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Modelling and simulation of an Economy with "Basic Income" or "Job Guarantee"

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A country experiences a rapid and large drop in the price of its main export product. The economic dynamics from such a shock shall be modelled, simulated and discussed under three different regimes: The Current regime, a regime with Basic Income and a regime with Job Guarantee. Modern Money Theory (MMT) will be the foundation for what can be done via the two alternative regimes.

Preface

In this Master's thesis mathematical models for an economy has been designed and simulated. This thesis is a part of the study program Cybernetics and Robotics at the Norwegian University of Science and Technology (NTNU) and has been carried out and accomplished during the spring semester of 2016.

The intention of this report is to document the work that has been carried out during the project period and to present the results of the simulations. The reader of this report is assumed to be familiar with cybernetics and have an interest for economics.

I would like to thank my supervisor at NTNU, Trond Andresen, for his valued guidance, encouragement and the helpful advice he has provided throughout the time of this project. I would also like to thank my sister, Helene, for creating the illustration on the front page and my mother for all her support.

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Sammendrag

I denne rapporten har det blitt utviklet en dynamisk modell av et lands økonomi. Økonomien blir utsatt for en stor eksportkrise når prisen på landets viktigste eksportprodukt faller raskt. Som resultat av krisen øker arbeidsledigheten og Brutto Nasjonal Produkt (BNP) faller drastisk.

Økonomien er modellert under tre forskjellige regimer: "dagens"-regime, et regime med jobbgaranti (JG), og et regime med borgerlønn (BI). De alternative regimene blir introdusert for å bekjempe arbeidsledighet og for å støtte den fallende økonomien. De tre modellene er simulert over en periode på seks år, for å observere virkningen av et slikt sjokk på den økonomiske dynamikken over tid.

Jobbgaranti

JG er et statlig program som tilbyr arbeid til alle, med mål om å nå full sysselsetting samtidig som det fremmer prisstabilitet. JG-lønnen vil automatisk bli minstelønn i samfunnet, siden alle kan få en jobb gjennom jobbgarantien og JG-lønnen er tilgjengelig for alle. Jobbgarantien fungerer som et sikkerhetsnett for de som har mistet jobbene sine i privat sektor, men siden lønnen er på nivå med landets minstelønn, vil folk gå tilbake til private stillinger når jobber igjen er tilgjengelig i privat sektor.

Moderne Pengeteori

Moderne pengeteori (MMT) er grunnlaget for jobbgarantien. Når JG innføres vil det i begynnelsen være et kostbart program og trykking av penger kan være nødvendig, avhengig av den opprinnelige tilstanden i økonomien. MMT hevder at en regjering som har sin egen valuta aldri kan gå tom for den, og har alltid råd til å betale for det den ønsker å kjøpe seg. MMT mener at en regjerings mål ikke bør være å unngå budsjettunderskudd, men å jobbe for full sysselsetting og prisstabilitet.

Borgerlønn

I borgerlønn-programmet gir regjeringen alle en inntekt som er høy nok til å dekke grunnleggende behov som bolig, klær og mat. Det som skiller borgerlønn fra andre minsteinntektsordninger, er at regjeringen gir alle den samme borgerlønn-inntekten på en individuell

vi

basis i tillegg til eventuelle andre inntekter de måtte ha. Borgerlønn er også et dyrt program og i modellen vil den bli finansiert på tre forskjellige måter: gjennom skatt, trykking av penger, og en blanding av beskatning og trykking av penger.

Resultater og Konklusjon

Resultatene av simuleringene viser at færre mennesker vil miste jobbene sine i privat sektor både under JG-regimet og BI-regimet, og at pengestrømmen er høyere enn i økonomien uten de alternative regimene.

Eksportkrisen har stor innvirkning på økonomien. BNP faller kraftig i både jobbgarantien og under "dagens"-regime, men med jobbgaranti klarer man å holde husholdningenes forbruk nært det opprinnelige nivået, som tyder på at levestandarden er nær ved å være opprettholdt.

De tre måtene å finansiere borgerlønnen på har gitt svært ulike resultater. Ved å finansiere borgerlønn med skatter, vil BNP falle kraftig, men ved å finansiere borgerlønnen ved å trykke penger, vil BNP ende opp på samme nivå som ved starten av simuleringen, og arbeidsledigheten ender opp på 6,5 % sammenlignet med 20 % i "dagens" økonomi.

Eksportkrisen fører til at handelsbalansen faller under 0, som vil svekke landets valuta. Under JG-regimet og BI-regimet finansiert av beskatning, ender valutakursen opp på et nivå som er i nærheten av valutakursen i "dagens" modell. Mens i BI-regimet finansiert ved trykking av penger, er verdien på landets valuta nesten halvert.

BI-regimet finansiert av pengetrykking vil gi størst økonomisk vekst, med hensyn til BNP, privat sysselsetting og husholdningenes sparing og forbruk, men ved å øke pengemengden, vil myndighetene måtte sette inn drastiske tiltak for å stabilisere prisene.

Det vil være mindre krevende for regjeringen å fremme prisstabilitet under et JG-regime. JG-regimet når full sysselsetting, og det holder husholdningenes kjøpekraft nær sitt opprinnelige nivå, og derfor er JG oppfattet som det beste valget av de to alternative regimene.

Summary

In this report there has been designed a dynamic model of a country's economy using a stock-flow approach. The economy is hit by a great export crisis when the price of the country's main export product drops rapidly. As a result, unemployment is increasing and GDP is falling drastically.

The economy is modelled under three different regimes; "Today's" regime, the Job Guarantee (JG) regime, and a Basic Income (BI) regime. The alternative regimes are introduced to the model with the purpose to fight unemployment and support the struggling economy. All three models are simulated over a period of 6 years, to observe the effect on the economic dynamics from such a shock over time.

Job Guarantee

The JG is a governmental program that offers work to everyone, with the goal to reach full employment while keeping price stability. The JG wage will automatically become the minimum wage in the society, since everyone can get a job through the JG program, the JG wage is available for everyone. The JG program functions as a safety net for those that have lost their jobs in the private sector, but since it is paid at a minimum wage, people will move back to private employment when jobs are again available in the Private sector.

Modern Monetary Theory

Modern Monetary Theory (MMT) is the foundation for the Job Guarantee. When JG is first introduced it will be an expensive program and money creation might be necessary, depending on the initial state of the economy. MMT claims that a sovereign government which holds its own currency can never run out of it, and can always afford to pay for what it wants to purchase. A government's goals should not be to avoid budget deficits, but to pursue full employment and price stability.

Basic Income

In the BI program, the government grant everyone an income that is high enough to cover basic needs such as housing, clothing and food. What makes the basic income scheme

different from other minimum income schemes, is that the government gives everyone the same basic income on an individual basis in addition to any other income they may or may not have. The BI is also an expensive program and in the designed model it will be funded by three different methods; funding by taxation, money creation, and a mix of taxation and money creation.

Results and Conclusion

The results of the simulations show that fewer people will lose their jobs in the private sector in both the JG regime and the BI regime, and that the money flow is higher than in the economy without the alternative regimes.

The export crisis has great impact on the economy. The GDP will suffer a drastic fall under both the JG regime and "Today's" regime, but with the JG the households' consumption is kept close to its original level, which suggests that the standard of living is close to its initial level.

The three ways of funding the Basic Income have given very different results. By funding the Basic Income with taxes, the economy will experience a drastic fall in GDP, while by funding it through money creation, the GDP will end up at the same level as it started and unemployment is only 6,5% compared to 20% in the "Regular" economy.

The export crisis causes net exports to fall below 0, which weakens the domestic currency. Under the JG regime and the BI regime funded by taxation the exchange rate ends up close to the exchange rate in the "Regular" model. While in the BI regime funded by money creation, the value of the domestic currency is reduced by 50%.

The BI regime funded by money creation will give the greatest economic growth, with regards to GDP, private employment and households' saving and consumption, but by increasing the money supply, the government will have to take drastic measures to stabilize the prices.

It will be less challenging for the government to promote price stability under a JG regime. The JG regime also offers full employment, and it keeps households' spending power close to its initial level, and is therefore considered as the better choice by the two alternative regimes.

Contents

Chapter 1

Introduction

The recession in Europe and U.S. that followed after the financial crisis in 2008 reduced consumption and demand for imported goods, which hurt the economies of exporting countries. Especially the following slowdown in China's economy had a great impact on the global industrial commodity market. When China's import demand did not reach other countries' expectations, the prices of oil, minerals and other commodities started to fall. This has caused a decline in export markets of almost all commodities, and countries which economy have depended on international trade have suffered (Friedman, 2016).

In this thesis macroeconomic models will be designed for an economy that experiences a great, rapid fall in price on its main export product. The economic dynamics of such a shock will be simulated and discussed under three different regimes: the current regime, a regime with Basic Income and a regime with Job Guarantee. Modern Monetary Theory (MMT) will be the foundation for what can be done via the two alternative regimes

1.1   Background

When a country, which economy is dependent on foreign trade, experiences a great negative shock in export, the domestic economy will start to suffer too. As the export falls the production will be reduced, which as well as causing unemployment in the export sector will also have impact on suppliers to the export industry.

Norway as well as other oil exporting countries are now facing an export crisis due to the drop in oil prices. In January 2016 the oil prices had fallen to \$30.7 per barrel from \$125 per barrel two years earlier (DePersio, 2016).

The petroleum industry has been Norway's largest export industry for decades, in 2013 it counted for 85% of all export (Norsk olje og gass, 2014). Most of the production is located to Western Norway, where the export crisis has hit businesses the hardest. It is not only the petroleum sector that is affected by the drop in oil prices, but also other businesses. In Western Norway 46 % of companies were expecting an economic recession and 30 % would make cuts in staff during the first half of 2016 (Nærings Foreningen, 2016).

How can a government help to fight unemployment and avoid recession in a situation of crisis? The Job Guarantee and Basic Income are two different programs that can be applied to address these issues.

Job Guarantee

The Job Guarantee approach is to offer jobs to everyone, with the goal to reach full employment. The Job Guarantee is a governmental program that offers jobs at a minimum wage to everyone that wants a job. The jobs are offered locally, so people would not have to move, they should be adjusted to include individuals with disabilities and those who only want to work part time.

Flatgård (2013) simulated an economy with a JG regime, and found that the money flow in the society would increase and fewer people would lose their jobs during a financial crisis.

Since it is possible to achieve improvement in the economy with a JG regime during a financial crisis it is fair to believe that the economic situation can be improved during an export crisis too.

Basic Income

The Basic Income approach guarantees everyone an income. No matter if they are working, unemployed, are not able or are not looking for work, a basic income is paid to all on an individual basis. The basic income should be enough to cover basic needs, such as food, clothes and housing.

The Basic Income regime will not directly solve the problem of unemployment, as the Job Guarantee does, but by strengthening the spending power of the people, this thesis will discuss if demand can increase sufficiently for businesses to keep employment up.

Modern Monetary Theory

Both the JG and the BI are expensive solutions, so how could a country which is in an economic crisis possibly afford either of these schemes?

Modern Monetary Theory, claims that a country that holds its own currency, can never run out of money and is not restricted by budgetary limitations. Under careful control such a government can print more money when needed to cover additional spending. This thesis will see if increased government spending can be justified with respect to price stability.

Literature

The Job Guarantee and Modern Monetary Theory have been developed by the same people. The sections about JG and MMT are based on articles and lectures from the leading economists in the field; Randal Wray, William Michell and Warren Mosler.

The Basic Income is at the time being up for discussion through many channels. Most articles are on the social aspects of a Basic Income, but a few authors have also written about the economy of Basic Income, and the model will be based on literature by these, such as Philippe Van Parijs and Keith Rankin.

