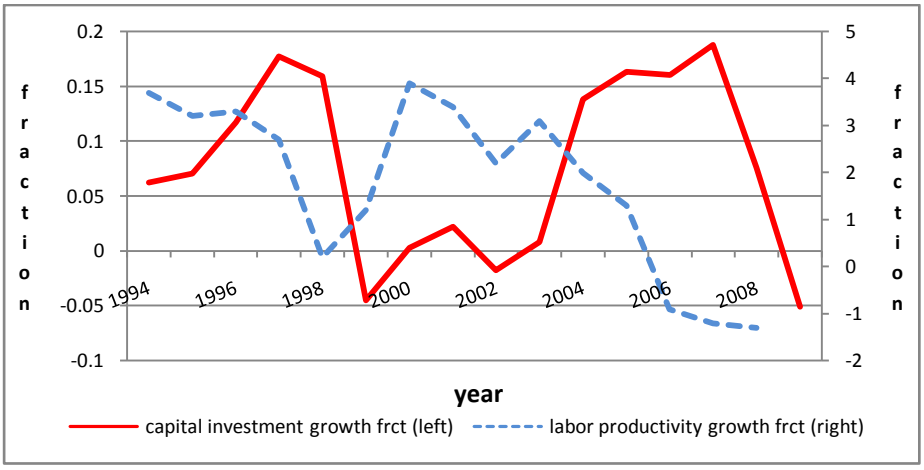


Figure 3-24 Development of Capital Investment Growth and Labor Productivity Growth Fraction, 1994 – 2009
Source: Statistics Norway

Labor share in Norway has been decreasing gradually since 1994 while the share of capital returns to total national income has been increasing. It is shown that the growth fraction of capital investment was relatively high in 1990s and mid-2000. Labor productivity growth replicated the growth of capital investment with delays (*Figure 3-24)*.

Capital investment is the primary factor that determines labor productivity in developed country like Norway where labor is scarce. As labor productivity is boost up, GDP expands and wages increases. Norway real wage grew at around 3% per year from 1988 to 2007; labor productivity growth was 2.5% annually from 1988 to 2007 (Norges Bank, 2009).

Figure 3-25 presents the development of real annual wages for the tertiary educated and non-tertiary educated from 1993 to 2008. In 1993, the tertiary educated annual wages was slightly above NOK300,000 whereas the annual wage for non-tertiary educated was about NOK120,000. After 15 years, the real annual wages for tertiary educated and non-tertiary educated reached NOK500,000 and NOK350,000 respectively. From the graph, it seems that these two trends are emerging.

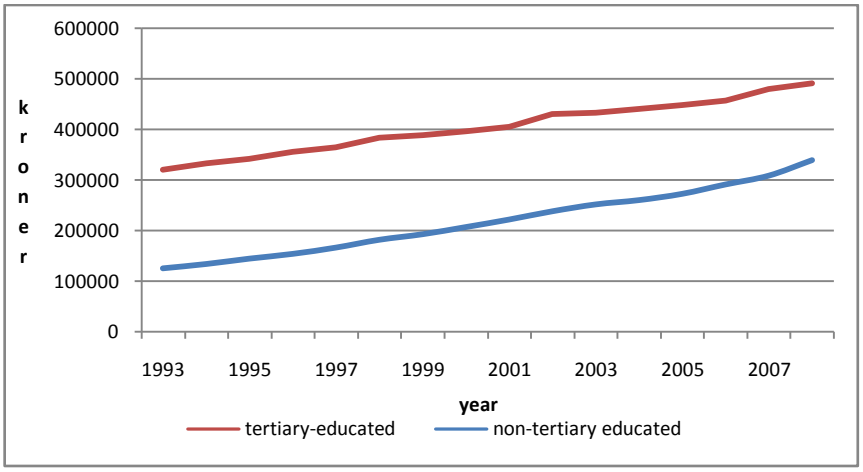


Figure 3-25 Development of Individual Real Wage for Tertiary Educated and Non-tertiary Educated Laborers, 1993 – 2008
Source: Statistics Norway

Figure 3-26 describes the factors that influence wages for the skilled and unskilled. The ratio of wages for skilled and unskilled laborers is termed as wage premium, which is the relative earnings of the skilled laborers to the unskilled. Perceived Wage Premium is the ratio of wages of skilled and unskilled laborers. The Perceived Wage of Skilled and the Unskilled are a delayed perception of the wages. It takes time for individuals to gather information and update their perception. Then, they form a mental perception of how the wages for skilled relates to the unskilled. If the ratio is more than one, it means the Perceived Wage of Skilled is higher than the unskilled, or vice versa. By and large, wage growth is the consequence of the growth in labor productivity and labor share. In our model, labor share is treated as an exogenous input. However, efficiency wage model explains that higher wages are offered by firms as the economy is approaching to full employment (Brigden & Thomas, 2003). The efficiency wage model is based on the assumption that higher wages attracts more qualified laborers and increase workforce quality and eventually leads to higher productivity. Therefore, in our model, unemployment rate has impact on individuals' wages.

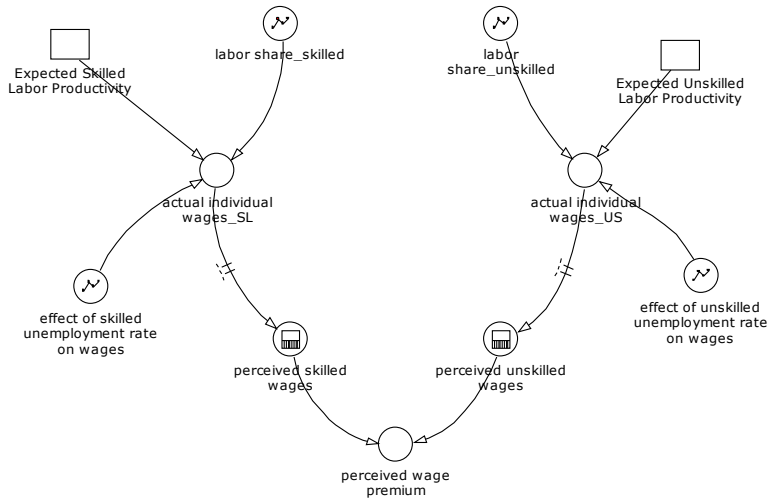


Figure 3-26 SFD- Factors Influencing Wages and Perceived Wage Premium

Referring to the trends of skilled and unskilled wages in *Figure 3-25*, the growth of real wage for tertiary and non-tertiary educated labor is mainly the effect of rising labor productivity and tight labor market from 1994 to 2008.

When take a closer look, the relative earnings by education attainment have been decreasing since 1997. *Figure 3-27* compares the relative earnings of tertiary educated to the upper secondary educated in Norway, the United States, and German from 1997 to 2007. The relative earnings of tertiary educated in the United States had been much higher than Norway and Germany until 2006. The relative earnings in the United States did not grow much from 1997 to 2007. But the trend in Germany was increasing rapidly. It increased about 30% in 10 years. However, the relative earnings by education attainment in Norway present a decreasing trend, implies an almost 20% drop in 10 years.

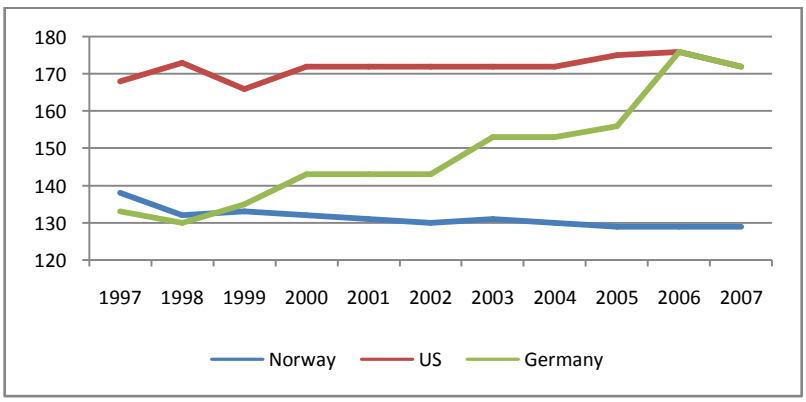


Figure 3-27 Trends in Relative Earnings by Education Attainment in Norway, US, and Germany
Source: OECD Education at a Glance (2009)

4.0 Analysis

Model testing is part of our validation to uncover flaws in the model. As Barlas (1994) expressed it as a "confidence-building process". He further explained that "validity" in system dynamics represents the validity of the *internal structure* of the model, not only the output behavior. Through structural assessment, once the model is confirmed to have "the right behavior for the right reasons", then both the modeler and stakeholders will build up confidence toward the model. In this sense, "Models are not true or false, but lie on a continuum of usefulness" (Barlas & Carpenter, 1990). System dynamic models are causal model (Qudrat-Ullah & Seong, 2009). The purpose of system dynamic modeling is to identify the structure and decision rules that generate the behavior of a system. Therefore, the structural validity testing is the first crucial step in validation process before proceeding to behavior validity testing.

We follow Yaman Barlas validation process in this section. The validation testing is carried out in two levels: structural validation and behavior validation. The following table summarizes our validation tests.

Test No	Test Name	Purpose	Result Location
(A) Structural Validation Testing			
A1	**Parameter Verification Test**	Evaluate constant parameters against knowledge of the real system conceptually and numerically.	Appendix **A**
A2	**Structure Verification Test**	Compare the structure of model against the structure of the real system.	Appendix **A**
A3	**Local Extreme Condition Test**	Evaluate model equations under extreme condition and assess the plausibility of the local results against the real system.	Appendix **A**
A4	**Dimensional Consistency Test**	Analyze model equations to eliminate parameters that have no meaning in real life.	Appendix **C**
A5	**Extreme Condition Test**	This is different that the local extreme condition test. This test is to assign extreme values to selected parameters and compare the global simulated behavior to the real system. To determine if the simulated behavior replicated the real system if extreme condition also takes	Appendix **A**

		place in real system.	
A6	**Parameter Sensitivity Test**	Determine the sensitivity of selected parameter to the model, especially the parameters with uncertain values.	Section **4.5** Appendix **A**
(B) Behavior Pattern Testing			
B1	**Integration Error Test**	Evaluate if the integration method or timestep is correctly chosen for the model.	Appendix **A**
B2	**Behavior Reproduction Test**	Uncover flaws in the structure or parameters of the model and assess whether the flaws conflict with the purpose of the model.	Section **4.7**
B3	**Behavior Sensitivity Test**	Determine the sensitivity of the change of assumption to the model behavior.	Section **4.8**

Figure 4-1 Overview of Validation Tests

The model is initialized in the equilibrium state before any testing is performed. Results are presented in Appendix **A**.

4.1 Parameter Verification Test (A1) & Structure Verification Test (A2)

The exogenous parameters in our model are divided into two categories: statistical data and estimated value. The parameters with estimated value are highly uncertain. Thus we will test the sensitivity of these parameters in section 4.5 for parameter sensitivity. For the statistical parameters, we compare the simulated behavior with relevant historical behavior. Results are presented in Appendix **A**.

We conclude that the behavior of the model is not sensitive to parameter value changes and the tested behaviors replicated real system behaviors.

4.2 Local Extreme Condition Test (A3)

In this test, we assess the behavior of the following stocks in the model under extreme condition. This is a local test because we examine the direct corresponding loops to the stocks. Results are presented in Appendix **A**.

The following loops are tested to examine the behaviors for the corresponding stocks:

Loop Number & Name	*Corresponding Stock Behavior*
Reinforcing Loop	
R1 (Aggregate Demand and Skilled Input Loop)	Reference Skilled Labor Fraction
Counteracting Loop	
C1,C2,C3,C13 – C15 (Motivation to University Loops)	Domestic Skilled Labor Force Total Skilled Labor Force
C7 (Foreign Skilled Labor Loop)	Foreign Skilled Labor Force
C8 (Foreign Unskilled Labor Loop)	Foreign Unskilled Labor Force

Figure 4-2 Overview of Local Extreme Condition Tests

We conclude that the tested local behavior presented the expected trend under different extreme condition tests.

4.3 Dimensional Consistency Test (A4)

Formulas and units are assessed and presented in Appendix **C**.

4.4 Extreme Condition Test (A5)

In this test, we intend to examine the effect of extreme condition on skilled labor supply at the global level. So, we set extreme values to some parameters to determine if our model is robust enough to take on extreme values. The following parameters are tested. Simulated results are presented in Appendix **A**.

(1) Reduce the inflow to tertiary education and unskilled labor force by reducing age group 18 to zero from year 2020
(2) Average aggregate demand growth fraction becomes -3.3% from 2020 to 2030
(3) Domestic Skilled Labor hiring rate becomes 100 years
(4) Foreign Skilled Labor hiring rate becomes 100 years
(5) Domestic Unskilled Labor hiring rate becomes 10 years
(6) Foreign Unskilled Labor hiring rate becomes 100 years

We conclude that the tested global behavior presented the expected trend under different extreme condition tests.

4.5 Parameter Sensitivity Test (A6)

The table below presents exogenous parameters with uncertain value. We test the sensitivity of these values to the model by assigning values two times greater or smaller to these parameters. After that, we use correlation coefficient[18] and mean absolute percent error [19](MAPE) to determine the correlation of the relevant behavior in the base run to the tested behavior. Tested results are presented in Appendix **A**.

Parameter	Estimated Value
Incompletion fract_Univ1_19 to 24	GRAPH(TIME,1994<<@year>>,10<<year>>,{0.36,0.37,0.32, 0.28})
Incompletion_fract_Univ2 _19 to 24	GRAPH(TIME,1994<<@year>>,10<<year>>,{0.28,0.26,0.22, 0.16})
Incompletion_fract_Univ1 _25 to 29	GRAPH(TIME,1994<<@year>>,10<<year>>,{0.35,0.35,0.3,0. 28})
Incompletion_fract_Univ2 _25 to 29	GRAPH(TIME,1994<<@year>>,10<<year>>,{0.28,0.26,0.21, 0.16 })
hiring_SL _AT	0.6 year
hiring_USL _AT	0.5 year
frct of _F_SL leaving	0.01 per year
frct of _F_USL leaving	0.05 per year
distr_starting wage	3
distr_foregone earnings	4
distr_foregone earnings	1
distr_ease of finding job	2

Figure 4-3 List of Tested Parameters

[18] Correlation(r) = NΣXY - (ΣX)(ΣY) / Sqrt([NΣX^2 - (ΣX)^2][NΣY^2 - (ΣY)^2])

[19] MAPE= $1/n \sum_{k=1}^{n} |(X - Y)|/Y * 100$

From the parameter sensitivity tests, we discovered that only the MAPE with the following parameters are higher than 10%. The rest of the tests do not alter the behavior modes of Domestic Skilled LF and Total Skilled LF.

Parameter	Domestic Skilled LF	Total Skilled LF
	Mean Absolute Percent Error	Mean Absolute Percent Error
Incompletion fract_Univ1_19 to 24 = 0.14	8.16%	1.97%
Incompletion fract_Univ1_19 to 24 = 0.72	20.52%	4.77%

Table 4-4(a) Parameter Sensitivity Test on Incompletion frct_Univ1_19 to 24

In the base run, the values for the parameters are between 0.28 and 0.36. As shown in *Table 4-3(a)*, when the incompletion fraction of tertiary students from 19 to 24 years old is lowered to 0.14, meaning only 14% of the students leave tertiary education before they completion, the domestic skilled labor force presents a 8.16% deviation from the absolute mean of the base run. On the contrary, when the fraction is raised two times higher than in the base run, which is to 0.72, the domestic skilled labor force is sensitive to this change. But the Total Skilled Labor Force is not as sensitive. The deviations from the absolute mean in the base run are 20.52% and 4.77%. This test reveals that if Incompletion fract_Univ1_19 to 24 falls in the range of 0.14 to 0.72, the fitness of the data to the base run for Domestic Skilled LF will be in the range of 8.16% to 20.52% and Total Skilled LF will be in the range of 1.97% to 4.77%. The alteration of Incompletion fract_Univ1_19 to 24 in the test does not change the behavior mode of Domestic Skilled LF and Total Skilled LF.

Parameter	Domestic Skilled LF	Total Skilled LF
	Mean Absolute Percent Error	Mean Absolute Percent Error
Incompletion_fract_Univ2_19 to 24 = 0.08	6.47%	1.41%
Incompletion_fract_Univ2_19 to 24 = 0.56	16.77%	3.59%

Table 4-4(b) Parameter Sensitivity Test on Incompletion frct_Univ2_19 to 24

We test the sensitivity of Incompletion_fract_Univ2_19 to 2 with the value of 0.08 and 0.56. As shown in *Table 4-3(b)*, with 0.08, the MAPE for Domestic Skilled LF and Total Skilled LF are below 10%, whereas when the fraction is increased to 0.56, meaning 56% of the students leave without completion, the absolute mean deviation of the tested behaviors from the base run lead to 16.77% and 3.59%. This represents that with the values between 0.08 and 0.56, the absolute mean error will be 6.47% to 16.77% and 1.41% to 3.59% for Domestic Skilled LF and Total Skilled LF respectively. In the base run, the values are between 0.16 and 0.28.The alteration of Incompletion fract_Univ2_19 to 24 in the test does not change the behavior mode of Domestic Skilled LF and Total Skilled LF.

Parameter	Domestic Skilled LF	Total Skilled LF
	Mean Absolute Percent Error	Mean Absolute Percent Error
Incompletion_fract_Univ1_25 to 29 = 0.14	3.4%	10.9%
Incompletion_fract_Univ1_25 to 29 = 0.7	8.5%	10.9%

Table 4-4(c) Parameter Sensitivity Test on Incompletion frct_Univ1_25 to 29

In this test, we use fraction 0.14 and 0.7. The results show that the MAPE of the tested behavior to Total Skilled LF is slightly higher than 10%. So, if the fractions of tertiary students in age group 25 to 29 leave the education before completion falls in the range of 0.14 to 0.7, the confidence level is about 90%. In the base run, the values are between 0.28 and 0.34. The parameter is insensitive to the model and the parametric alteration does not change the behavior mode of Domestic Skilled LF and Total Skilled LF.

Parameter	Domestic Skilled LF	Total Skilled LF
	Mean Absolute Percent Error	Mean Absolute Percent Error
Incompletion_fract_Univ2_25 to 29 = 0.08	2.7%	11.1%
Incompletion_fract_Univ2_25 to 29 = 0.56	6.3%	12.1%

Table 4-4(d) Parameter Sensitivity Test on Incompletion frct_Univ2_25 to 29

Lastly, the Incompletion_fract_Univ2_25 to 29 is tested with the values of 0.08 and 0.56. The MAPE to Domestic Skilled LF is considered as insignificant, only 2.7% and 6.3%; the MAPE to Total Skilled LF are 11.1% and 12.1%. This means that if the value for this parameter falls in the range of 0.08 to 0.56, the confidence level is about 90%. In the base run, the values are between 0.16 and 0.28. The parameter is insensitive to the model behavior, especially Domestic Skilled LF, but more sensitive to Total Skilled LF. The parametric alteration does not change the behavior modes of Domestic Skilled LF and Total Skilled LF.

In conclusion, the model passes the parameter sensitivity test. Most of the tested parameters are insensitive to the model behavior; the changes of these parameters do not change the behavior mode of the model.

4.6 Integration Error Test (B1)

The timestep for the base run is set to 0.03125 with Euler first order fixed step integration method. We reduced the timestep to 0.00390625 to examine integration error. The results are presented in Appendix **A**.

We conclude that the model is stable and generates the same behavior given different timesteps.

4.7 Behavior Reproduction Test (B2)

The model starts at year 1994 until 2009 to determine the fitness of the simulated behavior to the reference mode. There are two reference modes: skilled labor supply and skilled labor demand. The model is able to reproduce a behavior similar to the reference mode—linear increment (*Figure 4-4*). Through statistical significance testing, mean absolute percent error (MAPE) is used to determine the fitness of the simulated behavior to the reference mode, we obtain the MAPE for Total Skilled LF is 4.21% and 3.53% for Indicated Total Skilled Labors Needed (*Figure 4-5*). As the percentage error is less than 5%, the confidence level of the simulated behavior to the reference mode is more than 95%. The model has passed the behavior reproduction test.

Reference Mode (1): Skilled Labor Supply

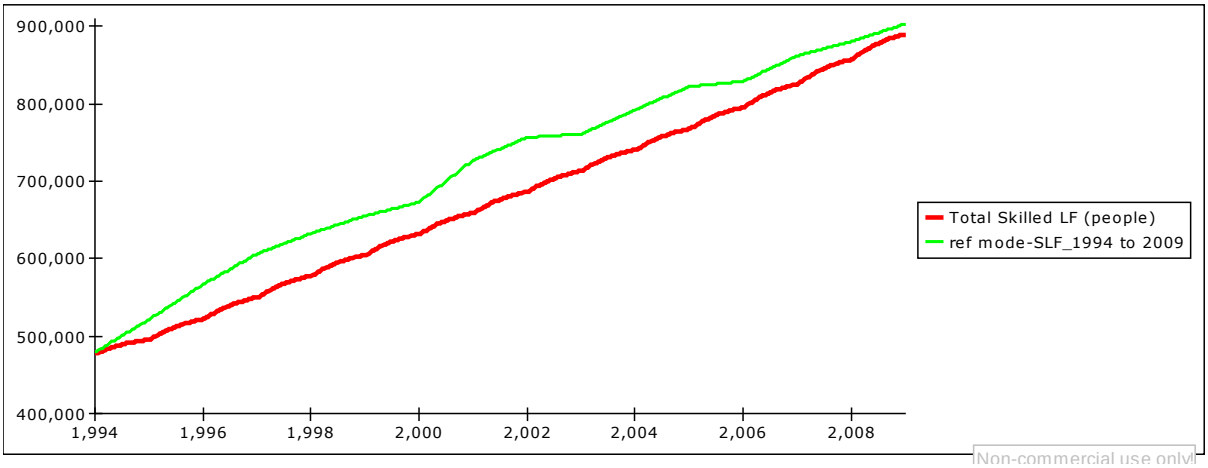


Figure 4-5 Behavior Reproduction Test-Simulated Behavior of Total Skilled LF and Estimate of Skilled Labor Force (Reference Mode)

As shown in *Figure 4-5*, the simulated behavior of Total Skilled LF matches the increasing trend of the estimated historical trend, Ref Mode-SLF_1994 to 2009. However, the simulated behavior of Total Skilled LF is somewhat lower than the reference behavior. To formulate the reference mode, we take the historical data of the working age population with tertiary education attainment. After that, we determined the labor force participation rate from for the skilled workers from 1994 to 2009 from OECD reports. With these three inputs, we produced the reference mode from 1994 to 2009. The reference mode does not differentiate the tertiary education attainment and labor force participation rate in different age groups; whereas in our model, dynamic changes are captured in different age groups by

breaking down inflows and outflows for different age groups. Therefore, the error margin can be reduced.

Reference Mode (2): Skilled Labor Demand

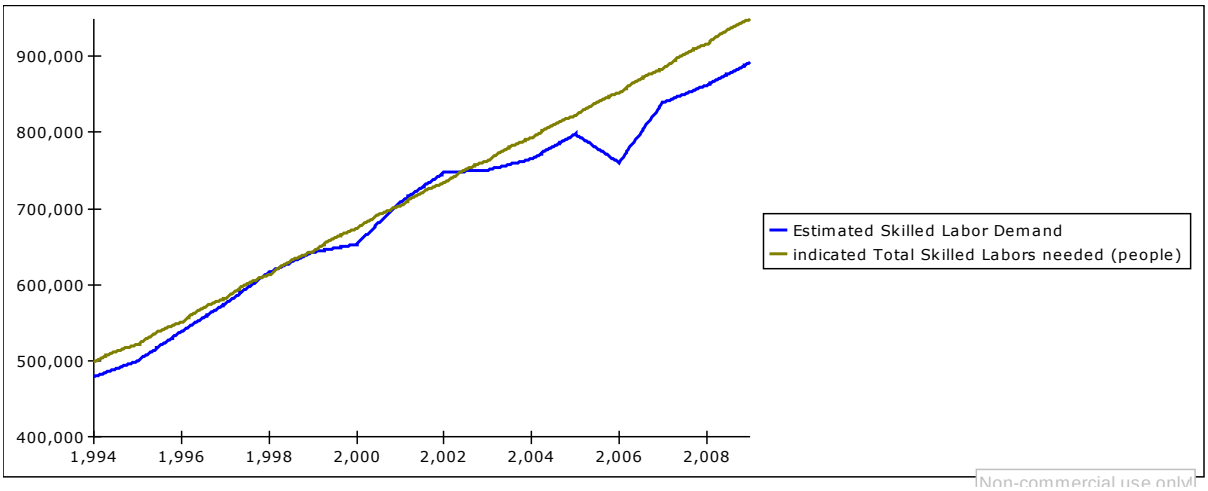


Figure 4-6 Behavior Reproduction Test-Simulated Behavior of Indicated Total Skilled Laborers Needed and Estimate of Desired Skilled Labor Demand (Reference Mode)

As shown in *Figure 4-6*, the simulated behavior of skilled labor demand (Indicated Total Skilled Laborers Needed) replicates the linear increasing trend presented in the reference mode (ref mode-Skilled Labor Demand). However, the simulated skilled labor demand is higher than the reference skilled labor demand throughout the simulation. In the reference mode, the reference behavior does not incorporate any feedback from macroeconomic development such as the effect of skilled labor force growth on the development of AD that requires skilled labor input; whereas in the simulated behavior, the model contains this causal relationship. The more rapid the growth in the skilled labor force leads to more rapid growth in the fraction of AD that requires skilled labor input. In a highly aggregate level, skilled labor supply and skilled labor demand form a reinforcing relationship; supply boosts demand and the higher demand will lead to higher supply eventually. Nevertheless, this reinforcing relationship is not captured by the extrapolated trends of skilled labor supply and demand in the reference mode.

As we have been able to reproduce the historical behavior, we will present our base run (*Figure 4-3*).

4.7.1 Base Run

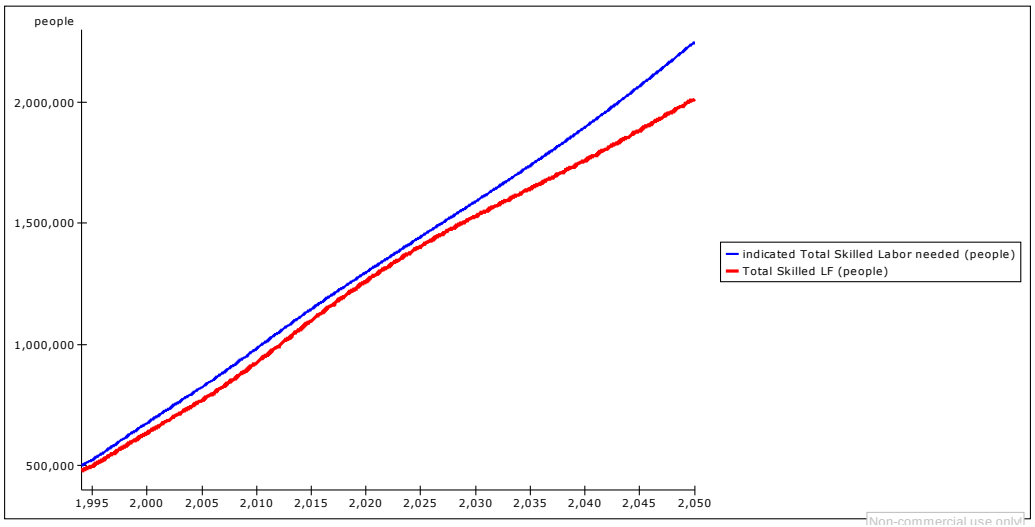


Figure 4-7 Base Run – Total Skilled Labor Force (Supply) and Indicated Skilled Labor Needed (demand)

In the base run, Total Skilled LF and Indicated Total Skilled Laborers Needed increase linearly from 1994 to 2050 (*Figure 4-7*). Total Skilled LF is made up by Domestic Skilled LF and Foreign Skilled LF. Indicated Total Skilled Labor Needed serves as the demand for skilled laborers. The relationship between Domestic Skilled LF, Total Skilled LF, and Indicated Total Skilled Labor Needed is illustrated in skilled job density loop (C2, *Figure 3-4*) and foreign skilled labor loop (C7, *Figure 3-4*). Indicated Skilled Laborers Needed and Total Skilled LF determine SL Gap. This gap is filled by employing more skilled laborers from the Unemployed Domestic Skilled Labor stock. If the total labor force in the country is insufficient to fill the gap, then the need for foreign skilled laborers is created. In our model, we exclude the attractiveness of the country to the potential foreign laborers; we assume that Norway is as competitive as other countries when it comes to attracting skilled and unskilled laborers to work in the country.

However, not only that Total Skilled LF fails to fulfill the gap, the gap will be widening in the future. This is due to the increasing outflows from Domestic Skilled LF such as aging, early withdrawal from the labor force, and old age retirement, while the inflow of tertiary graduates and foreign skilled laborers to the labor force is insufficient to cover the

outflows and the growth of skilled job demand. In 1994, wage premium was 2.4 and gradually decreased until 1.5 in 2012. Skilled job density was decreasing from 1.04 to 1.01 between 1994 and 1996. After that, it increases until 1.03 in 2008. This means more skilled jobs were available. So, the perceived wage premium loop (C1 & C3, *Figure 3-7*) and the skilled job density loop (C2, *Figure 3-4*) were the dominating loops from 1994 to 2010. But the dominance is shifting to the expected lifetime earnings loop (C13 & C14, *Figure 3-9*) and foregone earnings loop after 2010. From 1994 to 2005, expected forgone earnings increased 15%. In the same period, expected lifetime earnings dropped 15% (C13 & C14) as perceived wage premium dropped. As a result, from 1994 to 2010, Motivation to University dropped sharply until from 1.3 to 1.05 in 2010.

To summarize, from 1994 to 2010, the dominance of C1 & C3, and C2 propelled the attractiveness of skilled job. Enrollment in tertiary education increased from 140,000 students in 1994 until 155,000 in 2005. It dropped slightly in mid 2000, but increased drastically to 160,000 in 2010. From 2010 to 2020, it is projected that enrollment in tertiary education among age group 19 to 29 will grow strong and linearly until 225,000 students by 2050. After these students graduated, they flood into skilled labor force and took up employment. As the supply of skilled labor increase, it increases the fraction of AD that requires skilled input too. Therefore, Indicated Skilled Laborers Needed continues to rise.

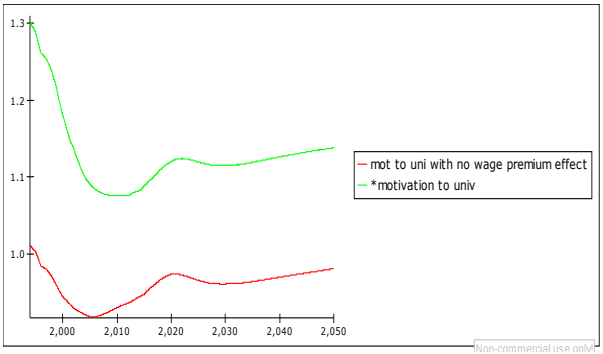
After 2010, Motivation to University starts to pick up and continues to rise until 1.13 in 2020 and almost remains stable until 2050. This is due to the weakening of the perceived wage premium loop. Even though skilled job density and expected lifetime earnings continue to rise and expected foregone earnings remains low, it is insufficient to compensate the weakening of the perceived wage premium loop. As a result, skilled labor shortage is reduced significantly from 2015 to 2020. After that, the gap between skilled labor supply and demand starts to widen until 2050.

4.8 Behavior Sensitivity Test (B3)

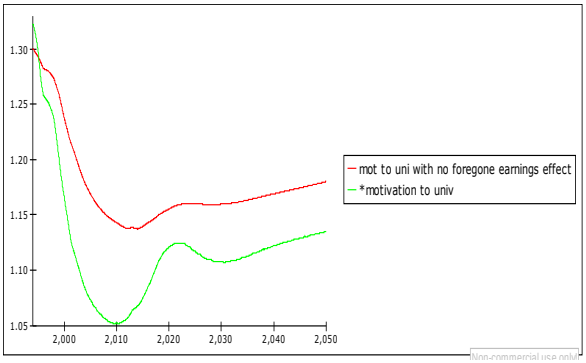
In the behavior sensitivity test, we will cut out some feedback loops to determine the influence of particular feedback loops on the model behavior. From this test, we determine which loops are responsible for the behavior in base run.

(1) Cutting Motivation to University Loops

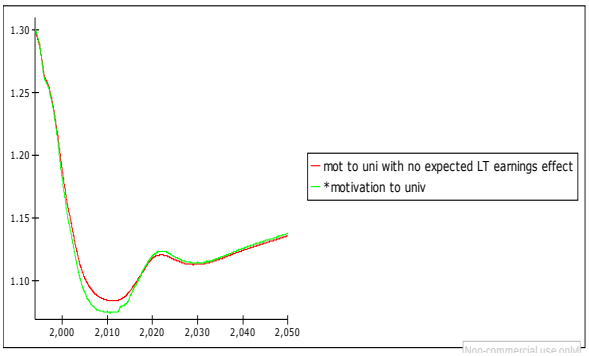
As we mentioned in Section 1.1, individuals rank the importance of starting wage, expected foregone earnings, expected lifetime earnings, and the ease of finding job when they make a decision to pursue tertiary education. These factors make up the Motivation to University. The weight distribution of these elements in the base case is: Perceived Wage Premium (0.3), Expected Foregone Earnings (0.4), Expected Lifetime Earnings (0.1), and Ease of Finding Job (0.2). The total is 1. Below is the comparison of the results on Motivation to University after eliminating the feedback loop one by one.



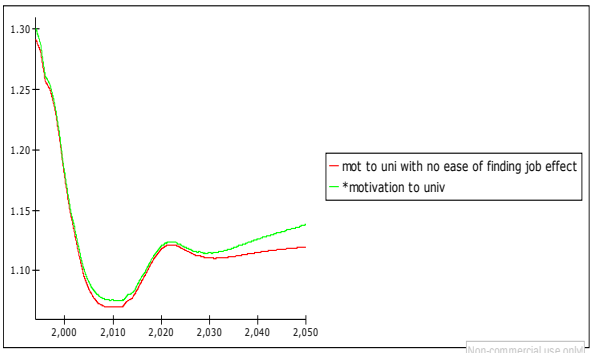
(a) No Perceived Wage Premium effect



(b) No Expected Foregone Earnings effect



(c) No Expected Lifetime Earnings effect



(d) No Ease of Finding Job effect

Figure 4-8 (a-d) Sensitivity of Motivation to University by cutting feedback loops one at a time

(a) No Perceived Wage Premium Effect

In this test, we cut C1 and C3 (*Figure 4-8a*). After cutting this loop, wage premium does not affect individuals' decision to pursue tertiary education. They only consider expected foregone earnings, expected lifetime earnings, and ease of finding job. Motivation to University reduced from 1.3 to 1.0 in 1994 and remains below 1.0 throughout the simulation. As fewer students entered tertiary education, Total Skilled LF decreases. Therefore skilled job density is escalated (C2); more jobs are awaiting skilled laborers to fill. More foreign skilled labors are being hired into the country to fill the job as shortage increased (*Figure 4-9-1* and *4-9-2*). This reduces skilled job density. Hence, Motivation to University remains stable until 2050.

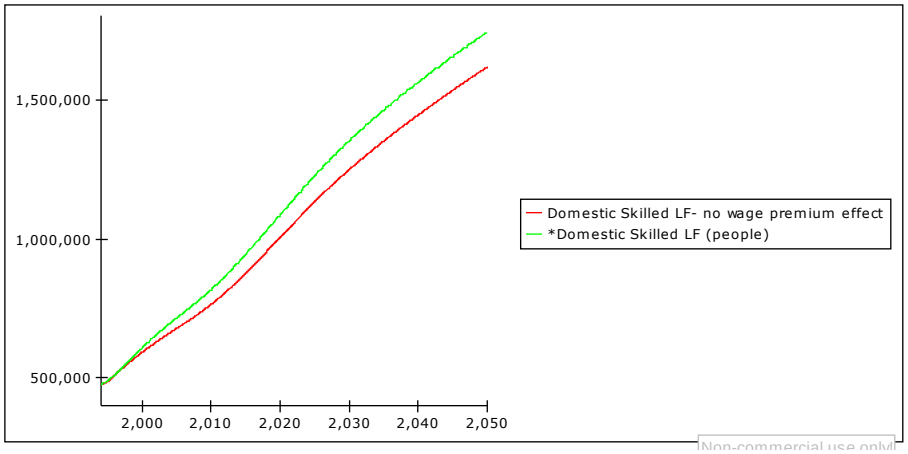


Figure 4-9-1 Domestic Skilled Labor force: No Perceived Wage Premium Effect on Motivation to University

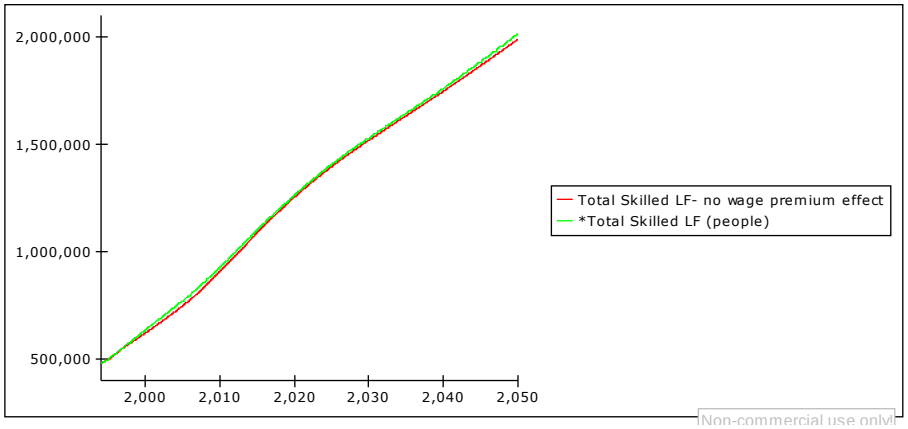


Figure 4-9-2 Foreign Skilled Labor force: No Perceived Wage Premium Effect on Motivation to University

It is shown from *Figure 4-9-3* below shows that the elimination of this loop does not stop the gap between Indicated total skilled laborers needed and total skilled labor force from widening.

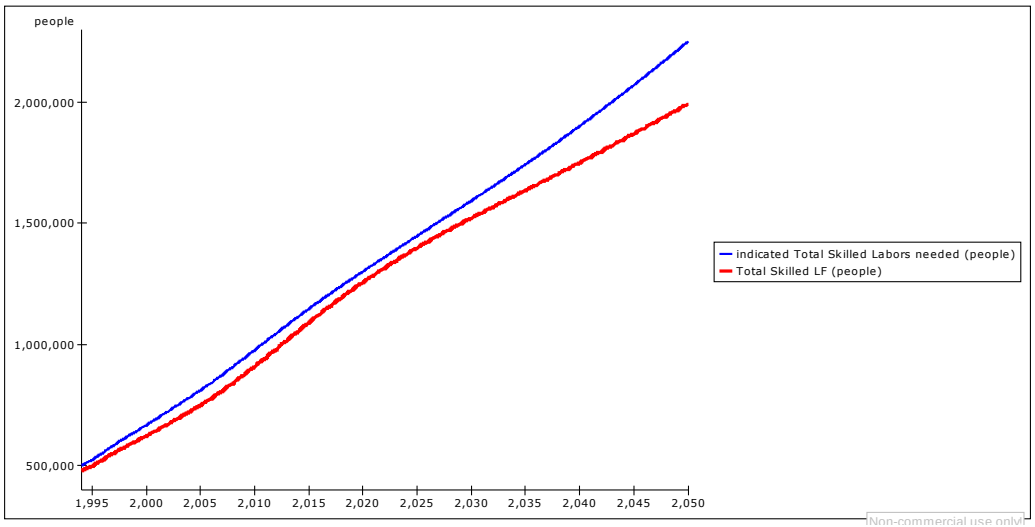


Figure 4-9-3 Indicated Total Skilled Labor Needed and Total Skilled Labor Force: No Perceived Wage Premium Effect on Motivation to University

(b) No Expected Foregone Earnings Effect

In this test, we cut C15. This loop is considered the most important factor among the four factors that contribute to Motivation to University. After this loop is cut, only perceived wage premium, expected lifetime earnings, and ease of finding jobs will affect individuals' decision to tertiary education. The result shows that Motivation to University is almost 10% to 15% higher than the base run (*Figure 4-8(b)*). Student enrollments rose from 140,000 to 165,000, followed by a reduction from 2000 to 2004. After that, it increases to about 225,000 in 2050.Thus, *Figure 4-10-1* shows that the number of domestic skilled labor is higher than in the base run. Since the number is not considerably large, the impact on the total skilled labor force is not significant too (*Figure 4-10-2*).

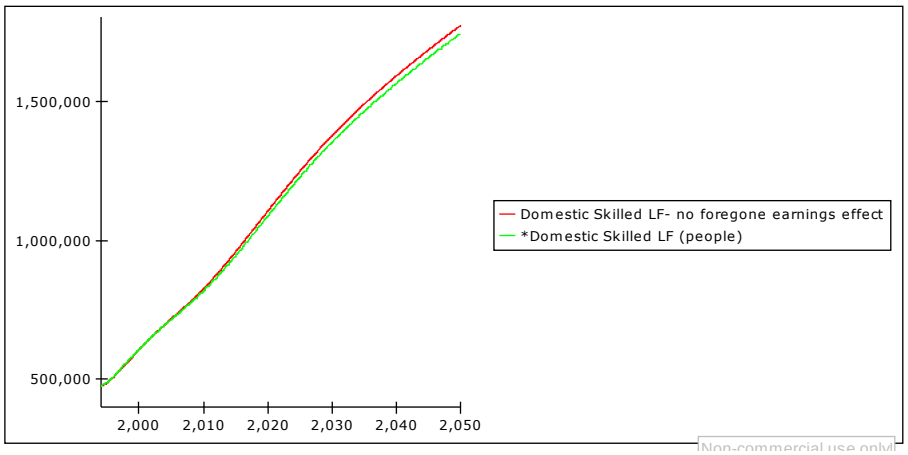


Figure 4-5-1 Domestic Skilled Labor force: No Foregone Earnings Effect on Motivation to University

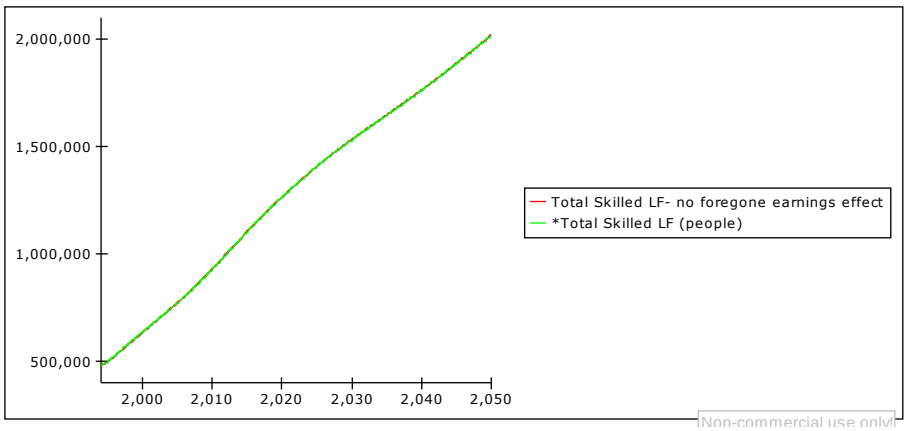


Figure 4-5-2 Total Skilled Labor force: No Foregone Earnings Effect on Motivation to University

It is shown from *Figure 4-5-3* that the elimination of this loop does not stop the gap between Indicated total skilled laborers needed and total skilled labor force from widening. Though, the gap is drawn closer between 2015 and 2025.

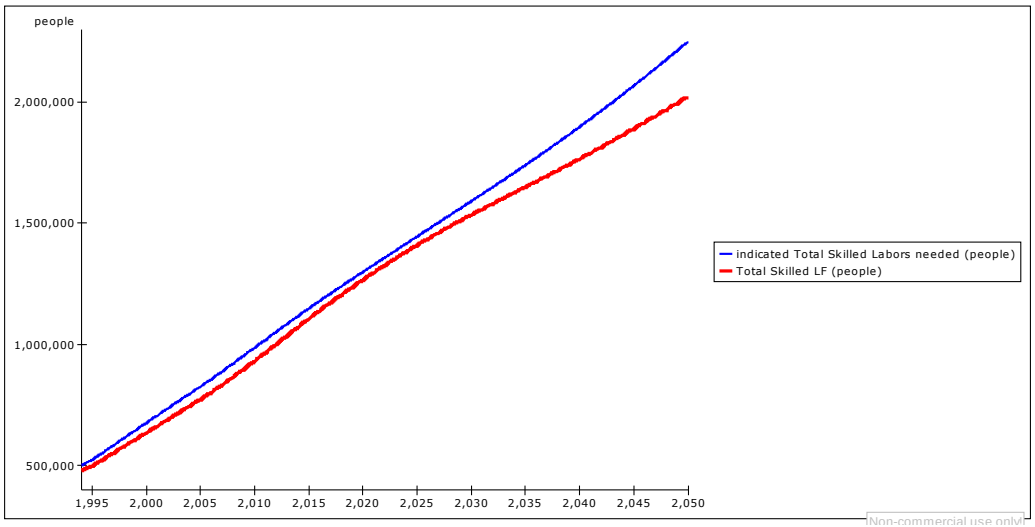


Figure 4-10-3 Indicated Total Skilled Labor Needed and Total Skilled Labor Force: No Expected Foregone Earnings Effect on Motivation to University

(c) No Expected Lifetime Earnings Effect

The C13 and C14 loop are cut. In this test, individuals only consider wage premium, expected foregone earnings, and ease of finding jobs. When perceived wage premium is high, the expected earnings over a lifetime are high (C14). However, the falling wage premium reduces individuals' expected lifetime earnings. Therefore, once this loop is cut, Motivation to University increases slightly from 2000 to 2012 compared to base run (*Figure 4-8(c)*). There are no significant effects on the Domestic Skilled LF and Total Skilled LF stocks (*Figure 4-11-1 and 4-11-2*).

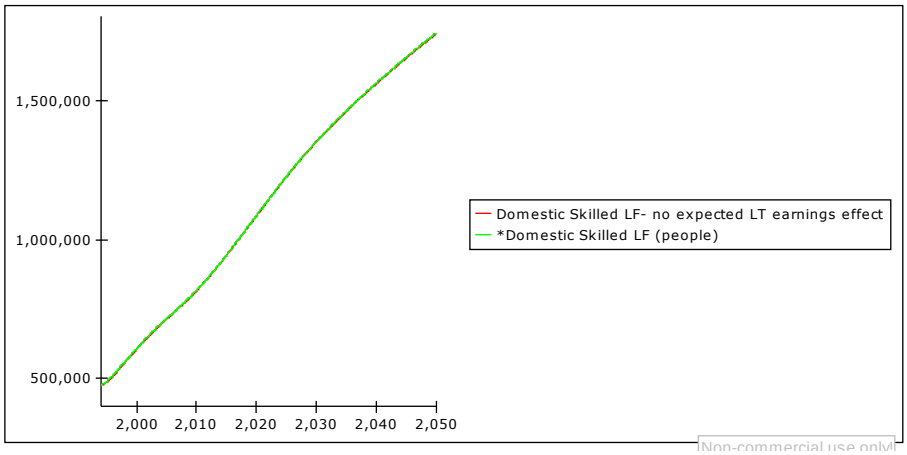


Figure 4-11-1 Domestic Skilled Labor force: No Expected Lifetime Earnings Effect on Motivation to University

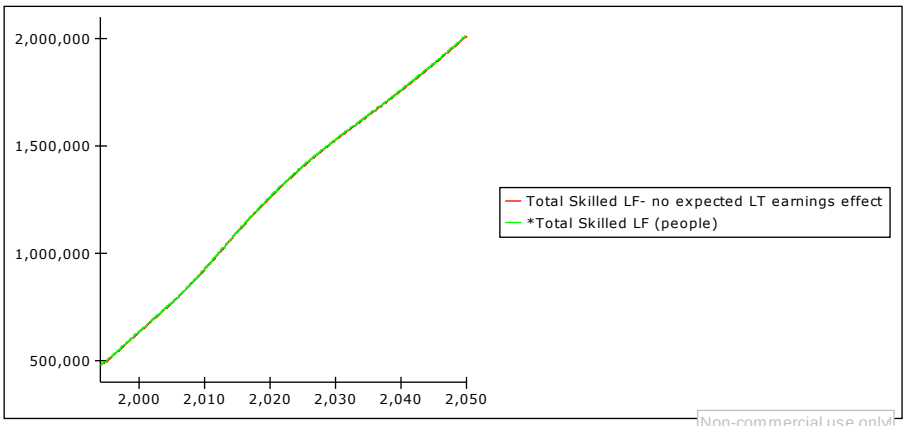


Figure 4-11-2 Total Skilled Labor force: No Expected Lifetime Earnings Effect on Motivation to University

It is shown from *Figure 4-11-3* that the elimination of this loop does not stop the gap between Indicated total skilled laborers needed and total skilled labor force from widening.

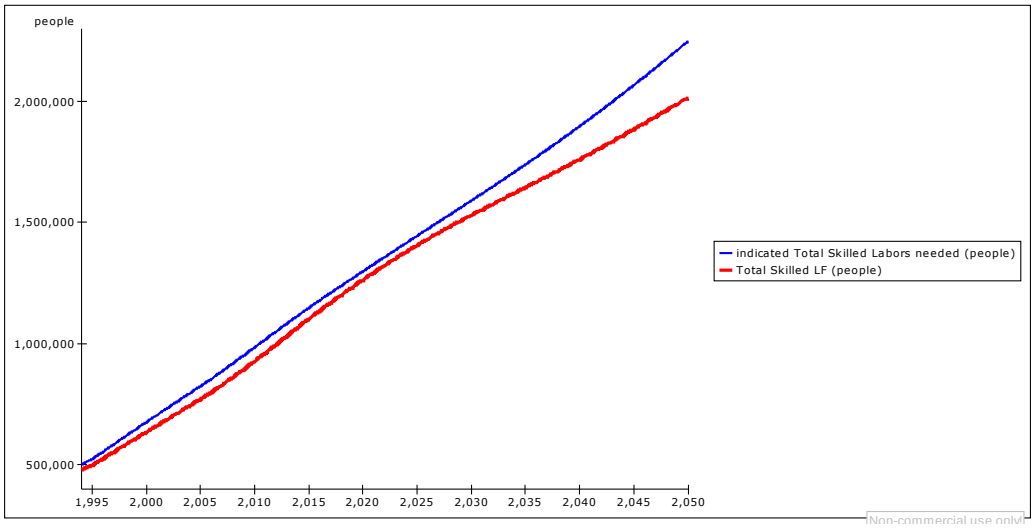


Figure 4-11-3 Indicated Total Skilled Labor Needed and Total Skilled Labor Force: No Expected Lifetime Earnings Effect on Motivation to University

(d) No effect of Ease of Finding Job

In this test, we eliminated C2. By cutting this loop, the job availability does not matter to the potential students' decisions to tertiary education; potential students only consider economic returns. From 1994 to 2002, Motivation to University was mainly determined by perceived wage premium. As perceived wage premium starts to fall from 2.40 to 1.5 from 1994 to 2010, so did Motivation to University (*Figure 4-8(d)*). After 2020, the ease of finding job takes over the dominance. The weakening of feedback loops of perceived wage premium and expected lifetime earnings in conjunction with the strengthening of

expected foregone earnings gradually provides less incentive for individuals to go to tertiary education from 1994 to 2010. As the domestic skilled labor force decreases, skilled job opportunity increases due to fewer tertiary graduates. In the base run, the Effect of Ease of Finding Job takes over the dominance and boost up Motivation to University from 2025. But in this test, without the effect from ease of finding job, Motivation to University remains stable from 2025 to 2050. There are no significant effects on the Domestic Skilled LF and Total Skilled LF stocks (*Figure 4-12-1 & 4-12-2*).

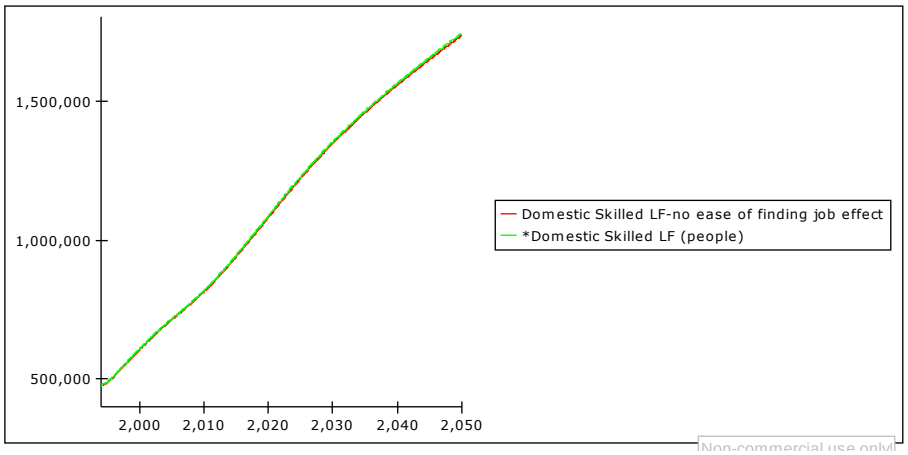


Figure 4-12-1 Domestic Skilled Labor force: No Ease of Finding Job Effect on Motivation to University

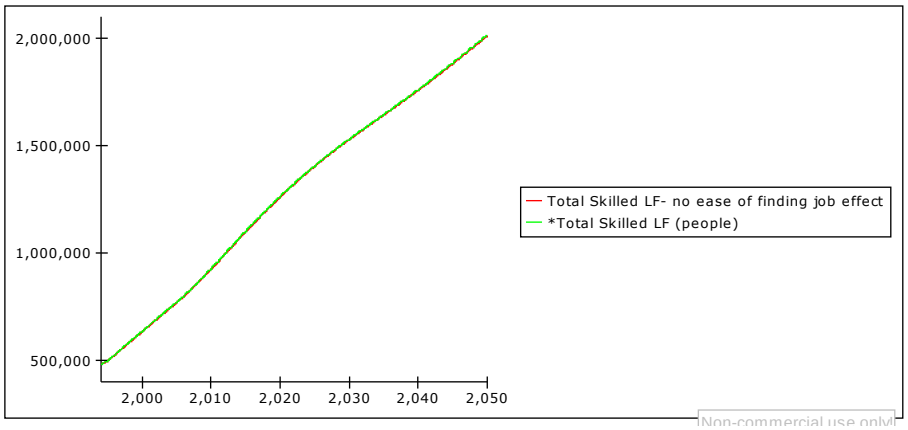


Figure 4-12-2 Total Skilled Labor force: No Ease of Finding Job Effect on Motivation to University

It is shown from *Figure 4-12-3* below that the elimination of this loop does not stop the gap between Indicated total skilled laborers needed and total skilled labor force from widening.

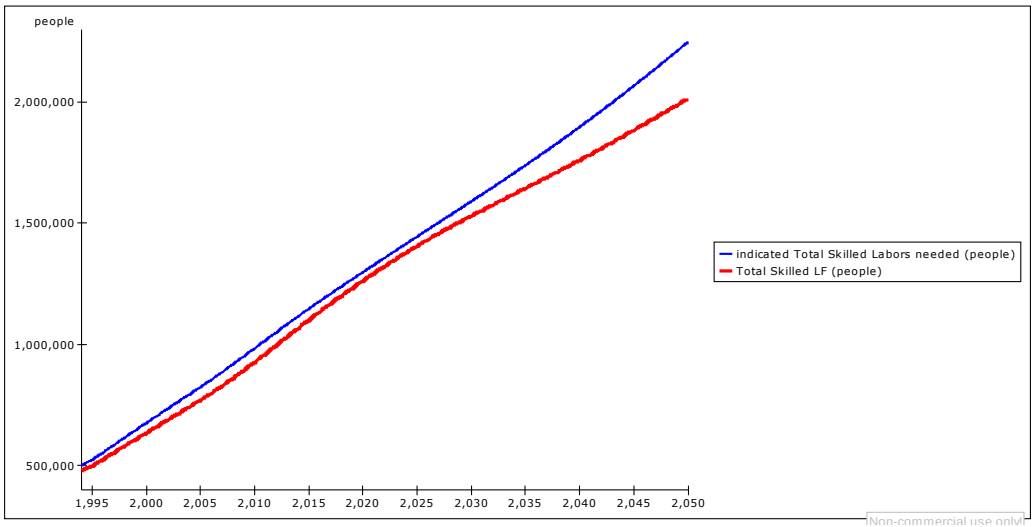


Figure 4-12-3 Indicated Total Skilled Labor Needed and Total Skilled Labor Force: No Ease of Finding Job Effect on Motivation to University

From the tests above, it reveals that economic returns to tertiary education influence the motivation for individual to participate in tertiary education from 1994 to 2010 is strong. Later on, the effect of job availability gains strength and is able to offset the negative impact of lower perceived wage premium imposes on the motivation. Nevertheless, the development of Total Skilled LF seems very resistant from the loop cutting sensitivity tests above. By changing the weight of factors that affects individuals' decision making is not enough to increase the supply of skilled labor force. As the system is dynamic and behavior changes over time, it is necessary to trace further to see how foreign laborers affect wages, job opportunity, and job composition. These three factors affect skilled labor supply in Norway.

(2) Cut inflow to foreign skilled labor force (C7)

In this test, we cut the inflows of foreign skilled laborers. This test is to determine the effect of foreign laborers on the development of skilled laborers demand and supply. After the loop is eliminated, Motivation to University increases by 0.05 in 2050 (*Figure 4-13-1*). The increment is insignificant. Therefore, the number of tertiary students in age group 19 to 29 does not increase significantly, so does the Domestic Skilled LF stock (*Figure 4-13-2 & 4-13-3*).

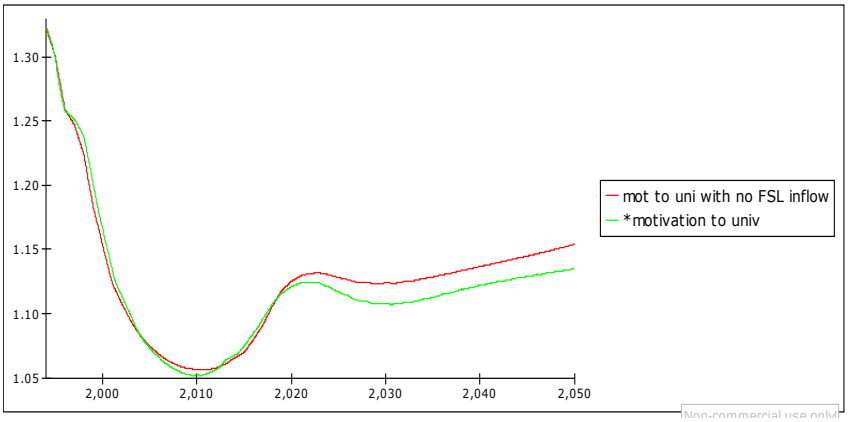


Figure 4-13-1 Motivation to University: No Foreign Skilled Labor Inflow

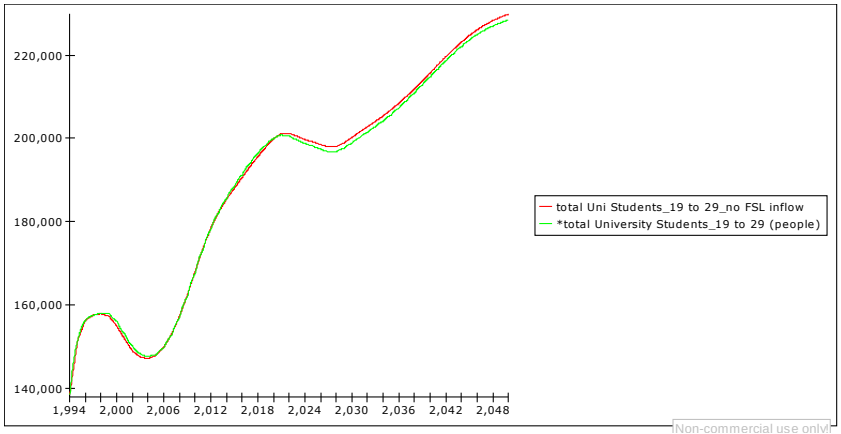


Figure 4-13-2 Total University Students_19 to 29: No Foreign Skilled Labor Inflow

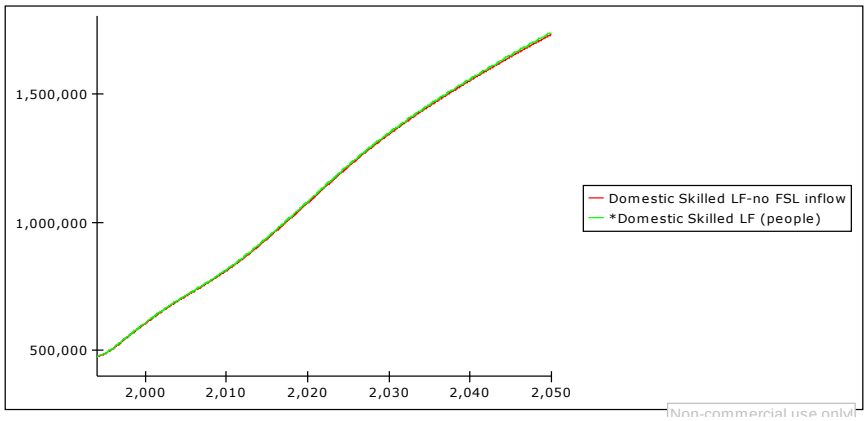


Figure 4-13-3 Domestic Skilled Labor force: No Foreign Skilled Labor Inflow

Due to the lack of foreign skilled labor inflow, Total Skilled LF is about 300,000 lower than in the base run (*Figure 4-13-4*). This constitutes to the visible enlarging gap from as early as 2005.

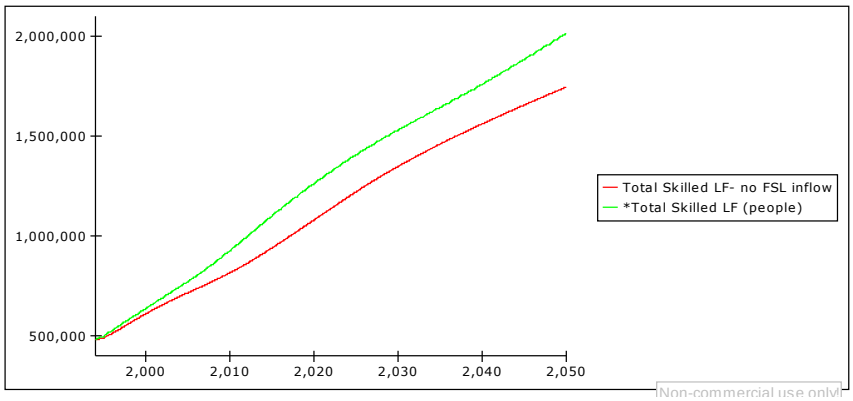


Figure 4-13-4 Total Skilled Labor force: No Foreign Skilled Labor Inflow

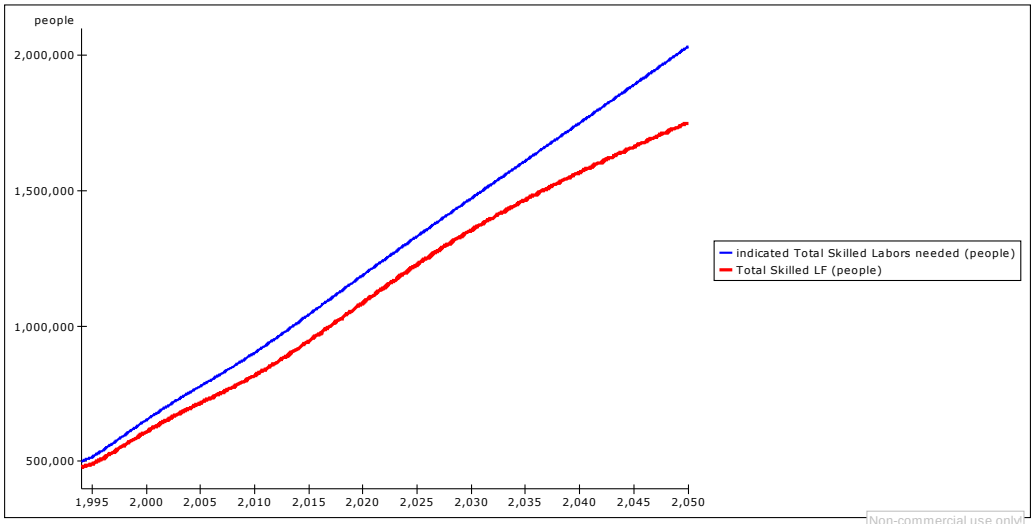


Figure 4-13-5 Indicated Total Skilled Labor Needed and Total Skilled Labor Force: No Foreign Skilled Labor Inflow

Skilled labor force does not rely on foreign laborers as heavily as unskilled labor force before 2010. Therefore the halt of foreign skilled labor inflow can be more or less compensated by domestic skilled labor force. Job opportunity will be increasing due to lower skilled labor supply. Job availability leads to rising Motivation to University after 2020. Fewer tertiary graduates combined with larger outflows from skilled labor force constitute to the slowdown of the total skilled labor force accumulation. Hence, the gap of skilled labor supply and demand is much wider than in the base run (*Figure 4-7*).

(3) Cut inflow to foreign unskilled labor force (C8)

When the inflow of foreign unskilled labor is zero, unskilled labor shortage worsens. Therefore, firms invest in capital to substitute human input. This will lead to the reduction of unskilled labor demand. Amidst high unemployment rate, wages for the unskilled dips further. Therefore, wage premium increases and so does Motivation to University (*Figure 4-14-1*).

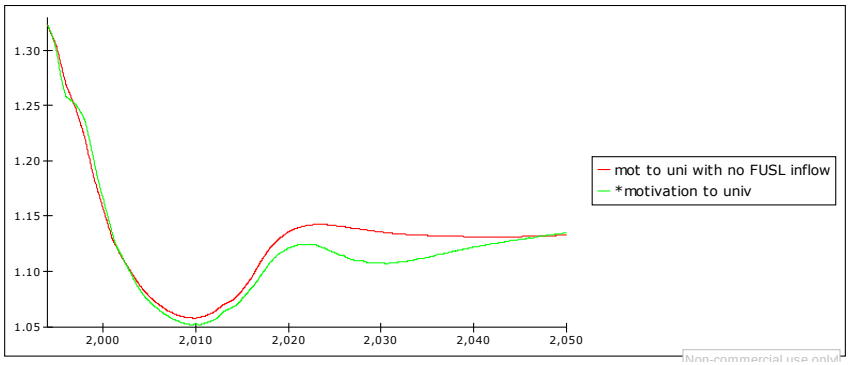


Figure 4-14-1 Motivation to University: No Foreign Unskilled Labor Inflow

Nevertheless, the slight increment in Motivation to University fails to boost local skilled labor production significantly (*Figure 4-14-2 & 4-14-3*).

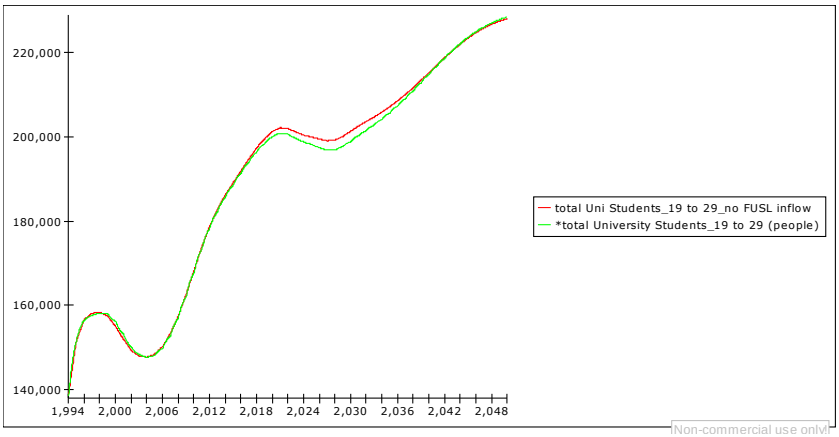


Figure 4-14-2 Total University Students_19 to 29: No Foreign Unskilled Labor Inflow

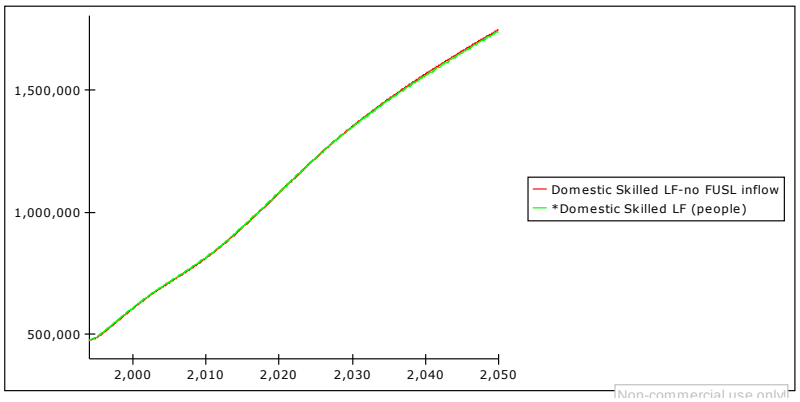


Figure 4-14-3 Domestic Skilled Labor Force: No Foreign Unskilled Labor Inflow

Due to the labor shortage in general, GDP grows sluggishly. Therefore aggregate demand growth slows down too. This leads to lower demand for labor. So, the skilled labor gap is narrowed between 2020 and 2030 (*Figure 4-14-4*) and the need for foreign skilled labor is also reduced (*Figure 4-14-5*).

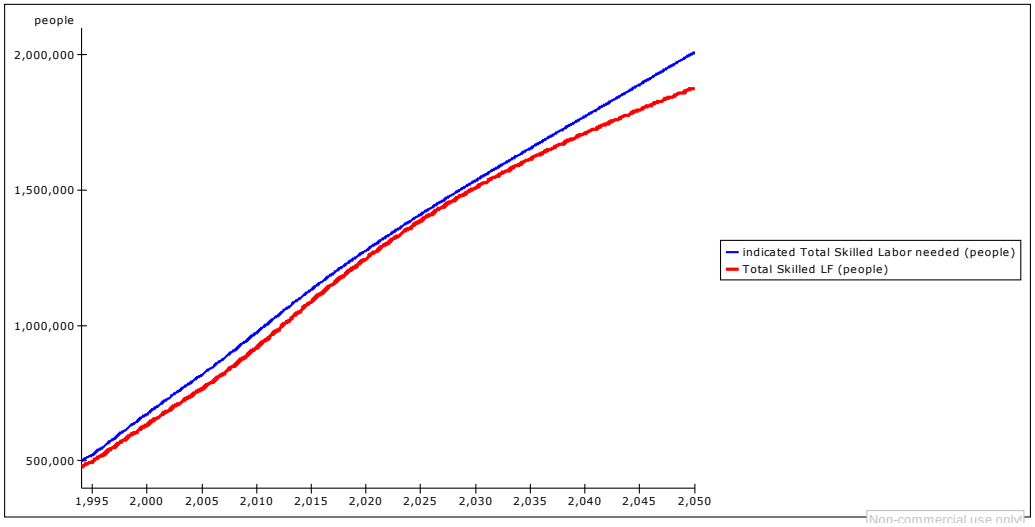


Figure 4-14-4 Indicated Total Skilled Labor Needed and Total Skilled Labor Force: No Foreign Unskilled Labor Inflow

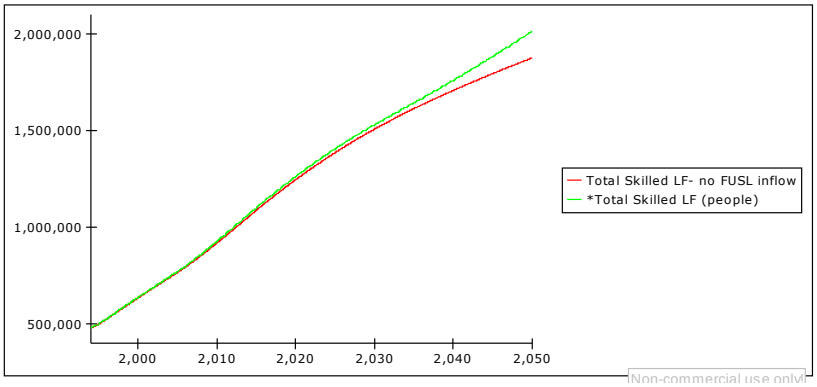


Figure 4-14-5 Total Skilled Labor Force: No Foreign Unskilled Labor Inflow

(4) Constant Reference Skilled Labor Fraction (cut R1)

By eliminating the feedback loop that increase the fraction of skilled aggregate demand (R1), AD_skilled only grows parallel to the total aggregate demand. The proportion of skilled and unskilled AD remains the same throughout the entire simulation, that is 26% of skilled AD to 74% unskilled AD. In this scenario, capital investment in production and the demand for skilled labor form a substitution effect. Higher labor productivity replaces skilled labor input. As skilled labor shortage is reduced, skilled wages grows very slowly. As the need for unskilled labor is high, higher capital investment to boost unskilled labor productivity leads to higher wage growth for the unskilled labor. Therefore, wage premium suffers. In addition to the decreasing skilled job density (about 0.55, almost two skilled labor for one skilled job), Motivation to University is almost 15% lower than in the base run from 2010 onwards (*Figure 4-15-1*). Hence, Domestic Skilled Labor Force is lower than in the base run (*Figure 4-15-2*).

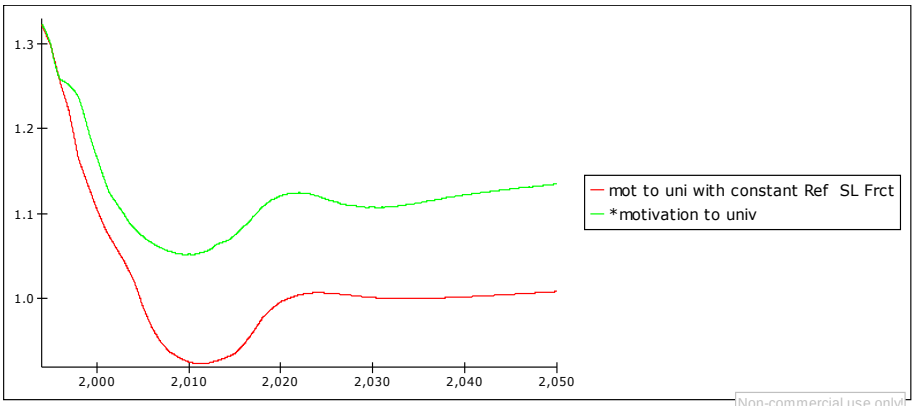


Figure 4-15-1 Motivation to University: Constant Reference Skilled Labor Fraction

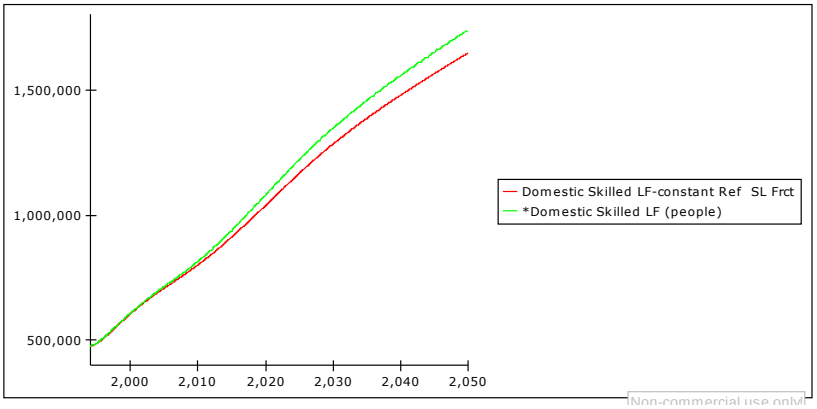


Figure 4-15-2 Domestic Skilled Labor Force: Constant Reference Skilled Labor Fraction

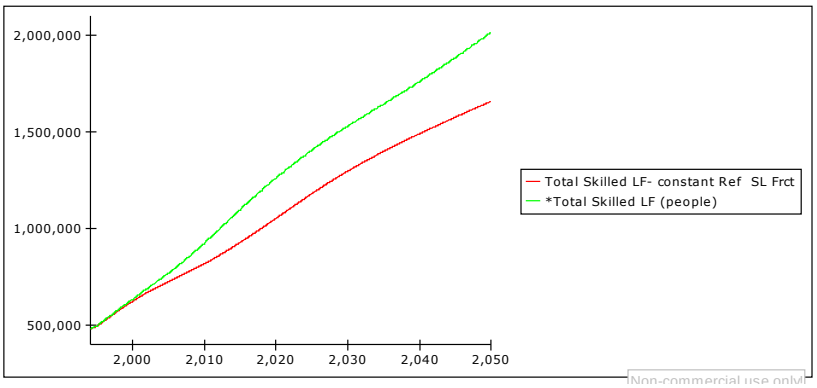


Figure 4-15-3 Total Skilled Labor Force: Constant Reference Skilled Labor Fraction

Due to low skilled labor demand, no foreign skilled labor is introduced to the country. Combined with slower domestic skilled labor production, total skilled labor force in the country is about 500,000 lower than in the base run (*Figure 4-15-3*).

This test shows that if the fraction of AD that requires skilled input does not increase, the demand for skilled labor will grow slower and this constitutes to slower growth in skilled labor force stock. However, with the tertiary education attainment rate, the stock of skilled labor supply will supersede the demand throughout the simulation (*Figure 4-15-4*). It grows at a decreasing rate and presents a goal seeking behavior. This is because that the surplus of skilled labor will reduce skilled job density and skilled wages. Therefore, Motivation to University deteriorates over time.

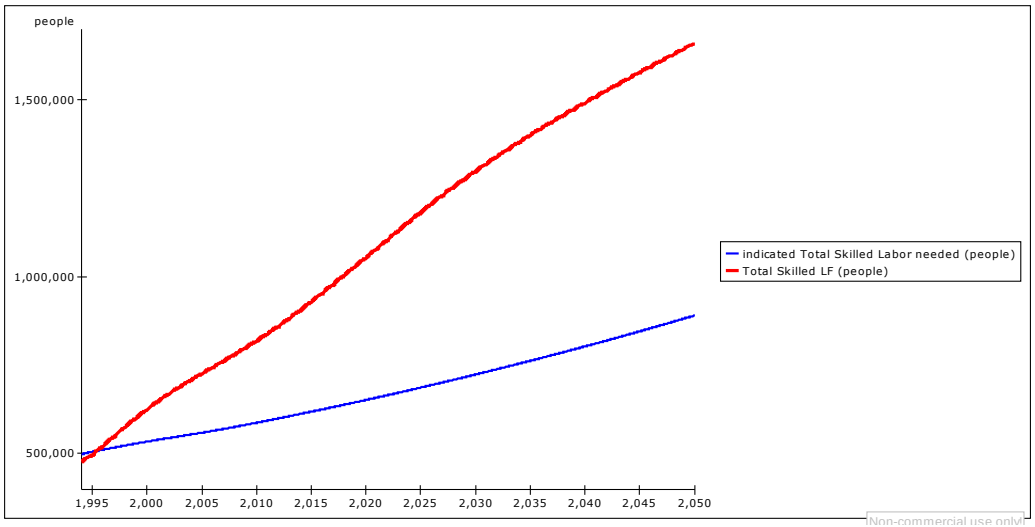


Figure 4-15-4 Indicated Total Skilled Labor Needed and Total Skilled Labor Force: Constant Reference Skilled Labor Fraction

In a summary, from the previous behavior sensitivity tests, it shows that without inflow of foreign skilled labor, skilled labor shortage will reach 500,000 people by 2050; however, without the inflow of foreign unskilled labor, skilled labor shortage will almost diminish between 2020 and 2030. By 2050, skilled labor shortage will be about 100,000 people.

Higher wage premium and lower foregone earnings are particularly important from 1994 to 2010 in attracting individuals to pursue tertiary education. After 2030, as wage premium remains at 1.6 until 2050, ease of finding job become the predominant loop that serve as the main attraction to tertiary education.

If the fraction of skilled labor in the country remains constant throughout the simulation, skilled labor supply will surpass the demand. Under such condition, the skilled labor will face an oversupply situation and unemployment rate for the skilled will hike.

After performing loop cutting tests to determine the sensitivity of each single loop to the model behavior, we will formulate feasible policy to boost skilled labor supply in the following section.

5.0 Policy

In the past decade, industrial restructuring, globalization, and technological advancement have gradually changed the skill requirements and job composition in Norway. It is predicted by Statistics Norway that in the coming years, aggregate demand in Norway[20] will grow by 3.3% - 3.9% from 2011 to 2013. Investment in capital and technology and the transformation to a knowledge- and technology-intensive economy will indeed call for a stronger demand for skilled labor in the near future.

Another strong demand for skilled labor arises from the new national initiative in research and development (R&D). The national science and innovation strategy aims to increase the R&D spending in the country from 1.6% of the GDP in 2005 to 3.0% in 2014. In terms of R&D spending, Norway still lags behind other OECD countries (*Figure 5-1*). In 2007, 42,000 of researchers, technicians, and other employees with at least five years of higher education were involved in R&D activities in Norway. This number accounts for 6% of the total skilled labor force. If the country is to achieve the R&D spending target, it is probable that another 42,000 skilled laborers are needed by 2014.

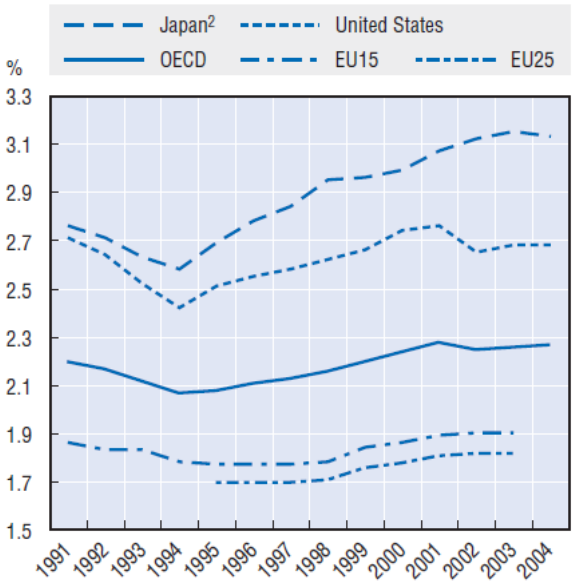


Figure 5-1 Trends in R&D Spending as the Percentage of GDP in OECD Countries, 1991 - 2004
2- data are adjusted up to 1995
Source: OECD Science, Technology and Industry Outlook (2006)

[20] Consumption in households and non-profit organizations + general government consumption + gross fixed capital formation in mainland Norway.

Nevertheless, the gap between the demand and supply for skilled laborers seems to enlarge regardless of the effort from the government to boost skilled labor supply. We hypothesized that economics returns to tertiary education and job density influence individuals' decision to become skilled laborers. Thus, it affects the development of the skilled and unskilled labor force stocks over time. These two stocks are competing for the working age population, which is growing at a decreasing rate. So, we study the prevailing factors behind the competition that persuade individuals in their decision-making process.

With the labor force and motivation to tertiary education endogenously built in our model, we study how the feedback loops work. From the analysis in previous section, we understand that labor shortage development is dynamic because supply and demand itself keeps evolving over time. The choice of policy depends on the aggressiveness of policy makers to solve the situation—to mitigate the shortage immediately or to promote the production of domestic skilled labor in long run. If the government has an aggressive goal to close the gap between skilled labor supply and demand in the shortest time frame, more foreign skilled labor and foreign students can be brought into the country to reduce shortage; this will further deteriorate the incentive to pursue tertiary education. On the contrary, the moderate inflows of foreign skilled labor and students will exert upward pressure on wages and slow down the transformation of economy, but it will protect the domestic skilled labor production by boosting motivation to tertiary education. In favor of the latter, we propose the following policies:

(1) Incorporate internship program into current tertiary education curriculum;
(2) Increase tertiary education participation among population age 30 to 35 through online education;
(3) Increase foreign skilled labor and foreign student stocks

Policy 1 – Incorporate internship program into current tertiary education curriculum

Through the analysis in section 4.8, it shows that the in absence of expected foregone earnings, Motivation to University will increase 15% by 2050 (*Figure 4-3b*). Thus, this is a leverage point for policy formulation. In order to boost motivation for tertiary education participation domestically, fostering facilities that promote internship as part of students' curriculum will provide financial returns to students during their study period. From a broader perspective, internship does not only benefit students financially, it also helps students gain real working experience and increase the possibility of landing a job faster and easier after graduation. The purpose of this policy is threefold: (1) to reduce students' expected foregone earnings; (2) to reduce skilled working hiring adjustment time; and (3) as an marketing effort to lure foreign students to study in Norway. In the following, we will discuss the benefits of internship, followed by a detailed explanation of how this policy can raise domestic skilled labor supply, and then the cost effectiveness analysis (CEA).

Internship is an opportunity for students to integrate real working experience as part of the tertiary education. The program is carried out with planned and supervised work related to students' studies. The compensation from internship participation is one of the benefits to students, but the most important advantages obtained from internship participation stem from clearer career directions and expectations, job preparedness, marketability, interpersonal and leadership skills, and social or professional networking opportunities. A survey shows that 94% of respondents in the United States indicated the experiential advantage from internship compliment their first permanent job search and attainment (Coco 2000). 90% of colleges in the United States offer students some type of for-credit internship or work-related learning experience (Divine, et al., 2007). In contrast to the United States, internship arrangement in Norwegian tertiary education system is almost obtained through individual efforts from job fair or individual internship search from private organization websites, school announcements, or governmental-related organizations. Besides, there are other private or not-for-profit organizations that serve as a portal for paid-internship

programs[21]. Only a few programs indicated possibilities of integrating internship into the study plan.

From the employers' perspectives, internship is a cost-effective way to get to know the pool of talents for future hiring effort. It is an opportunity for employers to market and advertise themselves to the future potential employees. Through internship, employers and interns can assess each others' needs and wants to avoid future expectation mismatch. Interns are usually eager to learn and perform well, so they will likely introduce fresh perspectives that challenge entrenched processes and attitudes.

For educational institutions, internship program will achieve program differentiation and departmental branding purposes. Programs that integrate real work experience distinguish themselves as more inclusive and practical; therefore the departments can brand themselves as institutions that reinforce theoretical learning through real life experience. More particularly, educational institutions can foster close ties with business community to explore skilled labor demand to avoid mismatch of supply and demand.

The inclusion of internship program in tertiary education curriculum will compensate part of the expected foregone earnings of students and increase expected lifetime earnings (*Figure 5-2*). Besides, internship will enhance students' marketability and thus leads to shorter job search time and adjustment time in the work force. With these benefits, the Motivation to University will be increased. This policy targets on tertiary students between age 19 and 29 because this group of student is more likely lack of professional work experience. We do not encourage the compulsory inclusion of internship into tertiary education because this will cost substantial amount of time and governmental spending to ensure every students get placement; rather, it is going to be voluntary-based. We propose to broaden the responsibilities of current career planning units within educational institutions by hiring more staff. The tasks of the new staff include student counseling, placement, workforce preparation seminars, marketing internship programs to potential employers, setting up internship placement, and follow-ups.

[21] These organizations required participation fees from students in order to place them. Some of the internship program is paid, and some is non-paid. Examples of this type of organization are: AIESEC , Internship.NO, IAESTE, etc.

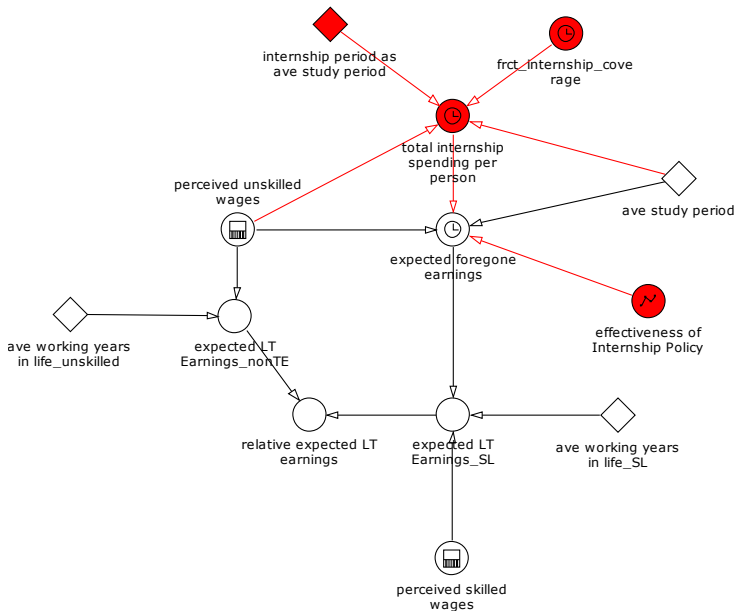


Figure 5-2 SFD-Policy 1: Internship Reduces Expected Foregone Earnings of Tertiary Students

Figure 5-2 shows the new structure added to the model (the red elements). Total internship spending per person is determined by the average length of study, the perceived real unskilled wages, and the fraction of internship coverage. The average length of study is 3 years. Fraction of internship coverage is a policy goal which determines the fraction of the foregone earnings of students that the government intends to cover. This is the amount that the government will be spending on each student. Internship period as average study period denotes the length of internship during tertiary education. It is assumed that students participate in internship program in summer every year for three months. Thus, in total, students will accumulate 9 months of internship experience.

Internship spending per student per year is initialized at NOK 85,158 per person per year. The fraction of internship coverage is the percentage of tertiary students' expected foregone earnings that government intended to cover, both directly or indirectly; it will be 0.3 in 2014. Direct foregone earnings covered denotes the wages students receive during the internship period; indirect foregone earnings covered represents the spending on administrative costs in maintain the career placement units as well as incentives to private firms to employ interns. From 2015 to 2050 the fraction will increase 1% annually. Thus, it will reach 65% by 2050 and this is the proposed maximum fractional coverage. The purpose of the annual increment is to increase the attractiveness of internship participation. Without

the annual increment, Motivation to University will only increase insignificantly after the implementation of Policy 1. After 10 years since the implementation, the effect of internship will wear off due to the increment of perceived wage premium. As perceived wage premium starts to pick up from 2015, unskilled wages increases slower. This represents that the financial returns from internship participation loses its appeals. Therefore, with an annual increment of internship coverage fraction ensures the attractiveness of this policy to students. The total internship spending per person encompasses costs for facility maintenance, staff compensation, marketing effort, and incentives to business to recruit interns.

We also add Policy 1 to our model by developing two stocks, namely Internship Budget and Internship Capacity (*Figure 5-3*).