The macroeconomic models are designed using a stock-flow approach, which has rarely been done before, the designed models are mainly based on dynamic models for economy developed by Trond Andresen. The models also have a great inspiration from the models created by Flatgård (2013), in his master thesis on Job Guarantee.

The numbers used in these models are based on the Norwegian economy, and most of the numbers are retrieved from Statics Norway (Statistisk Sentralbyrå, SSB).

1.2 Objectives

To get a better view of the impact a Job Guarantee regime or a Basic Income regime will have on the dynamics of an economy, it will be designed dynamic models for the economy where the two regimes will be introduced as a response to an export crisis. The objective of the thesis is to design three dynamic models of the economy:

- A model of the economy as it is under the current regime

- A model where Job Guarantee is introduced to the current regime

- A model where Basic Income is introduced to the current regime

There will be implemented an export crisis in the models, and when the crisis has hit the economy, Job Guarantee or Basic Income will be introduced. The models will be simulated and the economic development of such a shock in export will be analysed for the different regimes with focus on changes in employment, private spending power, Gross Domestic Product (GDP) and price stability.

1.3   Limitations

This thesis covers topics such as modelling of macroeconomics, the impact of export crisis, Job Guarantee and Basic Income, which all are big topics. Due to the time limitation, it has not been possible to go into the depth of all of these topics at the same extent.

The economy in this report, will be viewed from an engineering perspective, as a dynamic system with money flowing between sectors. Few economic models have been developed using block diagrams, and the design of the models will mainly be based on theory developed by Andresen (1998, 2013).

When creating a model for a macro economic system, there is one important factor that should be taken into account, the role of human behaviour. To some extent human behaviour can be predicted, but it is important to have in mind that what differs systems including humans from other systems is that they know they are part of a system and can behave unpredictable. Flawless assumptions of human behaviour are impossible to make.

1.4   Approach

The design of the models will be based on literature presented in chapter 2. The models will be designed as a network of money flows represented by block diagrams. The block diagrams will be built and simulated in Simulink, which is a graphical programming environment for simulating and analysing dynamic systems.

1.5   Structure of the Report

The rest of the report is organized as follows. Chapter 2 gives an introduction to Modern Monetary Theory, Job Guarantee, Basic Income and the theory of the block diagram approach to macroeconomic dynamics. Chapter 3 will give a detailed description of how the models are developed, and their design will be based on the material in the foregoing chapters. In chapter 4 the results of the simulation will be presented and discussed. Chapter 5 will give a discussion of the results and in chapter 6 there will be presented a final conclusion to the report. Chapter 7 will give some suggestions for future work.

Chapter 2

Literature study

In this chapter the literature which has been used to design the models in chapter 3 will be introduced. The three first sections 2.1 - 2.3 cover the topics Modern Monetary Theory, Job Guarantee and Basic Income. In section 2.4 the theory of how an economy can be represented as block diagrams will be presented.

2.1 Modern Monetary Theory (MMT)

A sovereign government can choose the money of account, it imposes taxes in this currency, and generally prices are denominated in the same unit of account. According to Tymoigne and Wray (2013) a government which has monopoly on its own currency can never run out of it and can always pay for what it wants to purchase and fulfil future payments. By being able to by-pass self-imposed constraints on its budgetary operation it is less constrained than a non-sovereign unit and can focus on price stability and full employment.

This section will give an introduction to MMT and its approach to money, taxation, inflation, budget deficits, consolidation of Treasury and Central Bank, and why it claims that monetarily sovereign governments has the maximum domestic policy space.

2.1.1 Background

MMT is an alternative approach to monetary theory that has its foundation in the chartalist state money approach of George Friedrich Knapp also adopted by John Maynard Keynes, the Post-Keynesian economists Hyman Minsky's functional finance approach and Abba P. Lerner's views on banking. In addition, MMT focuses on the value of currency

and by studying the monetary system they have proposed a Job Guarantee program (Fullwiler et al., 2012).

2.1.2   Fiat Money

Historically, money can be divided into three categories: commodity, credit and fiat money. Commodity money are made of a material which has value in itself, such as gold or silver coins. Credit money refers to liabilities of a checkable bank deposit. And fiat money is a tax credit which is not linked to any tangible assets (Mosler, 1994).

Most countries today have a fiat monetary system, often the shift from commodity money to fiat money has occurred during war times, when war expenses exceed the government's stock of commodities, governments issued fiat money to pay debts and the exceeding expenses (Carey, 2009).

During the 19th century until World War I the gold standard operated as the primary monetary system for the international economy. It was a fixed exchange rate system where monetary authorities were willing to exchange a specific amount of gold for its currency (Godden, 2009). After the economic chaos that followed World War I the gold standard system collapsed during the Great Depression of the 1930s. In 1947 the gold standard was replaced by the Bretton Woods fixed exchange rate system, and most countries fixed their exchange rate to the U.S. dollar that still used the gold standard (Godden, 2009). When the the Bretton Woods system was abolished in 1971, most Western countries converted to a fiat monetary system (Carey, 2009).

2.1.3   Taxes

Since fiat money has no intrinsic value, it is faith in the government which issues it that gives it value as money (Carey, 2009). According to Mosler (1994) a fiat monetary system is one where the currency is accepted for exchange only because the government demands it for taxes.

Tymoigne and Wray (2013) show that by imposing taxes, fines or fees, the government creates a demand for its currency which gives it value. In figure 2.1 a simplified monetary model is represented with two sectors, a governmental and a non-governmental. The government injects its own currency and demands taxes to be paid in the same currency. When the currency is repaid as taxes, the currency is destroyed. Since a sovereign

government is the monopoly supplier of its currency and can never run out of it, taxes are not needed to fund governments expenditures, but to increase the circulation of the currency and promote price stability. The higher the capacity to tax is, the higher the demand for the currency is. Tymoigne and Wray (2013) says that taxes should be used in terms of fairness or as a mean to control inflation, rather than a source of income.
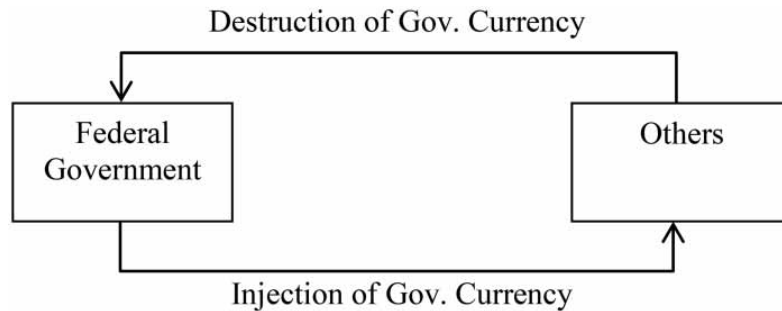

Figure 2.1: Monetary Model with two Sectors (Tymoigne and Wray, 2013)

Consider the non-governmental sector in figure 2.1 as the domestic Private sector. The Private sector wants to accumulate a certain amount of the governments currency for tax payments, private purchases, savings and debt settlements. If the governmental sector drains the Private sector with high taxes, this will not be possible. As long as the Private sector wants to accumulate the governments currency, Tymoigne and Wray (2013) claim there is no need for the government to have a balanced budget and it does not need to take back all the currency.

2.1.4 Inflation

A critic to MMT is that if a government runs a deficit budget in a non-growth economy it will cause an increase in money supply relative to GDP which will in turn cause inflation (Palley, 2015).

Regarding the issue of inflation, MMT is concerned with the ratio between taxing and spending, not with money supply relative to GDP. At full employment, if the Private sectors desire to save is higher than the deficit, there is no reason for inflation. But if the deficit is higher than the net savings, a demand-led inflation may occur. The fiscal balance is dependent on the Private sectors will to save. The fiscal position, if a government is in a fiscal surplus, deficit or a balanced budget is irrelevant for a monetarily-sovereign government according to Tymoigne and Wray (2013), a governmetn should first of all try

to reach full employment and price and financial stability.

2.1.5   Treasury and Central Bank

Today most countries separate the Treasury and the Central Bank (CB). However, in macroeconomic models it is customary to merge these two together. In practice the Treasury is a claimer of the profits of the CB, and from an economic perspective it is unnecessary to distinct between these two (Bassetto and Messer, 2013). The grey
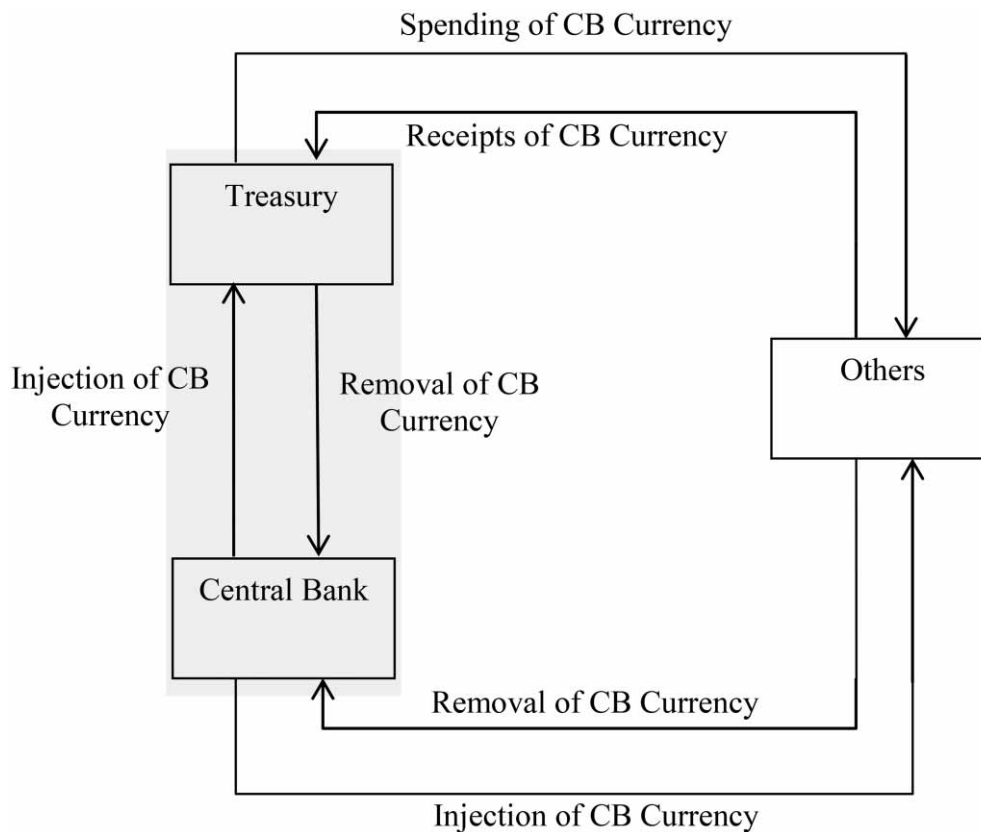
Figure 2.2: Separated Treasury and Central Bank (Tymoigne and Wray, 2013)

area of figure 2.2 shows the government where Treasury and CB are distinguished. The Treasury receives CB currency from taxes and bond sales, it exchanges financial assets for real assets and it places some currency on its account at the CB. The CB remove and inject CB currency in the governmental and non-governmental sector through open-market purchases of treasuries and other financial assets. It does not impact the balance of real assets in the non-governmental sector. The transactions in between the grey area have no direct impact on the macro economy, the CB's purchases of bonds from the Treasury will not affect the balance of CB currency in the non-governmental sector (Tymoigne

and Wray, 2013). Palley (2015) criticizes MMT for the simplification of consolidating these institutions. And argues that by doing so MMT dismisses political economy. Many countries have chosen to separate the Central Bank from the fiscal authority, and a full consolidation of the two institutions may cause politicians to use it for electoral purposes.