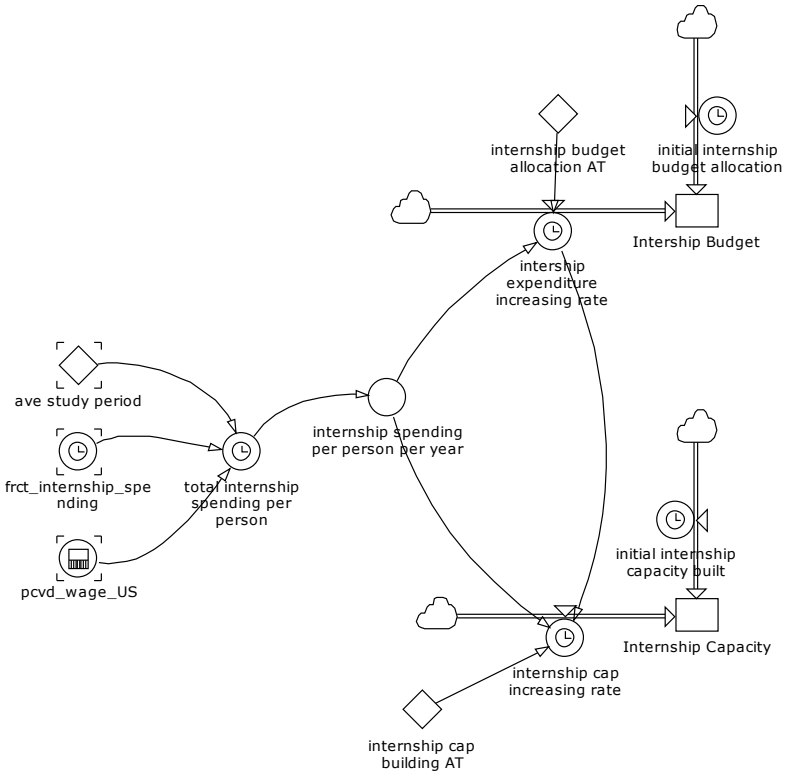


Figure 5-3 SFD-Policy 1: Internship Budget and Internship Capacity Stocks Added to the Model

Resources are pre-requisite to the implementation of a new policy. First and foremost is the funding. Funding is needed to recruit staff, to communicate, to deploy, to monitor, and to follow up. Mazmanian and Sabatier (1981) assert that money is critical in any program initiations and the success in reaching policy objectives relies on the threshold level of funding. The probability of achieving the policy objectives is proportional to the level of funding above the threshold.

So, we propose the establishment of Internship Budget from 2012 with the consideration of a delay for the budget to be approved. We assumed that by 2013, budget is approved and be allocated for this policy. The inflow of initial internship budget allocation is a one-off investment at the initial stage. It is calculated based on the estimated desired number of tertiary students who will be participating in the internship program in 2015. It is the same for Internship Capacity. The internship capacity building adjustment time is set to be 2 years. The initial internship capacity built will be ready by 2015. Internship capacity is an abstract representation of human resources needed, framework formulation, and placement arrangement through setting up connection with firms. Firstly, planning needs to be initiated at the Ministry of Education and Research. After that, approval of budget needs to be obtained from the parliament. Thirdly, funding will be allocated to educational institutions for expanding the services offered by current internal career planning units. Lastly, in order to encourage firms to participate in the internship programs, incentives can be provided to participating firms through tax incentive and partial wage subsidy by the Ministry of Education and Research.

The enrollment of students into the internship programs can be initiated in 2015 as we assumed it takes three years for the budget and capacity building. The other inflows to the stocks are annual additional allocation for expected extra capacity and students' internship financial compensation. As the number of participating student grows, internship expenditure increasing rate will grow.

The following structure explains how internship capacity is determined.

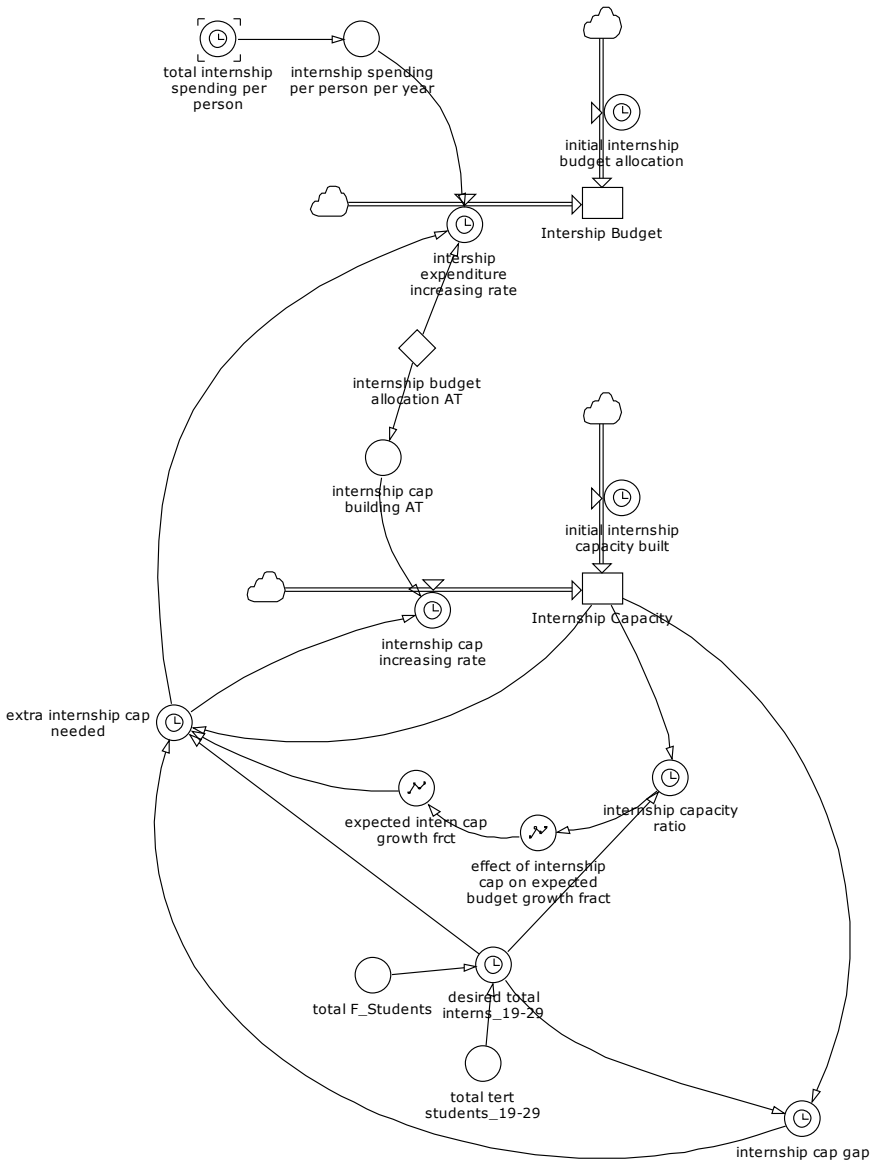


Figure 5-4 SFD-Policy 1: The Determination of Internship Capacity

The desired total number of interns is determined by the number of tertiary students between 19-29 years old and total number of foreign students (*Figure 5-4*). Internship capacity gap denotes the difference between the current capacity and the desired capacity, measured by number of people. If there is an excess of capacity, this variable will become a negative value.

The extra internship capacity is determined by the internship capacity gap and expected intern growth fraction. The growth fraction is expected to be 0.2 from 2015 to 2019;

after that, it gradually decreases 0.05 marginally every five years. This is because the age group of 19 to 29 is growing decreasingly, thus capacity becomes excess.

When the capacity exceeds the desired number of interns, the ratio of internship capacity and desired total interns is greater than one. Thus the expected internship capacity growth fraction will zero out and the extra internship capacity will become negative due to the negative value in internship capacity gap (negative internship expenditure increasing rate). This means that the capacity will reduce accordingly by reducing budget allocation.

In their book, Mazmanian and Sabatier (1981) contend that a policy decision that deviates from status quo will likely be implemented successfully if (1) the policy objectives are clear and consistent; (2) sound theory that identify the principal factors and causal linkages affecting policy objectives is provided to implementation agents; (3) implementation plans and process are carefully designed and carried out by agents; (4) implementation agencies possess sufficient managerial and political skills and experiences and is committed to carry out the implementation plans.

With Policy 1, objectives have been clearly spelled out previously and causal linkages have also been presented to form relevant theories. However, we are uncertain the effectiveness of the implementation agencies. Therefore, we presume that the effectiveness of Policy 1 will gradually increase from 30% from 2014 to 70% in 2050. At the beginning stage, staff dealing with internship counseling and placement may be lack of experience to handle students; the connection with businesses may be weak; students might not be getting full information and training yet; on top of that, some students might be interested in internship programs or might be interested in studying abroad instead. Therefore, the full effect of this policy will likely kick in some time after its introduction and we assume the effectiveness will be lower than 100%.

Then, we run the model with Policy 1 integrated. These are the comparison of the simulated and base run behavior from Policy 1.

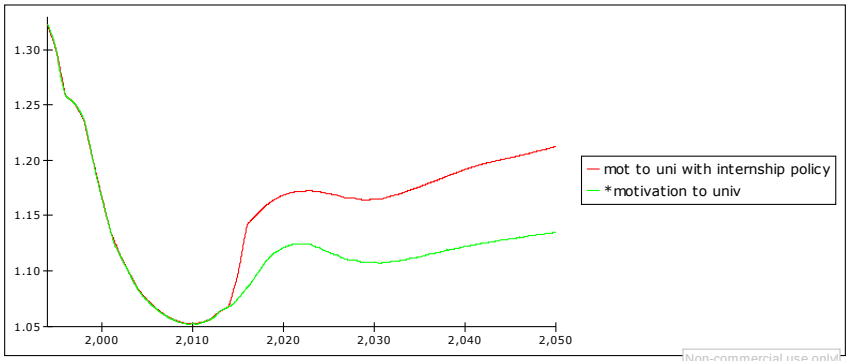


Figure 5-5 Motivation to University: the impact of Internship Policy

With the internship policy alone, Motivation to University will rise about 9% from 1.05 to about 1.15 in 2020 (*Figure 5-5*). By 2050, Motivation to University will reach 1.20. Hence, more students will enroll in tertiary education. From 2014 to 2050, an increment of 2% in tertiary student enrollment in age group 19 to 29. This leads to 5,756 more students enrolled in tertiary education (*Figure 5-6*) compared to the base run.

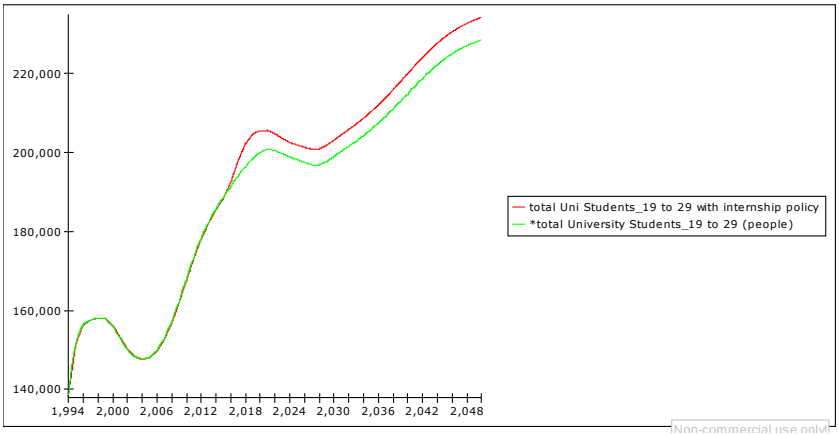


Figure 5-6 Total University Students in age group 19 to 29: the impact of Internship Policy

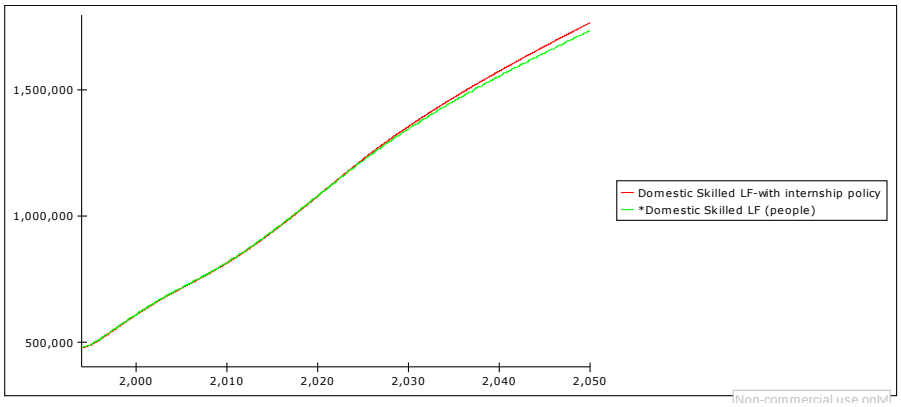


Figure 5-7 Domestic Skilled Labor Force: the impact of Internship Policy

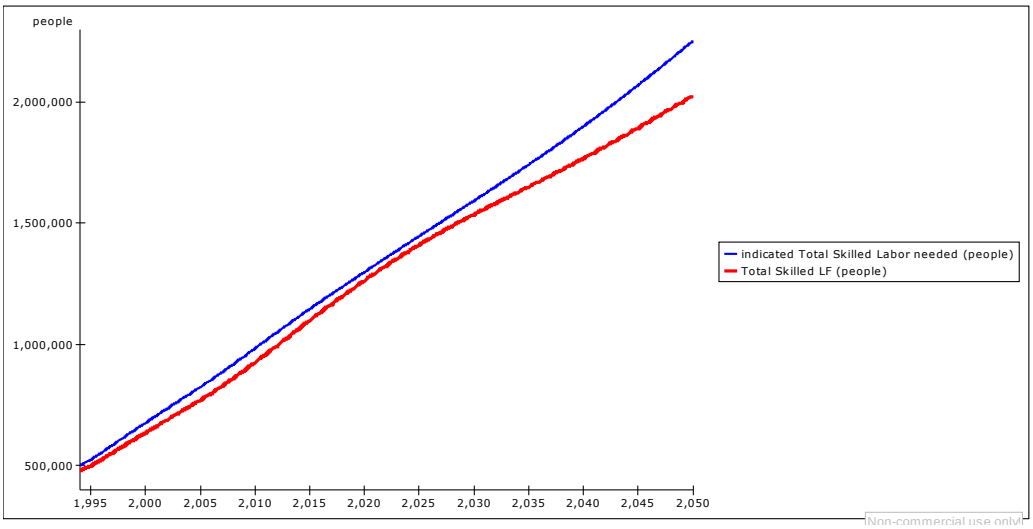


Figure 5-8 Indicated Total Skilled Labor Needed and Total Skilled Labor Force: the impact of Internship Policy

The domestic skilled labor force will result in 29,778 additional skilled laborers if Policy 1 is implemented (*Figure 5-7*). A total of 24,769 skilled labor job vacancies are filled from 2014 to 2050 (*Figure 5-8*).

The following table demonstrates the changes take place with the implementation of Policy 1.

	Domestic Skilled LF	**Reduction in Skilled Labor Shortage**	**Internship Budget** (NOK/year)
Changes from Policy 1	34,402 (people)	24,769 (people)	35 billion
CEA (NOK/people)	1,022,414	1,420,033	-
Performance Analysis (MAPE)[22]	0.64%	6.28%	-

Figure 5-9 The Impact of Internship Policy on Domestic Skilled Labor Force, Skilled Labor Shortage, and Cost-Effectiveness Analysis, and Performance Analysis

[22] Mean absolute percentage error.

With Policy 1 in place, Domestic Skilled LF increases 34,402 people. This leads to a reduction of 24,769 skilled labor shortages. The total internship budget approaches 35 billion kroner per year. From the CEA, about 1.0 million kroner will be spent per domestic skilled laborer produced by 2050; about 1.4 million kroner per year per skilled labor shortage reduced. The policy performance analysis shows that the deviation from the base run for domestic skilled labor force and skilled labor shortage are only 0.64% and 6.28%.

Policy 2 - Increase tertiary education participation (undergraduate level) among population age 30 to 35 through online or long distance tertiary education

The *Competence Reform 2000* action plan aims at providing continuing education and training to individuals through public and private institutions. The reform enables mature students over 25 years who have not finished formal upper secondary education to have their formal and non-formal qualification recognized (*realkompetanse*). As a result, mature students flooded to tertiary education in the first few years after the reform was launched. However, the number of mature students who entered tertiary education through this reform started to decline after the implementation (OECD, 2004b). This could be due to individuals' reluctance in giving up their jobs and expected foregone earnings for a few years. Through our simulation, it reveals that without the inhibition of lost earnings, tertiary education participation rate is indeed higher than the base run—where expected foregone earnings is the major concern of potential tertiary students. This could imply that students will defer participation in tertiary education.

Statistics shows that students who entered tertiary education immediately after upper secondary education did not increase much from 1992 to 2002. However, the age of students who enter tertiary education had been increasing (*Figure 5-10*). This implies that individuals tend to participate in unskilled labor force after secondary education for a number of years before they continue to tertiary education.

Age	1992	2002
19	13.1	13.6
20	20.8	28.0
21	24.5	33.8
22	24.3	34.4
23	22.9	31.3
24	19.2	27.6
25	15.4	23.0
26	12,4	18.8
27	9.9	15.5
28	7.9	12.7

Figure 5-10 Students at ISCED 5 & 6 Level as percentage of the Respective Age Groups
Source: Equity in Education, Country Analytical Report: Norway

As foregone earnings are one of the most important factors that influence individuals' decision to tertiary education, we propose a policy to encourage the tertiary education participation in age group of 30 to 35 through long distance or online tertiary education.

This policy will enable individuals who are employed to obtain undergraduate level tertiary education. In 1999, a bill for employees' right to education was passed. However, the bill does not cover paid leaves matter. It depends on the negotiation between the employees and employers (Brandt, 2000). With this policy, potential students can remain in employment while pursuing tertiary education without losing their income.

The government believes that the dividing line between work life and educational system must be reduced. So, the Norwegian University Network for Lifelong Training (Norgesuniversitet) was established in 2000. It provides a database or search engine on several thousand trainings and courses, ranging from short seminars to Master's degree programs, module-based add-on courses and Internet-based instructions. Study shows that not only those who live far away from educational institution would take up online or distance education, often people who are employed or have family with children would opt for this non-traditional learning method (OECD, 2000). As online or distance learning puts more responsibility for learning on the students and on the interaction of students and information-technological based learning material in the absence of direct supervision, this type of learning is more suitable for mature students.

Since the infrastructure for the online and long distance education has been built, the government can take the opportunity to utilize the facility to a fuller extent in order to accommodate individuals' needs while trying to boost the production of skilled labor. From *Figure 5-10* it indicates that the participation rate at age 28 was merely 12.7% in 2002. So we inferred the participation rate in 30 to 35 to be lower than 12.7% initially. This policy will compliment the *Competence Reform 2000* by further boosting the inflow to tertiary education. Since the online and long distance tertiary education is provided to those who are working and studying for a tertiary degree, the duration for the study is proposed to be extended to four years instead of three years in on-campus undergraduate studies.

We build this new structure into our existing model and implement this policy from 2012. According to OECD Thematic Higher Education Review (2005), the current policies on higher education have not formulated any numerical target. We set a goal in our simulation of this policy— to achieve 15% participation rate among the age group of 30-35 in 2050.

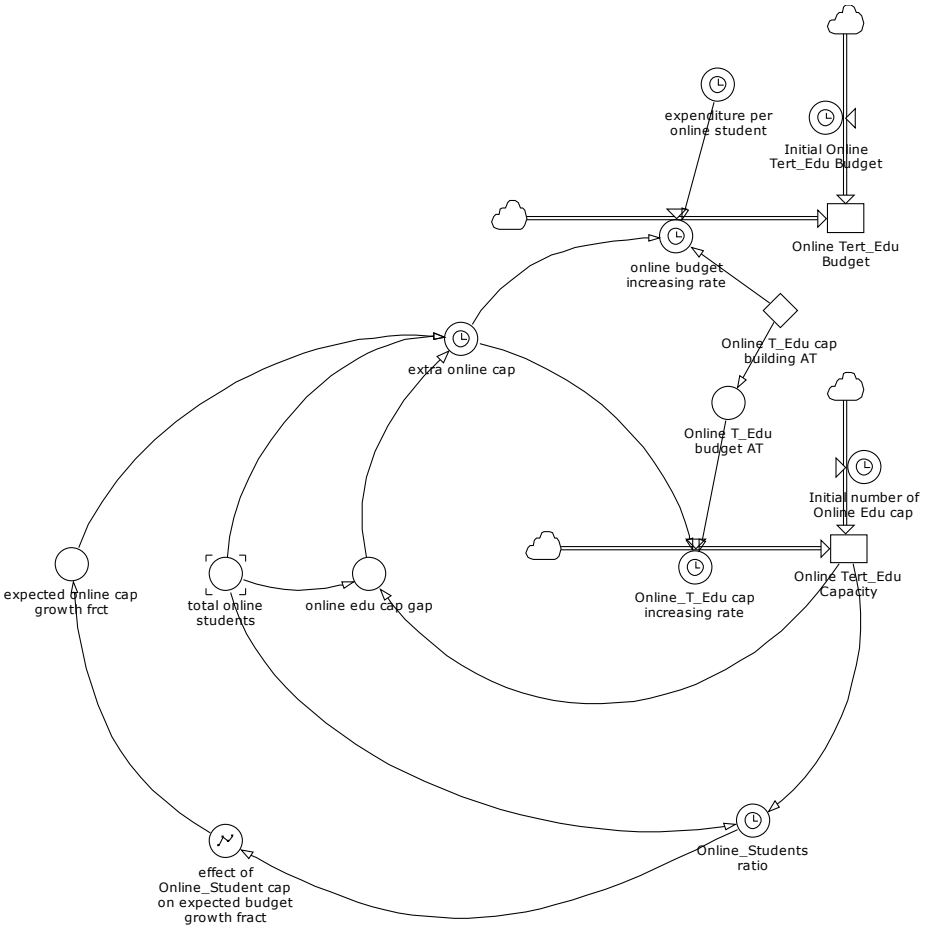


Figure 5-11 SFD- Policy 2: Online Tertiary Education Policy

As in the previous section, we established two stocks: Online Tertiary Education Budget and Online Tertiary Education Capacity (*Figure 5-11*). Online tertiary education budget covers the spending in building the infrastructure, staff compensation, operating and maintenance costs for this program. Online tertiary education capacity represents the human and technological capacity available for students' enrollments.

A one-off investment is allocated to Online Tertiary Education Budget to enhance current Norwegian University Network for Lifelong Training capacity from 2013. By 2015, the capacity for online tertiary education will be ready and to enroll 1,000 students under this program.

After 2015, online tertiary education gap will be assessed based on the current capacity and current number of students who enrolled in online tertiary education program. If the capacity is insufficient, extra online capacity will be needed. Extra online tertiary

education capacity will also take future capacity growth into consideration. Thus, as long as capacity is not oversupply, expected online capacity growth fraction will be at least 2% annually. This is to accommodate the expected increasing number of student enrollments. The ratio of online students over capacity is the ratio of online student enrollments and Online Tertiary Education Capacity. If the ratio is over 1, that means there is a shortage of capacity and the expected online capacity growth fraction will be increased. On the contrary, expected online capacity growth fraction will be zero out if the ratio is lower than 0.98 where there is excess capacity. When there is excess capacity, online education capacity gap will become negative and so does online budget increasing rate. Online budget increasing rate is determined by the extra online tertiary education capacity needed. This will reduce Online Tertiary Education Budget. So, less spending is needed for operating and maintenance costs or human input.

Expenditure per online student is initialized at 70,000 kroner per year per student. According to OECD Education at a Glance (2009), annual expenditure on educational institutions per student is reported to be 70,000 kroner per year on average. With this number, we expected a 5% increment for price and wage growth. By 2050, the expenditure per online student approaches 189,000 kroner per student per year.

Due to uncertainty of the effectiveness of the implementation, as in the previous policy, we presume that the effectiveness of Policy 2 will gradually increase from 30% from 2014 to 77% in 2050. The effectiveness of the policy will be affected by the administration of relevant higher education, infrastructure, and information dissemination to persuade individuals to participate in this program.

Figure 5-12 demonstrates the stock of Online Tertiary Graduates after the implementation of Policy 2. By 2050, the number of tertiary students who graduate through this program will reach over 6,000 per year from 2040 onwards. Motivation to University drops slightly after the implementation of this policy (*Figure 5-13*). This is because of lower skilled job density, as there are more skilled laborers to fill up skilled job vacancies. As a consequence, tertiary student enrollment of age group 19 to 29 is 1,215 lower than in the base run (*Figure 5-14*). However, this policy results in an increment of about 129,065 domestic skilled laborers (*Figure 5-15*) by 2050. With this policy implemented alone, 153,460 skilled job vacancies will be filled by 2050 (*Figure 5-16*).

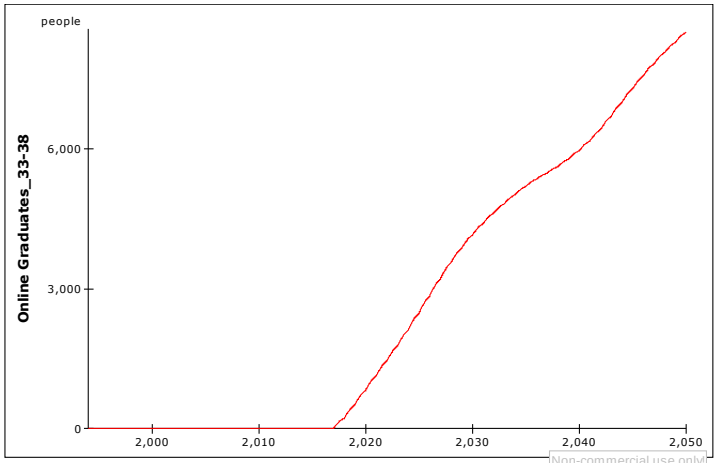


Figure 5-12 Online Graduates_33 to 38: Online Tertiary Education Policy

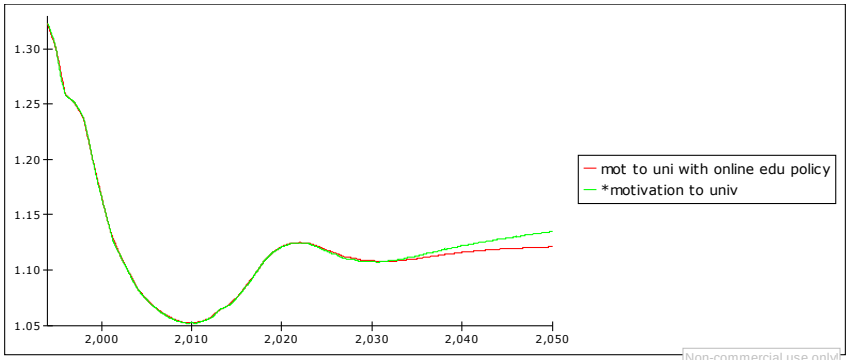


Figure 5-13 Motivation to University: Online Tertiary Education Policy

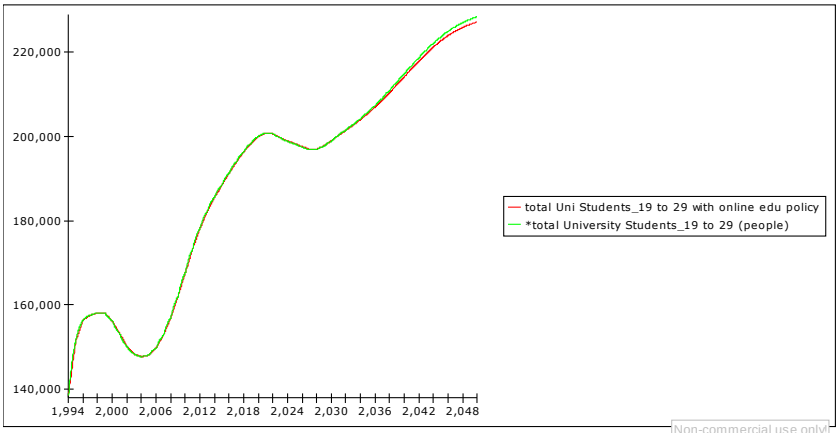


Figure 5-14 Total University Students_19 to 29: Online Tertiary Education Policy

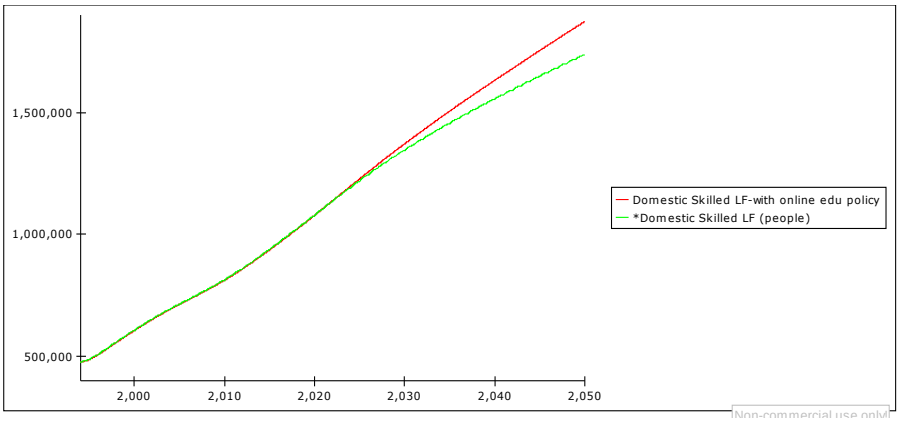


Figure 5-15 Domestic Skilled Labor Force: Online Tertiary Education Policy

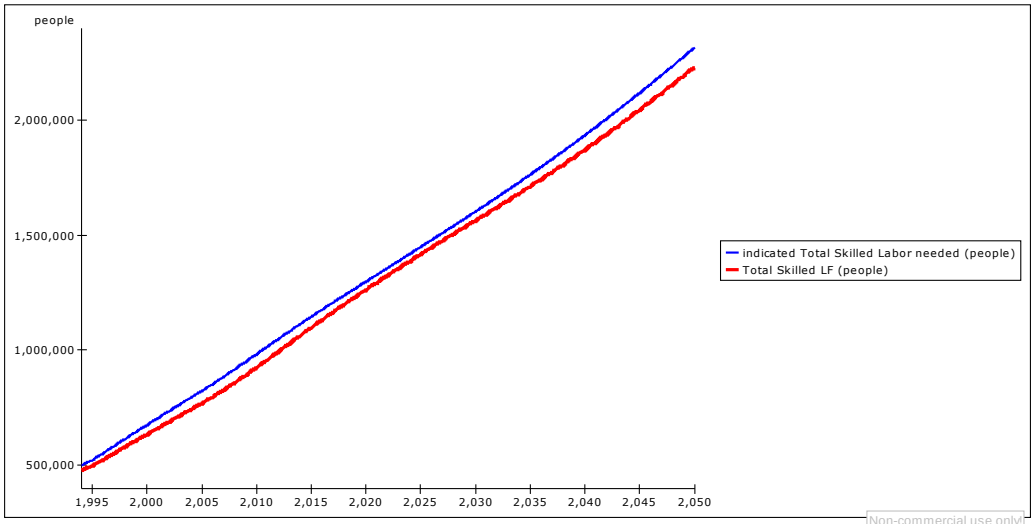


Figure 5-16 Indicated Total Skilled Labor Needed and Total Skilled Labor Force: Online Tertiary Education Policy

The table below demonstrates the changes of domestic skilled labor force, skilled labor shortage, CEA, and performance analysis for Online Tertiary Education Policy.

	Domestic Skilled LF	**Reduction in Skilled Labor Shortage**	**Online Tertiary Education Budget** (NOK/year)
Changes from Policy 2	129,065 (people)	153,460 (people)	8.1 billion
CEA (NOK/people)	62,650	52,691	-
Performance Analysis (MAPE)	1.90%	25.90%	-

Figure 5-17 The Impact of Online Tertiary Education Policy on Domestic Skilled LF, Skilled Labor Shortage, Cost-Effectiveness Analysis, and Performance Analysis

After the implementation of Policy 2 from 2012, domestic skilled labor force will increase about 138,469 people whereas the shortage of skilled labor will be decrease by about 221,392 people. This policy will cost 8.7 billion kroner per year in 2050. It costs about 63,069 kroner for the addition of one domestic skilled laborer and 52,691 kroner per shortage reduced. The performance analysis indicates that with Policy 2 alone, Domestic Skilled LF will only increase 1.90% but 25.90% reduction of skilled labor shortage compared to the base run.

Policy 3 - Increase international skilled laborer inflow and foreign student mobility

As an extension to Policy 1 and 2, we recommend that the country further liberalizes the immigration policy to attract foreign skilled laborers. There are three objectives for increasing the inflow of skilled laborers: (1) to reduce skilled labor shortage; (2) to speed up the accumulation of human capital ; (3) to encourage knowledge circulation and transfer in order to promote innovation. Norway has low skilled international labor mobility. The foreign labor stock from 1998 to 2007 increased from 3.0% to 8.6%. The increment seems drastic but most of the labor immigrants are unskilled. In 2008, 25% of the work permit was granted to unskilled laborers in building and construction industry. The skilled work permits or specialist permits which is specially granted to skilled workers only took up 2% - 3% of the total permits approved. Under the specialist rule which was introduced in 2002, 5000 specialist permits quota was set for the country. However, from 1999 to 2008, specialist permits only increased from 428 to 3,384. Conversely, skilled migration to the United States, Canada, Australia, and the United Kingdom is quite significant. *Figure 5-17* shows that the share of foreign skilled labor in skilled employment in Australia, Canada, and United States is relatively high, about 25%, 18%, and 10% respectively.

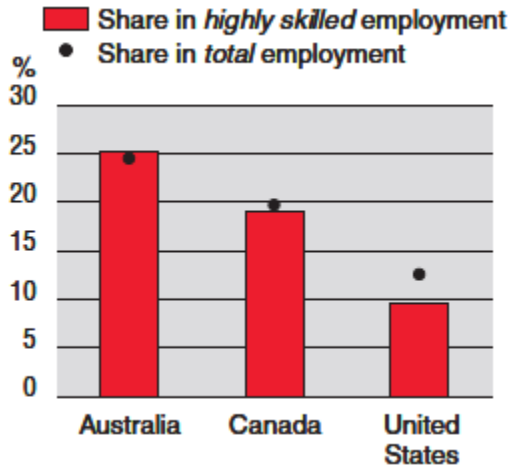


Figure 5-18 Share of Foreign-born in Highly Skilled Employment in Australia, Canada, and United States
Source: International Mobility of the Highly Skilled

This leads to the question of how to attract foreign skilled laborers to the country. First, we take a look at the drives for skilled labor migration. Skilled laborers mostly respond to better economic opportunities abroad relative to their home countries. Other than this,

factors such as intellectual pursuits, growth of multinational corporations, or hardship in their home countries due to war or political suppression are also reasons for migration.

Some national barriers to skilled labor migration will undermine the attractiveness of Norway as a migration destiny. These barriers includes access to labor market or regulatory information and general living conditions of the descendents of skilled labor migrants (Ministry of Labour and Social Inclusion, 2007-2008, UDI, 2003). In order to tackle this barrier, social inclusion and language training program should be provided at the home countries of potential source of skilled labor. Although there are programs as such provided at no cost to the immigrants and their families, they will have to arrive in the country first before they can start to get aquatinted with the culture. Nonetheless, if they were to migrate to the English-speaking countries, this factor will be less likely to affect their decision. In its effort to attract foreign skilled laborers, the government has introduced a more liberal immigration policy for skilled migration. In the beginning of 2010, skilled laborers will be granted a residence permit to remain in Norway to attend Norwegian language course or up to two years to take additional education or gain experience in order for their education to be recognized by the Norwegian system. Despite the new scheme to attract foreign skilled laborers to migrate to the country on their own fund, to get adapted to the society, and to break the entry barrier to the job market, and to learn Norwegian and cultural differences, the "social inclusion process" of the potential foreign skilled laborers will likely to take up a couple of years. In reality, those who are highly capable and desired talents will tend to be lured away by countries that are seen as foreign labor magnet, such as the United States, Canada, United Kingdom, and Australia. So, pull and push approach need to work together in order to make Norway an attractive choice for potential foreign laborers. It is essential for the government to establish agencies in potential source country to proactively market the opportunities available in Norway and to foster communication between potential foreign laborers and employers. Countries with high skilled labor reserve with lower living standard will become a push factors for the skilled laborers to seek for emigration. The lower-than-expectation outcome in its effort to promote Ukrainian laborers to migrate to Norway stems from the lack of information on Norway's labor market and regulatory framework (UDI, 2003). As a pull approach, these agencies' task is to market Norway's competitive advantage in order to attract foreign skilled laborers. The competitive advantage of Norway lies in its high living standards, balanced work and leisure lifestyle, well-planned social welfare, and friendly environment for families. With appropriate branding with these qualities and

effective marketing campaign, Norway will be able to enhance its attractiveness to potential foreign skilled laborers. Since this policy will involve establishing physical presence abroad, it is too broad of a scope to add the policy structure to our current model.

Another source of skilled migration would be from the European countries where skilled laborers are more or less familiar with Norway due to proximity. According to Nordic Labor Journal Online[23], it is indicated that Norway tends to attract more European Union citizens. But most Nordic or European laborers usually stay on a temporary basis (OECD, 2004), only 60% of them stay for more than 10 years. Compared with Sweden and Finland, labor immigrants who stay for more than 10 years make up 67% and 76% of the total labor immigrants. So, policies are needed to encourage foreign skilled laborers to stay longer.

The third source of foreign skilled labor comes from foreign students. Foreign students are potential labor force reserves. As Norway provides free tuition in tertiary education, it becomes a strong attraction to potential tertiary students abroad. In the recent years, many European countries have started or are planning to charge tuition fees, including Germany, Denmark, and Sweden (in 2011). Norway will be able to take the opportunity to attract talented tertiary students to study in the country. Nevertheless, Norway still attracts far too few foreign students to study and to stay in Norway (OECD, 2005). In 2008, there were only 5,900 international students in Norway (OECD, 2010).

OECD countries are increasingly seeking ways to attract foreign students (OECD, 2002). Among these countries, the United States attracts the most foreign students, about one-third of all foreign students studying in OECD countries. Statistics shows that many of these students remain in the host country upon graduation. For example, 47% of the foreign-born PhD graduates remain in the United States. There are many benefits to retaining foreign

[23] http://www.nordiclabourjournal.org/i-fokus/theme-joint-nordic-drive-for-more-foreign-labour/joint-nordic-drive-for-more-foreign-labour.

The information is said to be adapted from the report "Recruitment of highly skilled labour from third-countries to the Nordic countries: Regulations, policies and realities" on commission from the Nordic Council of Ministers and a range of Nordic engineering and employee organizations. "The report shows Sweden is best at attracting third-country labour, while Norway attracts the most EU citizens…. researchers from FAOS, Fafo and Uppsala University guess Norway's high wages makes the country particularly attractive to EU citizens, while Sweden's many large companies make that country a good starting point for labour recruitment from countries outside of the EU and the Nordic region."

students as potential skilled labor force. These students have adapted to the culture and society during their stay. The hesitation of migrating and adapting to a new environment and to master a new language will be less of a concern to foreign students. In 2008, 8100 study permits were issued. The largest increase of student group was from EEA countries, particularly from Germany, France, and Spain. Most of these students participate in undergraduate courses or the Erasmus program. They only stay on a temporary basis. The largest groups of foreign tertiary students outside of EEA were from China and Russia. These students usually take the entire degree program and stay for several years (UDI, 2008). In 2010, UDI launched a specialist or skilled labor job-seeking scheme to attract the recently tertiary graduates from Norwegian education institutions to remain in the country for up to six months to search for jobs.

In order to facilitate the job-seeking process for foreign students, the career planning units within tertiary education institutions need to function at a broader level. At the moment, most career planning units provide seminars and trainings on how to write CV and application, how to search jobs from job databases, but mostly in Norwegian (OECD, 2005). Some of the careers planning units serve as a meeting place between graduates and potential employers. In a way, the units become a platform solely for Norwegian-speaking students and employers. In a broader extent, career planning units can foster communication between foreign students and potential employers by organizing events not only for Norwegian-speaking students, but also for non-Norwegian students. There are few career services outside tertiary education institutions. The proposed internship policy in the previous section will also serve as a strong attraction to the foreign students. By making the internship program as a competitive advantage of the tertiary education system in Norway, foreign students will not only be able to receive wages during internship to offset the high living costs, but will also gain invaluable working experience. The relevant working experience will provide support and enhance foreign students' learning process as well as groom them to be experienced job seekers after graduation.

Also, more tertiary programs offered in English are needed to achieve the desired outcome of this policy. As English is an international language, requiring foreign students' Norwegian proficiency will turn away potential foreign students who are outside of Nordic countries.

So, we build the foreign student policy into our model (*Figure 5-19*). In this new structure, we establish an inflow of foreign students who will study for three years in the country. The goal for the number of students the country intends to recruit is a fraction of the anticipated skilled job vacancies. The expected skilled job vacancies is the product of expected skilled labor loss rate due to old age retirement, early retirement, sickness and disability exit rate, foreign skilled labor, foreign students leaving rates, and the current skilled labor shortage. The expected skilled job demand is smoothed with a 5 year delay.

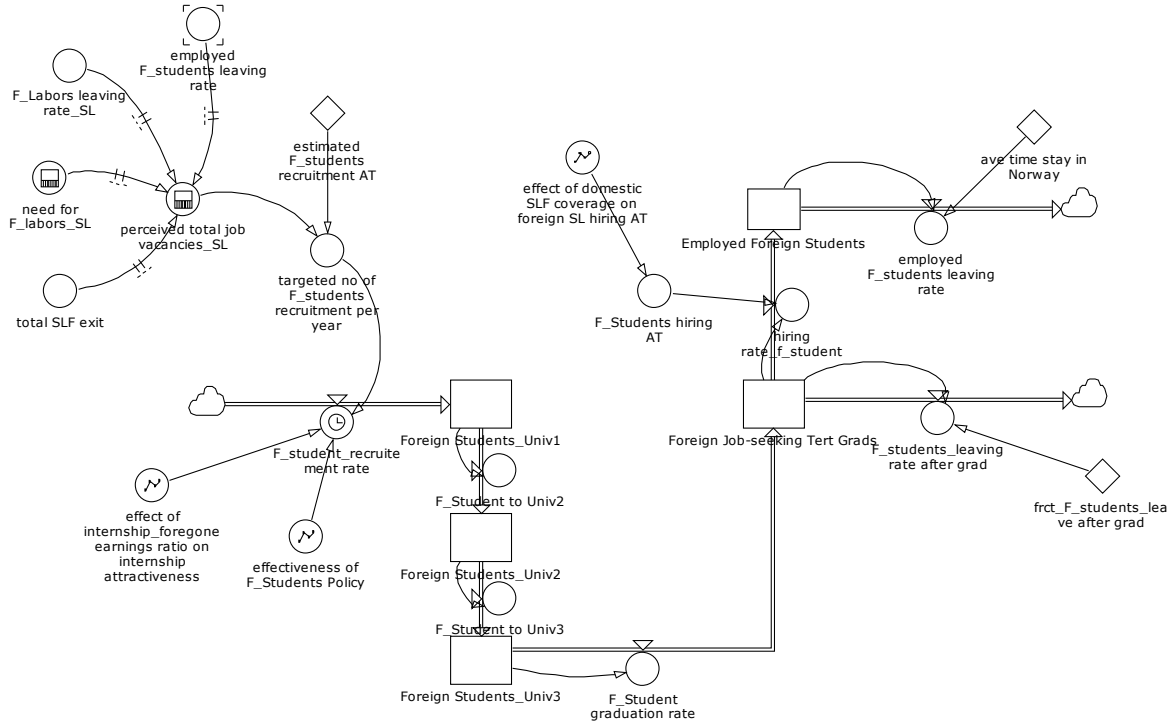


Figure 5-19 SFD- Policy 3: Foreign Student Policy

The estimated foreign student recruitment adjustment time is set for 10 years. This represents a less aggressive approach to reduce skilled labor shortage. In another word, it means that the targeted number of foreign students to be recruited to the country is 10% of the current skilled job vacancies. We presume internship policy will play a role in attracting foreign students' interest. As in the previous two policies, an effectiveness parameter is included. In the beginning stage, we expect that the marketing effort only achieve 30% effectiveness. As this policy involves the inflow from foreign sources, the uncertainty is relatively higher. Therefore, we estimate the effectiveness of this policy reach only 50% by 2050 conservatively.

After graduation, we expect 40% of these students remain in the country to seek employment and 60% leave the country. 40% of the employed foreign students are expected to stay in the country for an average of 10 years[24]. This characterizes 4% of the employed foreign students will probably be leaving the country for various reasons.

As in the previous two policies, Extra Tertiary Education Capacity for Foreign Students and Foreign Student Education Budget stocks are to be set up in order to initialize this program. Extra Tertiary Education Capacity represents the added capacity to current education institutions for human input and facility extension.

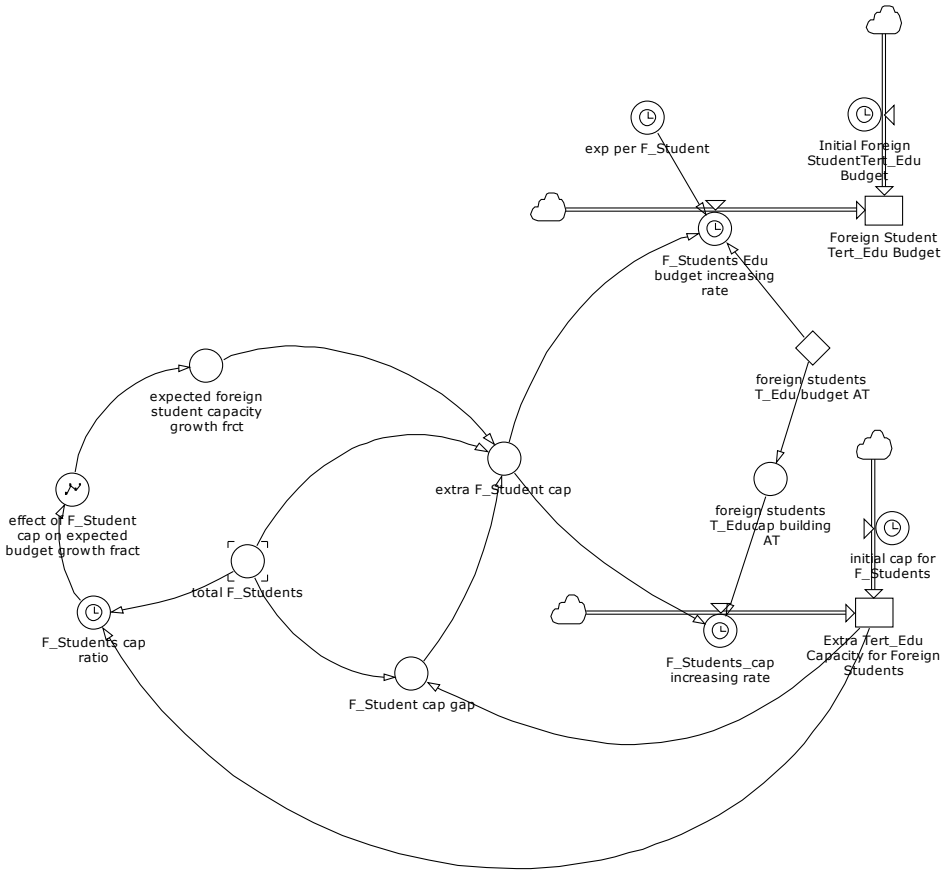


Figure 5-20 SFD- Policy 3: Foreign Student Policy

The program is initialized in 2012. One-off initial budget allocation is expected to be approved in 2013 (*Figure 5-20*). We assumed the extra capacity for foreign tertiary students will be ready for enrollment by 2015. It is estimated that it will take two years get budget

[24] From OECD International Migration Outlook 2009, 40% of the foreign-born labors stayed in the country for less than 10 years.

approved and three years for capacity building adjustment time, the delay involve is five years to build up additional capacity. Therefore, we propose to set 5% annual expected foreign student capacity growth fraction to build more capacity to avoid overcrowding in tertiary education.

The expected foreign student capacity growth fraction is influenced by the foreign student capacity ratio. When the ratio is higher than one, that means more capacity is needed; when the ratio is lower than 1, it represents excess capacity and the budget growth fraction will be zero out. The extra foreign student capacity is determined by the foreign student capacity gap and the expected capacity growth. If the capacity gap becomes negative when there is excessive capacity, Foreign Students Budget increasing rate will be a negative flow. This implies a reduction of Foreign Student Tertiary Budget as well as Extra Tertiary Education Capacity for Foreign Students.

After the implementation of Policy 3, it will boost up skilled labor supply by having 6,403 foreign students employed in the country (Figure 5-21). As skilled job density is reduced in the absence of other policy to boost Motivation to University, the locals will end up staying away from tertiary education. This leads to a reduction of 41 domestic skilled laborers in the country by 2050. Although the reduction in domestic skilled labor force is insignificant, this provides a strong indication of the drawback of this policy being carried out alone. Thus, the change in total skilled labor force is insignificant (*Figure 5-22*). In conclusion, Foreign Tertiary Education Policy will only fill 13,875 job vacancies (*Figure 5-23*).

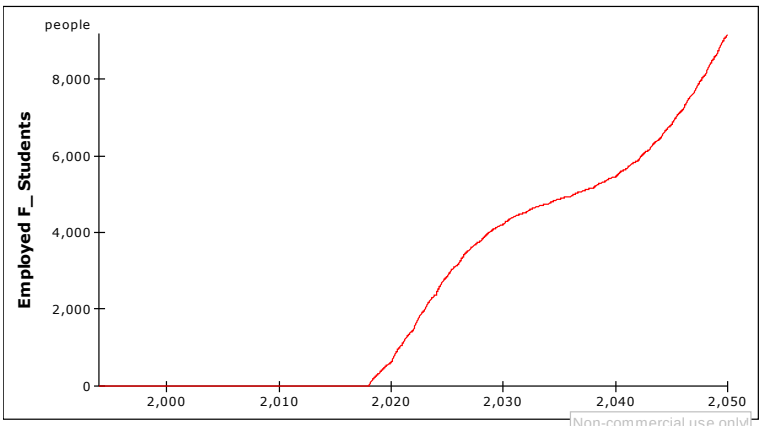


Figure 5-21 Employed Foreign Students: Foreign Student Policy

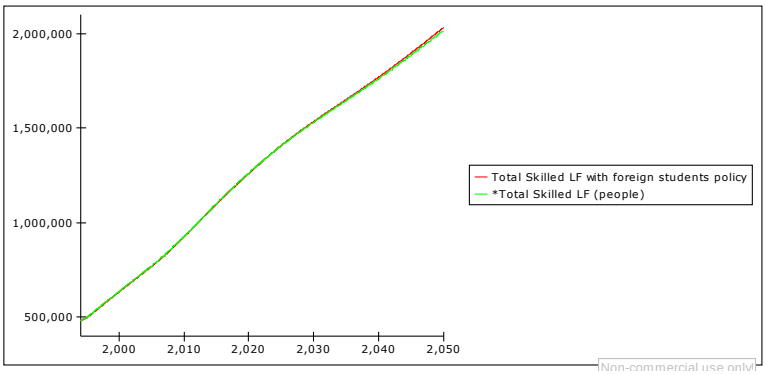


Figure 5-22 Total Skilled Labor Force: Foreign Student Policy

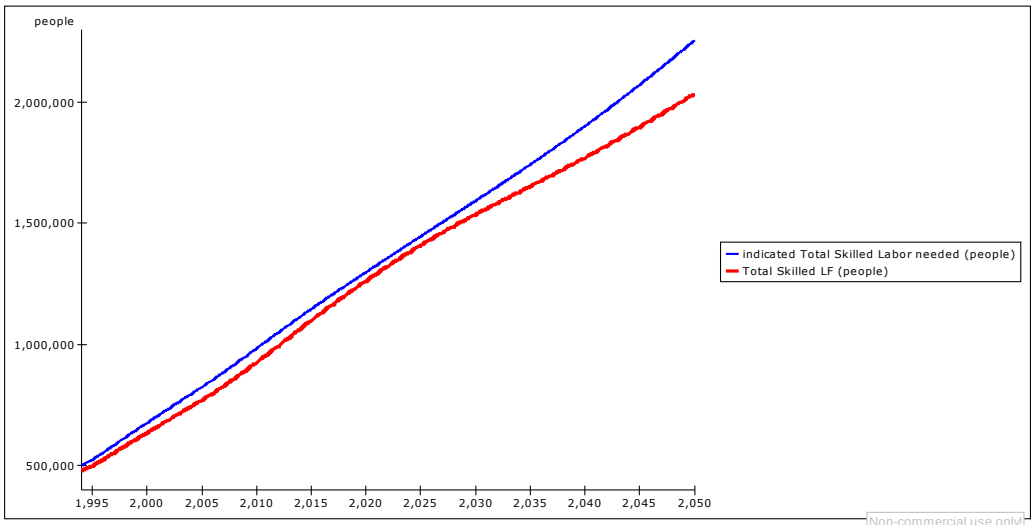


Figure 5-23 Indicated Total Skilled Labor Needed and Total Skilled Labor Force: Foreign Students Policy

The following table presents the changes of domestic skilled labor force, skilled labor shortage, CEA and performance analysis of Foreign Student Policy.

	Domestic Skilled LF	**Reduction in Skilled Labor Shortage**	**Foreign Student Tertiary Education Budget** (NOK/year)
Changes from Policy 3	-41 (people)	13,875 (people)	1.7 billion
CEA (NOK/people)	43 million	126,698	-
Performance Analysis (MAPE)	0%	2.05%	-

Figure 5-24 The Impact of Foreign Student Policy on Domestic SLF, Skilled Labor Shortage, and Cost-Effectiveness Analysis

After the implementation of Foreign Student Policy, the policy will cost 1.7 billion kroner per year in 2050. For every 43 million kroner per year spent on this policy reduce one domestic skilled laborer; on the contrary, for every 126,698 kroner per year spent reduces one skilled labor shortage. The performance analysis shows that Policy 3 will not bring changes to domestic skilled labor force but will reduce skilled labor shortage by 2.05% as compared to the base run.

We envisage three hurdles associated with the foreign student policy. First, comparatively high quality programs offered in English is the pre-requisite for the success of this policy; second, potential foreign students need to be convinced that the education quality of Norwegian tertiary programs meet international standard so they will choose Norway as the destination for their studies; third, the high living expenses in Norway might turn away foreign students. Many tertiary students from OECD countries receive limited financial support in terms of public loan, scholarships, and grants (Appendix E). Unless students are sponsored by organizations or governments, otherwise students will be required to cover their living expenses entirely from private sources.

Policy 4 - All three policies carried out concurrently

Finally, we combine all three policies and compare the cost effectiveness and performance of Policy 1, Policy 2, Policy 3, and Policy 1+2+3. The following table summarizes the changes in numbers, CEA, and Performance Analysis of each individual policy.

	Policy 1	Policy 2	Policy 3	Policy 4
	Performance Analysis (MAPE)			
Total University Students_19 to 29	1.40%	0.10%	0%	1.33%
Domestic Skilled LF	0.64%	1.90%	0%	2.48%
Skilled Labor Shortage	6.28%	25.90%	2.56%	34.51%

	Policy 1	Policy 2	Policy 3	Policy 4
	Changes in Absolute Numbers (people)			
Domestic Skilled LF	34402	129065	-41	157569
Skilled Labor Shortage	24769	153460	13875	225342

	Policy 1	Policy 2	Policy 3	Policy 4
	Cost-Effectiveness Analysis (CEA) (NOK/people)			
Domestic Skilled LF	1022414	62650	43 mil	298808
Skilled Labor Shortage	1420033	52691	126698	208939

Figure 5-25 Summary of Simulated Changes from Policy 1-4

From the summary above, Policy 4 results in the highest increase of domestic skilled labor and it costs 298,808 kroner per domestic skilled labor production per year in 2050. In terms of skilled labor shortage reduction, Policy 4 also achieves the most reduction among the four policies. It will successfully fill up 225,342 skilled jobs by 2050. Nevertheless, Policy 4 will cost 208,939 kroner per year per skilled labor shortage reduction.

Policy 2, the Online Tertiary Education Policy, alone will be able to boost up domestic skilled labor force by 129,065 laborers. It will successfully reduce skilled labor shortage by almost 153,000. This policy will cost the least to produce domestic skilled labor and to reduce shortage. However, the drawback is the minimal impact on encouraging

tertiary education participation for the age group of 19 to 29. As shown in the performance analysis above, the Total University Students_19 to 29 only increases 0.1% in 2050.

The internship policy (Policy 1) will increase 34,402 domestic skilled laborers in 2050, but the governmental spending is as high as 1.0 million kroner per person per year. This policy has the largest impact on promoting growth in tertiary education enrollments among age group 19 to 29, as compared to the other three policies. With this policy, the number of tertiary students between age 19 to 29 enrolled in tertiary education system will be 5,756 more than in the base run in 2050.

Policy 3 will reduce the least skilled labor shortage, with only about 14,000 skilled jobs filled. This policy has the most detrimental impact on domestic skilled labor production; the domestic skilled labor force will be reduced by 41 laborers in 2050. We consider that Policy 3 carried out alone will generate insignificant improvement with high costs. So, it is not cost effective to implement this policy alone. Nevertheless, the time delay involves in implementing this policy and to attract students to come to the country is long. Should Norway treat this policy as a backup plan and only launch this policy when the country fails to attract foreign skilled labor amidst strong international competition for talents, the economy transformation will be slowed down.

The choice of policy depends on the goal of the policy makers. Among all four policies, Policy 2 and 4 show biggest improvement in reducing skilled labor shortage. Even though Policy 4 incur 4 to 5 times higher spending per person, the policy will also raise the motivation to tertiary education among the 19 to 29 age cohorts, encourage tertiary education participation in age group 30 to 35, and attract foreign students to the country as skilled labor force reserve. Domestic skilled labor production is crucial to the country's human capital accumulation. Being overly independent on foreign labor or students to reduce skilled labor shortage is detrimental to domestic skilled labor production because it provides less incentive for individuals to participate tertiary education. However, as the population is growing at a decreasing rate, increasing immigration is essential to maintain positive population growth. From the behavior sensitivity test in section 4.8, it shows that in the absence of foreign skilled labor, Motivation to University will be lifted significantly (*Figure 4-13-1*). However, the lack of foreign skilled labor will lead to a more intensified skilled labor shortage (*Figure 4-13-5*). Thus, the country might lose its' competitiveness in the international market amidst

worsening skilled labor shortage. So, we perceive the need to grow domestic skilled labor force and reduce skilled labor shortage is equally important.

Figure 5-25 shows that with Policy 4 in place, the gap between skilled labor supply and demand will be drawn closer by 2050.

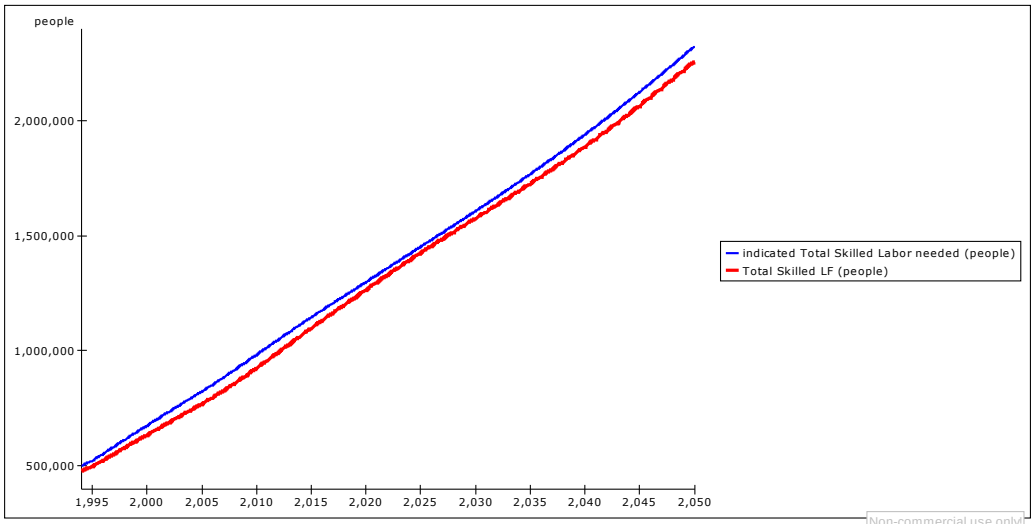


Figure 5-25 Indicated Total Skilled Labor Needed and Total Skilled Labor Force: All-in-One Policy

Domestic skilled labor force increases by 2050 with Policy 4 (*Figure 5-26*). Total university students in age group 19 to 29 also shows visible increment (*Figure 5-27*), so does Total Skilled Labor Force (*Figure 5-28*).

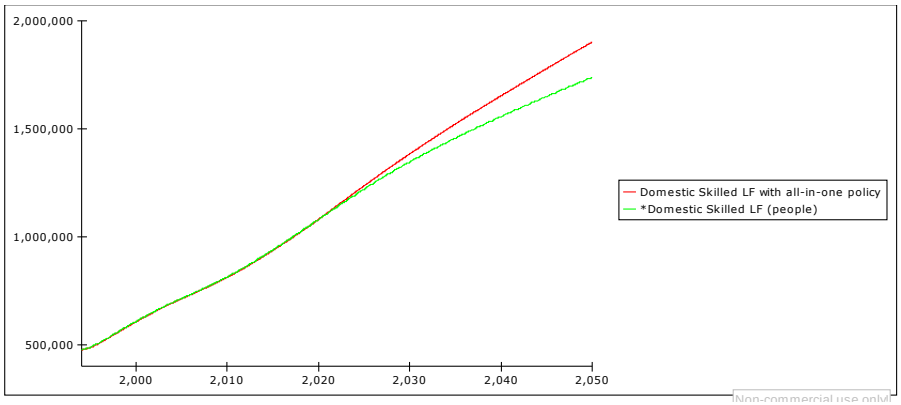


Figure 5-26 Domestic Skilled Labor Force: All-in-One Policy

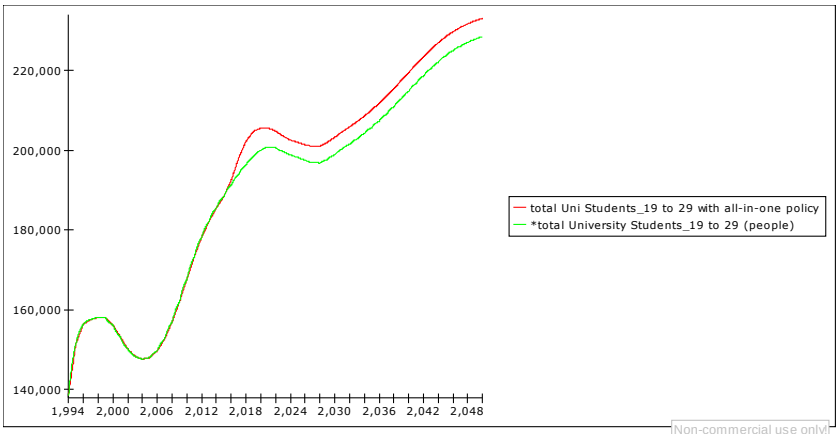


Figure 5-27 Total University Students_19 to 29: All-in-One Policy

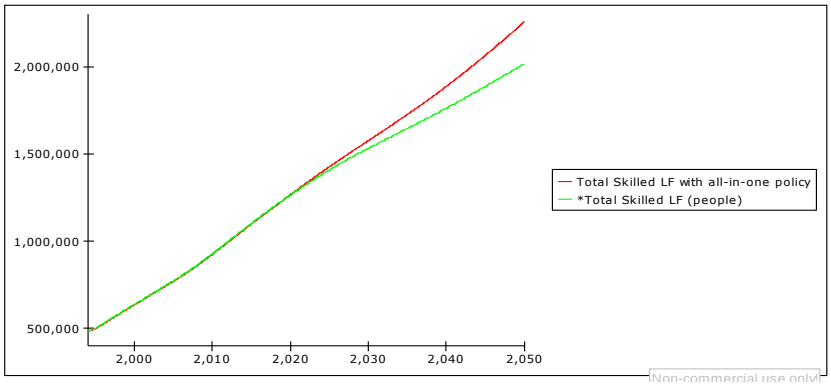


Figure 5-28 Total Skilled Labor Force: All-in-One Policy

6.0 Conclusion

Norway's economy has gone through unprecedented growth in the past decade. The strong growth in GDP, employment, labor productivity, real wage, labor immigration combine with increasing outflows from the labor force, such as early retirement scheme, sickness and disability, and old age retirement implies that Norway's labor market is tight. Since the working age population is growing at a decreasing rate, the skilled and unskilled labor forces are competing for laborers.

We hypothesize that perceived wage premium and skilled job opportunities are affected by capital investment, job composition, and skilled labor shortage. Perceived wage premium and skilled job density influence individuals' desire to pursue tertiary education in close feedback loops. Through the analysis, it shows that without the expected foregone earnings feedback loop, the motivation for individual to take up tertiary education increases considerably; on the contrary, perceived wage premium has strong positive effect on the motivation from 1994 to 2020. After 2020, the effect of skilled job density dominates Motivation to University. The introduction of foreign skilled laborers will mitigate the bottleneck situation, but in long run it will deteriorate the incentives for the local to pursue tertiary education. Since wages for skilled and unskilled are increasing due to the tight labor market, firms will increase capital investment. By investing more in capital for production, two different outcomes are revealed: a complimentary relationship for the skilled laborers and substitution effect on unskilled laborers. Capital investment will boost the requirements of skilled labor further but replace the need for unskilled labor due to higher labor productivity. As more unskilled laborers are being substituted, the shortage of unskilled labor will reduce, as will the unskilled wages. Thus, perceived wage premium increase and individuals are motivated to participate in tertiary education.

As a result, we propose the government to incorporate optional internship program as into tertiary curriculum. Secondly, we propose the government to utilize the existing digital education facilities to promote online tertiary education in age group 30-35 because this will eliminate the expected foregone earnings of individuals who participate. Besides, we propose the government to set goals for the number of students to be recruited to the country because these students can be potential skilled labor supply upon graduation.

All in all, the system is very resistant to any parametric changes. Depending on the goals of policy makers, Online Tertiary Education Policy will boost domestic skilled labor supply at a lower cost compared to the combination of Internship Policy, Online Tertiary Education Policy, and Foreign Student Policy. But the combination of policies will also encourage domestic skilled labor production as well as the recruitment of foreign students. Foreign students can be seen as skilled labor reserve for the country. Internship Policy and Foreign Student Policy implemented alone will lead to very costly outcome.

For future research, it will be interesting to study the psychological and social factors influence individuals decision to participate in tertiary education. Also, from our study, it will be useful to study how the economic returns to tertiary education and job opportunity affect skilled labor migration to the country.

References

Acemoglu, Daron. (1999). Changes in Unemployment and Wage Inequality: An Alternative Theory and Some Evidence. *American Economic Association, 89*(5), 1259-1278.

Andersson, T., Kind, J., Logan-Andersen, C. (2004). *Towards a New Growth and Innovation Policy in Norway*. Sweden: International Organisation for Knowledge Economy and Enterprise Development (IKED).

Arrow, K. (1962). Economic Welfare and the Allocation of Resources for Invention, *The Rate and Direction of Inventive Activity*. (pp.609-625). Princeton University Press. Reprinted in Nathan Rosenberg, ed. (1971). *The economics of technological change*. Penguin Books Ltd., pp. 164-181. Cited in Nerdrum (1999).

Balassa, Bella. (1969). Industrial Development in an Open Economy: The Case of Norway. *Oxford Economic Papers* 21 (3), 344-359.
Retrieved on 03/06/2010 from http://oep.oxfordjournals.org/content/21/3/344.full.pdf

Barlas, Yaman. (1996). Model Validation in System Dynamics. *1994 International System Dynamics Conference*. Methodological and Technical Issues.

Barlas, Yaman, S. Carpenter. (1990). Philosophical Roots of Model Validation: Two Paradigms. *System Dynamics Review. 6*(2): 148-166.

Becker, Gary S. (1993). *A Theoretical and Empirical Analysis with Special Reference to Education*, Third Edition. National Bureau of Economic Research.

Bjørnstad, Roger. (2000*),* The Effect of Skill Mismatch on Wages in a Small Open Economy with Centralized Wage Setting: The Norwegian Case. Discussion Papers No. 270. Statistics Norway, Research Department.

Bjørnstad, R., Cappelen, A., Holm, I., & Skjerpen, T. (2002). Past and Future Changes in the Structure of Wages and Skills. Statistic Norway. Cited in OECD (2004), pp. 9

Blanchard, O. (1997). The Medium Run. *Brookings Papers on Economic Activity*. *2*(1997), 89-141. Cited in IMF (1999).

Borjas, George J. (2005). *Labor Economics (3rd Edition)*. London: McGraw-Hill/Irwin.

Brandt, Ellen. (2000). Policies for Lifelong Learning and for Higher Education in Norway: Correspondence or Contradiction?. *European Journal of Education*. *35*(3), 271-283.

Brinch, C., Hernæs, E., and Strøm, S. (2001). Labor Supply Effects of an Early Retirement Programme. Memorandum No. 33/2001. Department of Economics University of Oslo. Cited in OECD (2004a)

Brigden, Andrew, Thomas, Jonathan. (2003). What does economic theory tell us about labor market tightness?. Working aper No. 185. Bank of England.
Retrieved on 03/06/2010 from
www.bankofengland.co.uk/publications/workingpapers/wp185.pdf

Caballero, R. , Hammour. (1998). Jobless Growth: Appropriability, Factor Substitution and Unemployment. *Carnegie-Rochester Conference Serices on Public Policy*. *48*, 51-99. Cited in IMF (1999).

Coco, Malcolm. (2003). Internship: A Try Before you Buy Arrangement. *S.A.M. Advance Management Journal*. *65*, 41-45.

Divine, R., Linrud J., Miller, R., Wilson, J. (2007). Required Internship Programs in Marketing: Benefits, Challenges and Determinants of Fit. *Marketing Education Review*. *17*(2).

Dominitz, Jeff, Manski, Charles F. (1996). Eliciting Student Expectations of the Returns to Schooling. *The Journal of Human Resources, 31*(1), 1-26. University of Wisconsin Press

European Centre for the Development of Vocational Training (CEDEFOP). (2008a). *Future Skill Needs in Europe: Medium-Term Forecast Synthesis Report*. CEDEFOP.

European Centre for the Development of Vocational Training (CEDEFOP). (2008b). *Skill Needs in Europe Focus on 2020*. CEDEFOP.

European Centre for the Development of Vocational Training (CEDEFOP). (2009). *Future Skill Supply in Europe Synthesis Report—Medium Term Forecast Up to 2020*. CEDEFOP.

Fredriksen, Dennis. (1998). *Projections of Population, Education, Labour Supply and Public Pension Benefits: Analysis with the Dynamic Micro-simulation Model MOSART*. Statistics Norway. Oslo.

Forrester, J.W. (1972). Principles of Systems. Second Edition. Wright Allen Press, Massachusette. Cited in Pinniam, N., Nakayama, M. (Unknown).

Hægeland, Torbjørn, Klette Tor J., Salvanes, Kjell. (1999). Declining Returns to Education in Norway? Comparing Estimates across Cohorts, Sector and over Time. *The ScandinavianJournal of Economics, 101*(4), 555-576. Oxford, UK: Blackwell Publishers.

Kahn, Lawrence M. (1998). Against the Wind: Bargaining Recentralisation and Wage Inequality in Norway 1987-91. *The Economic Journal*, *108*(448), 603-645. Retrieved on 9/2/2010 from http://www.jstor.org/stable/2565784.

Katz, Lawrence F., Loveman, Gary W., Blanchflower, David G. (1993). A Comparison of Changes in The Structure of Wages in Four OECD Countries. Working Paper No. 4297. National Bureau of Economic Research.

International Monetary Fund (IMF). (1999).Working Paper of the International Monetary fund: Deconstructing Job Creating.

Linquist, K. & Skjerpen, T. (2003). Exploring the Change in Skill Structure of Labour Demand in Norwegian Manufacturing. Statistics Norway.

Meadows, Donella H. (1980). The Unavoidable A Priori, an excerpt from *Elements of the System Dynamcs Method* (Randers, Jørgen, e., 1980). Waltham, MA: Pegagus Communications. 488p.

Ministry of Labour and Social Inclusion. (2007-2008). Labour Migration. Report to the Storting. No. 18.

Nerdrum, L. (1999). The Economics of Human Capital. (pp. 174) Oslo: Scandinavian University Press.

NOBE. (2002). Forecasts of the Economic Growth in OECD Countries and Central and Eastern European Countries for the Period 2000-2040. New York & Geneva: United Nations.

Norges Bank. (2009). Productivity growth in Norway 1948 – 2008. Hagelund, Kåre.

Organization for Economic Co-operation & Development (OECD). (2000). OECD Thematic Review on Adult Learning: Norway. Background Report.

Organization for Economic Co-operation & Development (OECD). (2002). International Mobility of the Highly-Skilled-Policy Brief.

Organization for Economic Co-operation & Development (OECD). (2003). The Economic and Social Aspects of Migration.

Organization for Economic Co-operation & Development (OECD). (2004a). Ageing and Employment Policies: Norway. OECD.

Organization for Economic Co-operation & Development (OECD). (2004b). Developing Highly Skilled Workers: Review of Norway. OECD Economic Survey: Norway.

Organization for Economic Co-operation & Development (OECD). (2005). OECD Thematic Review of Tertiary Education : Country Background Report for Norway.

Organization for Economic Co-operation & Development (OECD). (2006a). Sickness, Disability and Work: Breaking the Barriers-Norway, Poland, Switzerland.

Organization for Economic Co-operation & Development (OECD). (2006b). *Thematic Review of Tertiary Education: Norway*. OECD Economic Survey: Norway. Retrieved on 14/08/2009 from http://www.oecd.org/dataoecd/2/28/37457548.pdf

Organization for Economic Co-operation & Development (OECD). (2007a). *OECD Economic Surveys: Norway 2007*. Chapter 1: Norway's Economic Success and the Challenge on Preserving It.

Organization for Economic Co-operation & Development (OECD). (2007b). *Chapter 4: Reforms to Boost Labour Supply*. Retrieved on 20/05/2009 from http://www.oecd.org/dataoecd/2/4/34458251.pdf

Organization for Economic Co-operation & Development (OECD). (2008a). *OECD Economic Surveys: Norway 2008*.

Organization for Economic Co-operation & Development (OECD). (2008b). *Jobs for Youth: Norway 2008*.

Organization for Economic Co-operation & Development (OECD). (2009). *OECD Education at a Glance: 2009*.

Organization for Economic Co-operation & Development (OECD). (2010). *International Migration Outlook: 2010*.

Peterson, Willis L. (1971). *Principles of Economics: Micro*. United States: Richard D. Irwin, Inc.

Pinniam, N., Nakayama, M. (Unknown). *System Dynamics Application to Suburban Development*, Department of Rural Technology, Faculty of Science and Technology
Tannen, Michael B. (1978). The Investment Motive for Attending College. *Industrial and Labor Relations Review*,*31*(4), 489-497. Cornell University.

Qudrat-Ullah, Hassan, Seong, Baek Seo. (2009). How to do Structural Validity of a System Dynamics type Simulation Model: The Case of an Energy Policy Model. *Energy Policy*. *38*(2010), 2216-2224.

Thammasat University. Faculty of Agriculture, Utsunomiya University.

Salvanes, Kjell G. (1996). Job Creation and Job Destruction in Norway: 1976 – 1992. OECD Job Study.Oslo.

Salvanes, K.G. and S.E. Førre. (2003). Effects on Employment of Trade and Technical Change: Evidence from Norway. *Economica*. *70*(278) , 293-329.
Retrieved on 09/07/2010 from http://www.jstor.org/stable/3548849

Sharpe, Andrew, Arsenault, Jean-Francois, & Harrison, Peter. (2008). The Relationship Between Labour Productivity and Real Wage Growth in Canada and OECD Countries. Research Report No. 2008-8. Centre for the Study of Living Standards.

Stack, Steven. (1978). The Effect of Direct Government Involvement in the Economy on the Degree of Income Inequality: A Cross-National Study. *American Sociological Review*. *43*(6). 880-888.
Retrieved on 17/07/2010 from http://www.jstor.org/stable/2094627

Statistics Norway. Retrieved on 18/02/2010 from
http://www.ssb.no/emner/02/03/sos101/sos101.pdf

Statistics Norway. (2007). Population 16 years and over, by level of education, gender and county of residence 2007. Retrieved on 20/05/2009 from
http://www.ssb.no/english/subjects/04/01/utniv_en/tab-2008-08-21-01-en.html

Sterman, John D., (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World*, London: Jeffrey J. Shelstad.

The Norwegian Directorate of Immigration (UDI). (2003). The Evaluation of the Results of the Introduction of the New Regime for Migration of Skilled Labour to Norway: The Case of Ukraine. Executive Summary.

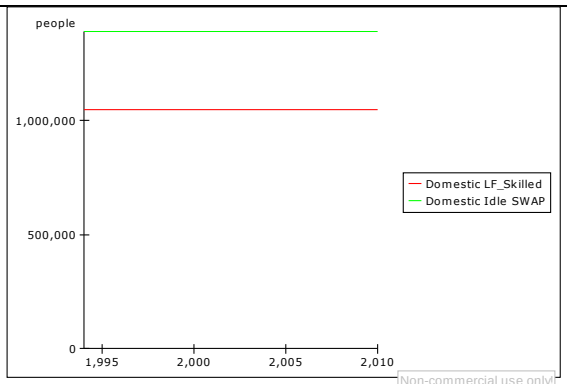
The Norwegian Directorate of Immigration (UDI). (2008). Facts and Figures 2008. Retrieved on 20/05/2009 from http://www.udi.no/upload/Pub/Aasrapport/2008/UDI%20Tall%20og%20fakta_eng_web.pdf

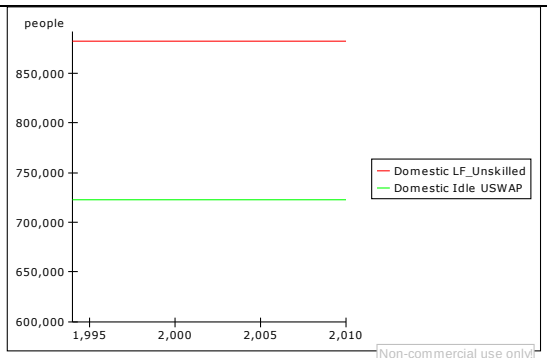
Trendle, Bernard. (2008). Skilled Labour Shortages-definition, cause and implications. Working Paper No. 54 . Labour Market Research Unit-Department of Education, Training and the Arts: Queensland Government. Australia. Retrieved on 03/06/2010 from http://www.training.qld.gov.au/resources/employers/pdf/wp54-skill-labour-shortages.pdf

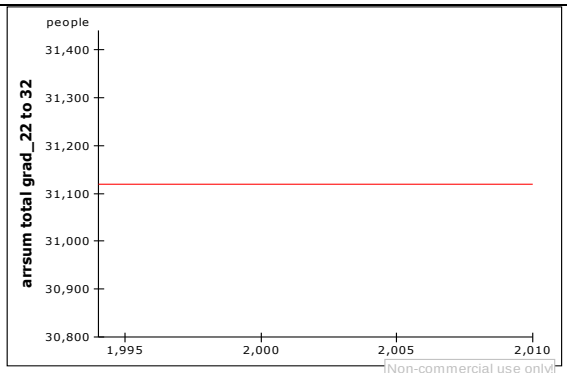
Zauberman, Gal, Kim, Kyu B., Malkoc, Selin A., Bettman, James R. (2008). Discounting Time and Time Discounting: Subjective Time Perception and Intertemporal Preferences. *Journal of Marketing Research*, XLV. American Marketing Association.

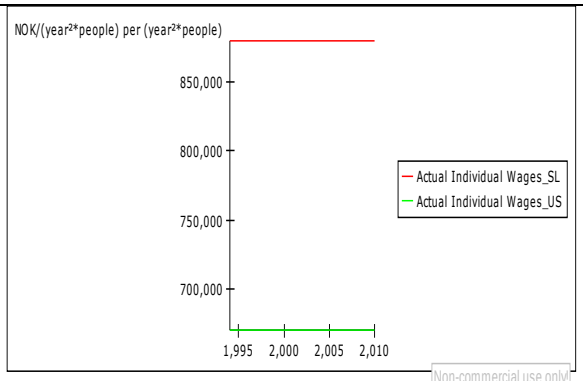
Appendix A – Validation Test Results

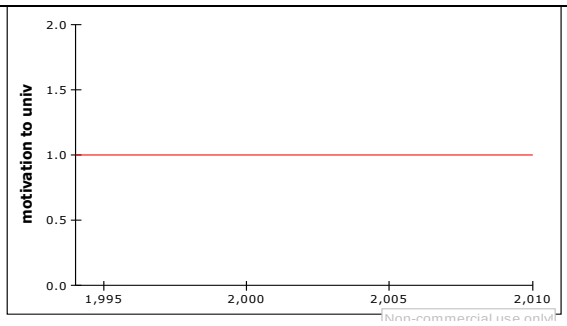
Equilibrium Test

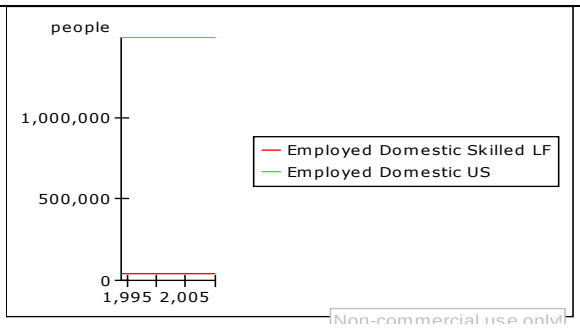


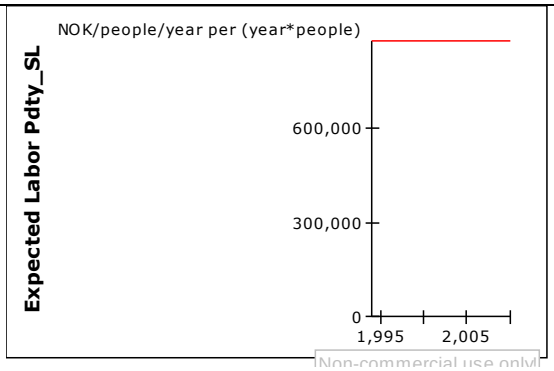


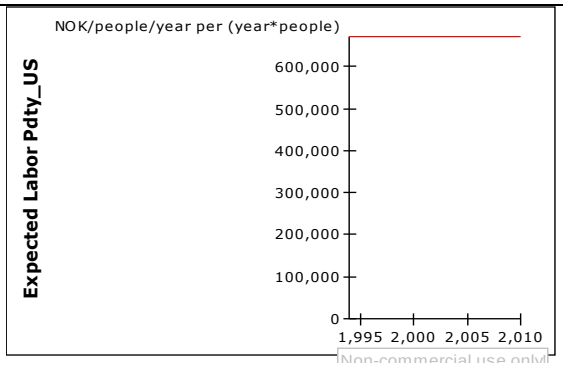


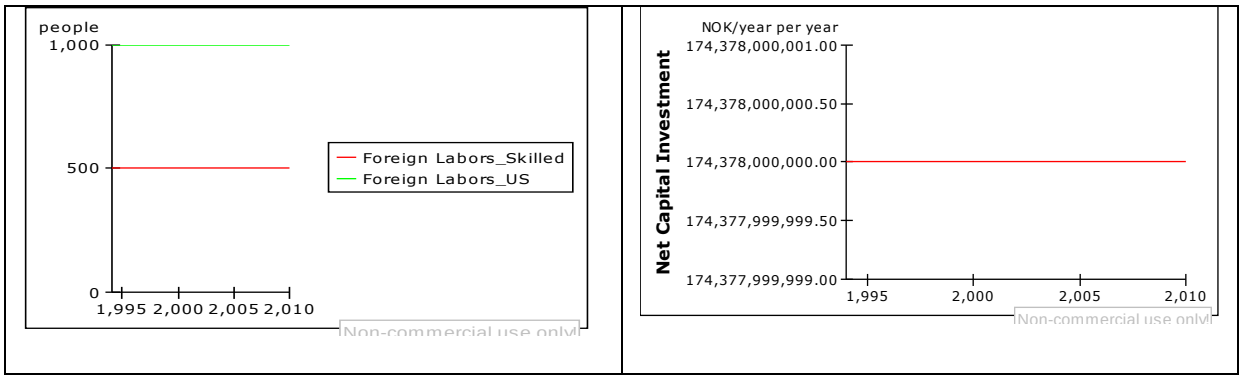











people
1,000
500
0
1,995
2,000
2,005
2,010
Foreign Labors_Skilled
Foreign Labors_US
Non-commercial use only
NOK/year per year
Net Capital Investment
174,378,000,001.00
174,378,000,000.50
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1,995
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Non-commercial use only

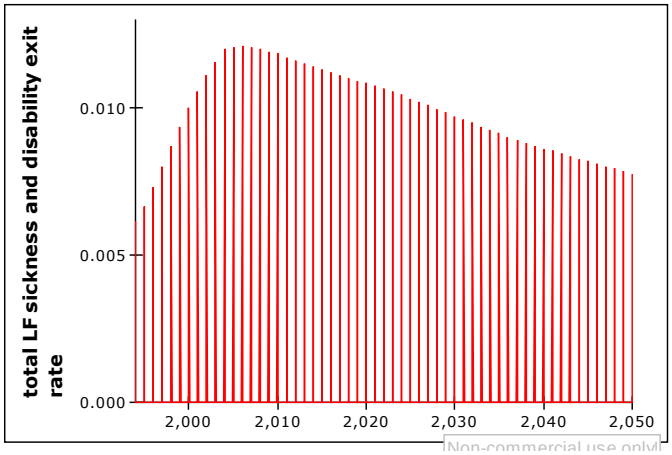
4.1 Parameter Verification Test (A1) & Structure Verification Test (A2)

The following table presents all the exogenous parameters in our model. It is divided into parameters with statistical data and estimated value. In the parameter and structure verification test, we compare the behaviors generated in our model through statistical data to determine if these behaviors are conceptually and numerically reasonable as compared to the real system. We will test the parameters with estimated value in the parameter sensitivity testing section later on.

Statistical Data	Estimated Value
Labor Force Submodel	
frct_death	
frct_AFP_skilled	
frct_AFP_unskilled	
frct_leaving_SLF_30 to 49	
frct_leaving_SLF_50 to 61	
frct_leaving_USLF_30 to 39	
frct_leaving_USLF_40 to 49	
frct_leaving_USLF_50 to 61	
Idle_SWAP_enter_SLF	
frct_unskilled_Idles_re-enter	
frct_To_Idled_USLF_AG_19	
Tertiary Education Submodel	
Age Group 18	Incompletion fract_Univ1_19 to 24
frct_NOT_to_Univ1_AG_19	Incompletion_fract_Univ2_19 to 24
frct_To_Univ1_AG_19	Incompletion_fract_Univ1_25 to 29
	Incompletion_fract_Univ2_25 to 29
Job Demand Submodel	
Aggregate Demand	hiring_SL _AT
Reference Skilled Labor Fraction	hiring_USL _AT
	F_Labors_SL_AT
	F_Labors_US_AT
	natural_UR_SL
	natural_UR_US

	frct of _F_SL leaving
	frct of _F_USL leaving
Wages Submodel	
	labor share_skilled
	labor share_unskilled
Motivation to University Submodel	
	distr_starting wage
	distr_foregone earnings
	distr_foregone earnings
	distr_ease of finding job
Labor and Capital Submodel	
	Ave Capital Investment Growth Rate

Labor Force Submodel Statistical Parameter Verification



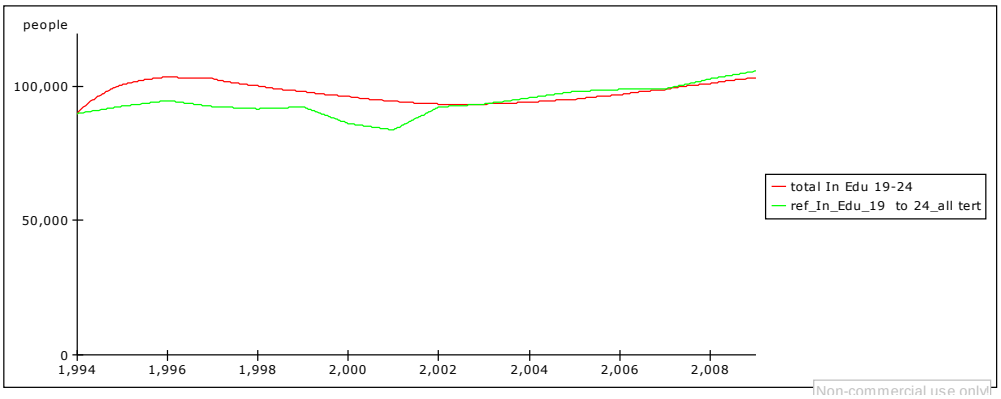
We compared the simulated behavior of the statistical parameters with the statistical input from OECD (2004, 2006):

- Outflow from disability recipient to work is almost nil.
- Disability benefit recipiency rates among the working age population is 11.4%.
- The beneficiary rate increased most among young workers aged 20-34 and very little for those over 50.
- Employment rate among the disability recipients is only 45%. Since 2000, the employment rate for disability recipients has been falling despite existing and new employment integration programs and campaigns.
- Employment rate of disabled people aged 20-34 and disabled persons with tertiary education are between 70% and 88%.
- The inflow to disability benefits was over 1% of the working age population from the beginning of 1990s to 2005.
- Age group of 50-66 will increase 40% until 2015; age group over 67 will increase 200% by 2050.
- The simulated behavior does not reach 1% in the beginning of the simulation because in our model, the labor force stock is constructed as an array with 49 age groups from 19 to 67. We estimated the initial values of the skilled and unskilled labor force. We also broke down the sickness and disability fractions for three different age groups, namely 30-39, 40-49, and 50-61. People who become 62 usually opt for early retirement rather. Those who reach 67 will leave the labor force as old age retiree. Around 2000, the outflow from labor force due to sickness and disability is close to 1% of the working age population. The outflow will continue to rise over 1% after 2005

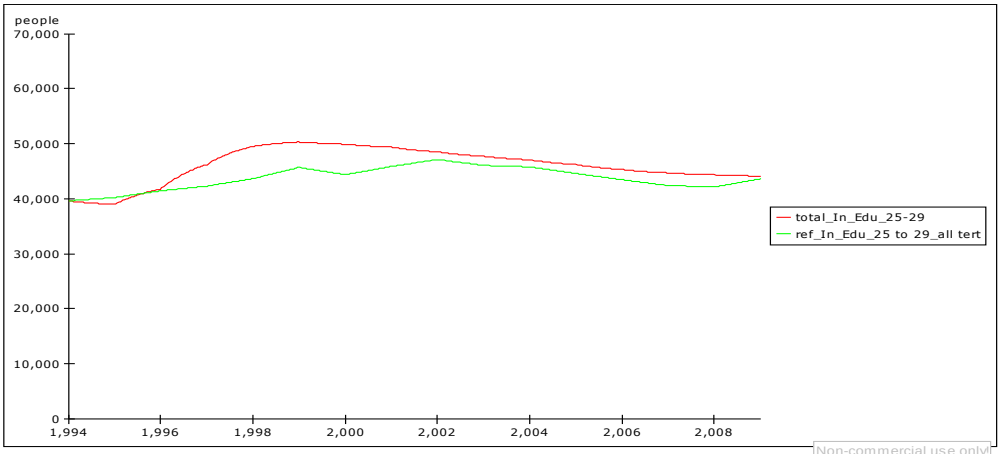
due to the lack of incentive for the recipients to re-enter the labor market if everything remains status quo, this trend will remain. About 20% - 30% of the working age population leaving the labor force from 1994 to 2005 due to old age retirement. After the introduction of Early Retirement Scheme (AFP) in 1989, the outflow through this schmed was under 5% until 1998 where the AFP qualified age was reduced to 62 from 66. The fraction of age group 62-66 opt to leave the labor force through this scheme was increasing significantly after 1998. Therefore, the outflow of old age retirement decreased. As the working age population is growing at a decreasing rate, the outflows will gradually decrease.