2.1.6 Foreign Sector

In figure 2.3 a foreign sector, "Rest of the World", has been added to the circulation model. The Foreign sector cannot legally create and issue the domestic currency (foreign to them), the domestic currency must come from the domestic economy. The domestic government does not impose taxes on the Foreign sector as it does on the non-governmental domestic sector. Still the Foreign sector demand the currency, thus taxes are only a sufficient condition for driving a currency, but not a necessary condition (Tymoigne and Wray, 2013).
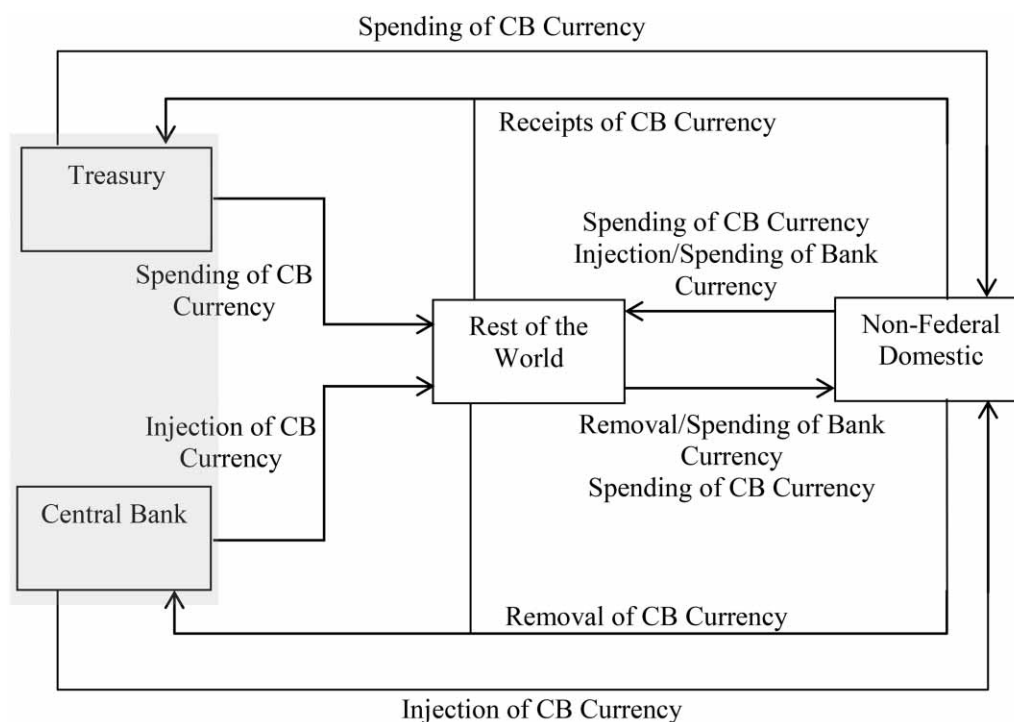

Figure 2.3: Circulation Model with Foreign sector (Tymoigne and Wray, 2013)

There is a spectre of exchange rate regimes to choose from. The exchange rate can be managed in the way China does, it can be fixed to another currency, it can be floating or a country can adapt another currency like the Euro. A country that has a fixed currency or has adopted a foreign currency, usually wants a trade surplus to get enough of the other

currency. Wages will then be kept low to avoid import and this restricts the domestic policy space. Thus the maximum domestic policy space is given by a floating exchange rate regime (Wray, 2015).

MMT also argues that a monetary sovereign government can avoid debt crisis, and a default is a choice not to make promised payments, not an inability. As long as debt is in the domestic currency, the government is always able to pay. If debt is in a foreign currency or the domestic currency is pegged a debt crisis could occur (Tymoigne and Wray, 2013).

To summarize, MMT argues that a monetary sovereign government that keep a floating exchange rate regime has the maximum domestic policy space. By issuing its own currency, it can never run out of money and can always afford to purchase what it wants.

2.2   Job Guarantee (JG)

There have been implemented several job-creation programs all over the world, in the U.S. there was the New Deal of the 1930s, that included the Works Progress Administration and the Civilian Conservation Corps. In Argentina over two million new jobs were created through the Plan Jefes y Jefas (2002), where jobs were guaranteed for heads of poor households. More recently was the National Rural Employment Guarantee Act (2005) in India, were all employment was offered to any adult living in rural areas (Wray, 2008). This chapter will give an introduction to another job-creation program, the Job Guarantee. In this section the JG program will be presented, how it can be funded and the expected effect of JG on private employment and inflation.

2.2.1   The JG program

Under Job Guarantee (also sometimes referred to as Employer of Last Resource (ELR)) the Public sector offer work at a fixed wage to anyone which is willing and able to work. Since JG work is available to everyone, the JG wage will automatically become the minimum wage. To avoid the JG program to compete with the Private sector, the wage could be set to the legal minimum wage (Mitchell and Mosler, 2001).

Wray (2012) suggests that JG jobs should be approved and funded by the National Government's labour ministry and all local governmental sectors and non-profit organi-

zations can propose projects. Jobs should be tailored to education and experience. The program should be available locally, so people do not have to relocate to get a job, and it should provide flexible working conditions, as part time and seasonal work.

In the JG approach unemployment is viewed as a buffer stock of labour for sale with no buyers at the current wage level. The only entity that could afford to buy this stock is the government. This stock will increase when Private sector activity is low and decrease when activity is high (Mitchell and Mosler, 2001). The JG will in times of recession allow those that lose their jobs to preserve good habits by offering them to continue working and thus avoid fallouts from the workforce. In good times, the Private sector, which offers a better salary, can recruit the JG workers (Wray, 2012).

Flatgård (2013) shows in his simulations of implementing JG in an economy which is in a financial crisis, that in the economy with JG the money flow increases and that fewer people lose their jobs in the private market under the JG regime.

2.2.2 Funding

As described in section 2.1, according to MMT, in a sovereign government the Public sector is the provider of the governments currency and the Private sector depends on the Public sector to provide them with it. To acquire the currency, the Private sector offers services and goods for sale. The total aggregated spending of the Private sector includes all wages and profits. If the Private sector does not want to spend all its earnings, unemployment will occur. To meet the Private sector's desire to save and at the same time avoid unemployment, it is necessary with a non-government surplus, thus the government needs to increase its spending and be in deficit (Mitchell and Mosler, 2001).

One way to increase its spending is through the JG program. The JG will be very costly the first year, but as the economy grows private employment will rise, and the cost of the JG program will be reduced.

Murray (2012) simulated an implementation of the ELR in Missouri. He found that the ELR program could result in full employment in the Private sector. In the beginning of the simulation, the government would have to increase government spending by $2.58 billion, but since the income provided by ELR employment would have to be used in the Private sector, Private sector output, earnings and jobs would increase. The program would start of as a big governmental program, but would soon dwindle down as private

employment rises.

2.2.3   Inflation

The rise in demand that follows when full employment is reached, raises questions of inflation. The well-known Phillips Curve suggests a trade-off between unemployment and inflation, it represents in the short run a fall in inflation along with a growing unemployment rate. The accelerating inflation rate of unemployment (NAIRU) has been used to decide the rate of unemployment where inflation is constant. Monetarists believe that if unemployment is below this rate in the long run inflation will occur (Spangenberg, 2009).

In the NAIRU economy, the government's response to inflation is to repress demand. As unemployment rises firms' income- and wage expectations will be brought in line and inflation stabilized. While most OECD countries have desired to use unemployment to fight inflation, MMT believes that instead of keeping a NAIRU buffer stock, the JG could stabilize prices with the fixed wage buffer stock of employees (Mitchell and Mosler, 2001).

Wray (2012) argues that the JG will not cause hyperinflation. The JG will only hire "off the bottom", those that do not find jobs elsewhere and only to the point of full employment. The JG sets a lower floor for wages, but does not drive them up, thus it will not drive the economy beyond full employment.

The JG will increase demand, which could increase private production and employment which will reduce JG employment, but since it has no relative wage effect and the demand will be lower under a JG than NAIRU, Mitchell and Mosler (2001) claim that it should not cause more inflation than by keeping unemployment at the NAIRU level.

2.3   Basic Income (BI)

Another approach to support the economy is the Basic Income scheme. For centuries there has been proposals that suggests that the state should provide a minimum income to citizens who are unable to meet their own basic needs. As early back as the 16th century Thomas More wrote about providing everyone with some means to secure the necessities of life, with the intention to fight theft. As long as people could not get food in any other way, they would turn to theft no matter how high the punishment was. Later the idea of a Basic Income has been formulated by Thomas Pain in 1796, Joseph Charlier

and John Stuart Mill in 1848 (Parijs, 2013).

During the last two centuries the proposal has been on the table again and again under different names, such as "state bonus", "citizen's wage", "universal benefits" and "basic income" (Parijs, 2004).

So far it has only been tried on a modest scale, but its popularity increases and in June, this year, Switzerland will be the first country that votes on having a national wage (Henderson, 2016).

Today a network of academics, students and social policy practitioners have formed the Basic Income European Network (BIEN) that aims to serve as a link between individuals and groups that are interested in a Basic Income.

This section will give an introduction to Basic Income, its views on other minimum income schemes with regards to unemployment, and how it can be funded.

2.3.1 Definition

BIEN has adopted Parijs definition of a Basic Income and defines it as *an income unconditionally granted to all on an individual basis, without means test or work requirement* (Parijs, 2004).

The goal of BI is to meet the basic needs of all citizens, such as housing, clothing and food. Instead of a government handing out coupons and founds earmarked for these purposes, a basic income is paid in cash. It is not supposed to substitute existing benefits such as free education and health care, but rather be a supplement (Parijs, 2004).

While BI is paid on an individual basis, other minimum income schemes take into account that living expenses for people living together is less per person than for people living alone, and pay less to individuals living together. The basic income is paid regardless of what kind of household the precipitants take part in, and is paid to individuals and not to households as a whole (Parijs, 2004).

The most striking feature of the Basic Income scheme is that is paid without means. Regardless of any other income, everyone receives the same amount of basic income, no matter if the receiver is rich or poor (Parijs, 2004).

2.3.2   The Unemployment Trap

In traditional means-tested minimum income scheme, a challenge is to motivate people to accept low-paid work. Consider an unemployed person that receives public benefits to reach a minimum level of income, if this person is offered low-paid work the public benefits will shrink in proportion with the salary he would receive. If the incentive for working is the salary, he would be indifferent to accepting the job or not.