Tertiary Education Submodel Statistical Parameter Verification

In this statistical parameter verification test, we compared the simulated behavior with the historical input from Statistics Norway database.



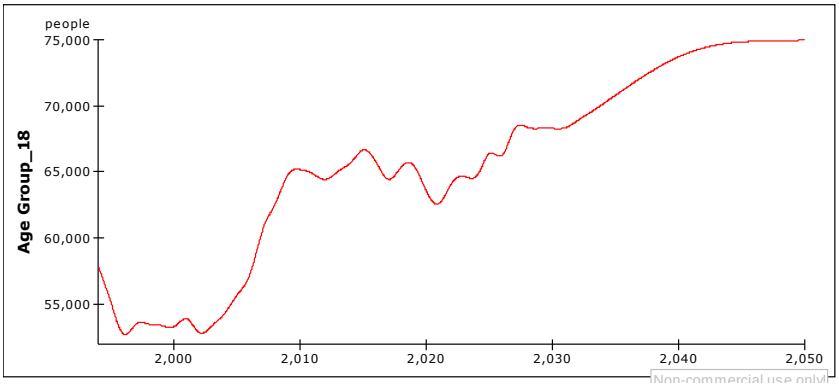
The reference trend represents the tertiary student enrollment in age group 19 to 24 from 1994 to 2008 (total_In_Edu_19-24). From 1994 to 2008, the trend was based on historical data (ref_In_Edu_19 to 24_all tert).



From 1994 to 2008, the simulated behavior of tertiary student enrollment in age group 25-29 (tota_In_Edu_25-29) replicated the historical trend (ref_In_Educ_25 to 29_all tert).

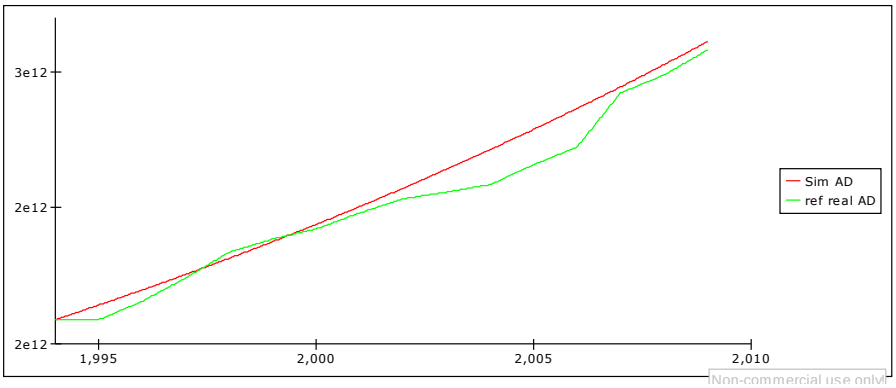
Age Group 18 is the population at age 18 in 1993. When the simulation starts in 1994, this age group will become the entrants to age group 19. As we mentioned earlier on, the age group 19 becomes the entry point to the unskilled labor force or tertiary education. The data on fraction of age group 19 transiting to tertiary education is adapted from OECD Education

at a Glance (2009). The remaining of age group 19 proceeds to unskilled labor force. The following figure presents the historical development and future projection of age group 18 based on statistical data from Statistics Norway. The future projection takes the future population growth of the country into consideration. Though, it will be the exogenous input to our model.



Job Demand Submodel Statistical Parameter Verification

The growth fraction of aggregate demand in the country is averaged to be 3.7%. This is the average growth fraction from 2001 to 2009 according to Statistics Norway, and it is also predicted that the growth fraction from 2011 to 2013 is between 3.3% and 3.9%. But the simulated behavior fits the historical trend better when we use 3.3%. Therefore, we will use 3.3% in our model. Statistics Norway predicts that the demand for goods and services in the country will remain strong in the near future. The following figure presents the simulated behavior of aggregate demand in the job demand submodel.

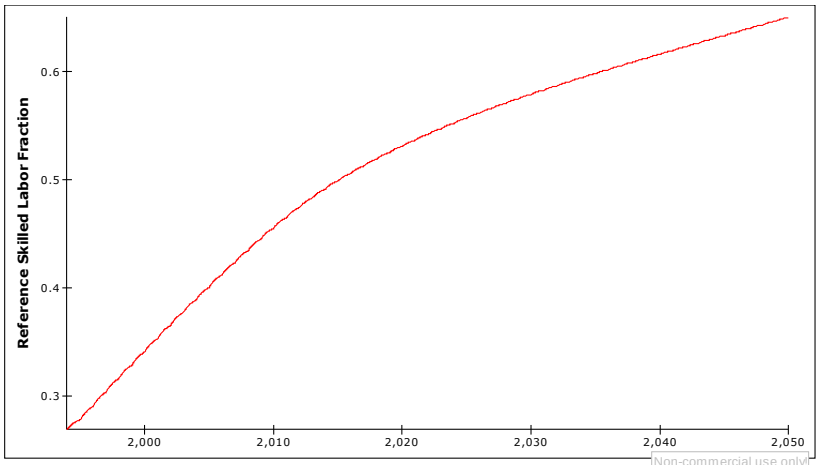


Aggregate demand growth fraction = 3.3% per year

Initially, Reference Skilled Labor Fraction is determined by the fraction of skilled labor in the total labor force. Since it has been publicly voiced out that the labor market is tight, we infer that the fraction of aggregate demand that required skilled input and the skilled labor supply is in equilibrium in the beginning of the simulation. We cross reference with foreign skilled labor inflows in 1990s. The specialist permits are granted to foreign labor with skilled or higher education, such as professional training in relevant occupation or tertiary education. It shows that the specialist permits granted during 1996 to 2000 was around 500. So, the skilled labor market seemed to be tight or the shortage was not severe.

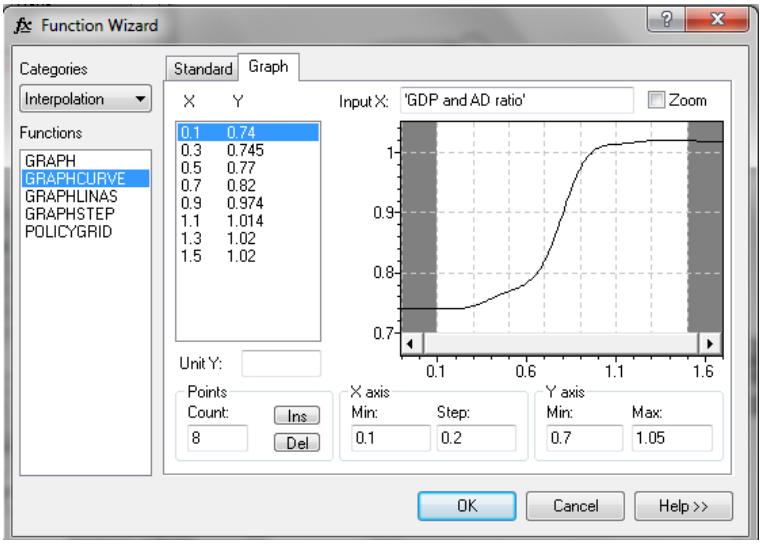
Hence, we simulate the aggregate demand that requires skilled input with the previously stated assumption and obtain the following behavior mode. The fraction of skilled aggregate demand will grow in parallel to the skilled labor force. As the working age population tertiary education attainment rate was increasing every year from 26% to 32% from 1997 to 2007, the Reference Skilled Labor Fraction increased accordingly too. The Reference Skilled Labor Fraction presents a goal-seeking behavior because the fractional increment will slow down gradually as the fraction is approaching 1, which is the maximum

of skilled aggregate demand can be in an economy. This development in line with the theory explained in Section 1.1 that one of the causes of labor shortage is the "supply generates demand" scenario. As this fraction of aggregate demand is increasing, so will aggregate demand that requires skilled input (AD_Skilled).

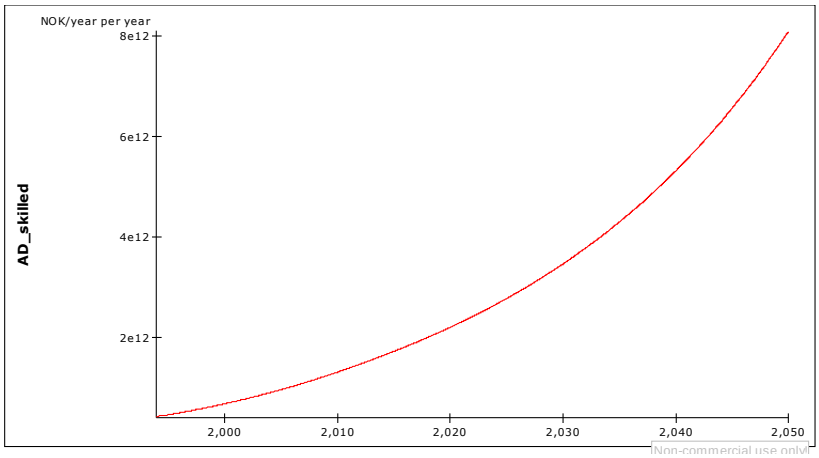


Reference Skilled Labor Fraction

AD_Skilled presents an exponential growth behavior because ave_AD_growth rate is set to be 3.3%. However, GDP in the country will have impact on the average aggregate demand growth rate. When the ratio of GDP and AD equals to 1, the average growth rate will be 3.3%; when the ratio is less than 1, the ave_AD_growth rate will be less than 3.3% and vice versa. The following non-linear graphical function is used for this purpose.



Non-linear Graphical Function on Average Aggregate Demand Growth Fraction

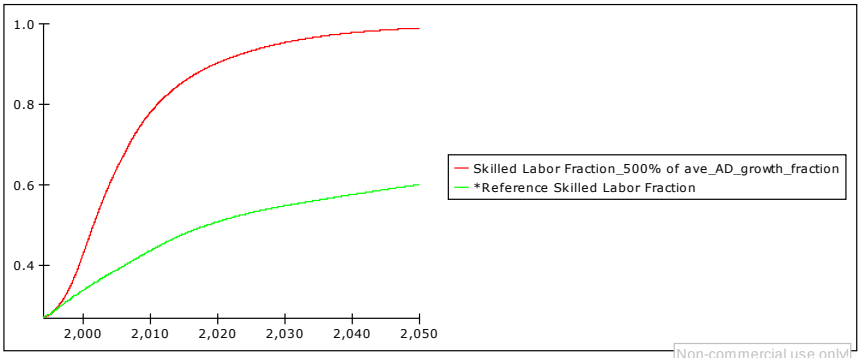


Simulated Aggregate Demand

4.2 Local Extreme Condition Test (A3)

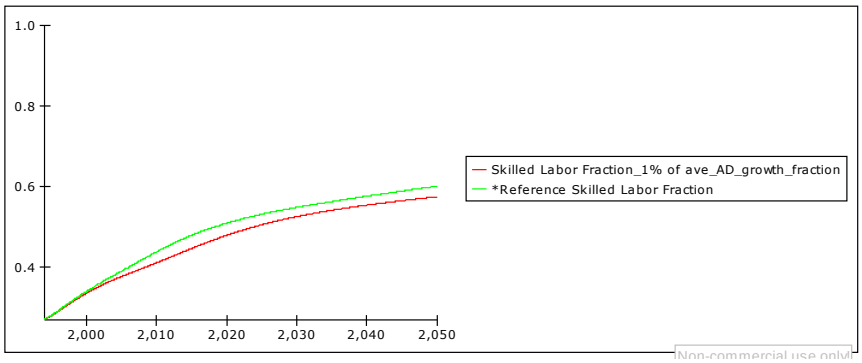
(1) R1 – Aggregate demand and skilled input loop

Increase ave_AD_growth rate by 500%. Ref Skilled Labor Fraction increases faster and reaches equilibrium at 1.0, which is also the maximum fraction of skilled aggregate demand the country will have.



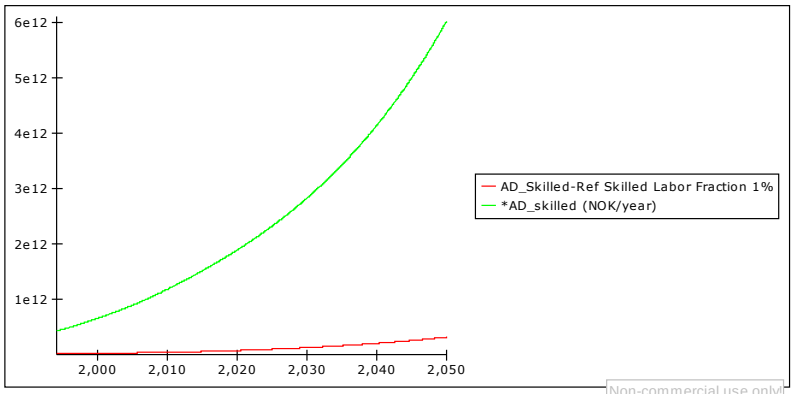
Ref Skilled Labor Fraction

Decrease ave_AD_growth rate by 99%, Ref Skilled Labor Fraction grows at a slower pace and only reaches slightly above 0.5 by 2050.

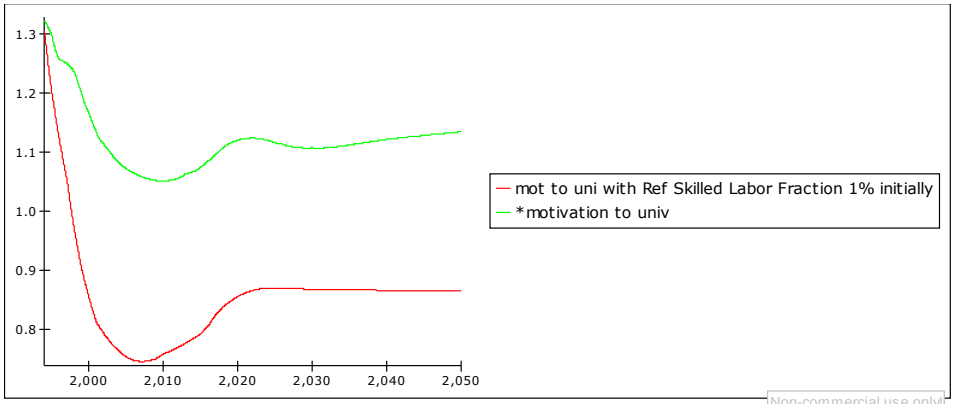


Ref Skilled Labor Fraction

Divide the initial value of Ref Skilled Labor Fraction by 27. Thus the initial value becomes 1%. Subsequently AD_Skilled only reaches almost NOK 317 billion instead of NOK 600 billion in 2050. But this development causes Motivation to University to drop drastically and remains below 1 from 2000 onwards.



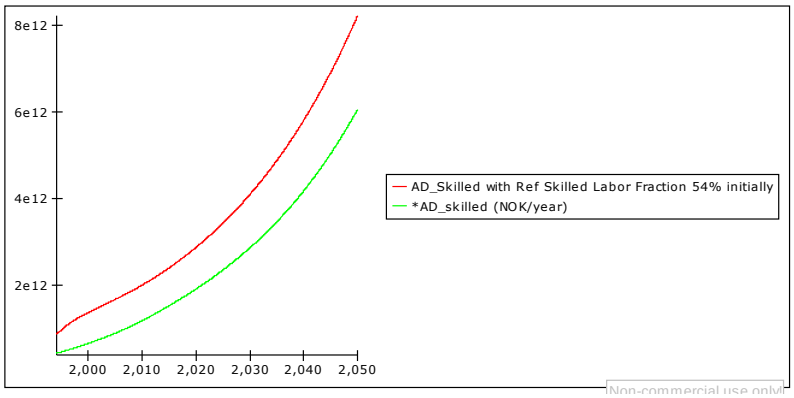
AD_Skilled



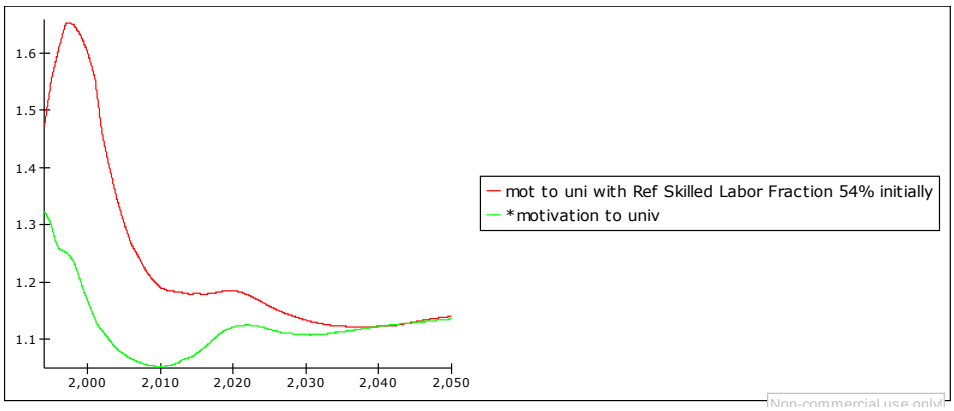
Motivation to University

Now, we shall shock the loop with the initial value two times greater than the value in base run. AD_Skilled in this test presents a higher trend than in the base run. This is because

the initial value of AD_Skilled is already higher due to larger fraction of skilled aggregate demand in the country in the beginning. Therefore, AD_Unskilled is lower than in the base run. Surprisingly, Motivation to University increases considerably from 1994 to 2000. After 2000, it starts taking downward turn until 2030 where it eventually stabilizes as in the base run. Since unskilled labor shortage diminishes because the fraction of aggregate demand that requires unskilled input decreases drastically, wages for unskilled labor drops. So, individuals find that expected foregone earnings are much lower and wage premium is high. This constitutes to the strong increment of motivation to university in the beginning. As time goes by, many foreign skilled laborers are brought into the country to fill the available vacancies. In the later stage, perceived skilled job density returns to the same level as in the base run. So, skilled job density loses its appeal when it comes to attracting individuals to pursue tertiary education.



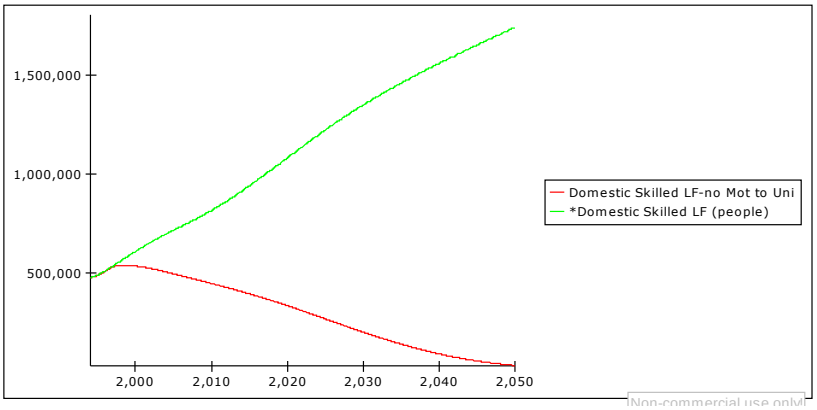
AD_Skilled



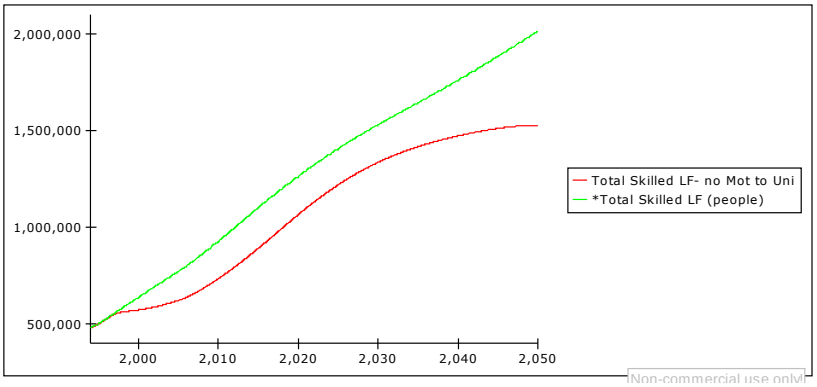
Motivation to University

(2) The effect of Motivation to University on Domestic Skilled Labor Force and Total Skilled Labor Force

We zero out the Motivation to University variable (C1, C2, C3, C13-C15), so that no inflow to tertiary education. Thus, the Domestic Skilled LF stock will be drained due to lack of inflow combines with persistent outflows. The simulated behavior presented a decaying behavior. Total Skilled LF is still increasing because more foreign skilled laborers are brought into the country. However, due to the increasing outflow from Domestic Skilled LF and only by relying on foreign skilled labor, Total Skilled Labor Force starts to grow at a decreasing rate from 2030 onwards.

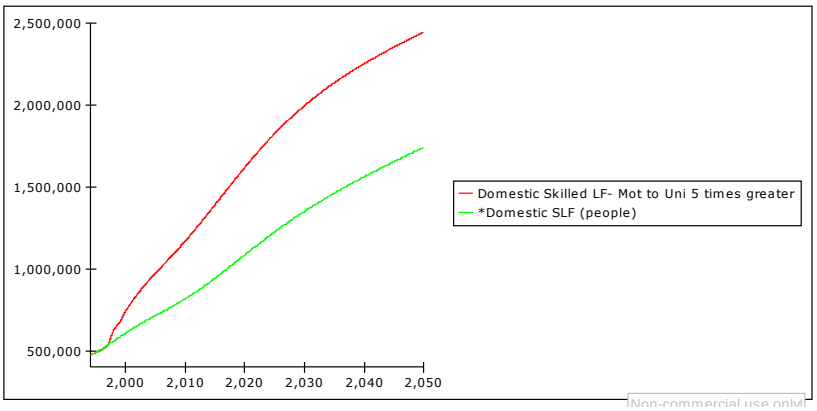


Domestic Skilled Labor Force

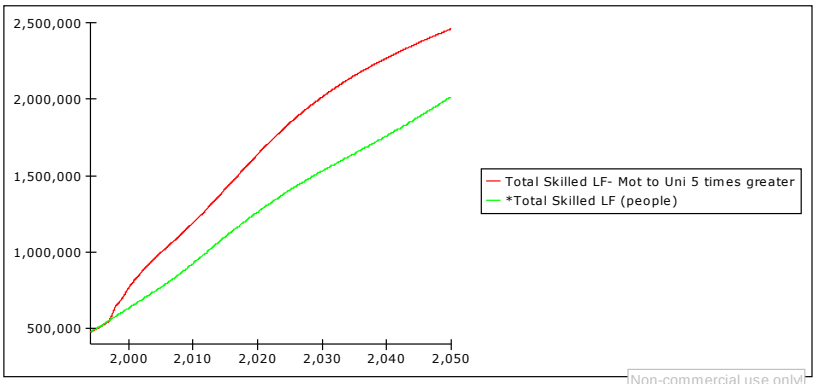


Total Skilled Labor Force

We exaggerate the Motivation to University by five times larger than the value in base run. Therefore, more entrants to tertiary education and more locally produced skilled laborers in the labor force. Domestic Skilled Labor Force and Total Skilled Labor Force present goal-seeking behavior as the fraction of available unskilled working age population is becoming smaller and smaller.



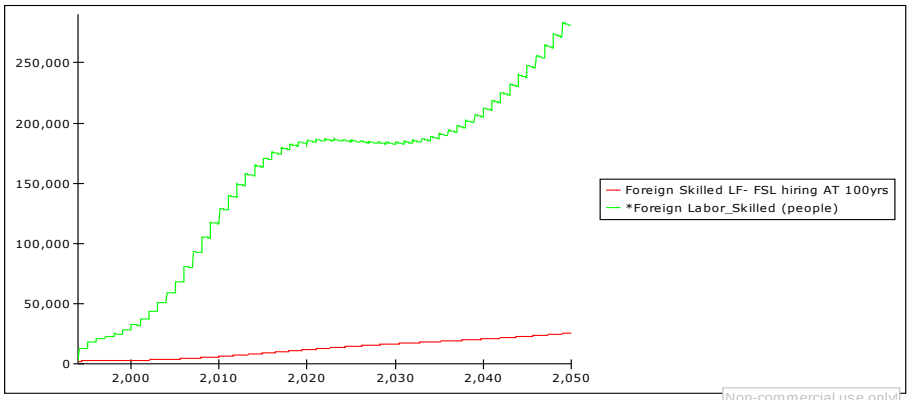
Domestic Skilled Labor Force



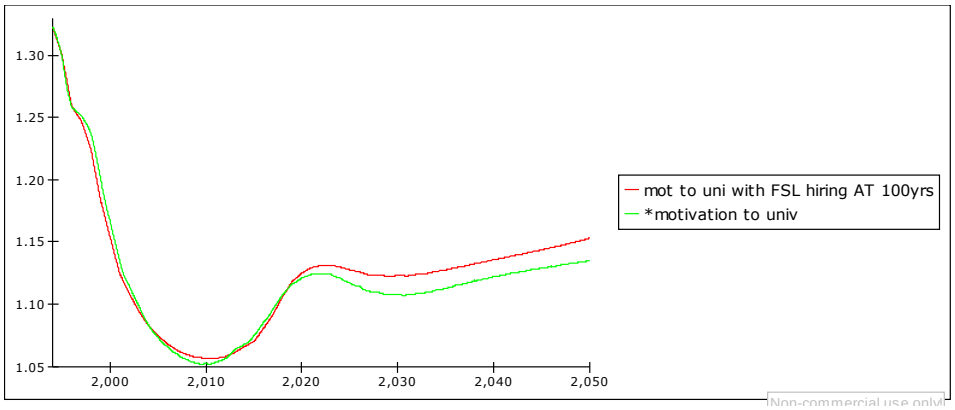
Total Skilled Labor Force

(3) C7 – Foreign Skilled Labor Loop

In this test, we lengthen F_Labors_SL_AT to 100 years from 2.5 years. Therefore Foreign Labor_Skilled stock is only about 25,000 in 2050 due to very low inflow. Since foreign skilled labor accumulation is slow, fraction of aggregate demand that requires skilled input grows slowly. Thus, Motivation to University grows slightly higher after 2020 when skilled job density springs up.

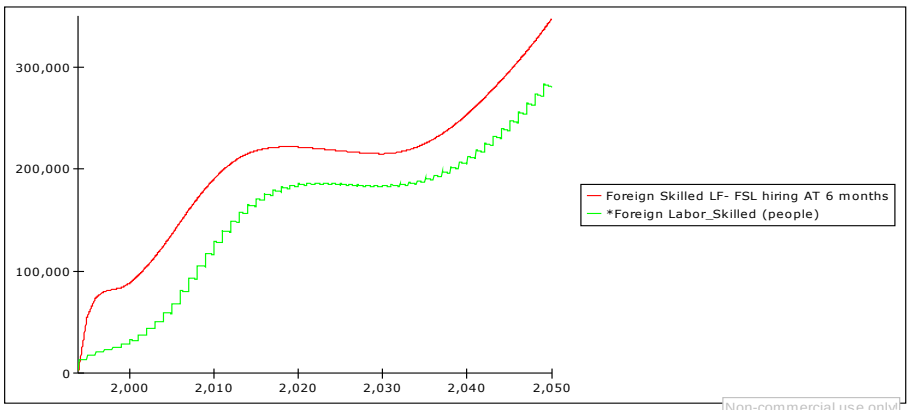


Foreign Skilled Labor Force



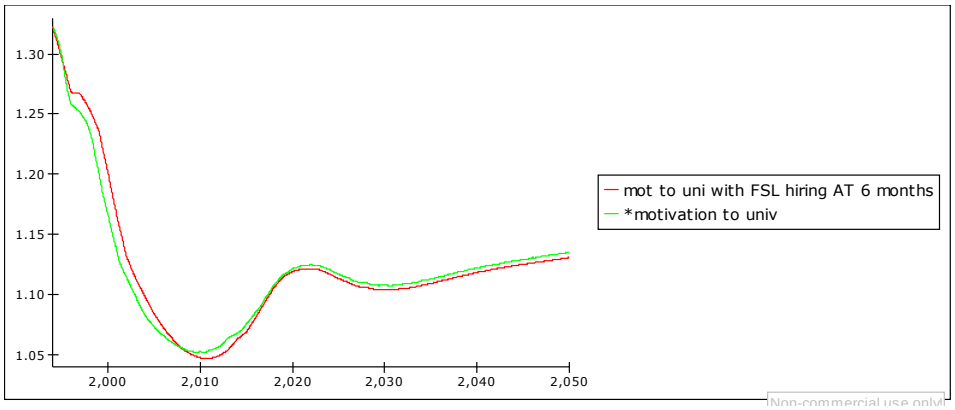
Motivation to University

The following figure presents the simulated behavior of Foreign Skilled Labor Force stock with Foreign Labors_Skilled Hiring AT equals to 0.5 year. Thus, the stock accumulates exponentially as long as Need for F_labors_SL is a positive. From 2005 to 2010, most of the jobs are filled, so the inflow of foreign skilled labor slows down until 2030. Shortage starts to appear again after 2032, so influx of foreign skilled labor takes place again.



Foreign Skilled Labor Force

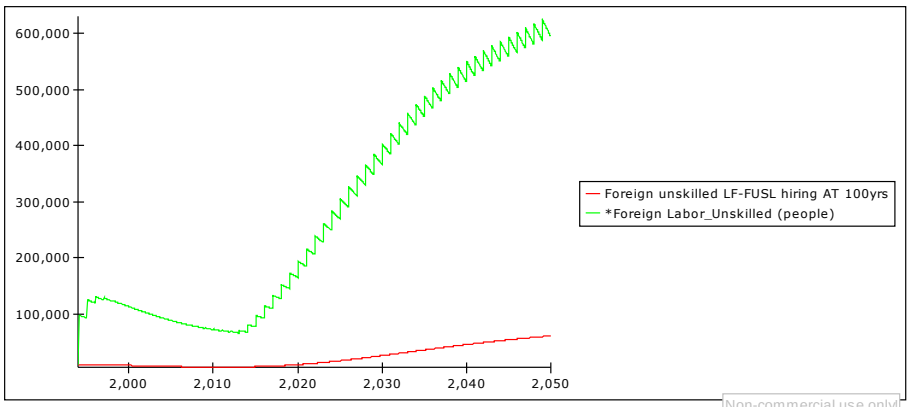
Prior to 2010, the Motivation to University is higher than the base run. This is because that more foreign skilled labor hired to the country will reduce skilled labor shortage and thus encourage the growth of Ref Skilled Labor Fraction. Therefore, aggregate demand that requires skilled input springs up considerably. This will prompt firms to increase investment in capital in order to reduce human input. As a result perceived wage premium increases significantly from 2000 to 2010. Since the effect of capital investment will bring forth labor need reduction, skilled labor shortage will be reduced. This explains why Motivation to University returns to almost the same level as in the base run after 2020.



Motivation to University

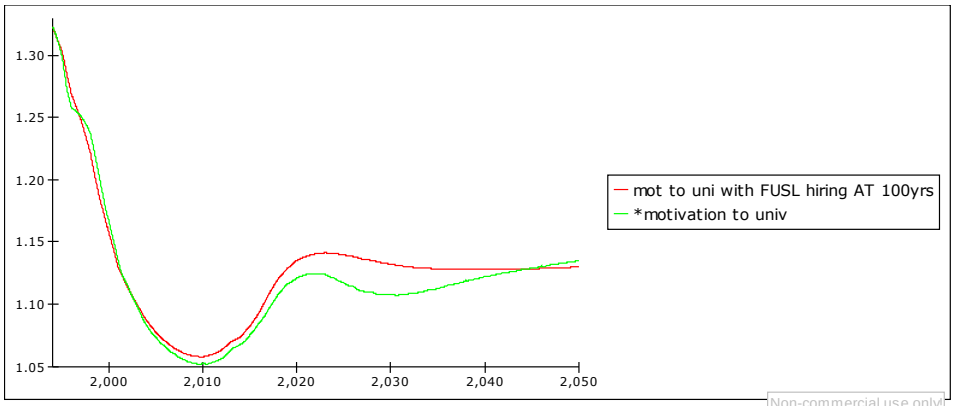
(4) C8 –Foreign Unskilled Labor Force Loop

This test is similar to the previous test on Foreign Skilled Labor Force. We lengthen Foreign Labors_Unskilled Hiring AT to 100 years. Hence, the stock accumulates at a very slow rate as compared to the behavior generated from base run.



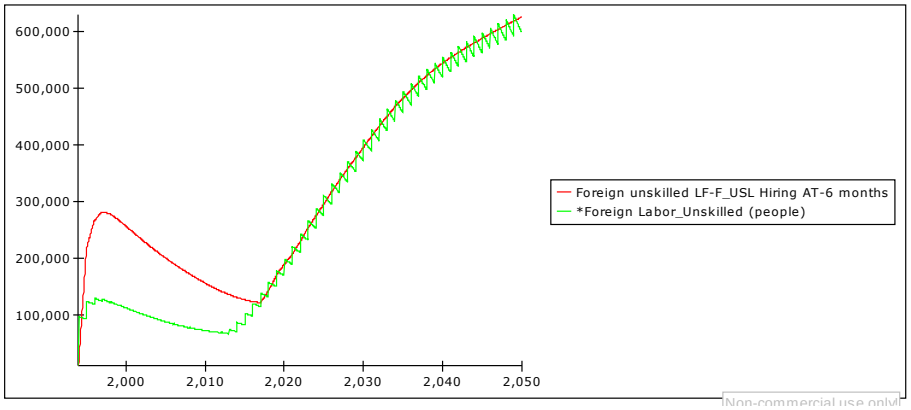
Foreign Unskilled Labor Force

Motivation to University presents a higher trend than in the base run after 2005. This is because that more domestic unskilled labor enters the labor force as a result of fewer foreign unskilled laborers being hired to the country. As the aggregate demand of the country grows slower due to lack of labor, shortages for unskilled labor reduces. More unskilled labor is unemployed. Thus, this drives down the wages for unskilled. So, wage premium increases.



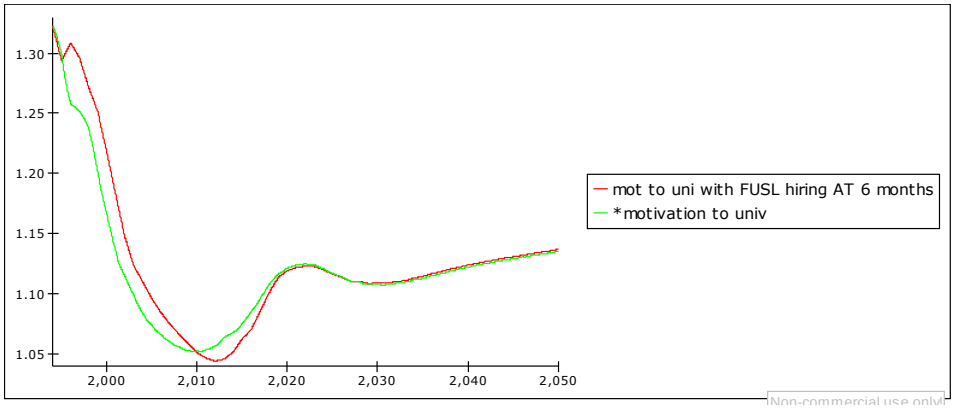
Motivation to University

Finally, we shorten Foreign Labors_Unskilled Hiring AT to 0.5 year. The simulated behavior presents an oscillation. This is due to the fact that the inflow to the stock is much larger, so jobs are filled up faster. Once the shortage is reduced, the foreign unskilled labor hiring slows down. As Foreign Unskilled LF grows, the outflow from the stock grows too. So the stock will drain faster. Therefore when the shortage occurs again, the hiring process takes place and jobs get filled up quickly. This process will continue to the future. As long as the demand for unskilled labor continues to be strong, the behavior of this stock will be oscillating in the future.



Foreign Unskilled Labor Force

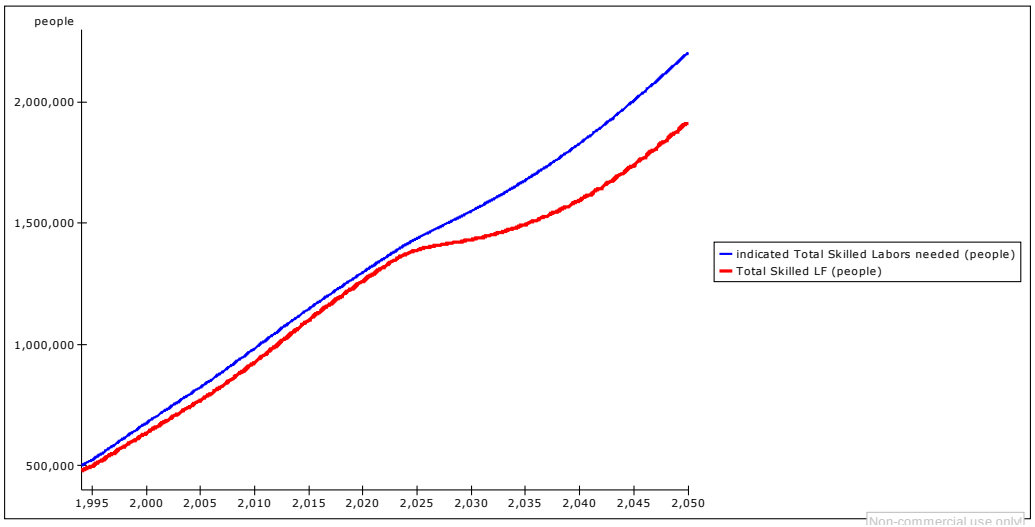
Motivation to University presents a higher trend than in the base run. This is because that more unskilled labor is brought into the country to fill up job vacancies, shortage is reduced. This will lead to lower wages and less capital investment from firms. Lower unskilled wages will lead to higher wage premium and expected lifetime earnings and lower foregone earnings. As unskilled labor shortage re-occur, Motivation to University returns to the level as in the base run.



Motivation to University

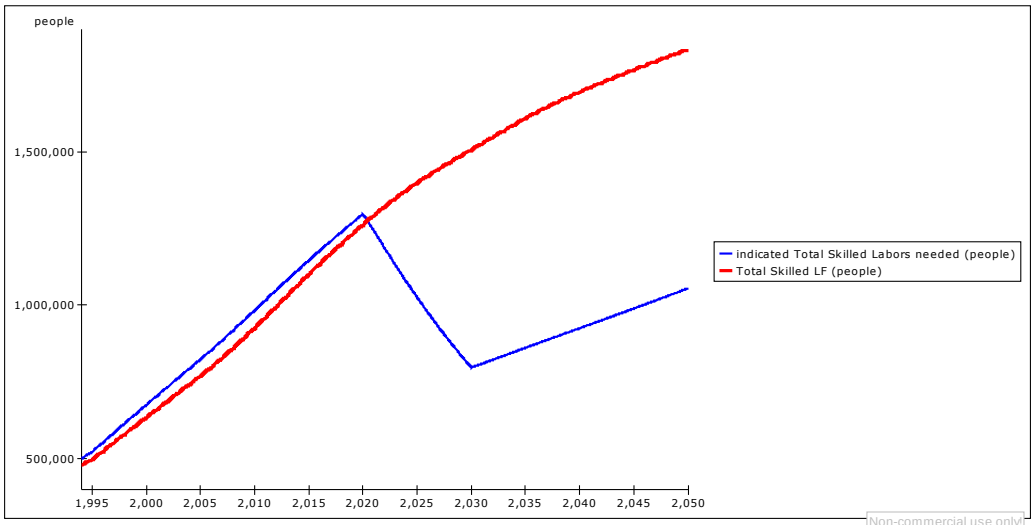
Extreme Condition Tests

(1) Reduce the inflow to tertiary education and unskilled labor force by reducing age group 18 to zero from year 2020



As the inflow to tertiary education and unskilled labor force becomes zero from 2020 while the outflows continue, then the shortage starts to worsen after a few years of delay. When the shortage starts to increase, it triggers the inflow of foreign skilled labor, which is the F_Labors hiring rate_SL. Even so, the hiring adjustment time for foreign skilled labor is longer than the hiring adjustment time for local skilled labor. Thus, the stock of total skilled labor increases at a slower pace. This development accounts for the widening gap between skilled labor demand and supply.

(2) Average aggregate demand growth fraction becomes -3.3% from 2020 to 2030

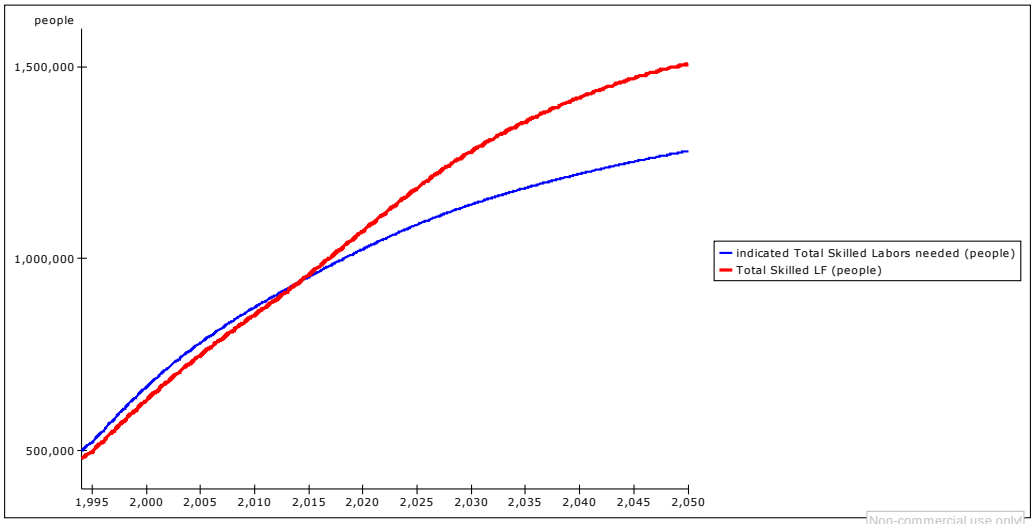


When the growth fraction of aggregate demand becomes -6.3% from 2020 to 2030, the aggregate demand stock decreases consistently for 10 years. So, the need of skilled labor reduces gradually. In this case, the locally produced skilled laborers are sufficient to cover the need. Therefore, foreign skilled labor immigration dropped significantly in this period. Motivation to University decreases from 2030 onwards due to reduced skilled job opportunity. The more lax job market imposes downward pressure in skilled wages, therefore perceived wage premium decreases consistently from 2020 onwards. When the aggregate demand growth resumes, skilled labor supply fails to catch up immediately. Hence the skilled labor supply and demand demonstrates a bigger gap than in the base case.

(3) Domestic Skilled Labor hiring adjustment time becomes 100 years

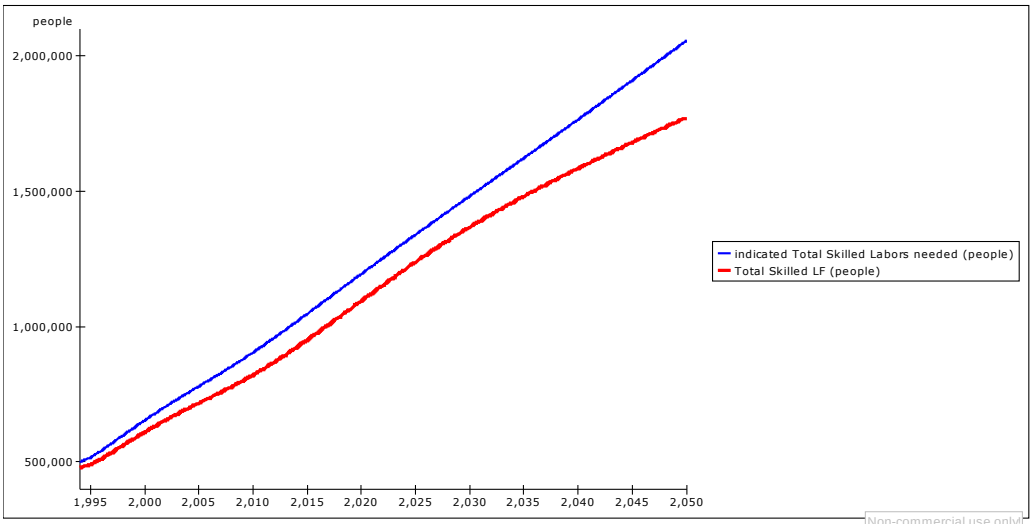
When the domestic skilled labor hiring adjustment time is elongated to enormously long, which is 100 years in our test, the number of unemployed skilled labor keeps pilling up. This is because that the inflow of tertiary graduates to seek jobs is constant while the outflow from the Unemployed Skilled LF is incredibly small. Therefore, skilled labor shortage aggravates. However, the need for foreign labor (Need for F_Labors_SL) will only be triggered if the total domestic skilled labor force fails to satisfy the indicated skilled labor needed. Total domestic skilled labor force is made up of employed domestic skilled labor and unemployed domestic skilled labor. So, the inflow of foreign skilled labor is very small even though the shortage of skilled labor is very high. As shown in the figure below, the

supply of skilled labor starts to exceed the demand from 2015 onwards. This is because it takes there are constant inflow to skilled labor force, even though the inflow is small. But it takes years for the skilled labor to retire or leave the labor force.