Figure 2.4 shows a minimum income scheme with linear taxation, where G is the level of the minimum income. The benefits a household receives is the difference between the Gross income and G, when the Gross income reaches G the benefits are zero, as long as the Gross income from work is less than G it makes no difference for a household's economy to be employed or not (Parijs, 2004).
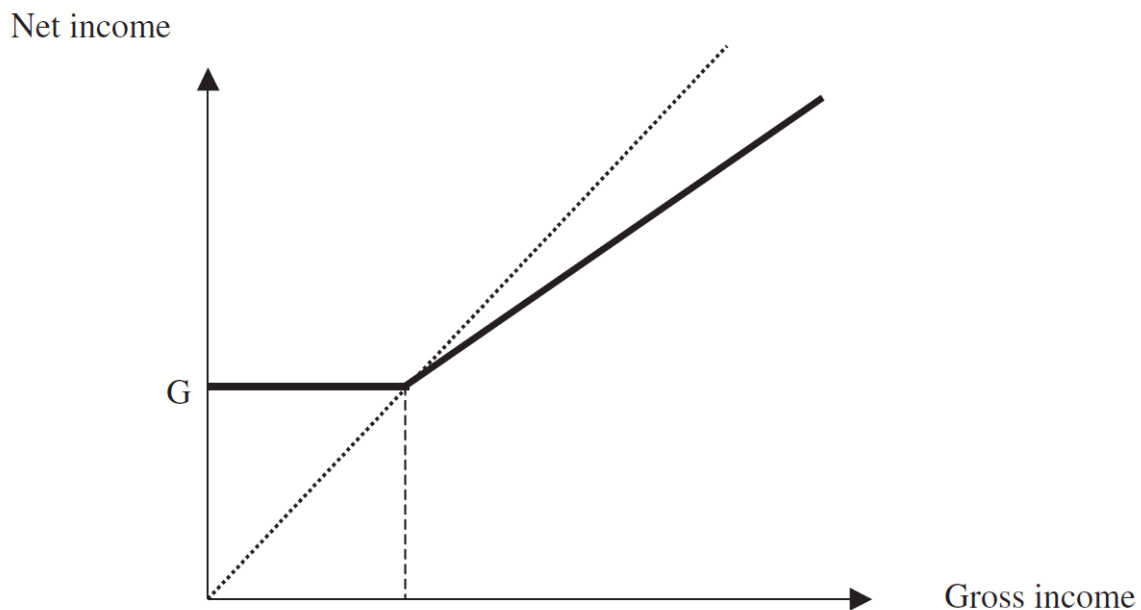
Figure 2.4: Minimum Income Scheme (Parijs, 2004)

One of the objectives of BI is to avoid this unemployment trap. Figure 2.5 shows a Basic Income scheme with linear tax. Here the gross income line is shifted up a length G. As long as the tax rate is below 100 percent, anyone that accepts paid work will increase their total income, even for low-paid work. The difference between the upper dotted line and the bold line are income taxes. In the point where the bold line and the lower dotted line meet, the taxes equals the amount received in basic income. Anyone that has a higher gross income will pay more than the basic income in taxes (Parijs, 2004).
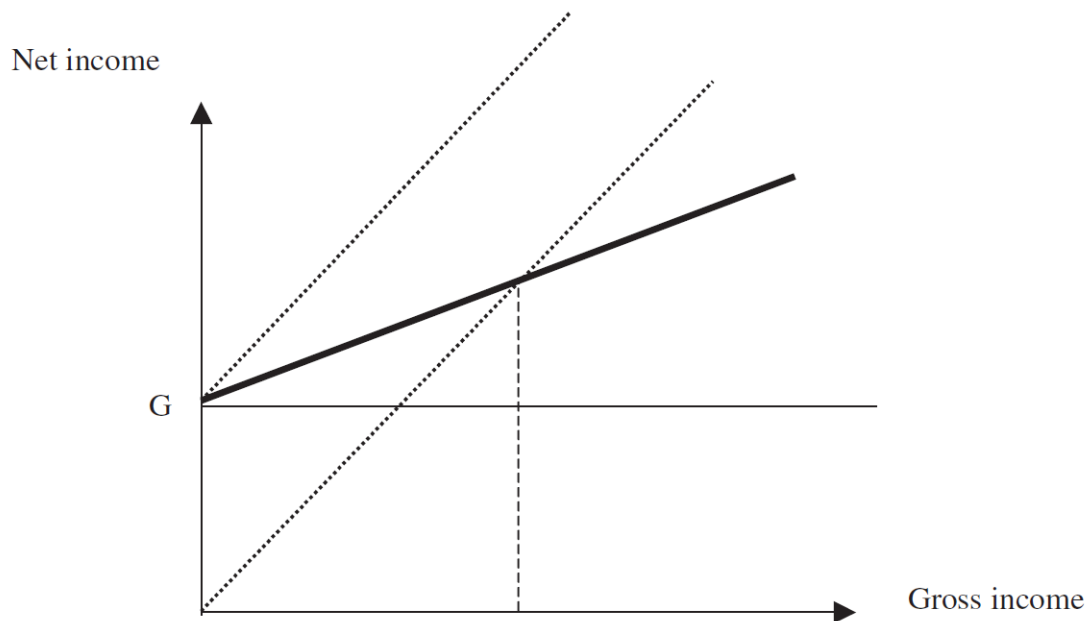
Net income

G

Gross income

Figure 2.5: Basic Income Scheme with flat Tax (Parijs, 2004)

2.3.3 Funding

There have been many different proposals as to how a basic income can be funded. It can simply be funded along with the governments other expenditures, where the money comes from different revenues. Or it has been proposed an earmarked funding for the basic income which comes from a specific tax. In Alaska, it is funded through an investment fund of the oil revenues. It has also been proposed to fund it through money creation (Parijs, 2004).

Rankin (1997) argues that it can be funded through taxes. He says that the full basic income should be at the same level as the social minimum level or higher, and it should be a replacement of other forms of income support. He argues that Basic Income is not an expensive reform, and taxes to support it can be calculated for any level of basic income. He views regressive tax rate as a benefit given to everyone that has a tax rate below the upper personal tax rate. By raising the tax rate and giving everybody a basic income, some will lose the tax benefits, but instead they receive a basic income benefit.

There have also been suggested schemes for partial basic income, like the Alaska dividend, where the amount received is not enough to cover all basic needs, but coexists with other benefits (Widerquist, 2015).

2.4   Dynamics of a Macro Economy

A macro economy can be considered as a dynamic system of money flowing between entities of households, firms, a government and foreign sectors. The transactions carried out between these sectors can be viewed as continuous flows of money. This chapter will give an introduction to the dynamics of these money flows and how a macro economy can be represented by block diagrams. Most of this section will be based on the literature by Andresen (1998, 2013).

2.4.1   Differential Equations

Differential equations are commonly used to represent motion and rate of change in physical objects, and can also be used to describe dynamics in economics. Consider the rate of change in the Gross Domestic Product (GDP), which can be represented by the following equation:

$$\dot{Y}(t) = gY(t), \tag{2.1}$$

where Y is the GDP, t is time and g is the growth rate. As long as g is constant 2.1 can easily be solved for Y:

$$Y(t) = Y(0)e^{gt} \tag{2.2}$$

which shows that Y is an exponentially growing (decaying) function of t if g is positive (negative). In the case where g is constant, Y can easily be computed.

Another way to calculate GDP is by the production approach where its given by the formula $GDP = C + G + I + NX$, where C is private consumption, G is government spending, I is the country's investments and $NX = $ *all export–all import*, is the nation's net exports (Investopedia, 2016). By this definition, we see that the growth rate g in equation 2.1 will not be constant, but dependent on factors such as the state of the economy, the international market and many other conditions. By modifying the differential equation in 2.1 we get

$$\dot{Y}(t) = g(Y,t)Y(t), \tag{2.3}$$

where g is a function of the current state Y and time. This representation gives a system that is a lot more difficult to analyse.

2.4.2 The "Vessel" Approach

By representing differential equations graphically by block diagrams, it is possible to get insight to the dynamics they represent. A. W. Phillips did this for a dynamic macro economy by modelling it as a system of sub entities of vessels interconnected by tubes. These vessels correspond well to a first-order time lag response. Figure 2.6 shows a first-order time lag response of one entity. If the incoming demand flow rises suddenly by one unit, the output will asymptotically approach the new level with a time lag T_p. The larger T_p is, more will be accumulated within the sector, and the longer it will take before an increase in incoming flow leads to increased outgoing flow (Andresen, 1998).
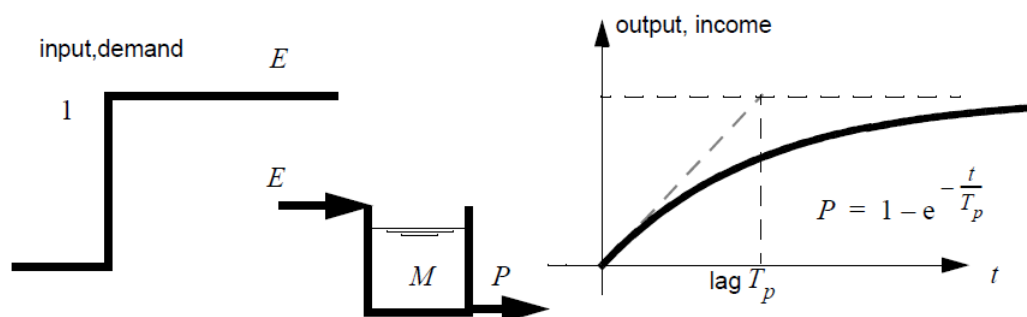
Figure 2.6: First-Order Time Lag Response (Andresen, 1998)

2.4.3 Single Units

Transactions made by a single agent, like a household, are discrete events. An agent can have a regular income where it receives a salary once a month which is spent as many small transactions distributed over the month or it can save most of its income and suddenly make one big transaction, like buying a car. Different households will often have different economic behaviour. If the average income and spending of thousands of households are looked at, it is assumed that the transactions can be viewed as a continuous money flow and be described by the first-order time lag. A sudden increase in the average income, will cause the average spending to rise with time.

Figure 2.7 shows a single microeconomic agent, the agent can be a household, a firm, a bank or a government. Where F_i is the incoming money flow to the unit, M is the money stock at the unit and F_o is the outgoing flow of money. The grey area represents the rest of the macro economy and the grey arrows represent flows of labour, goods, services.

Money are accumulated at M due to the agent's desire to keep a buffer to be able to cover discrepancies between F_i and F_o (Andresen, 1998).
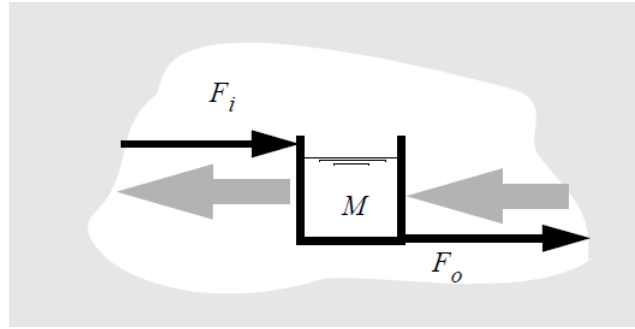

Figure 2.7: Single microeconomic Unit (Andresen, 1998)

If the income and spending are constant, $F_i = F_o = F$, we have

$$M = F\tau, \ or \quad \tau = \frac{M}{F} \tag{2.4}$$

And the local money velocity for the single unit is

$$v = \frac{1}{\tau} \tag{2.5}$$

Different agents will have different money velocity. A household with a low income, will spend its income fast to be able to cover all its expenditures, and will accumulate less than a household with a higher income. The velocity is also a parameter affected by behavioural assumptions, such as economic mood changes in times of recession. If the economy is in a recession, households would want to save more of their income and avoid wasting. Thus the money velocity would be lower. For now, the time lag, τ is considered to be constant.

The respond to a sudden rise in income will be as in the entity of figure 2.6, the outgoing flow F_o will asymptotically move towards the new income level F_i. F_o can be described by the following equation

$$F_o(t) = \frac{1}{\tau} M(t) \tag{2.6}$$

In the case of $F_i = 0$, the unit has no income, F_o will be a decaying exponential curve as in figure 2.8.
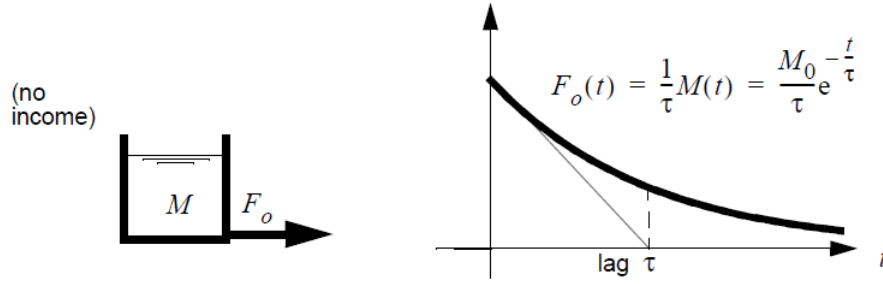
Figure 2.8: Micro Agent with no Income (Andresen, 1998)

The change in money stock M of the single unit in figure 2.7, will be incoming flow, F_i minus outgoing flow, F_o, and can be described by the following differential equation

$$\dot{M}(t) = -F_o(t) + F_i(t) \qquad (2.7)$$

By substituting (2.6) in (2.7) we get

$$\dot{M}(t) = -\frac{1}{\tau}M(t) + F_i(t) \qquad (2.8)$$

And the Laplace transformation gives

$$sM(s) - M_0 = -\frac{1}{\tau}M(s) + F_i(s) \qquad (2.9)$$

$$M(s) = \frac{\tau}{1+\tau s}F_i(s) + \frac{\tau}{1+\tau s}M_0 \qquad (2.10)$$

Where $M_0 = M(t = 0)$ is the initial money stock. If the incoming flow $F_i(s)$ is a step input flow with Laplace transform $1/s$ and $M_0 = 0$ (no accumulated money) as in figure 2.6, we get

$$M(s) = \frac{\tau}{(1+\tau s)s} \qquad (2.11)$$

Which has the inverse transfer

$$M(t) = \tau(1 - e^{-\frac{t}{\tau}}) \qquad (2.12)$$

Inserting (2.12) in (2.6) we get the spending flow, $F_o(t)$, of figure 2.6

$$F_o(t) = (1 - e^{-\frac{t}{\tau}}) \qquad (2.13)$$

that asymptotically approach the new input level.

Now consider the scenario in figure 2.8 with no income, where $F_i = 0$. This gives

$$M(s) = \frac{\tau}{1 + \tau s} M_0 \tag{2.14}$$

which has the inverse transfer $M(t) = M_0 e^{-\frac{t}{\tau}}$, this gives

$$F(t) = \frac{M_0}{\tau} e^{-\frac{t}{\tau}} \tag{2.15}$$

Which show that the output is exponentially decaying.

2.4.4 Aggregated Units

So far it has been shown that single microeconomic units can be represented as first-order time lag responses. Since households make few transactions with each other, all households can be viewed as one unit corresponding to a first-order time lag response represented by the differential equation

$$\dot{M}_h(t) = -\frac{1}{T_h} M_h(t) + F_{h,i}(t) \tag{2.16}$$

where M_h is the total amount of accumulated money at all households, $F_{h,i}$ is the incoming money flow to all household, and T_h is the average time lag for all units. Equation 2.16 gives the following transfer function for the aggregated household sector

$$h_h(s) = \frac{1}{1 + T_h s} \tag{2.17}$$

The behaviour of the single microeconomic unit in figure 2.7 can be applied to an aggregated unit, such as all firms as well. In addition to outgoing money flows to other sectors, the firms sector make transaction within itself. A share of a single firm's spending will be to other firms.

Let's assumed that all units within the aggregated sector will have a common, constant time lag, τ, and the units can be represented by the transfer function

$$h(s) = \frac{1}{1 + \tau s} \tag{2.18}$$

Each agent in the aggregated sector will have an outgoing flow from the sector which will be a share ρ of every agents individual spending, where $0 < \rho \leq 1$. The remaining share $(1 - \rho)$ will go to other units within the sector. Figure 2.9 shows the aggregated sector with income flow F_i and output flow F_o, for all individual units with money stocks $M1, M2, M3, ...$ and money flows between the units (the grey arrows).
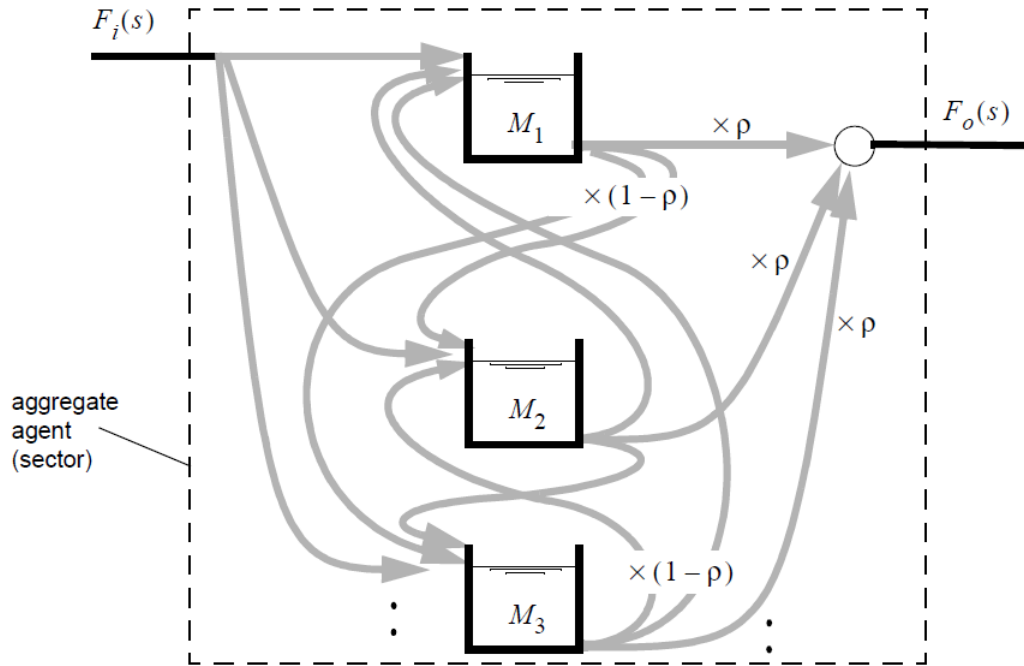

Figure 2.9: Aggregated Units (Andresen, 1998)

The transfer function for the aggregated sector can be found by Theorem 1:

Theorem 1. *Given a network of an infinite number of identical blocks which are first order transfer functions of the type (2.18), and which are interconnected by arbitrary coefficients, such that all transfer functions have identical outside spending coefficients ρ, and such that the remaining output coefficients for each transfer function sum to $(1 - \rho)$. Then the transfer function for the network, between any block input and any block output, is*

$$h_a(s) = \frac{1}{1 + T_a s}, \quad where \; T_a = \frac{\tau}{\rho} \tag{2.19}$$

The parameter ρ indicates the share of transactions within an aggregated sector. We see that both the transfer functions 2.17 and 2.19 are first order transfer functions. In the

household sector few transactions are carried out between the households, most households spend their income on goods and services from firms, hence ρ will be close to 1.

For proof of Theorem 1 see Andresen (1998, p. 8).

2.4.5 Block Diagrams

Differential equations are difficult to analyse and a good way to get insight to their dynamics are to represent them graphically by block diagrams. Figure 2.10 show a block diagram representation of a single unit represented by equation 2.8.
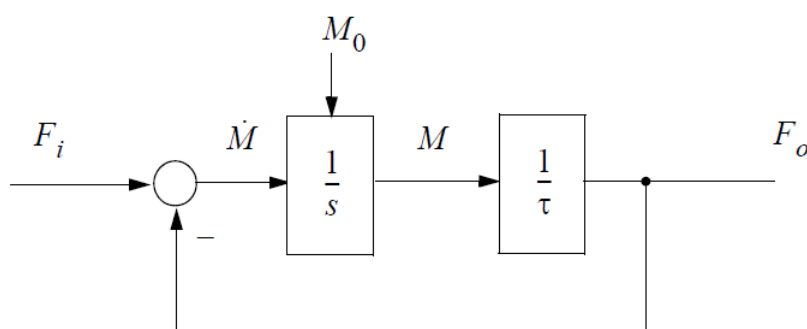

Figure 2.10: Block Diagram with one Sector (Andresen, 2013)

Consider an economy consisting of two aggregated sectors, a household sector and a firm sector. Households have an incoming flow of wages, W, and an outgoing flow of consumption, C, that is the firm sector's incoming flow. The Firms' output is W. M_h and M_f are households' and firms' money stock, respectively. All wages are consumed, hence $W = C$. Since the aggregated sectors change of money stock can both be represented by the dynamics of equation 2.8, the economy can be represented by the block diagram in figure 2.11.

This section has given an introduction to the dynamics of microeconomic units, and shown that aggregated sectors have the same dynamics as the single units. It has been shown how two aggregated sectors can be connected together in a block diagram. In the next chapter, this will be used to create block diagrams of a larger macro economy with more than two sectors.
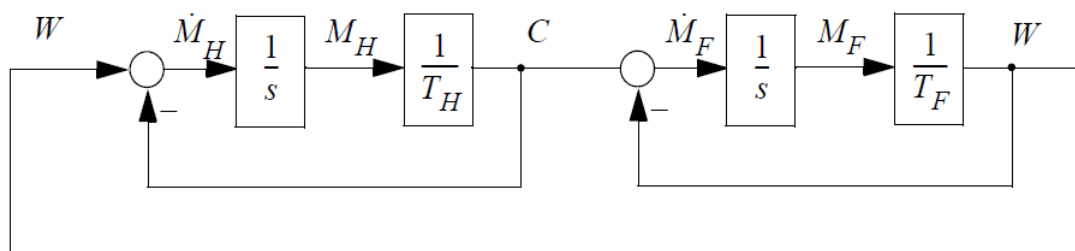
Figure 2.11: Block Diagram with two Sectors (Andresen, 2013)

2.5 Summary of Chapter 2

In this chapter there has been given an introduction to Modern Monetary Theory, Job Guarantee, Basic Income and to some dynamics of economic models.

The MMT approach to monetary policies opens up for governments to by-pass self-imposed constraints on its budgetary operations, which will be taken advantage of when designing the macroeconomic models that will be presented in the next chapter.

The Job Guarantee is a governmental program which offers public jobs at a fixed rate to everyone that are willing and able to work. The literature presented, claims that JG would help to increase private employment, which will be discussed further after the results of the simulations in chapter 4 have been presented.

The Basic Income approach is to grant everyone an unconditional income. The basic income is given to everyone regardless of what kind of household they belong to or if they have any other income. The BI wants to avoid unemployment traps that may occur in other minimum income schemes.

In section 2.4 some dynamics of economics were described, and it was shown that single and aggregated economic units could be represented as first-order time lag responses. It was then shown how their differential equations could be implemented in a block diagram, which will be explored further with more units in the next chapter.

Chapter 3

Design of the Models

This chapter will present the stock flow model designed for this thesis. There has been designed a model of a macro economy which is based on the Norwegian economy. It is in no way an attempt to be an exact model of the Norwegian economy. The model will represent an economy that initially has a strong balance of trade (it exports more than it imports) and initial conditions such as number of employees and average salaries are taken from the Norwegian economy. The economy will be exposed to a dramatic fall in its main export product, which will carry the economy into a crisis.

First the model of the regular economy will be presented, then the two different regimes, Job Guarantee and Basic Income, described in section 2.2 and section 2.3, will be introduced to the model to fight unemployment and the struggling economy. Then the block diagrams in chapter 2.4 will be expanded to include all the main sectors of the economy. Further, the design of the models will be inspired by the work done by Flatgård (2013, ch. 3).