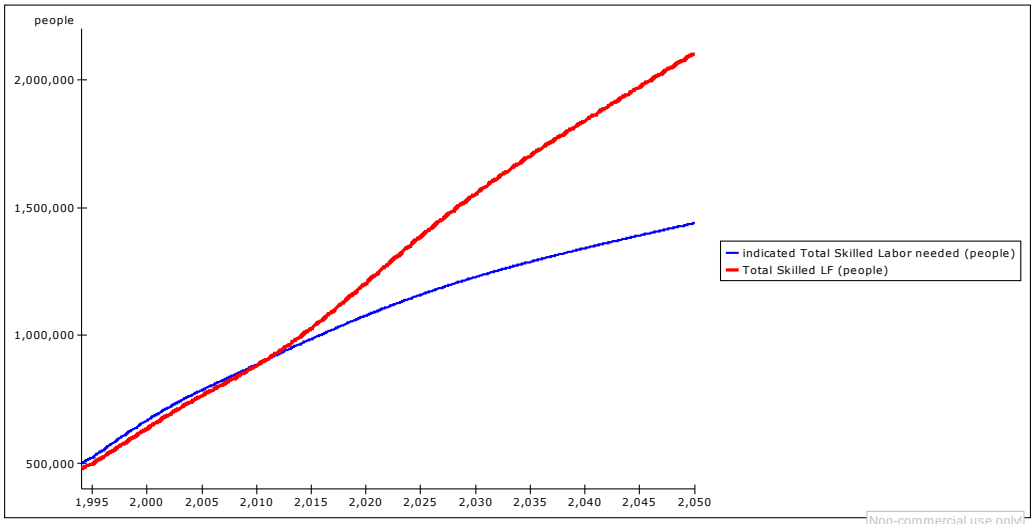
(4) Foreign Skilled Labor hiring adjustment time becomes 100 years

When the hiring adjustment time for foreign skilled labor is extended to 100 years, it represents very small inflow. Motivation to University increases slightly after 2020 because of higher skilled job density. Total Skilled Labor Force is trying to catch up with the demand. Only after around 2030, the outflow of domestic skilled labor force starts to exceed the inflow. Therefore, skilled labor shortage starts worsening.



(5) Domestic Unskilled Labor hiring adjustment time becomes 10 years

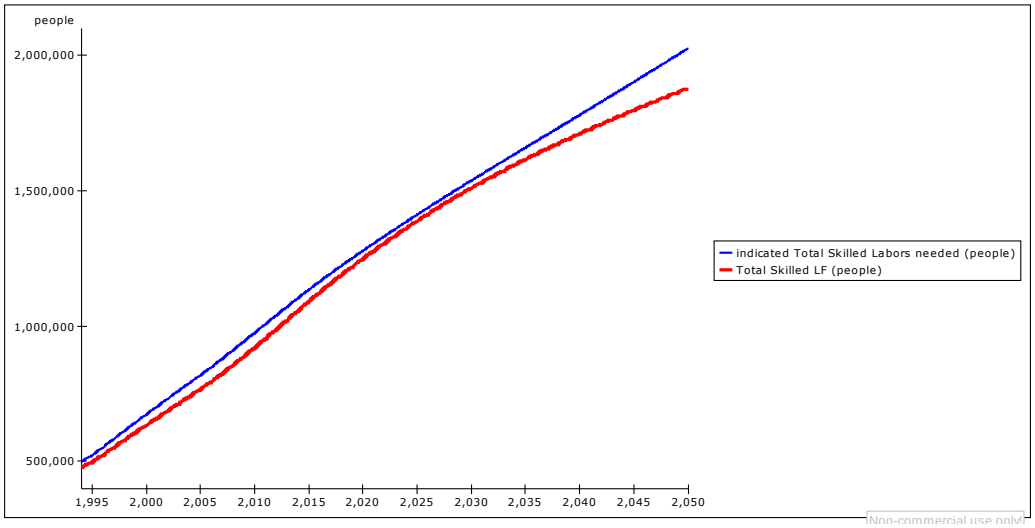
When the hiring adjustment for domestic unskilled labor is set to 10 years, that means the outflow from the unemployed domestic unskilled labor force is very slow. This will drive down wages as job seekers increase significantly. Also, this development will reduce the inflow of foreign unskilled labor. Currently, the hiring adjustment time for foreign unskilled labor is 1 year. This means that whenever firms fail to fill up vacancies with local unskilled labor, they will seek out foreign unskilled labor. Due to heighten unemployment rate, wages for unskilled presents a downward trend. Hence, wage premium hikes. This is the main reason for the significant increment for Motivation to University. As a consequence, domestic skilled labor production swells. This will eventually leads to the oversupply of skilled labor because of lower GDP due to labor shortage in general.



(6) Foreign unskilled labor hiring adjustment time becomes 100 years

The adjustment time for foreign unskilled labor hiring is elongated to 100 years. Thus the inflow to foreign unskilled labor stock becomes very small. Unskilled labor shortage increase drastically. As the unskilled labor market becomes tight, the wages for unskilled labor increases. As wages for the unskilled becomes higher and the unskilled labor market is tight, firms increase investment in capital for production. Therefore, the need for unskilled labor will be reduced. Subsequently, the unemployment rate of unskilled labor increase due to the decrease in unskilled job demand. From 2020 onwards, the wages for the unskilled is slightly lower than in the base case. Thus, perceived wage premium remains higher from 2010 until 2050. The higher perceived wage premium compensates for lower skilled job

density, so Motivation to University remains higher from 2010 onwards. As a result, total skilled labor force is able to closely following the demand. Only until 2030, the increasing outflow from total skilled labor force causes skilled labor shortage to enlarge.

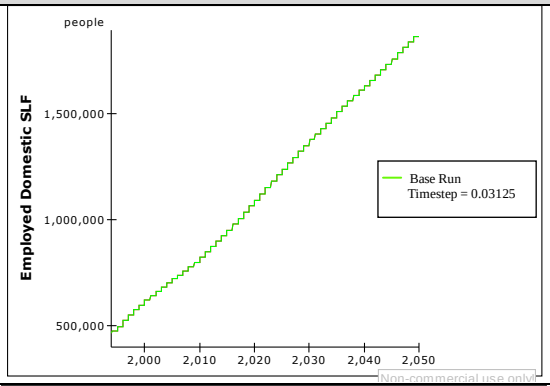
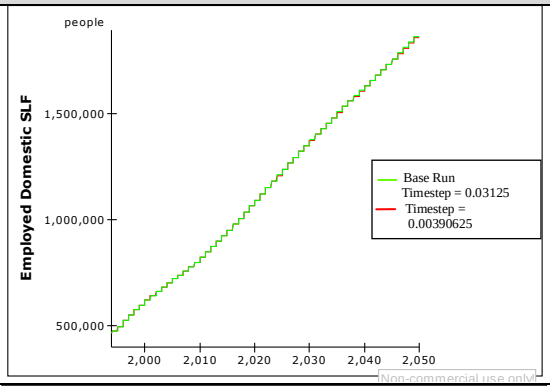
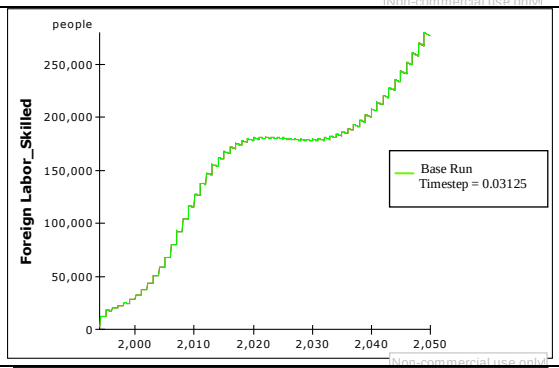
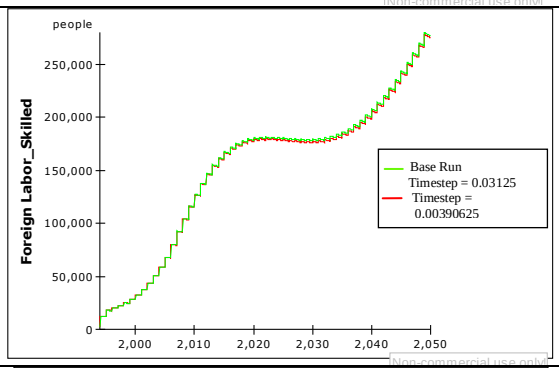
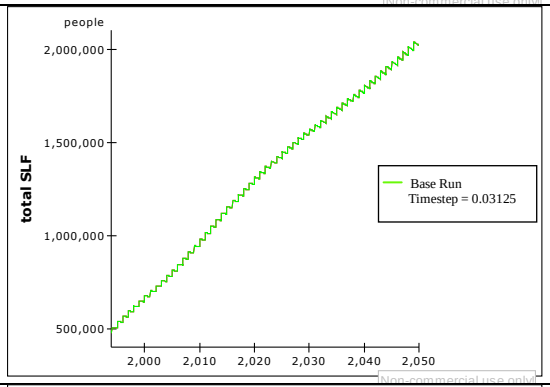
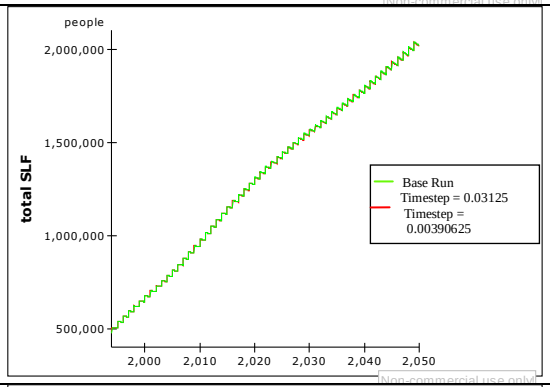
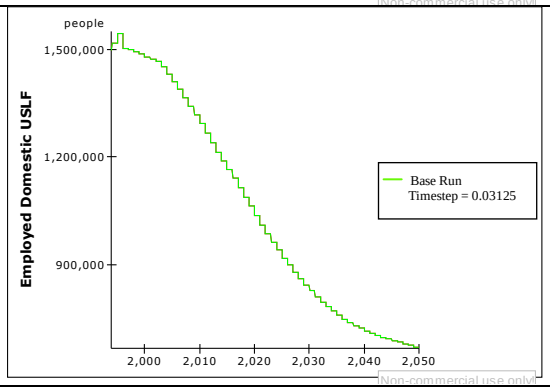
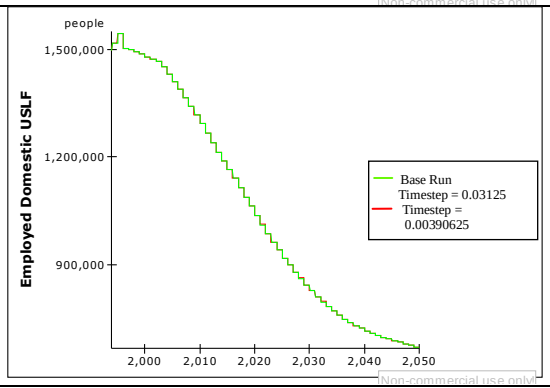


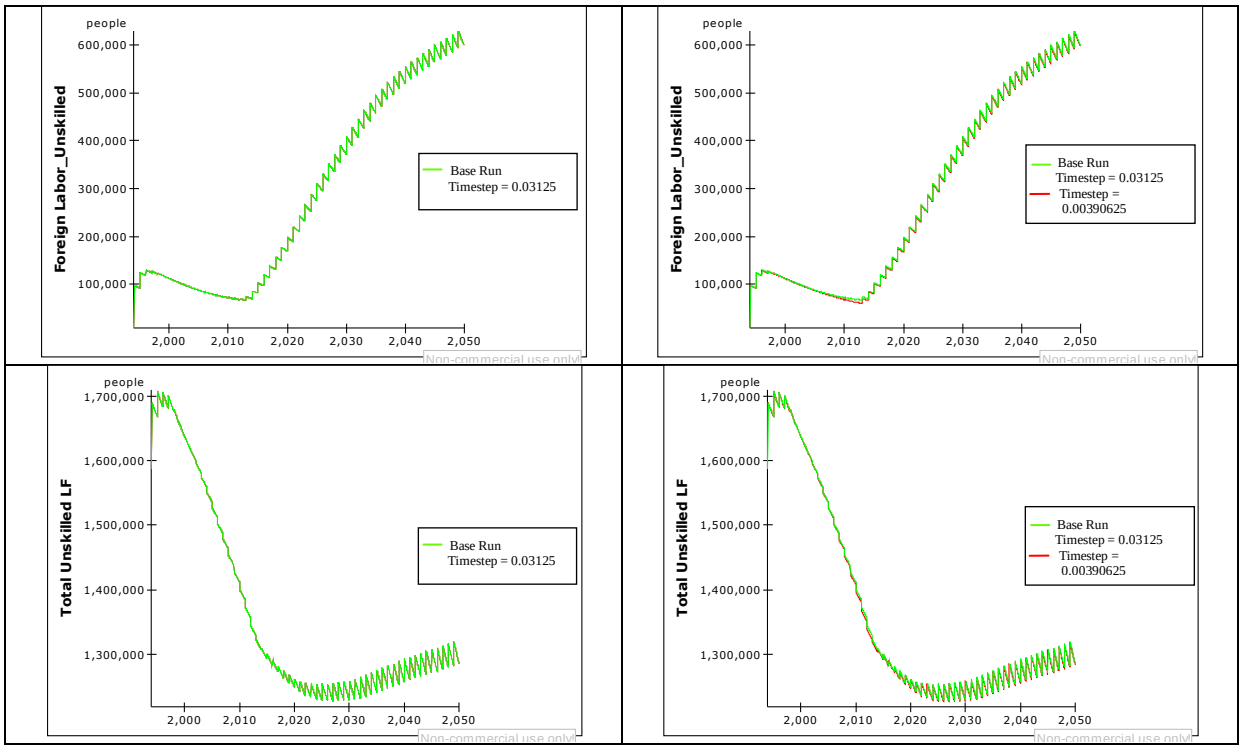
4.5 Parameter Sensitivity Test (A6)

Parameter	Domestic Skilled LF		Total Skilled LF	
	Correlation Coefficient	Mean Absolute Percent Error	Correlation Coefficient	Mean Absolute Percent Error
Incompletion fract_Univ1_19 to 24 = 0.14	0.9997	8.16%	0.9999	1.97%
Incompletion fract_Univ1_19 to 24 = 0.72	0.9999	20.52%	0.9984	4.77%
Incompletion_fract_Univ2_19 to 24 = 0.08	0.9995	6.47%	0.9999	1.41%
Incompletion_fract_Univ2_19 to 24 = 0.56	0.9998	16.77%	0.9990	3.59%
Incompletion_fract_Univ1_25 to 29 = 0.14	0.9998	3.32%	1.000	8.26%
Incompletion_fract_Univ1_25 to 29 = 0.7	0.9997	0.51%	0.9999	1.58%
Incompletion_fract_Univ2_25 to 29 = 0.08	0.9999	2.63%	1.0000	0.36%
Incompletion_fract_Univ2_25 to 29 = 0.56	0.9999	6.16%	1.0000	1.13%

hiring_SL _AT = 0.25	0.9999	0.24%	0.9998	0.43%
hiring_SL _AT = 1	0.9999	0.29%	0.9964	5.47%
hiring_USL _AT = 0.25	0.9999	0.22%	0.9999	0.32%
hiring_USL _AT = 0.1	0.9999	0.62%	0.9999	0.76%
F_Labors_SL_AT	0.9999	0.1%	0.9999	1.3%
F_Labors_SL_AT	0.9999	0.1%	0.9998	1.8%
F_Labors_US_AT	0.9999	0.1%	0.9999	0.3%
F_Labors_US_AT	0.9999	0.1%	0.9999	0.6%
frct of _F_SL leaving	0.9999	0.1%	0.9999	0.1%
frct of _F_SL leaving	0.9999	0.1%	0.9999	0.3%
frct of _F_USL leaving	0.9999	0.1%	0.9999	0.1%
frct of _F_USL leaving	0.9999	0.1%	0.9999	0.2%
distr_starting wage	0.9999	2.4%	0.9998	1.3%
distr_starting wage	0.9999	2.7%	0.9996	2.1%
distr_foregone earnings	0.9999	2.0%	0.9998	1.2%
distr_foregone earnings	0.9999	2.6%	0.9998	1.1%
distr_LT earnings	0.9999	0.2%	0.9999	0.2%
distr_LT earnings	0.9999	0.6%	0.9999	0.3%
distr_ease of finding job	0.9999	0.2%	0.9999	0.2%
distr_ease of finding job	0.9999	0.3%	0.9999	0.3%

4.6 Integration Error Test (B1)

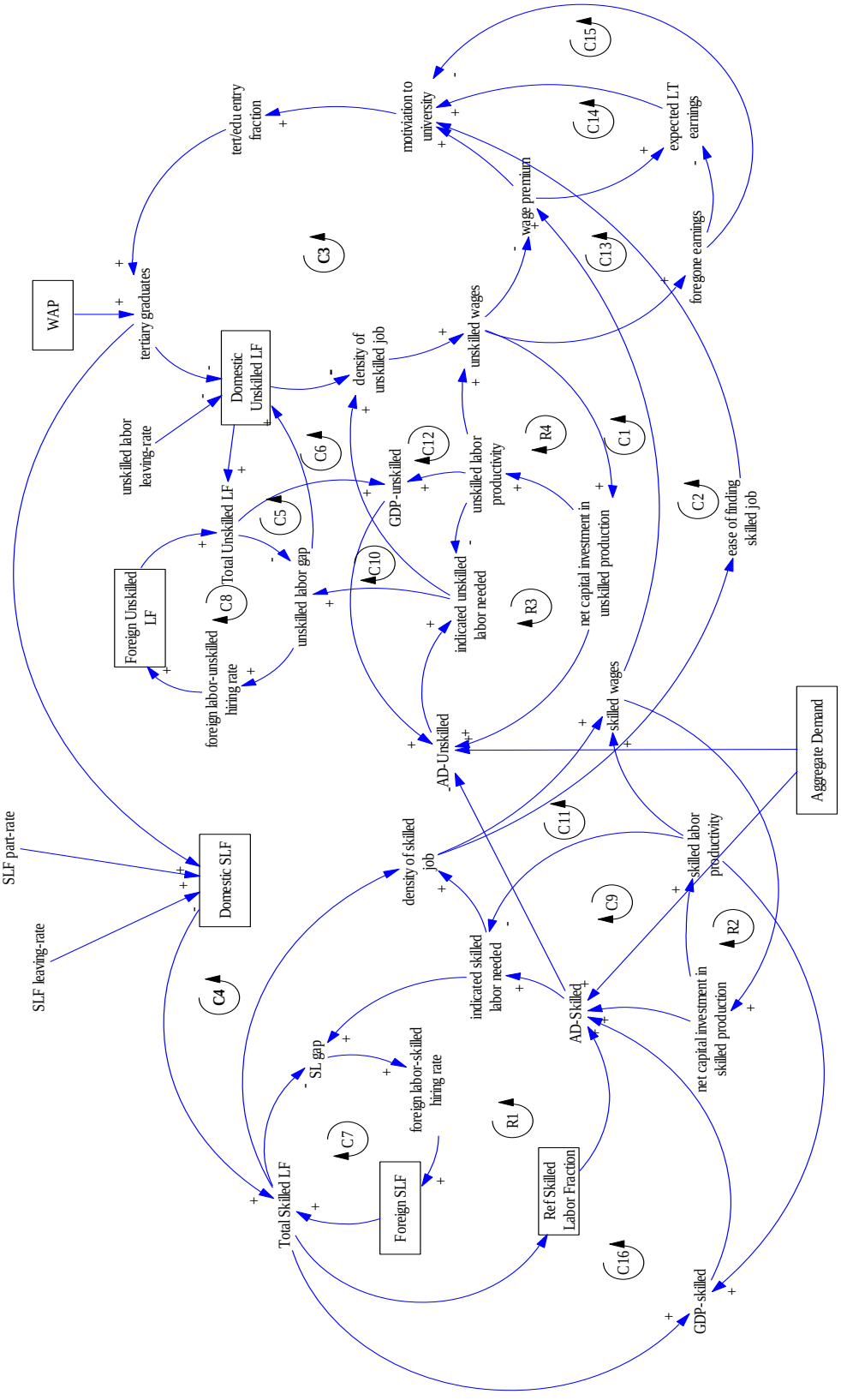
Timestep = 0.03125	Timestep = 0.00390625
	
	
	
	



4.7 Policy Parameter and Behavior Sensitivity Tests

We conduct parameter sensitivity tests on several uncertain added policy parameters for each individual policy as well as for combined policies. These parameters are:

Appendix B – Overview of Causal Loop Diagram & Loop Names

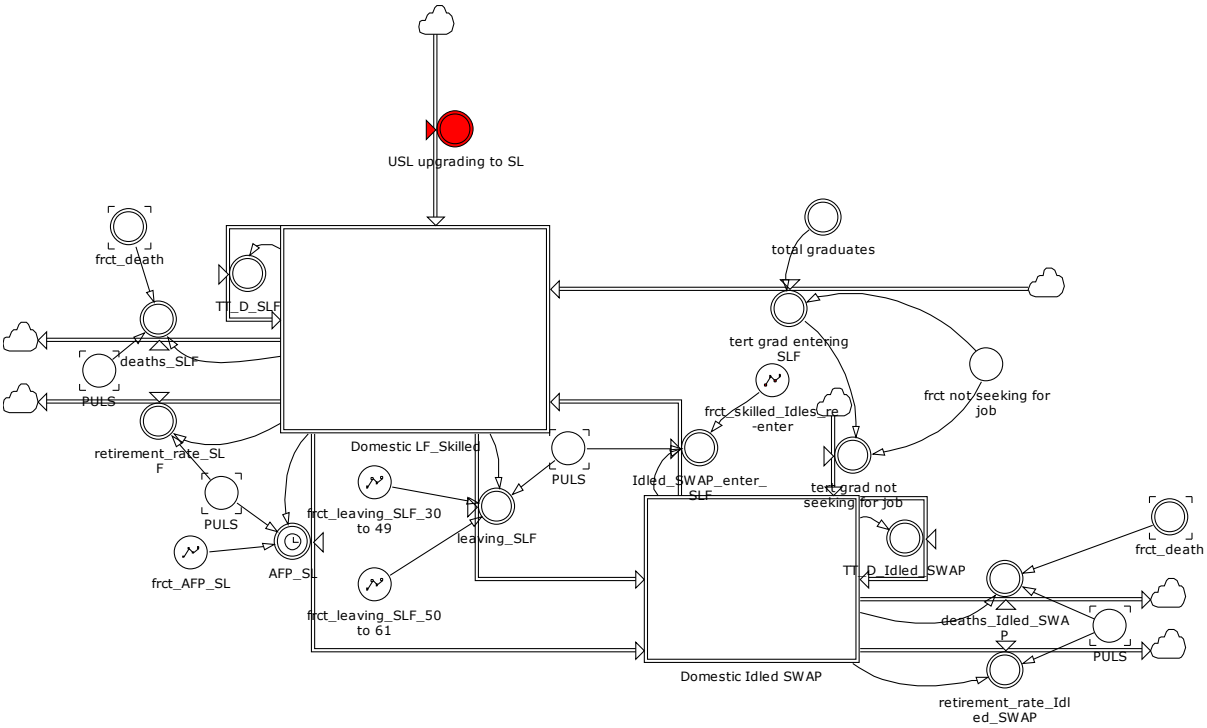


List of Loop Names

Loop Number	*Loop Name*
Reinforcing Loop	
R1	Aggregate Demand and Skilled Input Loop
R2	Capital Investment and Skilled Wages Loop
Counteracting Loop	
C1 & C3	Perceived Wage Premium Loop
C2	Skilled Job Density Loop
C7	Foreign Skilled Labor Force Loop
C8	Foreign Unskilled Labor Force Loop
C9	Capital Investment and Skilled Labor Gap Loop
C13 & C14	Expected Lifetime Earnings Loop
C15	Expected Foregone Earnings Loop

Appendix C – Model Documentation

Detailed View of Skilled Labor Force



Name	Dimensions	Unit	Definition	Note
actual GDP		NOK/year	GDP_skilled+GDP_unskilled	
actual individual wages_SL		NOK/(year*people)	'Expected Skilled Labor Productivity'*'labor share_skilled'*'effect of skilled unemployment rate on wages'	
actual individual wages_US		NOK/(year*people)	'Expected Unskilled Labor Productivity'*'labor share_unskilled'*'effect of unskilled unemployment rate on wages'	
AD increasing rate		NOK/year^2	'Aggregate Demand'*'ave_AD_growth fraction'	
AD_skilled		NOK/year	'Aggregate Demand'*'Reference Skilled Labor Fraction'	
AD_unskilled		NOK/year	('Aggregate Demand'-AD_skilled)	

AFP_SL	20..68	people/year	IF(TIME<=1997<<@year>>, { 0<<people>> ,0<<people>> ,0<<people>> ,0<<peopl e>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<pe ople>> ,0<<people>> ,0<<people>> ,0<<people>> ,0< <people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people >> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<peo ple>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<< people>> ,0<<people>> ,0<<people>> ,0<<people>> , 0<<people>> ,0<<people>> ,0<<people>> ,0<<people >> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<peo ple>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<< people>> ,0<<people>> ,0<<people>> ,0<<people>> , 0<<people>> ,0<<people>> ,'Domestic LF_Skilled'[67]*frct_AFP_SL ,0<<people>>} /TIMESTEP*PULS, { 0<<people>> ,0<<people>> ,0<<people>> ,0<<peopl e>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<pe ople>> ,0<<people>> ,0<<people>> ,0<<people>> ,0< <people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people >> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<peo ple>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<< people>> ,0<<people>> ,0<<people>> ,0<<people>> , 0<<people>> ,0<<people>> ,0<<people>> ,0<<people >> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<peo ple>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<< people>> ,0<<people>> ,'Domestic LF_Skilled'[63]*frct_AFP_SL ,'Domestic LF_Skilled'[64]*frct_AFP_SL ,'Domestic LF_Skilled'[65]*frct_AFP_SL ,'Domestic LF_Skilled'[66]*frct_AFP_SL ,'Domestic LF_Skilled'[67]*frct_AFP_SL ,0<<people>>} /TIMESTEP*PULS)	Divided by 2 because the fraction of of SLF who opted to retire early is less than nonTE LF. Need to find more documentation on this.

AFP_unskilled	20..68	people/year	IF(TIME<=1997<<@year>>, { 0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> , 0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> , 0<<people>> ,0<<people>> ,'Domestic LF_Unskilled'[67]*frct_AFP_unskilled ,0<<people>>} /TIMESTEP*PULS, { 0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> , 0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,'Domestic LF_Unskilled'[63]*frct_AFP_unskilled ,'Domestic LF_Unskilled'[64]*frct_AFP_unskilled ,'Domestic LF_Unskilled'[65]*frct_AFP_unskilled ,'Domestic LF_Unskilled'[66]*frct_AFP_unskilled ,'Domestic LF_Unskilled'[67]*frct_AFP_unskilled ,0<<people>>} /TIMESTEP*PULS)	

AG_18 and Incompletes entering_USLF	20..68	people/year	{'Age Group_18'*frct_To_USLF_AG_19/TIMESTEP*PULS,'Incompletes to USLF'[21],'Incompletes to USLF'[22],'Incompletes to USLF'[23],'Incompletes to USLF'[24],'Incompletes to USLF'[25],'Incompletes to USLF'[26],'Incompletes to USLF'[27],'Incompletes to USLF'[28],'Incompletes to USLF'[29],'Incompletes to USLF'[30],'Incompletes to USLF'[31],'Incompletes to USLF'[32],0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>}	

Age Group_18		people	GRAPHCURVE(TIME,1994<<@year>>,1<<year>>,{ 57821, 55038, 52724, 53510, 53473, 53372, 53293, 53873, 52835, 53349, 54293, 55704, 57236, 60587, 62574, 64754, 65164, 64855, 64422, 65046, 65700, 66645, 65730, 64431, 65366, 65472, 63495, 62613, 64142, 64650, 64718, 66381, 66255, 68267, 68365, 68282, 68280, 68333, 68885, 69492, 70138, 70800, 71461, 72102, 72696, 73234, 73697, 74080, 74378, 74595, 74739, 74827, 74872, 74895, 74909, 74929, 74968//Min:-1;Max:11// }<<people>>)	
Aggregate Demand		NOK/year	1588532000000<<NOK/year>>	real AD=rea GDP-change in real Inventories real AD=1588741000000<<NOK/year>>-209000000<<NOK/year>>=1588532000000
All Tert Graduates 1994 to 2008			GRAPHCURVE(TIME,1994<<@year>>,1<<year>>,{27540 ,26763 ,31702 ,31812 ,30083 ,30644 ,31324 ,31948 ,30323 ,30601 ,32160 ,32161 ,33626 ,35487 ,35330 ,35203//Min:20000;Max:40000// })	The state university colleges is a term for type of university college which is a result from a reform in 1994. This includes all tertiary graduates, including those with lower/higher, and doctoral studies.
arrsum DSLF		people	ARRSUM('Domestic LF_Skilled')	
arrsum DUSLF		people	ARRSUM('Domestic LF_Unskilled')	
arrsum PT 1		people	ARRSUM('Students as PT USL yr 1')	
arrsum PT 2		people	ARRSUM('Students as PT USL yr 2')	
arrsum PT 3		people	ARRSUM('Students as PT USL yr 3')	

arrsum total grad_22 to 32		people	ARRSUM('total graduates')*TIMESTEP	
ave capital investment growth fraction		1/year	0.08<<1/year>>*'Effect of Wage Growth on Capital Investment'	
ave study period		year	3	
ave time stay in Norway			40	
ave working years in life_SL		year	43	
ave working years in life_unskilled		year	48	
ave_AD_growth fraction		1/year	0.033<<1/year>>*'effect of GDP_AD differential on AD growth'	
ave_L_pdty_growth rate_SL		1/year	GRAPHCURVE(TIME,1994<<@year>>,5<<year>>,{0.0187,0.02,0.02055,0.01945,0.0193,0.0193,0.0193//Min:0.015;Max:0.025//}<<1/year>>)*'effect of UR_SL on probability of hiring high-quality labors'*'capital deepening effect on SL pdty'	L/pdty has slowed down since 2005 as the level in the beginning of 1990s. The ave L/pdty growth rate was around 2.5% from 1990 - 2003
ave_L_pdty_growth rate_US		1/year	GRAPHCURVE(TIME,1994<<@year>>,5<<year>>,{0.01944,0.0199,0.0206,0.02176,0.02197,0.02187,0.02187//Min:0.015;Max:0.023//}<<1/year>>)*'effect of UR_unskilled on probability of hiring high-quality labors'*'capital deepening effect on USL pdty'	

become US Idles at 19	20..68	people/year	{ 'Age Group_18'*frct_To_Idle_USLF_AG_19 ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> }/TIMESTEP*PULS	
capital deepening effect on SL pdty			DELAYINF(GRAPHCURVE('capital intensity index',0.1,0.05,{1,1,1.006,1.013,1.02,1.028,1.038,1.049,1.059,1.074,1.0845,1.09,1.092//Min:0.95;Max:1.1//}),1<<year>>,1)	
capital deepening effect on USL pdty			DELAYINF(GRAPHCURVE('capital intensity index',0.1,0.05,{1,1,1.006,1.018,1.034,1.052,1.073,1.092,1.105,1.111,1.116,1.119,1.118//Min:0.95;Max:1.15//}),1<<year>>,1)	
capital intensity		NOK/(year*people)	'Net Capital Investment'/'total LF'	
capital intensity index			('capital intensity'-'delayed cap intensity')/'delayed cap intensity'	

change in labor pdty_SL		NOK/(year²*people)	MAX('Expected Skilled Labor Productivity',1<<NOK/year/people>>)*'ave_L_pdty_growth rate_SL'	
change in labor pdty_unskilled		NOK/(year²*people)	MAX('Expected Unskilled Labor Productivity',1<<NOK/year/people>>)*'ave_L_pdty_growth rate_US'	
Constant_AD	1..16		0	
Constant_DSLF	1..57		0	
Constant_FSLF	1..57		0	
Constant_FUSLF	1..57		0	
Constant_TSLF	1..57		0	
Cont_USLF_AG_30		people/year	'To_Pot Students_AG_30'	
Cont_USLF_AG_31		people/year	TT_non_study_USLF_to_AG_31-To_Online_Univ1_AG_31	
Cont_USLF_AG_32		people/year	TT_non_study_USLF_to_AG_32-To_Online_Univ1_AG_32	
Cont_USLF_AG_33		people/year	TT_non_study_USLF_to_AG_33-To_Online_Univ1_AG_33	
Cont_USLF_AG_34		people/year	TT_non_study_USLF_to_AG_34-To_Online_Univ1_AG_34	
Cont_USLF_AG_35		people/year	TT_non_study_USLF_to_AG_35-To_Online_Univ1_AG_35	
deaths_AG_19		people/year	deaths_USLF[20]	
deaths_AG_20		people/year	deaths_USLF[21]	
deaths_AG_21		people/year	deaths_USLF[22]	
deaths_AG_22		people/year	deaths_USLF[23]	
deaths_AG_23		people/year	deaths_USLF[24]	
deaths_AG_24		people/year	deaths_USLF[25]	
deaths_AG_25		people/year	deaths_USLF[26]	
deaths_AG_26		people/year	deaths_USLF[27]	
deaths_AG_27		people/year	deaths_USLF[28]	
deaths_AG_28		people/year	deaths_USLF[29]	
deaths_AG_29		people/year	deaths_USLF[30]	
deaths_AG_30		people/year	deaths_USLF[31]	
deaths_AG_		people/year	deaths_USLF[32]	

31				
deaths_AG_32		people/year	deaths_USLF[33]	
deaths_AG_33		people/year	deaths_USLF[34]	
deaths_AG_34		people/year	deaths_USLF[35]	
deaths_Idle_SWAP	20..67	people/year	'Domestic Idle SWAP'[20..67]/TIMESTEP*PULS*frct_death[20..67]	
deaths_Inactive USWAP	20..67	people/year	MAX(0<<people>>,'Domestic Idle USWAP'[20..67])/TIMESTEP*PULS*frct_death[20..67]	
deaths_SLF	20..67	people/year	'Domestic LF_Skilled'[20..67]*frct_death[20..67]/TIMESTEP*PULS	
deaths_USLF	20..67	people/year	IF('Domestic LF_Unskilled'[20..67]>0<<people>>,'Domestic LF_Unskilled'[20..67])*frct_death[20..67]/TIMESTEP*PULS	
delayed cap intensity		NOK/(year*people)	DELAYINF('capital intensity',5<<year>>,1)	
delayed indicated SL needed		people	DELAYINF('indicated Total Skilled Labor needed',5<<year>>,1)	
delayed SLF fraction			DELAYINF('SLF fraction',1<<year>>,1)	
delayed total SLF		people	DELAYINF('total SLF',1<<year>>,1)	
delayed total SLF frct			DELAYINF('total SLF frct',1<<year>>,1)	
delayed total USLF		people	DELAYINF('Total Unskilled LF',1<<year>>,1)	
delayed Total Wages		NOK/year	DELAYINF('Total Wages',5<<year>>,1)	
density of skilled job			'indicated Total Skilled Labor needed'/'total SLF' //more than 1 means tight.	
density of unskilled job			'indicated Total USL needed'/'Total Unskilled LF'	
desired total interns_19-29		people	IF(TIME>2014<<@year>>,'total tert students_19-29'+0*'total F_Students')	
distr_ease of finding job			2	
distr_foregone earnings			4	
distr_LT earnings			1	

distr_wage premium			3	
Domestic Idle SWAP	20..68	people	{ 2445 //19// ,2619,2297,2352,2908,4022 //20..24 // ,3125,3077,3249,2905,2942 //25..29 // ,2507,2157,2147,2128,2152 //30..34 // ,1991,1821,1771,1820,1789 //35..39 // ,1637,1471,1276,1162,1022 //40..44 // ,1495,1688,1916,1861,1927 //45..49 // ,1837,1685,1578,1731,1780 //50..54 // ,1909,2002,2194,2269,2521 //55..59 // ,2685,2940,3025,3182,3201 //60..64 // ,3589,4436,5557 //65..67// }	
Domestic Idle USWAP	20..68	people	{ 16361 //19// ,11932,10466,9409,9209,12736 //20..24// ,9896, 9744, 10288, 9201, 9316 //25..29 // ,7939, 6832, 6797, 6738, 6816 //30..34 // ,6304, 5766, 5609, 5764, 5664 //35..39// ,5185, 4657, 4039, 3678, 3237 //40..44 // ,4733, 5346, 6069, 5894, 6102 //45..49 // ,5816, 5337, 4997, 5481, 5637 //50..54 // ,6044, 6339, 6947, 7184, 7982 //55..59 // ,8503, 9311, 9578, 10077, 10138 //60..64 // ,11366, 14047, 17597 //65..67// }	

Domestic LF_Skilled	20..68	people	{ 4045 //19// ,8993 ,9403 ,9570 ,9469 ,9936 //20..24// ,11728 ,12055 ,12529 ,12734 ,12988 //25..29// ,12901 ,13189 ,13288 ,13336 ,13657 //30..34// ,13770 ,13809 ,14182 ,14132 ,14048 //35..39// ,12772 ,12762 ,13819 ,12882 ,13097 //40..44// ,12971 ,13169 ,13547 ,12005 ,11407 //45..49// ,9019 ,8277 ,7179 ,7324 ,7029 //50..54// ,6617 ,6151 ,5704 ,5316 ,5097 //55..59// ,4327 ,4527 ,4452 ,4481 ,4316 //60..64// ,4083 ,3364 ,2809 //65..67// }	
Domestic LF_Unskilled	20..68	people	{ 29666 //19// ,25595 ,26761 ,27239 ,26950 ,28280 //20..24// ,33381 ,34312 ,35660 ,36244 ,36965 //25..29// ,37939 ,38760 ,39043 ,39178 ,40091 //30..34// ,40414 ,40524 ,41586 ,41443 ,41205 //35..39// ,43032 ,42999 ,40552 ,43392 ,44095 //40..44// ,43681 ,44329 ,45568 ,40519 ,38561 //45..49// ,35565 ,32738 ,28559 ,29110 ,27985 //50..54// ,26417 ,24644 ,22941 ,21463 ,20630 //55..59// ,20671 ,21570 ,21233 ,21364 ,20621 //60..64// ,18350 ,15119 ,12627 //65..67 // }	
Domestic Skilled LF		people	DELAYINF(ARRSUM('Domestic LF_Skilled'[20..67]),1<<year>>,1)	
Domestic Skilled LF with all-in-one policy			GRAPH(TIME,STARTTIME,1<<year>>,Constant_DSLF)	
Domestic USLF		people	DELAYINF(ARRSUM('Domestic LF_Unskilled'[20..67]),0.5<<year>>,1)	

dropOuts LF parti rate			1	
ease of finding jobs			GRAPHCURVE('pcvd density of skilled job',0.9,0.05,{1.01,1.01,1.01,1.05,1.1,1.17,1.25,1.32,1.405,1.49,1.56,1.61,1.63//Min:0.7;Max:2//})	
effect of wage premium			GRAPHCURVE('perceived wage premium',0.8,0.1,{0.63,0.74,0.835,0.93,1.07,1.18,1.305,1.44,1.515,1.565,1.61,1.66,1.71,1.76,1.84,1.92,1.95,2.02//Min:0.5;Max:2.5//})	
effect of domestic SLF coverage on foreign SL hiring AT			GRAPH('density of skilled job',0.8,0.1,{1.1,1.05,1,1,1,1,1,1//Min:0.95;Max:1.15//})	
effect of domestic USLF coverage on foreign USL hiring			GRAPH('density of unskilled job',0.8,0.1,{1.1,1.05,1,1,1,1,1,1//Min:0.95;Max:1.15//})	
effect of expected foregone earnings growth			GRAPHCURVE('perceived foregone earnings ratio',0.95,0.02,{1.158,1.14,1.106,1,0.935,0.906,0.852,0.824,0.798,0.776,0.766,0.762//Min:0.7;Max:1.2//})*'effect of internship_foregone earnings ratio on internship attractiveness'	
effect of F_Student cap on expected budget growth fract			GRAPH('F_Students cap ratio',0.95,0.02,{0,2.14,4.07,5,5//Min:-1;Max:5//})	
effect of GDP_AD differential on AD growth			GRAPHCURVE('GDP and AD ratio',0.1,0.2,{0.74,0.745,0.77,0.82,0.974,1.014,1.02,1.02//Min:0.7;Max:1.05//})	
effect of internship cap on expected budget growth fract			GRAPH('internship capacity ratio',0.7,0.05,{3.55,3.35,3.06,2.32,1.2,0.5,0,0//Min:-1;Max:4//})	

effect of internship_foregone earnings ratio on internship attractiveness			IF(TIME>2015<<@year>>,GRAPHCURVE('internship_foregone earnings ratio',0,0.03,{1,1.024,1.066,1.11,1.15,1.186,1.206,1.21//Min:0.9;Max:1.5//}),1)	
effect of Online_Student cap on expected budget growth fract			GRAPH('Online_Students ratio',0.98,0.05,{0,2.03,3.32,3.77,3.84//Min:-1;Max:4//})	
effect of relative expected LT earnings			GRAPHCURVE('relative expected LT earnings'/'pcvd relative expected LT earnings',0.75,0.01,{0.784,0.813,0.846,0.842,0.864,0.87,0.875,0.88,0.885,0.89,0.896,0.903,0.91,0.91,0.914,0.914,0.94,0.94,0.935,0.953,0.974,0.98,0.99,1.005,1.011,1.013,1.028,1.035,1.042,1.055,1.062,1.07,1.077,1.088,1.1,1.11,1.13,1.16,1.173,1.19,1.215,1.223,1.226,1.25,1.265,1.28,1.294,1.304,1.31,1.32,1.325//Min:0.75;Max:1.4//})	
effect of skilled unemployment rate on wages			GRAPHCURVE('unemployment rate_SL',0.01,0.02,{1.1,1.08,1.03,0.987,0.953,0.922,0.908//Min:0.85;Max:1.15//})	
effect of surplus on firing rate			GRAPHCURVE('surplus of F_labors_SL'/'total Employed SLF',0.1,0.1,{0.05,0.08,0.086,0.125,0.18,0.24,0.365,0.49,0.7,0.984//Min:-0.1;Max:1.1//})	
effect of unskilled unemployment rate on wages			GRAPHCURVE('unemployment rate_USL',0.01,0.02,{1.071,1.055,1.011,0.97,0.939,0.922,0.908//Min:0.85;Max:1.15//})	
effect of UR_SL on probability of hiring high-quality labors			GRAPH('unemployment rate_SL'/natural_UR_SL,0.8,0.1,{1,1,1,1.015,1.037,1.074,1.106,1.129//Min:0.95;Max:1.2//})	

effect of UR_unskilled on probability of hiring high-quality labors			GRAPH('unemployment rate_USL'/natural_UR_unskilled,0.8,0.1,{1,1,1,1.015,1.037,1.074,1.106,1.129//Min:0.95;Max:1.2//})	
Effect of Wage Growth on Capital Investment			GRAPHCURVE('frct_total wages growth',0.9,0.05,{0.94,0.95,1.01,1.04,1.08,1.126,1.15,1.184,1.19,1.2,1.2//Min:0.5;Max:1.5//})	
effectiveness of F_Students Policy			GRAPHCURVE(TIME,1994<<@year>>,5<<year>>,{0,0,0,0,0.09,0.31,0.39,0.44,0.47,0.496,0.496,0.5//Min:-0.1;Max:1//})	
effectiveness of Internship Policy			GRAPHCURVE(TIME,1994<<@year>>,4<<year>>,{0,0,0,0,0.03,0.305,0.56,0.62,0.65,0.66,0.67,0.68,0.695,0.695,0.7//Min:-0.1;Max:0.8//})	
effectiveness of Online Univ Policy			GRAPHCURVE(TIME,1994<<@year>>,5<<year>>,{0,0,0,0,0.09,0.39,0.52,0.61,0.67,0.716,0.76,0.77//Min:-0.1;Max:1//})	
ELT earnings			'relative expected LT earnings'/'pcvd relative expected LT earnings'	
Employed Domestic SLF		people	463917	
Employed Domestic USLF		people	1494200	
Employed F_ Students		people	DELAYINF('Employed Foreign Students',1<<year>>,1)	
employed F_students leaving rate		people/year	('Employed Foreign Students'/'ave time stay in Norway')/TIMESTEP*PULS	
Employed Foreign Students		people	0<<people>>	
Employed USLF		people	'Employed Domestic USLF'+'Foreign Labor_Unskilled'	
employment rate_SL			'Employed Domestic SLF'/'total SLF'	
employment rate_USL			'Employed Domestic USLF'/'Total Unskilled LF'	
entering_Online_Univ1_AG_19		people/year	To_Online_Univ_AG_30	

entering_Univ1_AG_19		people/year	To_Univ_AG_19/TIMESTEP*PULS	
estimated F_students recruitment AT		year	10<<year>>	
Estimated Skilled Labor Demand			GRAPH(TIME,1994<<@year>>,1<<year>>,{479114 ,499802 ,538477 ,574924 ,616100 ,642523 ,652978 ,708598 ,747457 ,750757 ,765194 ,798058 ,760718 ,839164 ,862120 ,891947 ,935149 ,965970 ,996835 ,1027139 ,1056780 ,1086150 ,1115276 ,1144827 ,1174042 ,1203720 ,1233956 ,1265359 ,1297369 ,1329610 ,1361744 ,1394738 ,1428319 ,1462251 ,1496946 ,1532241 ,1568473 ,1604921 ,1641977 ,1679440 ,1717412 ,1755652 ,1794122 ,1833649 ,1873751 ,1914939 ,1957133 ,2000354 ,2045724 ,2092300 ,2140464 ,2190129 ,2240880 ,2293468 ,2347816 ,2403604 ,2460222 })	
exp per F_Student		NOK/(year*people)	70000<<NOK/year/people>>*(1+RAMP(0.05<<1/year>>,2016<<@year>>))	
expected foregone earnings		NOK/people	('perceived unskilled wages'*'ave study period')-1*(IF(TIME>2014<<@year>>,'total internship spending per person'*'effectiveness of Internship Policy'))	
expected foreign student capacity growth frct			1.05*'effect of F_Student cap on expected budget growth fract'	
Expected Indicated SL needed		people/year	('indicated Total Skilled Labor needed'-'delayed indicated SL needed')/TIMESTEP*PULS	

expected intern cap growth frct			GRAPHCURVE(TIME,2014<<@year>>,5<<year>>,{0.25,0.15,0.1,0.05,0.05,0.05,0.03,0.03,0.03//Min:-0.1;Max:0.5//})*'effect of internship cap on expected budget growth fract'	
expected LT Earnings_nonTE		NOK/people	'perceived unskilled wages'*'ave working years in life_unskilled'	
expected LT Earnings_SL		NOK/people	('perceived skilled wages'*'ave working years in life_SL')-'expected foregone earnings'	
expected online cap growth frct			1.02*'effect of Online_Student cap on expected budget growth fract'	
Expected Skilled Labor Productivity		NOK/people/year	860000<<NOK/people/year>>	real gdp @ 1994 * frct of skilled gdp =1588741000000*0.3 = 476622300000 skilled employed labors = SLF * employed frct = 478265*0.97 = 463917 skilled labor pdty =476622300000/463917 = 1027387
Expected Unskilled Labor Productivity		NOK/people/year	720000	real GDP @ 1994 *(1- frct of skilled gdp) =1588741000000*0.7 =1112118700000 employed USL = USLF * employed frct =1589571*0.94 = 1494200 US labor pdty =1112118700000/1494200 =744290
expenditure per online student		NOK/(year*people)	70000<<NOK/year/people>>*(1+RAMP(0.05<<1/year>>,2016<<@year>>))	
extra F_Student cap		people	IF('F_Student cap gap'>0<<people>>,('F_Student cap gap'+'total F_Students'*'expected foreign student capacity growth frct'),'F_Student cap gap')	

extra internship cap needed		people	IF('desired total interns_19-29'>'internship cap gap',IF(TIME>2014<<@year>>,('desired total interns_19-29'-'Internship Capacity')*(1+'expected intern cap growth frct'),0<<people>>),('desired total interns_19-29'-'Internship Capacity'))	
extra online cap		people	IF(TIME>2013<<@year>>,IF('online edu cap gap'>0<<people>>,('online edu cap gap'+('total online students'*'expected online cap growth frct')),'online edu cap gap'))	
Extra Tert_Edu Capacity for Foreign Students		people	0	
F_Labors firing rate_SL		people/year	(MIN('surplus of F_labors_SL',MAX('Foreign Labor_Skilled',0<<people>>)))/(TIMESTEP)*PULS*'effect of surplus on firing rate'	
F_Labors firing rate_unskilled		people/year	MIN('surplus of_F_USL',MAX('Foreign Labor_Unskilled',0<<people>>))/TIMESTEP*PULS	
F_Labors hiring rate_SL		people/year	1*('need for F_labors_SL'/F_Labors_SL_AT/TIMESTEP*PULS)	
F_Labors hiring rate_unskilled		people/year	1*('need for F_labors_US'/F_Labors_US_AT)/TIMESTEP*PULS	
F_Labors leaving rate_SL		people/year	'Foreign Labor_Skilled'*'frct of _F_SL leaving'	
F_Labors leaving rate_unskilled		people/year	'Foreign Labor_Unskilled'*'frct of _F_USL leaving'	
F_Labors_SL_AT			(2.5-STEP(0.5,2006<<@year>>))*'effect of domestic SLF coverage on foreign SL hiring AT'	