3.1 The Regular Model

The model includes three sectors; a Public sector, a Private sector and a Foreign sector. Figure 3.1 shows the three sectors. The Public sector includes all governmental sector, including the Treasury and the Central Bank. These sectors are seen as one operating sector. The Public sectors has three incoming money flows, which it receives from the Private sector; taxes on income, value added taxes (VAT) and public revenues from firms. The public sector also takes in the number of new unemployed per month, that will

be used to calculate unemployment benefits. The Public sector has four spending flows [$NOK/month$], public purchases, investments, salaries to public employees and public benefits, that goes directly to the Private sector. The Private sector has one additional income flow to what it receives from the Public sector, net export [$NOK/month$] from the Foreign sector. The Private sectors consumptions [$NOK/month$] is sent to the Foreign sector to update changes in import.
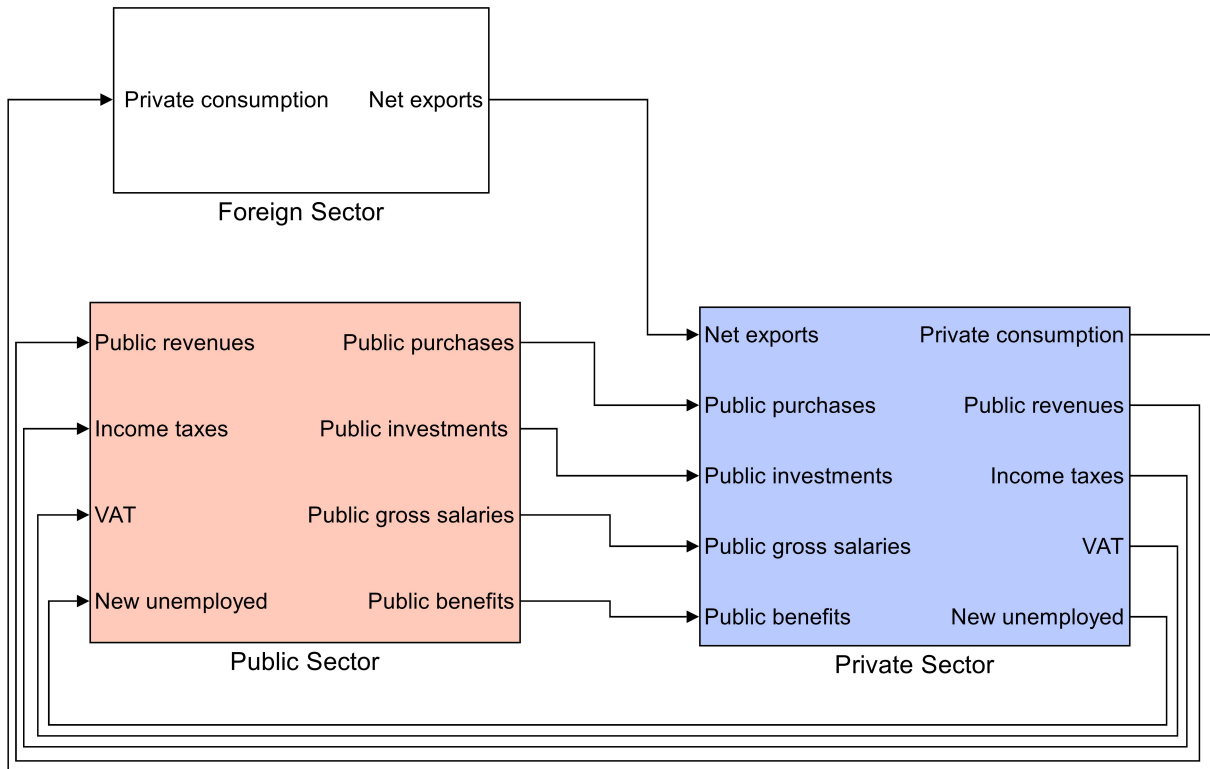

Figure 3.1: All Sectors

It is assumed that any debt the private or Public sector hold, will be constant, so that repayment of debt and new loans cancel each other. Thus a financial sector has been excluded from the model. These three sectors will be sufficient enough to observe the effects of an export crisis on the economy.

In chapter 4, the models will be simulated over a time period of 6 years. There will be no adjustment for inflation during this period, so all values will be nominal.

3.1.1   Public Sector

The Public sector is the governing sector, and the expressions public and government will be used alternately. The Public sector is all governmental sectors, such as local, state and

federal sector, consolidated together with the Central Bank and the Treasury.

Figure 3.2 shows the Public sector. The nominal public purchases and investments are held constant throughout the simulations. It is a fair assumption that a government would increase its spending in a time of economic crisis to motivate the private economic activity. In this model the introduction of the two schemes, Basic Income and Job Guarantee will increase government spending, thus other public expenditures are held constant for simplicity.
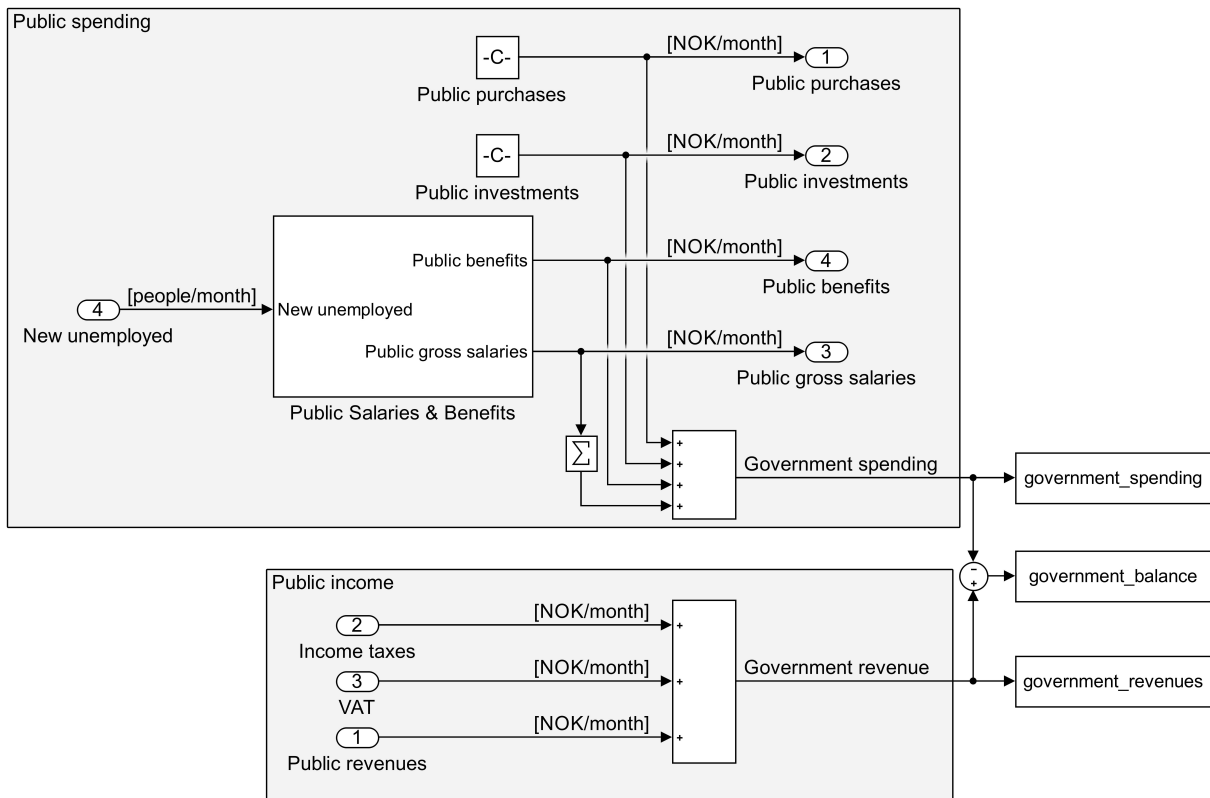
Figure 3.2: Public Sector

Figure 3.3 shows the subsystem "Public Salaries & Benefits". It is assumed that everyone which is employed in the Public sector will stay employed during the crisis and no new workers are employed, thus the total nominal public salaries are constant. Since the number of employees in the Public sector is held constant, all unemployed are from the Private sector. It is also assumed that all pensions and social benefits except unemployment benefits are constant. Unemployment benefits are given to all unemployed for a certain period of $T_{g,rb}$ months. Since there is a limit to how many months an unemployed can receive unemployment benefits, the subsystem takes in new unemployed [*people/month*]. The integrator stores all unemployed, *ue*, that are entitled to receiving

unemployment benefits. The change of ue is given by the differential equation

$$\dot{ue} = \dot{ue}_n - \frac{1}{T_{g,rb}} ue \qquad (3.1)$$

where $\dot{ue}_n$ is new unemployed per month. Unemployment benefits are 62.4 % of what they would have received if they were working in the Private sector. The total unemployment benefits, UB, are then

$$UB = ue\ 0.624\ W_{priv} \qquad (3.2)$$

where W_{priv} is the private salary rates. Equations (3.1) and (3.2) are implemented in the block-diagram in figure 3.3.
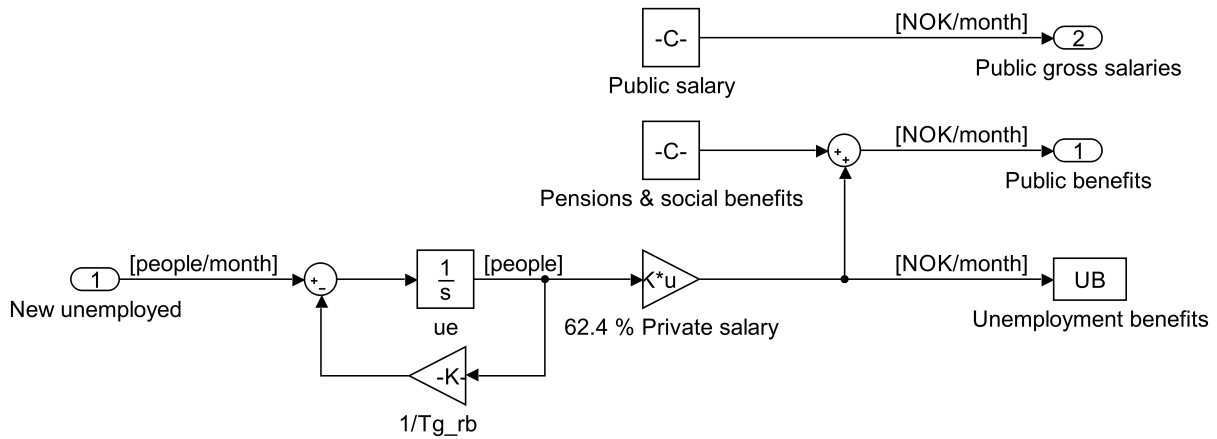
Figure 3.3: Public Salaries & Benefits

Figure 3.2 shows that total government spending is the sum of public purchases, public investments, public benefits and public salaries. The total government income is the sum of income taxes, VAT and public revenues. The government balance is then the difference between government spending and government revenue. We see that there is no direct link between public spending and public income.

3.1.2   Private Sector

The Private sector includes the aggregated firms and households sectors (figure 3.4). The firms' net revenues are the sum of net exports, investments and public- and household purchases after VAT is subtracted. The households' income are net salaries, both for public and private employees, and net benefits, which includes pensions, social benefits and unemployment benefits. Both the firms sector and household sector take in "economic

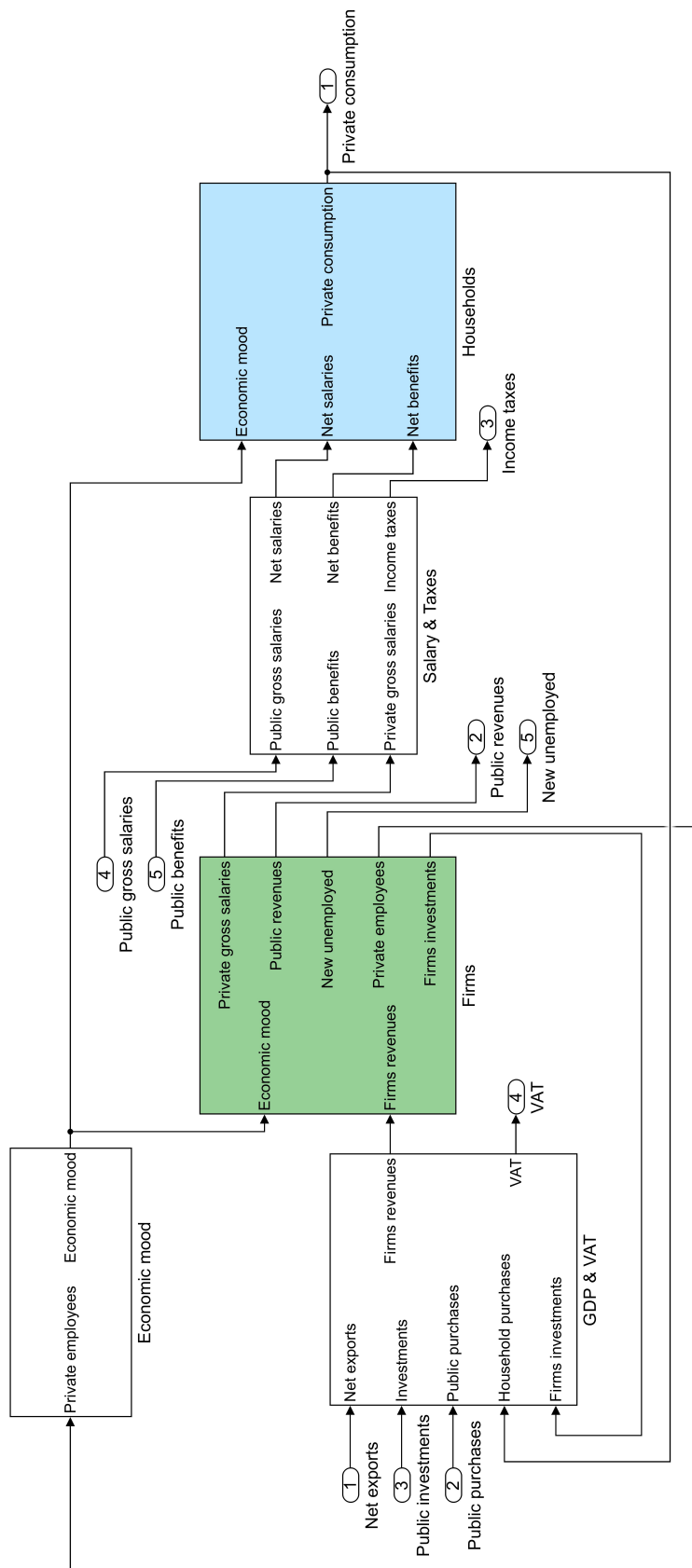mood", which is a scalar between 0 and 1.

Figure 3.4: Private Sector

Firms

The firms sector's revenues, R_f, comes from public and private purchases and investments and net exports. It spends its income on taxes and profits to the Public sector (public revenues), salaries to the Private sector, and firms buy goods and services and invests in other firms. The income is divided by the three entities, government sector, households and firms by the representative shares, government gain, g_g, salary gain, s_g and purchase gain, p_g. Where

$$g_g + s_g + p_g = 1 \tag{3.3}$$

and the change in firms' money stock M_f can be described by the following equations

$$\dot{M}_f = R_f - (g_g + s_g - p_g)\frac{1}{T_f}M_f - S_d \tag{3.4}$$

Where T_f is the firms time lag which is dependent on the economic mood, m, which will be covered later. S_d is the discrepancy between the share of firms' income that are used to pay salaries and what is actually needed to pay all private employees. Firms' income changes due to change in foreign, public and private consumption. When consumption changes there is a change in demand for the firms' goods and service, this causes firms to hire more workers or to discharge employees. Since it takes time to hire new employees and most contracts have a period of notice, there is a delay, T_e, in employment, and there will be a discrepancy between what firms would want to use on salaries based on the firms' income and how many employees they actually have to pay. By using the identities of (3.3) in (3.4), we get

$$\dot{M}_f = R_f - \frac{1}{T_f}M_f + \frac{p_g}{T_f}M_f - S_d \tag{3.5}$$

Which is the differential equation that is implemented in the grey area of the block-diagram in figure 3.5.

A share, I_f, of the money flow that goes back to the firm sector are investments, which are also sent out of the firms sector to calculate GDP.

It is assumed that firms do not pay VAT on products purchased from other firms.

The private employees are divided into groups after what wage level they are at. First the salary-flow from the firms are divided by the average salary among private employees,
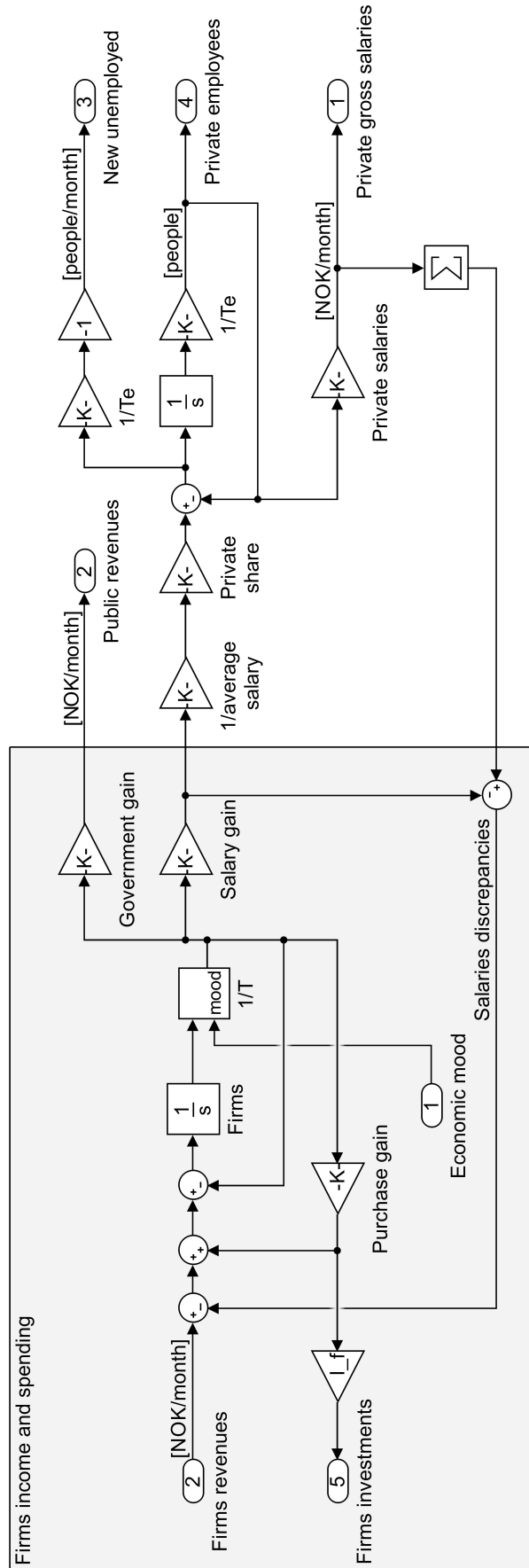
Figure 3.5: Firms Sector

then it is multiplied with a vector D_{priv} which is the distribution of wage levels among the private employees, where the sum of D_{priv} is 1. This gives the number of workers the firms would like to have employed at any time. As mentioned, there is a delay in employment, T_e. The difference between already employed, E, and wanted employees, E_d, at current demand level is integrated to update employment, E. The change in employment is given by the following equation

$$\dot{E} = E_d - \frac{1}{T_e}E \tag{3.6}$$

E is then multiplied with a vector, private salary, which contains the different wage levels, to get the total gross private salaries for all private employees. This gives the output vector "Private gross salaries" [NOK/month]. The sum of all elements in the private gross salaries vector is used to find the discrepancy between the amount firms would like to pay in salaries and what they have to pay.

$\dot{E}$ is the change of employees, by dividing it by the time lag T_e and multiplying it with -1 we get the number of new unemployed per month.

Taxes

The subsystem "Salary & Taxes" in figure 3.6 takes in all gross incomes; gross public income, G_{pub}, gross private income, G_{priv} and gross public benefits, G_b. The tax regime is a progressive one, where a higher income will be taxed at a higher tax rate. Those receiving public benefits are assumed to have a lower tax rate, tr_{nw}, than the tax rate, tr, for those working.

The net incomes, N_{pub}, N_{priv}, N_b, for all public employees, private employees and those not working, are given by the following equations

$$N_{pub} = G_{pub}(1 - tr) \tag{3.7}$$

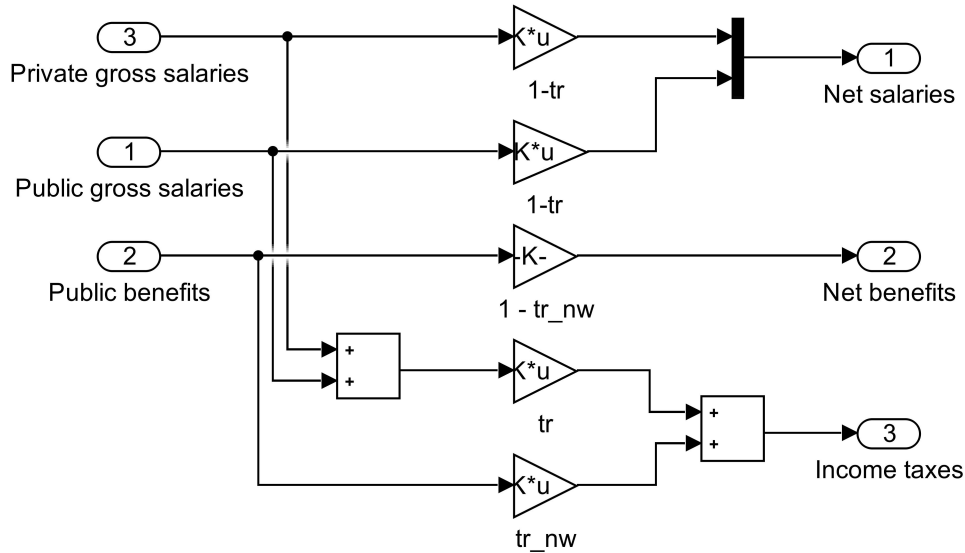$$N_{priv} = G_{priv}(1 - tr) \tag{3.8}$$

$$N_b = G_b(1 - tr_b) \tag{3.9}$$

Figure 3.6: Salary & Taxes

And the governments tax revenue from income, I_t is

$$I_t = (G_{pub} + G_{priv})tr + G_b tr_b \tag{3.10}$$

Households

After taxes have been subtracted from households' income, the households receive their net income. Figure 3.7 shows that households are divided into two groups, those that are employed, either private or public, and those that are not working, including unemployed, pensions and other receivers of social benefits. The two groups are assumed to spend their income at different pace. Those that are employed are able to save, and will use their income at a slower pace than those that are not working. It is assumed that those not working has an income that only cover their basic needs, and will spend most of their monthly income every month, and spend it faster.