F_Labors_US_AT			(1.25-STEP(0.25,2005<<@year>>))*'effect of domestic USLF coverage on foreign USL hiring'	
F_Student cap gap		people	IF('total F_Students'>'Extra Tert_Edu Capacity for Foreign Students','total F_Students'-'Extra Tert_Edu Capacity for Foreign Students')	
F_Student graduation rate		people/year	'Foreign Students_Univ3'/TIMESTEP*PULS	
F_Student to Univ2		people/year	'Foreign Students_Univ1'/TIMESTEP*PULS	
F_Student to Univ3		people/year	'Foreign Students_Univ2'/TIMESTEP*PULS	
F_student_recruitement rate		people/year	0<<people/year>>+STEP(('targeted no of F_students recruitment per year'),2014<<@year>>)*'effectiveness of F_Students Policy'*'effect of internship_foregone earnings ratio on internship attractiveness'	
F_Students cap ratio			IF(TIME>2014<<@year>>,'total F_Students'/'Extra Tert_Edu Capacity for Foreign Students')	
F_Students Edu budget increasing rate		NOK/year²	IF(TIME>2014<<@year>>,(('extra F_Student cap'*'exp per F_Student')/'foreign students T_Edu budget AT')/TIMESTEP*PULS)	
F_Students hiring AT			0.75*'effect of domestic SLF coverage on foreign SL hiring AT'	
F_Students_cap increasing rate		people/year	IF(TIME>2016<<@year>>,('extra F_Student cap'/'foreign students T_Educap building AT')/TIMESTEP*PULS)	
F_students_leaving rate after grad		people/year	TT_F_TertGrads*'frct_F_students_leave after grad'	
finish studies	20..68	people/year	'Students as PT USL yr 3'/TIMESTEP*PULS	

firing rate_SL		people/year	(MIN(MAX('surplus of F_labors_SL',0<<people>>),MAX('Employed Domestic SLF',0<<people>>)))/(TIMESTEP)*PULS*'effect of surplus on firing rate'	
firing rate_unskilled		people/year	(MIN(MAX('surplus of_F_USL',0<<people>>),MAX('Employed Domestic USLF',0<<people>>)))/(TIMESTEP)*PULS	
foregone earnings_no internship		NOK/people	'ave study period'*'perceived unskilled wages'	
Foreign Job-seeking Tert Grads		people	0<<people>>	
Foreign Labor_Skilled		people	2191	OECD International Migration Outlook 2006 (table A.2.2, A.2.3) Stock of Migrants in LF (males) (number of foreigners or foregin born individuals living and working) in 1994 - 2.8% of LF in 2004 - 4.1% of LF Assuming 0.2 is skilled total LF x 0.028 = 57887 57887 * 0.2 = 11577
Foreign Labor_Unskilled		people	10000	OECD International Migration Outlook 2006 (table A.2.2, A.2.3) Stock of Migrants in LF (males) (number of foreigners or foregin born individuals living and working) in 1994 - 2.8% of LF in 2004 - 4.1% of LF Assuming 0.8 is unskilled total LF x 0.028 = 57887 57887 * 0.8 = 46310

foreign skilled labors inflow		people/year	GRAPH(TIME,1994<<@year>>,1<<year>>,{1182 ,1245 ,1310 ,1379 ,1452 ,1528 ,1586 ,1899 ,2416 ,2565 ,3301 ,2842 ,4053 ,5491 ,5257 ,5605,5600//Min:-1;Max:6000//}<<people/year>>)	
Foreign Skilled LF-no wage premium effect			GRAPH(TIME,STARTTIME,1<<year>>,Constant_FSLF)	
Foreign Student Tert_Edu Budget		NOK/year	0	
foreign students T_Edu budget AT			2	
foreign students T_Educap building AT			3+'foreign students T_Edu budget AT'	
Foreign Students_Univ1		people	0<<people>>	
Foreign Students_Univ2		people	0<<people>>	
Foreign Students_Univ3		people	0<<people>>	
foreign unskilled labors inflow		people/year	GRAPH(TIME,1994<<@year>>,1<<year>>,{4507 ,5634 ,7042 ,8802 ,11003 ,13754 ,14270 ,17095 ,21742 ,23085 ,29712 ,25580 ,36475 ,49422 ,47314 ,50446 //Min:-1;Max:6000//}<<people/year>>)	
Foreign unskilled LF-FUSL hiring AT 6 months			GRAPH(TIME,STARTTIME,1<<year>>,Constant_FUSLF)	
fraction with PT job			0.55	
fractional growth of SLF		year^-1	'Reference Skilled Labor Fraction'*'SLF growth rate'	
fractional hiring increment rate_SL			GRAPHCURVE('employment rate_SL',0,0.1,{0.99,0.976,0.972,0.97,0.957,0.95,0.945,0.937,0.934,0.903,0.78//Min:0.5;Max:1.1//})	

fractional hiring increment rate_US			GRAPHCURVE('employment rate_USL',0,0.1,{1,1,1,0.984,0.98,0.965,0.94,0.895,0.798,0.697,0.535//Min:0.5;Max:1.1//})	
fractional skilled frct increment rate		year^-1	GRAPH('gap of skilled job frct',0,0.1,{1,0.965,0.89,0.816,0.66,0.426,0.3,0.21,0.14,0.06,0//Min:0;Max:1.1//}<<1/year>>)	
frct not seeking for job			0.15	
frct of _F_SL leaving		1/year	0.01	
frct of _F_USL leaving		1/year	0.05	
frct work part_time			0.5	
frct_AFP_SL			GRAPH(TIME,1994<<@year>>,10<<year>>,{0.01,0.02,0.04,0.04,0.04//Min:0;Max:0.1//})	
frct_AFP_unskilled			GRAPH(TIME,1994<<@year>>,5<<year>>,{0.04,0.15,0.19,0.19,0.19//Min:0;Max:0.4//})	

frct_death	1..82		{ 0.002,0.002,0.002,0.002,0.002 //0-4// ,0.0005,0.0005,0.0005,0.0005,0.0005 //5-9// ,0.0004,0.0004,0.0004,0.0004,0.0004 //10-14// ,0.0001,0.0001,0.0001,0.0001,0.0001 //15-19// ,0.0001,0.0001,0.0001,0.0001,0.0001 //20-24// ,0.0001,0.0001,0.0001,0.0001,0.0001 //25-29// ,0.0001,0.0001,0.0001,0.0001,0.0001 //30-34// ,0.0002,0.0002,0.0002,0.0002,0.0002 //35-39// ,0.0003,0.0003,0.0003,0.0003,0.0003 //40-44// ,0.006,0.006,0.006,0.006,0.006 //45-49// ,0.01,0.01,0.01,0.01,0.01 //50-54// ,0.02,0.02,0.02,0.02,0.02 //55-59// ,0.03,0.03,0.03,0.03,0.03 //60-64// ,0.03,0.03,0.03,0.03,0.03 //65-69// ,0.07,0.07,0.07,0.07,0.07 //70-74// ,0.1,0.1,0.1,0.1,0.1 //75-79// ,0.25,0.25 //over 80// }	
frct_F_students_leave after grad			0.6	
frct_internship_coverage			MIN((0.3+RAMP(0.01<<1/year>>,2015<<@year>>)),0.65)	
frct_labor_pdty_growth		year^-1	GRAPH(TIME,1994<<@year>>,1<<year>>,{0.037,0.032,0.033,0.027,0.02,0.012,0.039,0.034,0.022,0.031,0.02,0.013,-0.009,-0.012,-0.013}<<1/year>>)	
frct_labor_pdty_growth_SL		year^-1	GRAPH(TIME,1994<<@year>>,1<<year>>,{0.037,0.037,0.032,0.033,0.027,0.02,0.012,0.039,0.034,0.022,0.031,0.02,0.013,-0.009,-0.012,0.01//Min:-0.1;Max:0.1//}<<1/year>>)*'effect of UR_SL on probability of hiring high-quality labors'	

frct_leaving_SLF_30 to 49			GRAPH(TIME,1994<<@year>>,10<<year>>,{0.003,0.008,0.01,0.01//Min:0;Max:0.06//})	
frct_leaving_SLF_50 to 61			GRAPH(TIME,1994<<@year>>,10<<year>>,{0.03,0.07,0.06,0.06//Min:0;Max:0.02//})	
frct_leaving_USLF_30 to 39			GRAPHCURVE(TIME,1994<<@year>>,10<<year>>,{0.00716,0.0084,0.0088,0.00884//Min:0;Max:0.01//})	
frct_leaving_USLF_40 to 49			GRAPHCURVE(TIME,1994<<@year>>,10<<year>>,{0.0095,0.0154,0.017,0.017//Min:0;Max:0.04//})	
frct_leaving_USLF_50 to 61			GRAPHCURVE(TIME,1994<<@year>>,10<<year>>,{0.0185,0.0304,0.033,0.0323//Min:0;Max:0.06//})	
frct_NOT_to_Univ1_AG_19			1-frct_To_Univ1_AG_19	Jobs for Youth (OECD) - Norway The average young Norwegian has a relatively low probability of being out of employment after leaving education. That probability is of 10.3 percentage points for young men aged 20-29. Note: in Norway, being non-employed = inactive, rather than unemployed. (pg. 51)
frct_skilled_Idles_re-enter			GRAPHCURVE(TIME,1994<<@year>>,10<<year>>,{0.1,0.12,0.15,0.15//Min:0;Max:2//})	
frct_To_Idle_USLF_AG_19			GRAPHCURVE(TIME,1994<<@year>>,5<<year>>,{0.085,0.03,0.054,0.077,0.096,0.092,0.092//Min:-0.1;Max:0.5//})*frct_NOT_to_Univ1_AG_19	
frct_To_Online_Univ1_30 to 35			(0+RAMP(0.004<<1/year>>,2012<<@year>>))	
frct_To_Online_Univ1_AG_30			(0+RAMP(0.004<<1/year>>,2014<<@year>>))	

frct_To_Univ1_AG_19			GRAPHCURVE(TIME,1994<<@year>>,5<<year>>,{0.126,0.12,0.15,0.17,0.1776,0.1776//Min:0.1;Max:0.2//})*'motivation to univ'	
frct_to_Univ_20			GRAPHCURVE(TIME,1994<<@year>>,5<<year>>,{0.234,0.275,0.296,0.308,0.31,0.31,0.31//Min:0.2;Max:0.33//})*'motivation to univ'	
frct_to_Univ_21 to 25			GRAPHCURVE(TIME,1994<<@year>>,5<<year>>,{0.197,0.155,0.194,0.246,0.25,0.25,0.254//Min:0;Max:0.3//})*'motivation to univ'	
frct_to_Univ_26 to 29			GRAPHCURVE(TIME,1994<<@year>>,5<<year>>,{0.001,0.143,0.114,0.108,0.114,0.117,0.117//Min:0;Max:0.2//})*'motivation to univ'	
frct_To_USLF_AG_19			frct_NOT_to_Univ1_AG_19*(1-frct_To_Idle_USLF_AG_19)	
frct_total wages growth			'Total Wages'/'delayed Total Wages'	
frct_unskilled_Idles_re-enter			GRAPHCURVE(TIME,1994<<@year>>,10<<year>>,{0.11,0.087,0.069,0.06//Min:-0.05;Max:0.2//})	
gap of skilled job frct			'Reference Skilled Labor Fraction'/'max fract of skilled job'	
GDP and AD ratio			'actual GDP'/'Aggregate Demand'	
GDP_skilled		NOK/year	'Expected Skilled Labor Productivity'*'total Employed SLF'	
GDP_unskilled		NOK/year	'Employed USLF'*'Expected Unskilled Labor Productivity'	
Grad_19-24		people	In_Univ3_AG_22+In_Univ3_AG_23+In_Univ3_AG_24	
Grad_25-29		people	In_Univ3_AG_25+In_Univ3_AG_26+In_Univ3_AG_27+In_Univ3_AG_28+In_Univ3_AG_29	
Graduate_Turning_22		people/year	In_Univ3_AG_21/TIMESTEP*PULS	
Graduate_Turning_23		people/year	In_Univ3_AG_22/TIMESTEP*PULS	

Graduate_Turning_24		people/year	In_Univ3_AG_23/TIMESTEP*PULS	
Graduate_Turning_25		people/year	In_Univ3_AG_24/TIMESTEP*PULS	
Graduate_Turning_26		people/year	In_Univ3_AG_25/TIMESTEP*PULS	
Graduate_Turning_27		people/year	In_Univ3_AG_26/TIMESTEP*PULS	
Graduate_Turning_28		people/year	In_Univ3_AG_27/TIMESTEP*PULS	
Graduate_Turning_29		people/year	In_Univ3_AG_28/TIMESTEP*PULS	
Graduate_Turning_30		people/year	In_Univ3_AG_29/TIMESTEP*PULS	
Graduate_Turning_31		people/year	In_Univ3_AG_30/TIMESTEP*PULS	
Graduate_Turning_32		people/year	In_Univ3_AG_31/TIMESTEP*PULS	
Graduates_Lower_25-29		people/year	Graduates_lower_Turning_25+Graduates_lower_Turning_26+Graduates_lower_Turning_27+Graduates_lower_Turning_28+Graduates_lower_Turning_29	
Graduates_lower_Turning_25		people/year	Graduate_Turning_25	
Graduates_lower_Turning_26		people/year	Graduate_Turning_26	
Graduates_lower_Turning_27		people/year	Graduate_Turning_27	
Graduates_lower_Turning_28		people/year	Graduate_Turning_28	
Graduates_lower_Turning_29		people/year	Graduate_Turning_29	
growth frct of SGDP		year^-1	DELAYINF(L_Pdty_growth_rate_SL+'SLF growth rate',1<<year>>,1)	
growth frct of USGDP		year^-1	DELAYINF(L_Pdty_growth_rate_unskilled+'USLF growth rate',1<<year>>,1)	
hiring rate_f_student		people/year	((TT_F_TertGrads*(1-'frct_F_students_leave after grad'))/'F_Students hiring AT')	
hiring rate_SL		people/year	(MIN(MAX('SL gap'/'hiring_SL _AT',0<<people>>),MAX('Unemployed Skilled LF'/'hiring_SL _AT',0<<people>>))*'fractional hiring increment rate_SL')/TIMESTEP*PULS	

hiring rate_unskilled		people/year	(MIN(MAX('USL gap'/'hiring_USL _AT',0<<people>>),MAX('Unemployed USLF'/'hiring_USL _AT',0<<people>>))*'fractional hiring increment rate_US')/TIMESTEP*PULS	
hiring_SL _AT			0.6	
hiring_USL _AT			0.5	
historical pdty growth		year^-1	GRAPH(TIME,1994<<@year>>,1<<year>>,{0.037 ,0.032 ,0.033 ,0.027 ,0.02 ,0.012 ,0.039 ,0.034 ,0.022 ,0.031 ,0.02 ,0.013 ,-0.09 ,-0.012 ,-0.013 }<<1/year>>)	
Idle_SWAP_ enter_SLF	20..67	people/year	IF('Domestic Idle SWAP'[20..67]>0<<people>>,'Domestic Idle SWAP'[20..67]*'frct_skilled_Idles_re-enter'/TIMESTEP*PULS,0<<people/year>>)	
In_Online_Univ1_2_Turning_31		people/year	In_Online_Univ1_AG_30/TIMESTEP*PULS	
In_Online_Univ1_2_Turning_32		people/year	In_Online_Univ1_AG_31/TIMESTEP*PULS	
In_Online_Univ1_2_Turning_33		people/year	In_Online_Univ1_AG_32/TIMESTEP*PULS	
In_Online_Univ1_2_Turning_34		people/year	In_Online_Univ1_AG_33/TIMESTEP*PULS	
In_Online_Univ1_2_Turning_35		people/year	In_Online_Univ1_AG_34/TIMESTEP*PULS	
In_Online_Univ1_2_Turning_36		people/year	In_Online_Univ1_AG_35/TIMESTEP*PULS	
In_Online_Univ1_AG_30		people	0	
In_Online_Univ1_AG_31		people	0	
In_Online_Univ1_AG_32		people	0	
In_Online_Univ1_AG_33		people	0	
In_Online_Univ1_AG_34		people	0	
In_Online_Univ1_AG_35		people	0	
In_Online_Univ2_3_Turning_32		people/year	In_Online_Univ2_AG_31/TIMESTEP*PULS	
In_Online_Univ2_3_Turning_33		people/year	In_Online_Univ2_AG_32/TIMESTEP*PULS	

In_Online_Univ2_3_Turning_34		people/year	In_Online_Univ2_AG_33/TIMESTEP*PULS	
In_Online_Univ2_3_Turning_35		people/year	In_Online_Univ2_AG_34/TIMESTEP*PULS	
In_Online_Univ2_3_Turning_36		people/year	In_Online_Univ2_AG_35/TIMESTEP*PULS	
In_Online_Univ2_3_Turning_37		people/year	In_Online_Univ2_AG_36/TIMESTEP*PULS	
In_Online_Univ2_AG_31		people	0	
In_Online_Univ2_AG_32		people	0	
In_Online_Univ2_AG_33		people	0	
In_Online_Univ2_AG_34		people	0	
In_Online_Univ2_AG_35		people	0	
In_Online_Univ2_AG_36		people	0	
In_Online_Univ3_4_Turning_33		people/year	In_Online_Univ3_AG_32/TIMESTEP*PULS	
In_Online_Univ3_4_Turning_34		people/year	In_Online_Univ3_AG_33/TIMESTEP*PULS	
In_Online_Univ3_4_Turning_35		people/year	In_Online_Univ3_AG_34/TIMESTEP*PULS	
In_Online_Univ3_4_Turning_36		people/year	In_Online_Univ3_AG_35/TIMESTEP*PULS	
In_Online_Univ3_4_Turning_37		people/year	In_Online_Univ3_AG_36/TIMESTEP*PULS	
In_Online_Univ3_4_Turning_38		people/year	In_Online_Univ3_AG_37/TIMESTEP*PULS	
In_Online_Univ3_AG_32		people	0	
In_Online_Univ3_AG_33		people	0<<people>>	
In_Online_Univ3_AG_34		people	0<<people>>	
In_Online_Univ3_AG_35		people	0<<people>>	
In_Online_Univ3_AG_36		people	0<<people>>	
In_Online_Univ3_AG_37		people	0<<people>>	
In_Online_Univ4_AG_33		people	0	
In_Online_Univ4_AG_34		people	0	
In_Online_Univ4_AG_35		people	0	
In_Online_Univ4_AG_36		people	0	
In_Online_Univ4_AG_37		people	0	
In_Online_Univ4_AG_38		people	0	
In_Univ1_2_Turning_20		people/year	TT_fr_Univ1_2_AG_20*(1-'Incompletion fract_Univ1_19 to 24')	

In_Univ1_2_Turning_21		people/year	TT_fr_Univ1_2_AG_21*(1-'Incompletion fract_Univ1_19 to 24')	
In_Univ1_2_Turning_22		people/year	TT_fr_Univ1_2_AG_22*(1-'Incompletion fract_Univ1_19 to 24')	
In_Univ1_2_Turning_23		people/year	TT_fr_Univ1_2_AG_23*(1-'Incompletion fract_Univ1_19 to 24')	
In_Univ1_2_Turning_25		people/year	TT_fr_Univ1_2_AG_25*(1-'Incompletion fract_Univ1_19 to 24')	
In_Univ1_2_Turning_26		people/year	TT_fr_Univ1_2_AG_26*(1-'Incompletion_fract_Univ1_25 to 29')	
In_Univ1_2_Turning_27		people/year	TT_fr_Univ1_2_AG_27*(1-'Incompletion_fract_Univ1_25 to 29')	
In_Univ1_2_Turning_28		people/year	TT_fr_Univ1_2_AG_28*(1-'Incompletion_fract_Univ1_25 to 29')	
In_Univ1_2_Turning_29		people/year	TT_fr_Univ1_2_AG_29*(1-'Incompletion_fract_Univ1_25 to 29')	
In_Univ1_2_Turning_30		people/year	TT_fr_Univ1_2_AG_30*(1-'Incompletion_fract_Univ1_25 to 29')	
In_Univ1_2Turning_24		people/year	TT_fr_Univ1_2_AG_24*(1-'Incompletion fract_Univ1_19 to 24')	
In_Univ1_AG_19		people	8766	
In_Univ1_AG_20		people	13748<<people>>*0.6	
In_Univ1_AG_21		people	(16826<<people>>-2380<<people>>)*0.6	
In_Univ1_AG_22		people	(18355<<people>>-2487<<people>>)*0.6	
In_Univ1_AG_23		people	(17680<<people>>-2350<<people>>)*0.6	
In_Univ1_AG_24		people	(14511<<people>>-2167<<people>>)*0.6	
In_Univ1_AG_25		people	(11268<<people>>-1742<<people>>)*0.6	
In_Univ1_AG_26		people	(8999<<people>>-1479<<people>>)*0.6	
In_Univ1_AG_27		people	(7115<<people>>-1224<<people>>)*0.6	
In_Univ1_AG_28		people	(6941<<people>>-1011<<people>>)*0.6	
In_Univ1_AG_29		people	(5293<<people>>-883<<people>>)*0.6	

In_Univ2_3_Turning_21		people/year	TT_fr_Univ2_3_AG_21*(1-'Incompletion_fract_Univ2_19 to 24')	
In_Univ2_3_Turning_22		people/year	TT_fr_Univ2_3_AG_22*(1-'Incompletion_fract_Univ2_19 to 24')	
In_Univ2_3_Turning_23		people/year	TT_fr_Univ2_3_AG_23*(1-'Incompletion_fract_Univ2_19 to 24')	
In_Univ2_3_Turning_24		people/year	TT_fr_Univ2_3_AG_24*(1-'Incompletion_fract_Univ2_19 to 24')	
In_Univ2_3_Turning_25		people/year	TT_fr_Univ2_3_AG_25*(1-'Incompletion_fract_Univ2_19 to 24')	
In_Univ2_3_Turning_26		people/year	TT_fr_Univ2_3_AG_26*(1-'Incompletion_fract_Univ2_19 to 24')	
In_Univ2_3_Turning_27		people/year	TT_fr_Univ2_3_AG_27*(1-'Incompletion_fract_Univ2_25 to 29')	
In_Univ2_3_Turning_28		people/year	TT_fr_Univ2_3_AG_28*(1-'Incompletion_fract_Univ2_25 to 29')	
In_Univ2_3_Turning_29		people/year	TT_fr_Univ2_3_AG_29*(1-'Incompletion_fract_Univ2_25 to 29')	
In_Univ2_3_Turning_30		people/year	TT_fr_Univ2_3_AG_30*(1-'Incompletion_fract_Univ2_25 to 29')	
In_Univ2_3_Turning_31		people/year	TT_fr_Univ2_3_AG_31*(1-'Incompletion_fract_Univ2_25 to 29')	
In_Univ2_AG_20		people	13748<<people>>*0.4	
In_Univ2_AG_21		people	(16826<<people>>-2380<<people>>)*0.4	
In_Univ2_AG_22		people	(18355<<people>>-2487<<people>>)*0.4	
In_Univ2_AG_23		people	(17680<<people>>-2350<<people>>)*0.4	
In_Univ2_AG_24		people	(14511<<people>>-2167<<people>>)*0.4	
In_Univ2_AG_25		people	(11268<<people>>-1742<<people>>)*0.4	
In_Univ2_AG_26		people	(8999<<people>>-1479<<people>>)*0.4	
In_Univ2_AG_27		people	(7115<<people>>-1224<<people>>)*0.4	
In_Univ2_AG_28		people	(6941<<people>>-1011<<people>>)*0.4	
In_Univ2_AG_29		people	(5293<<people>>-883<<people>>)*0.4	
In_Univ2_A		people	1400	

G_30				
In_Univ3_AG_21		people	2380<<people>>	
In_Univ3_AG_22		people	2487<<people>>	
In_Univ3_AG_23		people	2350<<people>>	
In_Univ3_AG_24		people	2167<<people>>	
In_Univ3_AG_25		people	1742<<people>>	
In_Univ3_AG_26		people	1479<<people>>	
In_Univ3_AG_27		people	1224<<people>>	
In_Univ3_AG_28		people	1011<<people>>	
In_Univ3_AG_29		people	883<<people>>	
In_Univ3_AG_30		people	806<<people>>	
In_Univ3_AG_31		people	766<<people>>	
In_Univ4_AG_22		people	554<<people>>	
In_Univ4_AG_23		people	554<<people>>	
In_Univ4_AG_24		people	554<<people>>	
In_Univ4_AG_25		people	554<<people>>	
In_Univ4_AG_26		people	554<<people>>	
In_Univ4_AG_27		people	554<<people>>	
In_Univ4_AG_28		people	554<<people>>	
In_Univ4_AG_29		people	554<<people>>	
In_Univ4_AG_30		people	554<<people>>	
In_Univ4_AG_31		people	554<<people>>	
In_Univ4_AG_32		people	554<<people>>	
Incompetion_rate_Univ1_AG_20		people/year	TT_fr_Univ1_2_AG_20*'Incompletion fract_Univ1_19 to 24'	
Incompetion_rate_Univ1_AG_21		people/year	TT_fr_Univ1_2_AG_21*'Incompletion fract_Univ1_19 to 24'	
Incompetion_rate_Univ1_AG_22		people/year	TT_fr_Univ1_2_AG_22*'Incompletion fract_Univ1_19 to 24'	
Incompetion_rate_Univ1_AG_23		people/year	TT_fr_Univ1_2_AG_23*'Incompletion fract_Univ1_19 to 24'	
Incompetion_rate_Univ1_AG_24		people/year	TT_fr_Univ1_2_AG_24*'Incompletion fract_Univ1_19 to 24'	
Incompetion_rate_Univ1_AG_25		people/year	TT_fr_Univ1_2_AG_25*'Incompletion fract_Univ1_19 to 24'	

Incompetion_rate_Univ1_AG_26		people/year	TT_fr_Univ1_2_AG_26*'Incompletion_fract_Univ1_25 to 29'	
Incompetion_rate_Univ1_AG_27		people/year	TT_fr_Univ1_2_AG_27*'Incompletion_fract_Univ1_25 to 29'	
Incompetion_rate_Univ1_AG_28		people/year	TT_fr_Univ1_2_AG_28*'Incompletion_fract_Univ1_25 to 29'	
Incompetion_rate_Univ1_AG_29		people/year	TT_fr_Univ1_2_AG_29*'Incompletion_fract_Univ1_25 to 29'	
Incompetion_rate_Univ1_AG_30		people/year	TT_fr_Univ1_2_AG_30*'Incompletion_fract_Univ1_25 to 29'	
Incompetion_rate_Univ2_AG_21		people/year	TT_fr_Univ2_3_AG_21*'Incompletion_fract_Univ2_19 to 24'	
Incompetion_rate_Univ2_AG_22		people/year	TT_fr_Univ2_3_AG_22*'Incompletion_fract_Univ2_19 to 24'	
Incompetion_rate_Univ2_AG_23		people/year	TT_fr_Univ2_3_AG_23*'Incompletion_fract_Univ2_19 to 24'	
Incompetion_rate_Univ2_AG_24		people/year	TT_fr_Univ2_3_AG_24*'Incompletion_fract_Univ2_19 to 24'	
Incompetion_rate_Univ2_AG_25		people/year	TT_fr_Univ2_3_AG_25*'Incompletion_fract_Univ2_19 to 24'	
Incompetion_rate_Univ2_AG_26		people/year	TT_fr_Univ2_3_AG_26*'Incompletion_fract_Univ2_19 to 24'	
Incompetion_rate_Univ2_AG_27		people/year	TT_fr_Univ2_3_AG_27*'Incompletion_fract_Univ2_25 to 29'	
Incompetion_rate_Univ2_AG_28		people/year	TT_fr_Univ2_3_AG_28*'Incompletion_fract_Univ2_25 to 29'	
Incompetion_rate_Univ2_AG_29		people/year	TT_fr_Univ2_3_AG_29*'Incompletion_fract_Univ2_25 to 29'	
Incompetion_rate_Univ2_AG_30		people/year	TT_fr_Univ2_3_AG_30*'Incompletion_fract_Univ2_25 to 29'	
Incompetion_rate_Univ2_AG_31		people/year	TT_fr_Univ2_3_AG_31*'Incompletion_fract_Univ2_25 to 29'	
Incomplete_AG_20		people/year	Incompetion_rate_Univ1_AG_20	
Incomplete_AG_21		people/year	Incompetion_rate_Univ1_AG_21+Incompetion_rate_Univ2_AG_21	

Incomplete_AG_22		people/year	Incompetion_rate_Univ1_AG_22+Incompetion_rate_Univ2_AG_22	
Incomplete_AG_23		people/year	Incompetion_rate_Univ1_AG_23+Incompetion_rate_Univ2_AG_23	
Incomplete_AG_24		people/year	Incompetion_rate_Univ1_AG_24+Incompetion_rate_Univ2_AG_24	
Incomplete_AG_25		people/year	Incompetion_rate_Univ1_AG_25+Incompetion_rate_Univ2_AG_25	
Incomplete_AG_26		people/year	Incompetion_rate_Univ1_AG_26+Incompetion_rate_Univ2_AG_26	
Incomplete_AG_27		people/year	Incompetion_rate_Univ1_AG_27+Incompetion_rate_Univ2_AG_27	
Incomplete_AG_28		people/year	Incompetion_rate_Univ1_AG_28+Incompetion_rate_Univ2_AG_28	
Incomplete_AG_29		people/year	Incompetion_rate_Univ1_AG_29+Incompetion_rate_Univ2_AG_29	
Incomplete_AG_30		people/year	Incompetion_rate_Univ1_AG_30+Incompetion_rate_Univ2_AG_30	
Incomplete_AG_31		people/year	Incompetion_rate_Univ2_AG_31	

Incompletes to USLF	20..68	people/year	{0<<people/year>>,Incomplete_AG_20,Incomplete_AG_21,Incomplete_AG_22,Incomplete_AG_23,Incomplete_AG_24,Incomplete_AG_25,Incomplete_AG_26,Incomplete_AG_27,Incomplete_AG_28,Incomplete_AG_29,Incomplete_AG_30,Incomplete_AG_31,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>}	
Incompletes _to_Pot Students_AG_20		people/year	'Incompletes to USLF'[21]	
Incompletes _to_Pot Students_AG_21		people/year	'Incompletes to USLF'[22]	
Incompletes _to_Pot Students_AG_22		people/year	'Incompletes to USLF'[23]	
Incompletes _to_Pot Students_AG_23		people/year	'Incompletes to USLF'[24]	
Incompletes _to_Pot Students_AG_24		people/year	'Incompletes to USLF'[25]	
Incompletes _to_Pot Students_AG_25		people/year	'Incompletes to USLF'[26]	
Incompletes _to_Pot Students_AG_26		people/year	'Incompletes to USLF'[27]	

Incompletes_to_Pot Students_AG_27		people/year	'Incompletes to USLF'[28]	
Incompletes_to_Pot Students_AG_28		people/year	'Incompletes to USLF'[29]	
Incompletes_to_Pot Students_AG_29		people/year	'Incompletes to USLF'[30]	
Incompletion fract_Univ1_19 to 24			GRAPH(TIME,1994<<@year>>,10<<year>>,{0.36,0.37,0.32,0.28//Min:0;Max:0.05//})	
Incompletion_fract_Univ1_25 to 29			GRAPH(TIME,1994<<@year>>,10<<year>>,{0.35,0.35,0.3,0.28//Min:0;Max:0.05//})	
Incompletion_fract_Univ2_19 to 24			GRAPH(TIME,1994<<@year>>,10<<year>>,{0.28,0.26,0.22,0.16//Min:0;Max:0.05//})	
Incompletion_fract_Univ2_25 to 29			GRAPH(TIME,1994<<@year>>,10<<year>>,{0.28,0.26,0.21,0.16//Min:0;Max:0.05//})	

Incompletion_Univ1	20..68	people/year	{Incompetion_rate_Univ1_AG_20,Incompetion_rate_Univ1_AG_21,Incompetion_rate_Univ1_AG_22,Incompetion_rate_Univ1_AG_23,Incompetion_rate_Univ1_AG_24,Incompetion_rate_Univ1_AG_25,Incompetion_rate_Univ1_AG_26,Incompetion_rate_Univ1_AG_27,Incompetion_rate_Univ1_AG_28,Incompetion_rate_Univ1_AG_29,Incompetion_rate_Univ1_AG_30,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>}	

Incompletion_Univ2	20..68	people/year	{0<<people/year>>,Incompetion_rate_Univ2_AG_21,Incompetion_rate_Univ2_AG_22,Incompetion_rate_Univ2_AG_23,Incompetion_rate_Univ2_AG_24,Incompetion_rate_Univ2_AG_25,Incompetion_rate_Univ2_AG_26,Incompetion_rate_Univ2_AG_27,Incompetion_rate_Univ2_AG_28,Incompetion_rate_Univ2_AG_29,Incompetion_rate_Univ2_AG_30,Incompetion_rate_Univ2_AG_31,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>}	
indicated Total Skilled Labor needed		people	AD_skilled/'Expected Skilled Labor Productivity'	
indicated Total USL needed		people	AD_unskilled/'Expected Unskilled Labor Productivity'	
initial cap for F_Students		people/year	PULSE(3000<<people>>,2015<<@year>>,1000000000<<year>>)	
Initial Foreign StudentTert _Edu Budget		NOK/year²	PULSE(210000000<<NOK/year>>,2013<<@year>>,1000000000<<year>>)	
initial internship budget allocation		NOK/year²	PULSE(6400000000<<NOK/year>>,2014<<@year>>,1000000<<year>>)	
initial internship capacity built		people/year	PULSE(40000<<people>>,2014<<@year>>,10000<<year>>)	
Initial number of Online Edu cap		people/year	PULSE(1000<<people>>,2013<<@year>>,1000000000<<year>>)	

Initial Online Tert_Edu Budget		NOK/year²	PULSE(70000000<<NOK/year>>,2013<<@year>>,1000000000<<year>>)	
internship budget allocation AT			1	
internship cap building AT			2+'internship budget allocation AT'	
internship cap gap		people	IF(TIME>2014<<@year>>,'desired total interns_19-29'-'Internship Capacity')	
internship cap increasing rate		people/year	IF(TIME>2015<<@year>>,('extra internship cap needed'/'internship cap building AT')/TIMESTEP*PULS)	
Internship Capacity		people	0<<people>>	
internship capacity ratio			IF (TIME>2014<<@year>>,'Internship Capacity'/'desired total interns_19-29')	
internship period as ave study period			0.25	
internship spending per person per year		NOK/(year*people)	'total internship spending per person'/3<<year>>	
internship_ foregone earnings ratio			'total internship spending per person'/'foregone earnings_no internship'	
Intership Budget		NOK/year	0<<NOK/year>>	
intership expenditure increasing rate		NOK/year²	IF(TIME>2014<<@year>>,(('extra internship cap needed'*'internship spending per person per year')/'internship budget allocation AT')/TIMESTEP*PULS)	
L_Pdty_growth_rate_SL		year^-1	DELAYINF('ave_L_pdty_growth rate_SL',2<<year>>,1)	
L_Pdty_growth_rate_unskilled		year^-1	DELAYINF('ave_L_pdty_growth rate_US',1.5<<year>>,1)	
Labor Immigrants_ SL		people	DELAYINF('Foreign Labor_Skilled',1<<year>>,1)	
Labor Immigrants_ unskilled		people	DELAYINF('Foreign Labor_Unskilled',1<<year>>,1)	

labor share_skilled			GRAPHCURVE(TIME,1994<<@year>>,5<<year>>,{0.416 ,0.421 ,0.424 ,0.4284 ,0.431 ,0.433 ,0.435 ,0.4365 ,0.439 ,0.44 ,0.4406 ,0.441//Min:0.4;Max:0.45//})	
labor share_unskilled			GRAPHCURVE(TIME,1994<<@year>>,5<<year>>,{0.223,0.26,0.326,0.35,0.34,0.31,0.297//Min:0;Max:0.5//})	
leaving_SLF	20..68	people/year	{0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,'Domestic LF_Skilled'[31]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[32]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[33]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[34]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[35]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[36]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[37]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[38]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[39]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[40]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[41]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[42]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[43]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[44]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[45]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[46]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[47]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[48]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[49]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[50]*'frct_leaving_SLF_30 to 49' ,'Domestic LF_Skilled'[51]*'frct_leaving_SLF_50 to 61' ,'Domestic LF_Skilled'[52]*'frct_leaving_SLF_50 to 61' ,'Domestic LF_Skilled'[53]*'frct_leaving_SLF_50 to 61' ,'Domestic LF_Skilled'[54]*'frct_leaving_SLF_50 to 61' ,'Domestic LF_Skilled'[55]*'frct_leaving_SLF_50 to 61' ,'Domestic LF_Skilled'[56]*'frct_leaving_SLF_50 to 61' ,'Domestic LF_Skilled'[57]*'frct_leaving_SLF_50 to 61' ,'Domestic LF_Skilled'[58]*'frct_leaving_SLF_50 to 61' ,'Domestic LF_Skilled'[59]*'frct_leaving_SLF_50 to 61' ,'Domestic LF_Skilled'[60]*'frct_leaving_SLF_50 to 61' ,'Domestic LF_Skilled'[61]*'frct_leaving_SLF_50 to 61' ,'Domestic LF_Skilled'[62]*'frct_leaving_SLF_50 to 61' ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>>}/TIMESTEP*PULS	Divided by 2 because the SL who leaves the LF permanently due to disability is much lesser than the nonTE.

leaving_unskilled_rate	20..68	people/year	IF('Domestic LF_Unskilled'[20..68]>1<<people>>,{0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,'Domestic LF_Unskilled'[31]*'frct_leaving_USLF_30 to 39' ,'Domestic LF_Unskilled'[32]*'frct_leaving_USLF_30 to 39' ,'Domestic LF_Unskilled'[33]*'frct_leaving_USLF_30 to 39' ,'Domestic LF_Unskilled'[34]*'frct_leaving_USLF_30 to 39' ,'Domestic LF_Unskilled'[35]*'frct_leaving_USLF_30 to 39' ,'Domestic LF_Unskilled'[36]*'frct_leaving_USLF_30 to 39' ,'Domestic LF_Unskilled'[37]*'frct_leaving_USLF_30 to 39' ,'Domestic LF_Unskilled'[38]*'frct_leaving_USLF_30 to 39' ,'Domestic LF_Unskilled'[39]*'frct_leaving_USLF_30 to 39' ,'Domestic LF_Unskilled'[40]*'frct_leaving_USLF_30 to 39' ,'Domestic LF_Unskilled'[41]*'frct_leaving_USLF_40 to 49' ,'Domestic LF_Unskilled'[42]*'frct_leaving_USLF_40 to 49' ,'Domestic LF_Unskilled'[43]*'frct_leaving_USLF_40 to 49' ,'Domestic LF_Unskilled'[44]*'frct_leaving_USLF_40 to 49' ,'Domestic LF_Unskilled'[45]*'frct_leaving_USLF_40 to 49' ,'Domestic LF_Unskilled'[46]*'frct_leaving_USLF_40 to 49' ,'Domestic LF_Unskilled'[47]*'frct_leaving_USLF_40 to 49' ,'Domestic LF_Unskilled'[48]*'frct_leaving_USLF_40 to 49' ,'Domestic LF_Unskilled'[49]*'frct_leaving_USLF_40 to 49' ,'Domestic LF_Unskilled'[50]*'frct_leaving_USLF_40 to 49' ,'Domestic LF_Unskilled'[51]*'frct_leaving_USLF_50 to 61' ,'Domestic LF_Unskilled'[52]*'frct_leaving_USLF_50 to 61' ,'Domestic LF_Unskilled'[53]*'frct_leaving_USLF_50 to 61' ,'Domestic LF_Unskilled'[54]*'frct_leaving_USLF_50 to 61' ,'Domestic LF_Unskilled'[55]*'frct_leaving_USLF_50 to 61' ,'Domestic LF_Unskilled'[56]*'frct_leaving_USLF_50 to 61' ,'Domestic LF_Unskilled'[57]*'frct_leaving_USLF_50 to 61' ,'Domestic LF_Unskilled'[58]*'frct_leaving_USLF_50 to 61' ,'Domestic LF_Unskilled'[59]*'frct_leaving_USLF_50 to 61' ,'Domestic LF_Unskilled'[60]*'frct_leaving_USLF_50 to 61' ,'Domestic LF_Unskilled'[61]*'frct_leaving_USLF_50 to 61' ,'Domestic LF_Unskilled'[62]*'frct_leaving_USLF_50 to 61' ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>>},0<<people>>)/TIMESTEP*PULS	

Level_1		people	10000	
Level_2		people	0	
man per work			0.5	
max fract of skilled job			1	
modular			NUMBER(TIME) MOD 1	
motivation to univ			(('effect of wage premium'*'weight distr'[1])+('effect of expected foregone earnings growth'*'weight distr'[2])+('effect of relative expected LT earnings'*'weight distr'[3])+('ease of finding jobs'*'weight distr'[4]))	
natural_UR_SL			0.035	
natural_UR_unskilled			0.035	
need for F_labors_SL		people	DELAYINF(IF('SL gap'-'Unemployed Skilled LF'>0<<people>>,('SL gap'-'Unemployed Skilled LF'),0<<people>>),1<<year>>,1)	
need for F_labors_US		people	DELAYINF(IF('USL gap'-'Unemployed USLF'>0<<people>>,'USL gap'-'Unemployed USLF',0<<people>>),1<<year>>,1)	
Net Capital Investment		NOK/year	24780000000	
net capital investment rate		NOK/year²	'ave capital investment growth fraction'*'Net Capital Investment'	
nonTE wages from pdty		NOK/(year*people)	(GRAPHCURVE(TIME,1994<<@year>>,5<<year>>,{0.2,0.25,0.3,0.33,0.33,0.34,0.35//Min:-1;Max:11//}))*'Expected Unskilled Labor Productivity'	
online budget increasing rate		NOK/year²	IF(TIME>2013<<@year>>,(('extra online cap'*'expenditure per online student')/'Online T_Edu cap building AT')/TIMESTEP*PULS)	
online edu cap gap		people	'total online students'-'Online Tert_Edu Capacity'	
Online Graduates_3		people	DELAYINF(Level_2,1<<year>>,1)	

3-38				
Online T_Edu budget AT			3+'Online T_Edu cap building AT'	
Online T_Edu cap building AT			3	
Online Tert_Edu Budget		NOK/year	0	
Online Tert_Edu Capacity		people	0	
Online Univ Grad_33-38		people/year	Online_Graduate_Turning_34+Online_Graduate_Turning_35+Online_Graduate_Turning_36+Online_Graduate_Turning_37+Online_Graduate_Turning_38+Online_Graduate_Turning_39	
Online_Graduate_Turning_34		people/year	In_Online_Univ4_AG_33/TIMESTEP*PULS	
Online_Graduate_Turning_35		people/year	In_Online_Univ4_AG_34/TIMESTEP*PULS	
Online_Graduate_Turning_36		people/year	In_Online_Univ4_AG_35/TIMESTEP*PULS	
Online_Graduate_Turning_37		people/year	In_Online_Univ4_AG_36/TIMESTEP*PULS	
Online_Graduate_Turning_38		people/year	In_Online_Univ4_AG_37/TIMESTEP*PULS	
Online_Graduate_Turning_39		people/year	In_Online_Univ4_AG_38/TIMESTEP*PULS	
Online_Students ratio			IF(TIME>2014<<@year>>,'total online students'/'Online Tert_Edu Capacity')	
Online_T_Edu cap increasing rate		people/year	IF(TIME>2013<<@year>>,('extra online cap'/'Online T_Edu budget AT')/TIMESTEP*PULS)	
pcvd density of skilled job			DELAYINF('density of skilled job',2<<year>>,1)	
pcvd foregone earnings		NOK/people	DELAYINF('expected foregone earnings',3<<year>>,1)	
pcvd job density_unskilled			DELAYINF('density of unskilled job',2.5<<year>>,1)	
pcvd relative expected LT earnings			DELAYINF('relative expected LT earnings',5<<year>>,1)	

perceived foregone earnings ratio			'expected foregone earnings'/'pcvd foregone earnings'	
perceived skilled wages		NOK/(year*people)	DELAYINF('actual individual wages_SL',3<<year>>,1)	
perceived total job vacancies_SL		people	DELAYINF(('F_Labors leaving rate_SL'*TIMESTEP+'total SLF exit'*TIMESTEP+'employed F_students leaving rate'*TIMESTEP)+'need for F_labors_SL'/NUMBER(TIMESTEP)*PULS,5<<year>>,1)	
perceived unskilled wages		NOK/(year*people)	DELAYINF('actual individual wages_US',3<<year>>,1)	
perceived wage premium			'perceived skilled wages'/'perceived unskilled wages'	
Potential_Students_AG_19		people	46027	28213//age cohort of nonTE LF 15-19 =141062, assume the initial stock value is 141062/5 = 28213 INIT('nonTE Labor Force'[4]/5) 2502//assuming 10% of the total Turning_19 was already in the nonTE LF since they were 18 years old.
Potential_Students_AG_20		people	37527	29625//age cohort of nonTE LF 20-24 =148126, assume the initial stock value is 148126/5 = 29625 28213//age cohort of nonTE LF 15-19 =141062, assume the initial stock value is 141062/5 = 28213
Potential_Students_AG_21		people	37227	
Potential_Students_AG_22		people	36648	
Potential_Students_AG_23		people	36159	
Potential_St		people	41016	

udents_AG_24				
Potential_Students_AG_25		people	43277	
Potential_Students_AG_26		people	44056	
Potential_Students_AG_27		people	45948	
Potential_Students_AG_28		people	45445	
Potential_Students_AG_29		people	46281	
Potential_Students_AG_30		people	37939	28213//age cohort of nonTE LF 15-19 =141062, assume the initial stock value is 141062/5 = 28213 INIT('nonTE Labor Force'[4]/5) 2502//assuming 10% of the total Turning_19 was already in the nonTE LF since they were 18 years old.
Potential_Students_AG_31		people	38760	29625//age cohort of nonTE LF 20-24 =148126, assume the initial stock value is 148126/5 = 29625 28213//age cohort of nonTE LF 15-19 =141062, assume the initial stock value is 141062/5 = 28213
Potential_Students_AG_32		people	39043	
Potential_Students_AG_33		people	39178	
Potential_Students_AG_34		people	40091	
Potential_Students_AG_35		people	40414	

ppl over 16 w_tert_edu _SSB		people	GRAPH(TIME, 1994<<@year>>,1<<year>>,{ 617417 ,643056 ,671667 ,699424 ,725749 ,743809 ,758079 ,775867 ,795809 ,818981 ,849100 ,879759 ,907408 ,933304 ,976372 }<<people>>)	
PULS			IF(modular=0,1,0)	
Rate_11		people/year	Level_2/TIMESTEP*PULS	
Rate_4		people/year	'arrsum total grad_22 to 32'/TIMESTEP*PULS	
Rate_7		people/year	IF(TIME>1994<<@year>>,Level_1,0<<people>>)/TIMESTEP*PULS	
re-enter USLF	20..67	people/year	MAX(0<<people>>,'Domestic Idle USWAP'[20..67])/TIMESTEP*PULS*'frct_unskilled_Idles_re-enter'	
red symbol			1	
ref mode-SLF			GRAPH(TIME,1994<<@year>>,1<<year>>,{479114 ,521210 ,566593 ,606169 ,632526 ,655243 ,673078 ,727283 ,756531 ,761099 ,792058 ,822546 ,828963 ,862146 ,880768 ,903331 ,938866 ,961392 ,983501 ,1004604 ,1024624 ,1043961 ,1062652 ,1081342 ,1099312 ,1117319 ,1135444 ,1154235 ,1173163 ,1191883 ,1210094 ,1228656 ,1247319 ,1265868 ,1284657 ,1303534 ,1322778 ,1341769 ,1360835 ,1379804 ,1398755 ,1417490 ,1435979 ,1454877 ,1473793 ,1493117 ,1512773 ,1532761 ,1553921 ,1575507 ,1597787 ,1620671 ,1643834 ,1667810 ,1692514 ,1717693 ,1742895 })	

ref mode-SLF_1994 to 2009			GRAPH(TIME,1994<<@year>>,1<<year>>,{479114 ,521210 ,566593 ,606169 ,632526 ,655243 ,673078 ,727283 ,756531 ,761099 ,792058 ,822546 ,828963 ,862146 ,880768 ,903331 ,938866 ,961392 ,983501 ,1004604 ,1024624 ,1043961 ,1062652 ,1081342 ,1099312 ,1117319 ,1135444 ,1154235 ,1173163 ,1191883 ,1210094 ,1228656 ,1247319 ,1265868 ,1284657 ,1303534 ,1322778 ,1341769 ,1360835 ,1379804 ,1398755 ,1417490 ,1435979 ,1454877 ,1473793 ,1493117 ,1512773 ,1532761 ,1553921 ,1575507 ,1597787 ,1620671 ,1643834 ,1667810 ,1692514 ,1717693 ,1742895 })	
ref NFCF			GRAPH(TIME,1994<<@year>>,1<<year>>,{247800000 00 ,31547000000 ,37308000000 ,52641000000 ,8063 5000000 ,108534000000 ,85713000000 ,7271500000 0 ,65162000000 ,56157000000 ,53312000000 ,79143 000000 ,117675000000 ,159106000000 ,2120590000 00 ,206245000000 ,159026000000 })	

ref real AD			GRAPH(TIME,1994<<@year>>,1<<year>>,{1588530759496, 1588308563905, 1656188043139, 1742400284393, 1836780621556, 1885547889422, 1922428629625, 1981428677062, 2033466480095, 2057971493930, 2085880598984, 2158535828280, 2224185414212, 2423354252260, 2489342104275, 2581447762133})	
ref real GDP			GRAPH(TIME,1994<<@year>>,1<<year>>,{1588740546757 ,1656338607087 ,1742664166709 ,1837094865031 ,1885752296663 ,1922875901275 ,1981604209800 ,2033676981800 ,2058152916265 ,2086321353033 ,2159111342407 ,2224768260513 ,2423722113591 ,2489722959692 ,2543188000000 })	
ref real total labor compensation			GRAPH(TIME,1994<<@year>>,1<<year>>,{558352934712 ,577919216561 ,612279766002 ,647049095092 ,696068950000 ,726980707722 ,745284738389 ,768034149954 ,794035250681 ,794793840426 ,829941721094 ,867063566464 ,926867696686 ,1021168473019 ,1078045000000 ,1094639215686 })	

ref_In_Edu_19 to 24_all tert		people	GRAPH(TIME,1994<<@year>>,1<<year>>,{ 89896 ,92619 ,94802 ,92550 ,91680 ,92406 ,86235 ,83848 ,92410 ,93454 ,95781 ,98186 ,98931 ,99129 ,102850 ,105800 ,108762 ,111808 ,114938 ,118157 ,121465 ,124866 ,128362 ,131956 ,135651 ,139449 ,143354 ,147368 ,151494 ,155736 ,160097 ,164579 ,169188 ,173925 ,178795 ,183801 ,188947 ,194238 ,199677 ,205268 ,211015 ,216924 ,222997 ,229241 ,235660 ,242259 ,249042 ,256015 ,263183 ,270553 ,278128 ,285916 ,293921 ,302151 ,310611 ,319308 ,328249 }<<people>>)	
ref_In_Edu_25 to 29_all tert		people	GRAPH(TIME,1994<<@year>>,1<<year>>,{ 39616 ,40196 ,41442 ,42290 ,43646 ,45711 ,44361 ,45881 ,47123 ,46054 ,45782 ,44576 ,43454 ,42401 ,42138 ,43600,45082 ,46615 ,48200 ,49839 ,51533 ,53286 ,55097 ,56971 ,58908 ,60910 ,62981 ,65123 ,67337 ,69626 ,71994 ,74441 ,76973 ,79590 ,82296 ,85094 ,87987 ,90978 ,94072 ,97270 ,100577 ,103997 ,107533 ,111189 ,114969 ,118878 ,122920 ,127099 ,131421 ,135889 ,140509 ,145287 ,150226 ,155334 ,160616 ,166076 ,171723 //Min:-1;Max:50000// }<<people>>)	
Reference Skilled Labor Fraction			0.27	=(569907*0.9)/2067841 (skilledLF/LF)
relative expected LT earnings			'expected LT Earnings_SL'/'expected LT Earnings_nonTE'	

retirement_rate_Idle_SWAP	20..68	people/year	{ 0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,'Domestic Idle SWAP'[68]}/TIMESTEP*PULS	

retirement_rate_Idle_USWAP	20..68	people/year	{ 0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,'Domestic Idle USWAP'[68]}/TIMESTEP*PULS	

retirement_ rate_SLF	20..68	people/year	{ 0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,'Domestic LF_Skilled'[68]}/TIMESTEP*PULS	

retirement_ rate_unskill ed	20..68	people/year	IF('Domestic LF_Unskilled'[20..68]>1<<people>>,{ 0<<people>> ,0< <people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<people >> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<peo ple>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<< people>> ,0<<people>> ,0<<people>> ,0<<people>> , 0<<people>> ,0<<people>> ,0<<people>> ,0<<people >> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<peo ple>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<< people>> ,0<<people>> ,0<<people>> ,0<<people>> , 0<<people>> ,0<<people>> ,0<<people>> ,0<<people >> ,0<<people>> ,0<<people>> ,0<<people>> ,0<<peo ple>> ,0<<people>> ,0<<people>> ,0<<people>> ,0<< people>> ,0<<people>> ,'Domestic LF_Unskilled'[68]},0<<people>>)/TIMESTEP*PULS	
Sim AD			GRAPH(TIME,STARTTIME,1<<year>>,Constant_AD)	
SL gap		people	('indicated Total Skilled Labor needed'-'total Employed SLF'+('F_Labors leaving rate_SL'+'total SLF exit')*TIMESTEP) //positive means shortage of domestic labors, negative means surplus of domestic labors	
SL wages from pdty		NOK/(year*people)	'Expected Skilled Labor Productivity'*0.41	

SL_real_annual wages		NOK/year	GRAPH(TIME,1994<<@year>>,1<<year>>,{ 332765 ,341726 ,355560 ,365365 ,383614 ,389545 ,396352 ,406196 ,430387 ,433829 ,441328 ,448229 ,457104 ,479841 ,491850,506606 ,521804 ,537458 ,553582 ,570189 ,587295 ,604913 ,623061 ,641753 ,661005 ,680835 ,701260 ,722298 ,743967 ,766286 ,789275 ,812953 ,837342 ,862462 ,888336 ,914986 ,942435 ,970709 ,999830 ,1029825 ,1060719 ,1092541 ,1125317 ,1159077 ,1193849 ,1229665 ,1266554 ,1304551 ,1343688 ,1383998 ,1425518 ,1468284 ,1512332 ,1557702 ,1604433 ,1652566 ,1702143 //Min:-1;Max:11//}<<NOK/year>>)	
SL_shortage		people	DELAYINF('SL gap',3<<year>>,1)	
SLF fraction			DELAYINF('total SLF'/'total LF',5<<year>>,1)	
SLF growth frct		year^-1	('SLF fraction'-'delayed SLF fraction')/'delayed SLF fraction'*1<<1/year>>	
SLF growth rate		year^-1	('total SLF'-'delayed total SLF')/'delayed total SLF'*'fractional skilled frct increment rate'	
SLF over LF growth frct		year^-1	('total SLF frct'-'delayed total SLF frct')/'delayed total SLF frct'*1<<1/year>>	
smoothed growth frct of SGDP		year^-1	DELAYINF('growth frct of SGDP',1<<year>>,1)	
smoothed growth frct of USGDP		year^-1	DELAYINF('growth frct of USGDP',1.5<<year>>,1)	
smoothed net lack of SL		people	DELAYINF('SL gap',3<<year>>,1)	
smoothed UR unskilled			DELAYINF('unemployment rate_USL',1<<year>>,1)	
smoothed UR_SL			DELAYINF('unemployment rate_SL',1<<year>>,1)	

Students as PT USL yr 1	20..68	people	{0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>}	
Students as PT USL yr 2	20..68	people	{0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>}	

Students as PT USL yr 3	20..68	people	{0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>,0<<people>>}	
Students working PT_yr1	20..68	people/year	USL_to_Univ1*'fraction with PT job'*'man per work'	
Students working PT_yr2	20..68	people/year	'Students as PT USL yr 1'/TIMESTEP*PULS	
Students working PT_yr3	20..68	people/year	'Students as PT USL yr 2'/TIMESTEP*PULS	
surplus of F_labors_SL		people	IF('SL gap'<0<<people>>,-('SL gap'),0<<people>>)	
surplus of_F_USL		people	IF('USL gap'<0<<people>>,-('USL gap'),0<<people>>)	
SWAP reactive rate		people/year	ARRSUM(Idle_SWAP_enter_SLF)	
switch_Foreign Students_Policy			1	
targeted no of F_students recruitment per year		people/year	'perceived total job vacancies_SL'/'estimated F_students recruitment AT'	
tert grad entering SLF	20..68	people/year	'total graduates'*(1-'frct not seeking for job')	
tert grad not seeking for job	20..68	people/year	'tert grad entering SLF'*'frct not seeking for job'	
tert grad seeking job		people/year	ARRSUM('tert grad entering SLF')+'total USL upgrading to SL'	

tert students work part_time		people	'total tert students_19-29'*'frct work part_time'	
tert_grad_22 to 32		people	DELAYINF(Level_1,2<<year>>,1)	
To_Online_Univ1_AG_31		people/year	TT_non_study_USLF_to_AG_31*'frct_To_Online_Univ1_30 to 35'*'motivation to univ'*'effectiveness of Online Univ Policy'	
To_Online_Univ1_AG_32		people/year	TT_non_study_USLF_to_AG_32*'frct_To_Online_Univ1_30 to 35'	
To_Online_Univ1_AG_33		people/year	TT_non_study_USLF_to_AG_33*'frct_To_Online_Univ1_30 to 35'	
To_Online_Univ1_AG_34		people/year	TT_non_study_USLF_to_AG_34*'frct_To_Online_Univ1_30 to 35'	
To_Online_Univ1_AG_35		people/year	TT_non_study_USLF_to_AG_35*'frct_To_Online_Univ1_30 to 35'	
To_Online_Univ_AG_30		people/year	'TT_Pot Students_to_AG_30'*frct_To_Online_Univ1_AG_30*'effectiveness of Online Univ Policy'*'motivation to univ'	
To_Pot Students_AG_19		people/year	('Age Group_18'/TIMESTEP*PULS)*frct_NOT_to_Univ1_AG_19	
To_Pot Students_AG_20		people/year	'TT_Pot Students_to_AG_20'-To_Univ1_AG_20	
To_Pot Students_AG_21		people/year	'TT_Pot Students_to_AG_21'-To_Univ1_AG_21	
To_Pot Students_AG_22		people/year	'TT_Pot Students_to_AG_22'-To_Univ1_AG_22	
To_Pot Students_AG_23		people/year	'TT_Pot Students_to_AG_23'-To_Univ1_AG_23	
To_Pot Students_AG_24		people/year	'TT_Pot Students_to_AG_24'-To_Univ1_AG_24	
To_Pot Students_AG_25		people/year	'TT_Pot Students_to_AG_25'-To_Univ1_AG_25	
To_Pot Students_AG_26		people/year	'TT_Pot Students_to_AG_26'-To_Univ1_AG_26	

To_Pot Students_AG_27		people/year	'TT_Pot Students_to_AG_27'-To_Univ1_AG_27	
To_Pot Students_AG_28		people/year	'TT_Pot Students_to_AG_28'-To_Univ1_AG_28	
To_Pot Students_AG_29		people/year	'TT_Pot Students_to_AG_29'-To_Univ1_AG_29	
To_Pot Students_AG_30		people/year	'TT_Pot Students_to_AG_30'-To_Online_Univ_AG_30	
To_Univ1_AG_20		people/year	'TT_Pot Students_to_AG_20'*frct_to_Univ_20	
To_Univ1_AG_21		people/year	'TT_Pot Students_to_AG_21'*'frct_to_Univ_21 to 25'	
To_Univ1_AG_22		people/year	'TT_Pot Students_to_AG_22'*'frct_to_Univ_21 to 25'	
To_Univ1_AG_23		people/year	'TT_Pot Students_to_AG_23'*'frct_to_Univ_21 to 25'	
To_Univ1_AG_24		people/year	'TT_Pot Students_to_AG_24'*'frct_to_Univ_21 to 25'	
To_Univ1_AG_25		people/year	'TT_Pot Students_to_AG_25'*'frct_to_Univ_21 to 25'	
To_Univ1_AG_26		people/year	'TT_Pot Students_to_AG_26'*'frct_to_Univ_26 to 29'	
To_Univ1_AG_27		people/year	'TT_Pot Students_to_AG_27'*'frct_to_Univ_26 to 29'	
To_Univ1_AG_28		people/year	'TT_Pot Students_to_AG_28'*'frct_to_Univ_26 to 29'	
To_Univ1_AG_29		people/year	'TT_Pot Students_to_AG_29'*'frct_to_Univ_26 to 29'	
To_Univ_AG_19		people	'Age Group_18'*frct_To_Univ1_AG_19	
total AFP rate		year^-1	ARRSUM(AFP_unskilled+AFP_SL)/WAP	
total dropOuts seeking for jobs		people/year	ARRSUM('Incompletes to USLF')+0.000001<<people/year>>	
total Employed SLF		people	'Employed Domestic SLF'+'Foreign Labor_Skilled'+'Employed Foreign Students'*1	

total Employed USLF		people	'Employed Domestic USLF'+'Foreign Labor_Unskilled'	
total employed USLF exit		people/year	'total USLF exit'	
total entrants to USLF		people/year	ARRSUM('AG_18 and Incompletes entering_USLF')	
Total F_Labor Stock in Total Employment			'Total F_Labors'/('total Employed SLF'+'Employed USLF')	
Total F_Labors		people	'Foreign Labor_Skilled'+'Foreign Labor_Unskilled'	
total F_Students		people	'Foreign Students_Univ1'+'Foreign Students_Univ2'+'Foreign Students_Univ3'	
total graduates	20..68	people/year	{0<<people/year>>,0<<people/year>>,0<<people/year>>,Graduate_Turning_22,Graduate_Turning_23,Graduate_Turning_24,Graduate_Turning_25,Graduate_Turning_26,Graduate_Turning_27,Graduate_Turning_28,Graduate_Turning_29,Graduate_Turning_30,Graduate_Turning_31,Graduate_Turning_32,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>}	

total In Edu 19-24		people	DELAYINF(In_Univ1_AG_19+In_Univ1_AG_20+In_Univ1_AG_21+In_Univ1_AG_22+In_Univ1_AG_23+In_Univ1_AG_24+In_Univ2_AG_20+In_Univ2_AG_21+In_Univ2_AG_22+In_Univ2_AG_23+In_Univ2_AG_24+In_Univ3_AG_21+In_Univ3_AG_22+In_Univ3_AG_23+In_Univ3_AG_24,1<<year>>,1)	
total internship spending per person		NOK/people	IF(TIME>2014<<@year>>,'perceived unskilled wages'*'ave study period'*frct_internship_coverage*'internship period as ave study period')	
total LF		people	DELAYINF('total SLF'+'Total Unskilled LF',1<<year>>,1)	
total LF 1		people	'total SLF'+'Total Unskilled LF'	
total LF sickness and disability exit flow		people	ARRSUM(leaving_SLF+leaving_unskilled_rate)*TIMESTEP	
total LF sickness and disability exit rate			'total LF sickness and disability exit flow'/WAP	
total nonTE_LF_19-24		people	Potential_Students_AG_19+Potential_Students_AG_20+Potential_Students_AG_21+Potential_Students_AG_22+Potential_Students_AG_23+Potential_Students_AG_24	
total old age retirement fr LF		year^-1	ARRSUM(retirement_rate_SLF+retirement_rate_unskilled)/WAP	
total online students		people	'total online_students_Univ1'+'total online_students_Univ2'+'total online_students_Univ3'+'total online_students_Univ4'	
Total Online Univ Grad_33-38		people	'Online Univ Grad_33-38'*TIMESTEP	

total online_students_Univ1		people	In_Online_Univ1_AG_30+In_Online_Univ1_AG_31+In_Online_Univ1_AG_32+In_Online_Univ1_AG_33+In_Online_Univ1_AG_34+In_Online_Univ1_AG_35	
total online_students_Univ2		people	In_Online_Univ2_AG_31+In_Online_Univ2_AG_32+In_Online_Univ2_AG_33+In_Online_Univ2_AG_34+In_Online_Univ2_AG_35+In_Online_Univ2_AG_36	
total online_students_Univ3		people	In_Online_Univ3_AG_32+In_Online_Univ3_AG_33+In_Online_Univ3_AG_34+In_Online_Univ3_AG_35+In_Online_Univ3_AG_36+In_Online_Univ3_AG_37	
total online_students_Univ4		people	In_Online_Univ4_AG_33+In_Online_Univ4_AG_34+In_Online_Univ4_AG_35+In_Online_Univ4_AG_36+In_Online_Univ4_AG_37+In_Online_Univ4_AG_38	
Total Skilled LF		people	DELAYINF('total SLF',1<<year>>,1)	
Total Skilled LF with all-in-one policy			GRAPH(TIME,STARTTIME,1<<year>>,Constant_TSLF)	
total SLF		people	ARRSUM('Domestic LF_Skilled'[20..67])+'Foreign Labor_Skilled'+'Employed Foreign Students'*'switch_Foreign Students_Policy'	
total SLF exit		people/year	IF('Employed Domestic SLF'>0<<people>>,(ARRSUM(deaths_SLF)+ARRSUM(AFP_SL+leaving_SLF+retirement_rate_SLF)))	
total SLF frct			'total SLF'/'total LF 1'	
total student as PT USL		people	ARRSUM('Students as PT USL yr 1'+'Students as PT USL yr 2'+'Students as PT USL yr 3')	
total tert students_19-29		people	'total In Edu 19-24'+'total_In_Edu_25-29'	
total unemployed USLF exit		people/year	('total USLF exit'*'unemployment rate_USL')	

total University Students_19 to 29		people	DELAYINF(Univ_1+Univ_2+Univ_3+Univ_4,0.8<<year>>,1)	
Total Unskilled LF		people	ARRSUM('Domestic LF_Unskilled'[20..67])+'Foreign Labor_Unskilled'+'total student as PT USL'	
Total Unskilled LF 1		people	DELAYINF('Total Unskilled LF',1<<year>>,1)	
total unskilled to Univ1_AG_19 to 29	20..68	people/year	{0<<people/year>>,To_Univ1_AG_20,To_Univ1_AG_21,To_Univ1_AG_22,To_Univ1_AG_23,To_Univ1_AG_24,To_Univ1_AG_25,To_Univ1_AG_26,To_Univ1_AG_27,To_Univ1_AG_28,To_Univ1_AG_29,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>}	
total USL upgrading to SL		people/year	ARRSUM('USL upgrading to SL')	
total USLF exit		people/year	(ARRSUM(deaths_USLF)+ARRSUM(AFP_unskilled+leaving_unskilled_rate+retirement_rate_unskilled+USL_to_Univ1))	
Total Wages		NOK/year	'Total Wages_SL'+'Total Wages_USL'	

Total Wages_SL		NOK/year	('Employed Domestic SLF'+'Foreign Labor_Skilled')*'actual individual wages_SL'	
Total Wages_USL		NOK/year	('Employed Domestic USLF'+'Foreign Labor_Unskilled')*'actual individual wages_US'	
total_In_Edu_25-29		people	DELAYINF(In_Univ1_AG_28+In_Univ1_AG_25+In_Univ1_AG_26+In_Univ1_AG_27+In_Univ1_AG_29+In_Univ2_AG_25+In_Univ2_AG_26+In_Univ2_AG_27+In_Univ2_AG_28+In_Univ2_AG_29+In_Univ3_AG_25+In_Univ3_AG_26+In_Univ3_AG_27+In_Univ3_AG_28+In_Univ3_AG_29,1<<year>>,1)	
Total_USLF		people	'Employed Domestic USLF'+'Foreign Labor_Unskilled'+'Unemployed USLF'	
TT_D_Idle_SWAP	23..67	people/year	FOR(i=23..67|'Domestic Idle SWAP'[i]*1<<1/year>>)	
TT_D_Idle_unskilled	20..67	people/year	FOR(i=20..67|'Domestic Idle USWAP'[i]*1<<1/year>>)	
TT_D_SLF	20..67	people/year	FOR(i=20..67|'Domestic LF_Skilled'[i]*1<<1/year>>)	
TT_D_USKL	20..67	people/year	FOR(i=20..67|'Domestic LF_Unskilled'[i]*1<<1/year>>)	
TT_F_TertGrads		people/year	'Foreign Job-seeking Tert Grads'/TIMESTEP*PULS	
TT_fr_Univ1_2_AG_20		people/year	In_Univ1_AG_19/TIMESTEP*PULS	
TT_fr_Univ1_2_AG_21		people/year	In_Univ1_AG_20/TIMESTEP*PULS	
TT_fr_Univ1_2_AG_22		people/year	In_Univ1_AG_21/TIMESTEP*PULS	
TT_fr_Univ1_2_AG_23		people/year	In_Univ1_AG_22/TIMESTEP*PULS	
TT_fr_Univ1_2_AG_24		people/year	In_Univ1_AG_23/TIMESTEP*PULS	
TT_fr_Univ1_2_AG_25		people/year	In_Univ1_AG_24/TIMESTEP*PULS	
TT_fr_Univ1_2_AG_26		people/year	In_Univ1_AG_25/TIMESTEP*PULS	
TT_fr_Univ1_2_AG_27		people/year	In_Univ1_AG_26/TIMESTEP*PULS	

TT_fr_Univ1_2_AG_28		people/year	In_Univ1_AG_27/TIMESTEP*PULS	
TT_fr_Univ1_2_AG_29		people/year	In_Univ1_AG_28/TIMESTEP*PULS	
TT_fr_Univ1_2_AG_30		people/year	In_Univ1_AG_29/TIMESTEP*PULS	
TT_fr_Univ2_3_AG_21		people/year	In_Univ2_AG_20/TIMESTEP*PULS	
TT_fr_Univ2_3_AG_22		people/year	In_Univ2_AG_21/TIMESTEP*PULS	
TT_fr_Univ2_3_AG_23		people/year	In_Univ2_AG_22/TIMESTEP*PULS	
TT_fr_Univ2_3_AG_24		people/year	In_Univ2_AG_23/TIMESTEP*PULS	
TT_fr_Univ2_3_AG_25		people/year	In_Univ2_AG_24/TIMESTEP*PULS	
TT_fr_Univ2_3_AG_26		people/year	In_Univ2_AG_25/TIMESTEP*PULS	
TT_fr_Univ2_3_AG_27		people/year	In_Univ2_AG_26/TIMESTEP*PULS	
TT_fr_Univ2_3_AG_28		people/year	In_Univ2_AG_27/TIMESTEP*PULS	
TT_fr_Univ2_3_AG_29		people/year	In_Univ2_AG_28/TIMESTEP*PULS	
TT_fr_Univ2_3_AG_30		people/year	In_Univ2_AG_29/TIMESTEP*PULS	
TT_fr_Univ2_3_AG_31		people/year	In_Univ2_AG_30/TIMESTEP*PULS	
TT_non_study_USLF_to_AG_31		people/year	(Potential_Students_AG_30/TIMESTEP*PULS)-deaths_AG_30	
TT_non_study_USLF_to_AG_32		people/year	(Potential_Students_AG_31/TIMESTEP*PULS)-deaths_AG_31	
TT_non_study_USLF_to_AG_33		people/year	(Potential_Students_AG_32/TIMESTEP*PULS)-deaths_AG_32	
TT_non_study_USLF_to_AG_34		people/year	(Potential_Students_AG_33/TIMESTEP*PULS)-deaths_AG_33	
TT_non_study_USLF_to_AG_35		people/year	(Potential_Students_AG_34/TIMESTEP*PULS)-deaths_AG_34	
TT_Pot Students_to_AG_20		people/year	(Potential_Students_AG_19/TIMESTEP*PULS)-deaths_AG_19	
TT_Pot Students_to_AG_21		people/year	(Potential_Students_AG_20/TIMESTEP*PULS)-deaths_AG_20	
TT_Pot Students_to_AG_22		people/year	(Potential_Students_AG_21/TIMESTEP*PULS)-deaths_AG_21	

TT_Pot Students_to _AG_23		people/year	(Potential_Students_AG_22/TIMESTEP*PULS)-deaths_AG_22	
TT_Pot Students_to _AG_24		people/year	(Potential_Students_AG_23/TIMESTEP*PULS)-deaths_AG_23	
TT_Pot Students_to _AG_25		people/year	(Potential_Students_AG_24/TIMESTEP*PULS)-deaths_AG_24	
TT_Pot Students_to _AG_26		people/year	(Potential_Students_AG_25/TIMESTEP*PULS)-deaths_AG_25	
TT_Pot Students_to _AG_27		people/year	(Potential_Students_AG_26/TIMESTEP*PULS)-deaths_AG_26	
TT_Pot Students_to _AG_28		people/year	(Potential_Students_AG_27/TIMESTEP*PULS)-deaths_AG_27	
TT_Pot Students_to _AG_29		people/year	(Potential_Students_AG_28/TIMESTEP*PULS)-deaths_AG_28	
TT_Pot Students_to _AG_30		people/year	(Potential_Students_AG_29/TIMESTEP*PULS)-deaths_AG_29	
Unemployed Skilled LF		people	14348<<people>>	
Unemployed USLF		people	95374	
unemployment rate_SL			'Unemployed Skilled LF'/'total SLF'	
unemployment rate_USL			'Unemployed USLF'/'Total Unskilled LF'	

Univ Droputs to Idles	1..13	people/year	{0<<people/year>>,Incomplete_AG_20*(1-'dropOuts LF parti rate'),Incomplete_AG_21*(1-'dropOuts LF parti rate'),Incomplete_AG_22*(1-'dropOuts LF parti rate'),Incomplete_AG_23*(1-'dropOuts LF parti rate'),Incomplete_AG_24*(1-'dropOuts LF parti rate'),Incomplete_AG_25*(1-'dropOuts LF parti rate'),Incomplete_AG_26*(1-'dropOuts LF parti rate'),Incomplete_AG_27*(1-'dropOuts LF parti rate'),Incomplete_AG_28*(1-'dropOuts LF parti rate'),Incomplete_AG_29*(1-'dropOuts LF parti rate'),Incomplete_AG_30*(1-'dropOuts LF parti rate'),Incomplete_AG_31*(1-'dropOuts LF parti rate')}	
Univ_1		people	In_Univ1_AG_19+In_Univ1_AG_20+In_Univ1_AG_21+In_Univ1_AG_22+In_Univ1_AG_23+In_Univ1_AG_24+In_Univ1_AG_25+In_Univ1_AG_26+In_Univ1_AG_27+In_Univ1_AG_28+In_Univ1_AG_29	
Univ_2		people	In_Univ2_AG_20+In_Univ2_AG_21+In_Univ2_AG_22+In_Univ2_AG_23+In_Univ2_AG_24+In_Univ2_AG_25+In_Univ2_AG_26+In_Univ2_AG_27+In_Univ2_AG_28+In_Univ2_AG_29+In_Univ2_AG_30	
Univ_3		people	In_Univ3_AG_21+In_Univ3_AG_22+In_Univ3_AG_23+In_Univ3_AG_24+In_Univ3_AG_25+In_Univ3_AG_26+In_Univ3_AG_27+In_Univ3_AG_28+In_Univ3_AG_29+In_Univ3_AG_30+In_Univ3_AG_31	

Univ_4		people	In_Univ4_AG_22+In_Univ4_AG_23+In_Univ4_AG_24 +In_Univ4_AG_25+In_Univ4_AG_26+In_Univ4_AG_2 7+In_Univ4_AG_28+In_Univ4_AG_29+In_Univ4_AG_ 30+In_Univ4_AG_31+In_Univ4_AG_32	
US_real_ann ual wages		NOK/year	GRAPH(TIME,1994<<@year>>,1<<year>>,{ 134392 ,1 45006 ,154420 ,166811 ,182179 ,193155 ,207291 ,22 2103 ,238465 ,251972 ,260428 ,272846 ,291355 ,308 763 ,339336,356303 ,374118 ,392824 ,412465 ,43308 8 ,454743 ,477480 ,501354 ,526422 ,552743 ,580380 ,609399 ,639869 ,671862 ,705455 ,740728 ,777764 ,8 16653 ,857485 ,900359 ,945377 ,992646 ,1042279 ,1 094393 ,1149112 ,1206568 ,1266896 ,1330241 ,1396 753 ,1466591 ,1539920 ,1616916 ,1697762 ,1782650 ,1871783 ,1965372 ,2063640 ,2166822 ,2275163 ,238 8922 ,2508368 ,2633786 //Min:- 1;Max:11//}<<NOK/year>>)	
USL gap		people	('indicated Total USL needed'-'total Employed USLF')+('F_Labors leaving rate_unskilled'+'total employed USLF exit')*TIMESTEP//positive means shortage of domestic labors, negative means surplus of domestic labors	
USL leaving for SLF	20..68	people/year	1*'USL upgrading to SL'	

USL upgrading to SL	20..68	people/year	1*{0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,Online_Graduate_Turning_34,Online_Graduate_Turning_35,Online_Graduate_Turning_36,Online_Graduate_Turning_37,Online_Graduate_Turning_38,Online_Graduate_Turning_39,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>,0<<people/year>>}	
USL_shortage		people	DELAYINF('USL gap',3<<year>>,1)	
USL_to_Univ1	20..68	people/year	IF('Domestic LF_Unskilled'[20..68]>1<<people>>,'total unskilled to Univ1_AG_19 to 29',0<<people/year>>)	
USLF entry rate		people/year	'total entrants to USLF'	
USLF growth rate		year^-1	('Total Unskilled LF'-'delayed total USLF')/'delayed total USLF'*1<<1/year>>	
W premium			'SL wages from pdty'/'nonTE wages from pdty'	
WAP		people	ARRSUM('Domestic Idle SWAP'+'Domestic Idle USWAP')+'total SLF'+'Total Unskilled LF'	

WAP inactive fraction			ARRSUM('Domestic Idle SWAP'+'Domestic Idle USWAP')/WAP	
WAP reactive rate		people/year	ARRSUM('re-enter USLF')	
weight distr	1..4		{'distr_wage premium'/('distr_wage premium'+'distr_foregone earnings'+'distr_LT earnings'+'distr_ease of finding job'),'distr_foregone earnings'/('distr_wage premium'+'distr_foregone earnings'+'distr_LT earnings'+'distr_ease of finding job'),'distr_LT earnings'/('distr_wage premium'+'distr_foregone earnings'+'distr_LT earnings'+'distr_ease of finding job'),'distr_ease of finding job'/('distr_wage premium'+'distr_foregone earnings'+'distr_LT earnings'+'distr_ease of finding job')}	{effect of wage premium, effect of expected foregone earnings growth, effect of relative expected LT earnings, ease of finding jobs}

Appendix D – Tertiary Entry Fraction of Different Age Groups 19 – 24

	19	20	21	22	23	24
1994	15	24	27	28	26	22
1995	16	24	28	28	27	22
1996	17	26	29	29	28	24
1997	19	28	32	31	29	25
1998	14	29	33	32	30	26
1999	14	28	34	34	31	27
2000	13	28	34	34	32	27
2001	13	27	31	31	29	26
2002	12	25	30	30	29	26
2003	14	28	34	34	31	28
2004	13	29	34	35	32	28
2005	14	29	35	35	32	28
2006	15	30	36	35	32	28
2007	15	29	35	36	32	28

Tertiary Entry Fraction of Different Individual Age Group 19 – 24
Source: OECD StatExtract

	20-24	25-29	30-34	35-39
1994	26	12	5	3
1995	26	12	5	3
1996	27	12	5	3
1997	29	12	5	3
1998	30	13	5	3
1999	31	13	5	3
2000	31	14	5	4
2001	29	14	6	4
2002	28	15	6	5
2003	31	16	7	5
2004	31	16	7	5
2005	32	16	7	5
2006	32	16	7	5
2007	32	15	7	5

Tertiary Entry Fraction of Different 5-year-Age Group 20-39
Source: OECD StatExtract

Appendix E – Proportion of Tertiary Students who Benefits from Public Financial Aids in OECD Countries (2006/2007)

		Distribution of financial aid to students: Percentage of students that:				Distribution of scholarships/grants in support of tuition fees: Percentage of students that:			
		benefit from public loans only	benefit from scholarships/grants only	benefit from public loans AND scholarships/grants	DO NOT benefit from public loans OR scholarships/grants	receive scholarships/grants that is higher than the tuition fees	receive scholarships/grants whose amount is equivalent to the tuition fees	receive scholarships/grants that partially cover the tuition fees	DO NOT receive scholarships/grants in support of tuition fees
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OECD countries	Australia[1]	76	n	4	20	n	n	4.8	95.2
	Austria	a	19	a	81	18.4	n	1.2	80.4
	Belgium (Fl.)[2]	a	23	a	77	22.8	x(5)	x(5)	77.2
	Belgium (Fr.)	m	m	m	m	m	m	m	m
	Canada	m	m	m	m	m	m	m	m
	Czech Republic	m	m	a	m	m	m	m	m
	Denmark[2]	m	m	m	m	m	m	m	m
	Finland[2]	a	55	a	45	a	a	a	a
	France[2]	a	25	a	75	m	m	m	m
	Germany	m	m	m	m	m	m	m	m
	Greece	m	m	m	m	m	m	m	m
	Hungary	14	34	9	43	m	m	m	m
	Iceland	63	m	m	37	a	a	a	100.0
	Ireland	a	m	a	m	a	a	a	a
	Italy	n	17	n	83	7.9	3.2	5.4	83.5
	Japan	28	1	n	72	a	a	a	100.0
	Korea	m	m	m	m	m	m	m	m
	Luxembourg	m	m	m	m	m	m	m	m
	Mexico[2]	m	m	m	m	m	m	m	m
	Netherlands	11	65	19	5	70.0	n	14.0	16.0
	New Zealand	42	3	24	32	45.4	x(5)	x(5)	54.6
	Norway[2]	7	4	59	31	m	m	m	m
	Poland	m	m	m	m	m	m	m	m
	Portugal	m	m	m	m	m	m	m	m
	Slovak Republic	m	m	m	m	m	m	m	m
	Spain	n	38	n	62	18.7	4.3	15.2	61.9
	Sweden[2]	n	25	75	n	a	a	a	a
	Switzerland	2	11	m	87	m	m	m	m
	Turkey	m	m	m	m	m	m	m	m
	United Kingdom	m	m	m	m	m	m	m	m
	United States[2]	17	22	38	24	m	m	m	m
Partner countries	Brazil	m	m	m	m	m	m	m	m
	Chile[2]	m	m	m	m	m	m	m	m
	Estonia	m	m	m	m	m	m	m	m
	Israel	m	m	m	m	m	m	m	m
	Russian Federation	m	m	m	m	m	m	m	m
	Slovenia	a	33	n	67	m	m	m	m

1. Excludes foreign students.
2. Distribution of students in total tertiary education.
Source: OECD. See Annex 3 for notes *(www.oecd.org/edu/eag2009).*
Please refer to the Reader's Guide for information concerning the symbols replacing missing data.
StatLink http://dx.doi.org/10.1787/664366467748

Source: OECD Education at a Glance (2009)

Appendix F – Sick benefits to disability pension process in Norway

The process from sick benefits to disability pension, 2005

Time Scale	Progress
1 week	Up to three days of self-declared absence (up to 8 days in inclusive workplace enterprises)
2 weeks	First medical certificate for 1-2 weeks; as of day 16, NIA pays sickness benefit.
8 weeks	Follow-up plan by the employer and the employee with support from Workplace Centres; no sanctions but control by the Labor Inspection Authority.
9 months	Dismissal possible after 6-12 months.
12 months	End of sickness benefit payment and application for medical rehabilitation benefit (disability benefit possible but unlikely at this stage).
1.5 years	Local NIA assessment as to whether medical rehabilitation needs continue (8-9 months medical rehab on average).
2 years	End of medical rehabilitation, start of vocational rehabilitation (if needed) with a rehabilitation allowance.
3 years	Typical time for transfer into disability benefit (but much earlier transfer possible if no prospect for improvement).
3 years plus	Vocational rehabilitation can often stretch over several years (three year maximum since recently, two years on average).

Re-created from "Sickness, Disability, and Work: Breaking the Barrier" (OECD, 2006a), page 62.

Appendix G – ISCED Classification

Qualifications

Level of qualification

Low qualification	At most lower secondary (ISCED 0-2)
Medium qualification	Upper secondary (ISCED 3-4)
High qualification	Tertiary (ISCED 5-6)

ISCED 0: pre-primary education
Programmes at level 0, (pre-primary) defined as the initial stage of organised instruction, are designed primarily to introduce young children to a school-type environment, to provide a bridge between the home and a school based atmosphere. Upon completion of these programmes, children continue their education at level 1 (primary education).

ISCED 1: primary education or first stage of basic education
Programmes at level 1 are normally designed on a unit or project basis to give students a sound basic education in reading, writing and mathematics along with an elementary understanding of other subjects such as history, geography, natural science, social science, art and music. In some cases religious instruction is featured. The core at this level consists of education provided for children, the customary or legal age of entrance being not younger than five years or older than seven years. This level covers, in principle, six years of full-time schooling.

ISCED 2: lower secondary education or second stage of basic education
The contents of education at this stage are typically designed to complete the provision of basic education which began at ISCED level 1. In many, if not most countries, the educational aim is to lay the foundation for lifelong learning and human development. The programmes at this level are usually on a more subject oriented pattern using more specialised teachers and more often several teachers who conduct classes in their field of specialisation. The full implementation of basic skills occurs at this level. The end of this level often coincides with the end of compulsory schooling where it exists.

ISCED 3: (upper) secondary education
This level of education typically begins at the end of full-time compulsory education for those countries that have a system of compulsory education. More specialisation may be observed at this level than at ISCED level 2 and often teachers need to be more qualified or specialised than for ISCED level 2. The entrance age to this level is typically 15 to 16 years. The educational programmes included at this level typically require the completion of some nine years of full-time education (since the beginning of level 1) for admission or a combination of education and vocational or technical experience.
- ISCED 3A: programmes designed to provide direct access to ISCED 5A;
- ISCED 3B: programmes designed to provide direct access to ISCED 5B;
- ISCED 3C: programmes not designed to lead to ISCED 5A or 5B.

ISCED 4: post-secondary non tertiary education

ISCED 4 captures programmes that straddle the boundary between upper secondary and post-secondary education from an international point of view, even though they might clearly be considered as upper secondary or post-secondary programmes in a national context. These programmes can, considering their content, not be regarded as tertiary programmes. They are often not significantly more advanced than programmes at ISCED 3 but they serve to broaden the knowledge of participants who have already completed a programme at level 3.

Typical examples are programmes designed to prepare students for studies at level 5 who, although having completed ISCED level 3, did not follow a curriculum which would allow entry to level 5, i.e. pre-degree foundation courses or short vocational programmes. Second cycle programmes can be included as well.

- ISCED 4A: see text for ISCED 3
- ISCED 4B: see text for ISCED 3
- ISCED 4C: see text for ISCED 3

ISCED 5: first stage of tertiary education (not leading directly to an advanced research qualification)

This level consists of tertiary programmes having an educational content more advanced than those offered at levels 3 and 4. Entry to these programmes normally requires the successful completion of ISCED level 3A or 3B or a similar qualification at ISCED level 4A. They do not lead to the award of an advanced research qualification (ISCED 6). These programmes must have a cumulative duration of at least two years.

ISCED 5A: programmes that are largely theoretically based and are intended to provide sufficient qualifications for gaining entry into advanced research programmes and professions with high skills requirements.

ISCED 5B: programmes that are practically oriented/ occupationally specific and are mainly designed for participants to acquire the practical skills and know-how needed for employment in a particular occupation or trade or class of occupations or trades, the successful completion of which usually provides participants with a labour-market relevant qualification.

ISCED 6: second stage of tertiary education (leading to an advanced research qualification)

This level is reserved for tertiary programmes which lead to the award of an advanced research qualification. The programmes are, therefore, devoted to advanced study and original research and not based on course-work only. They typically require the submission of a thesis or dissertation of publishable quality which is the product of original research and represents a significant contribution to knowledge. They prepare graduates for faculty posts in institutions offering ISCED 5A programmes, as well as research posts in government, industry, etc.

Documentation by EULFS: Levels of education and training ISCED 1997 (http://circa.europa.eu/irc/dsis/employment/info/data/eu_lfs/Related_documents/ISCED_EN.htm)