The changes in the money stock of employed households, $M_{h,e}$ and not working households, $M_{h,nw}$ can be described by the following equations

$$\dot{M}_{h,e} = N_{pub} + N_{priv} - \frac{1}{T_p} M_{h,e} \tag{3.11}$$

$$\dot{M}_{h,nw} = N_b - \frac{1}{T_{nw}} M_{h,nw} \tag{3.12}$$

Where T_p and T_{nw} are the time lags of the employed households, and not working
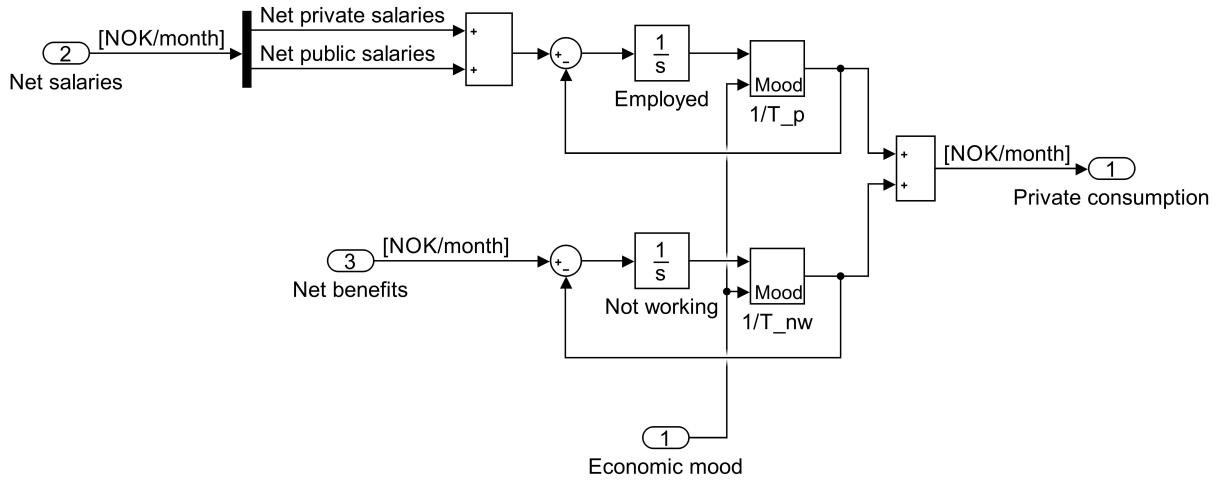
Figure 3.7: Households

households, respectively. T_p and T_{nw} are linearly dependent of the economic mood.

$$T_p = T_{p,max} - m(T_{p,max} - T_{p,min}) \tag{3.13}$$

$$T_{nw} = T_{nw,max} - m(T_{nw,max} - T_{nw,min}) \tag{3.14}$$

$T_{p,max}$ and $T_{nw,max}$ correspond to when the money velocity of the households has reached its maximum level, and $T_{p,min}$ and $T_{nw,min}$ when the velocity is at the lowest. Thus $T_{p,max} < T_{p,min}$ and $T_{nw,max} < T_{nw,min}$. The sum of the two groups' spending is the total private consumption.

Figure 3.8 shows the implementation of the money velocity systems, where the spending flow can be described by $Y = M/T$, which is the same identity described in equation 2.6.
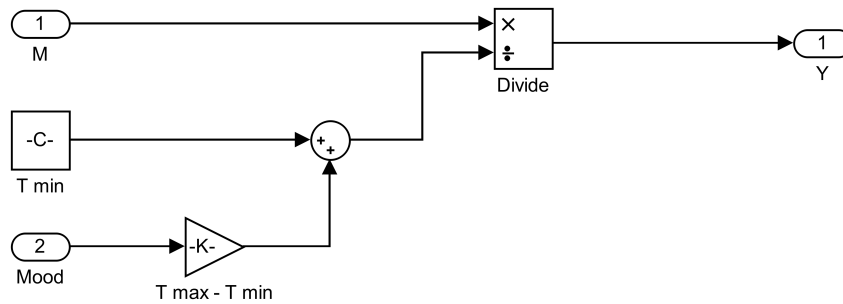
Figure 3.8: Money Velocity

GDP and VAT

Before the firms receives their revenue, VAT is subtracted from public and private consumption. Figure 3.9 shows the subsystem GDP & VAT. In addition to calculate VAT, the GDP is calculated here. $GDP = NX + I + G + C$, where NX is net exports, I investments, G government purchases, and C private consumption.
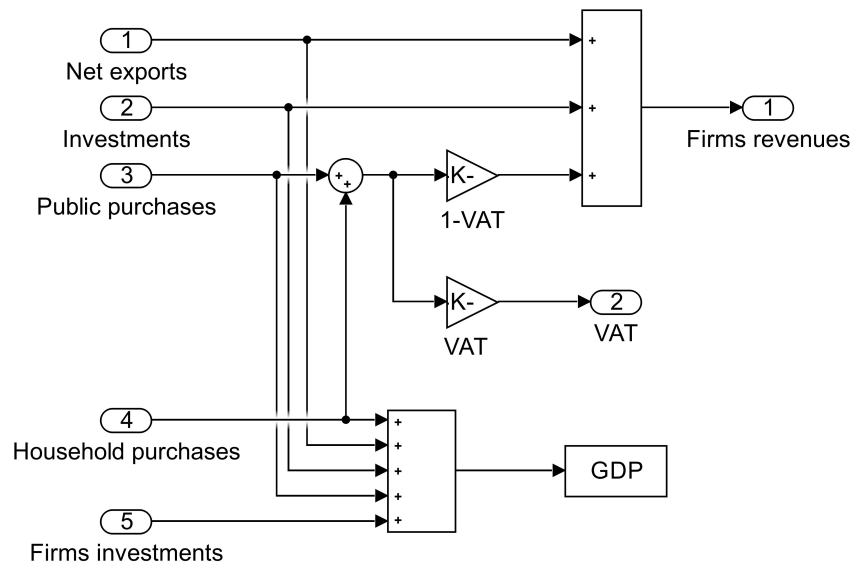

Figure 3.9: GDP & VAT

Economic mood

The economic mood, m, is a behavioural parameter that affects the money velocity. At times with low optimism people will only spend money on what is absolutely necessary, like food and housing, but they will not buy a new television or expensive trips for their holidays. This behaviour affects the velocity of money. The money velocity is higher when the economy is growing than in a recession.

The economic mood subsystem, figure 3.10, has one input, private employees [*people*]. f is an S-shaped function of the share of private employees, E_{priv} of the possible number of people working in the Private sector, E'_{priv}, and can be described by the following equation

$$f = \frac{1}{1 + e^{-g(u-h)}} \qquad (3.15)$$

where h is the rate of private employees when $f = 0.5$, g is the slope of the mood curve,

$u = \frac{E_{priv}}{E'_{priv}}$ and $E'_{priv} = E_{priv} + unemployed$. It is assumed to be a delay T_m from when the number of private employees changes until the mood, m is affected. The changes in m are given by

$$\dot{m} = f - \frac{m}{T_m} \tag{3.16}$$

When $m = 1$ the economy has a high optimistic mood and when $m = 0$ the economic mood is low. An s-shaped function has been chosen because when the economic mood is either very high or very low, small changes in the rate of private employees, will not cause the economic mood to rise or fall at the same pace, but significant changes will cause the mood to change rapidly.
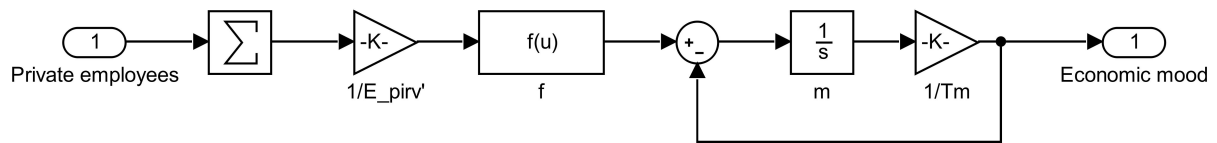
Figure 3.10: Economic Mood

3.1.3   Foreign Sector

The Foreign sector has only one incoming flow, "private consumption" which is used to determine import. A share of all private consumption, is from imports, hence the import will change when consumption changes, and private consumption is multiplied with an "import gain". Also here there is added a delay, T_i from private consumption changes to import changes, figure 3.11.

There are two groups of export, export of oil/petroleum and all other exports. Export of petroleum is chosen to be a function of oil prices, and is not dependent on any other part of system. There has been added a filter to smooth the input from the Export petroleum block. Other exports are made to be dependent on the import to export ratio.

As oil export falls the value of the domestic currency (NOK) falls and makes other exports more competitive on the foreign market, which will cause other exports to increase. The net export (total export - total import) is the outgoing money flow from the Foreign sector to the domestic economy.
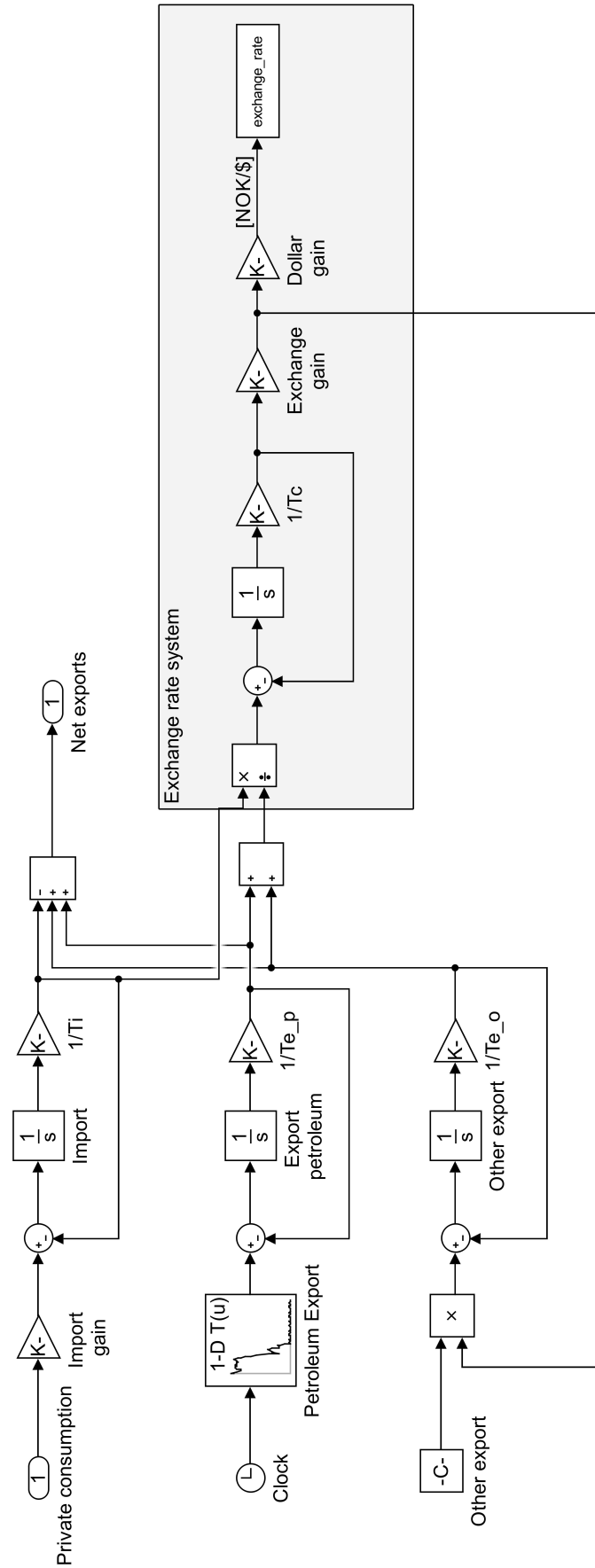
Figure 3.11: Foreign Sector

Exchange rate

To determine the exchange rate, numerous factors play a role, such as differential in inflation and interest rates of trading countries, a country's balance of trade, public debt, change in domestic money supply, terms of trade, political stability and economic performance (Bergen, 2016).

In the model it is assumed that the interest rates are the same in the domestic and foreign economy, and that the foreign economy has no inflation. As mentioned in section 3.1 the public debt is kept constant.

Only the balance of trade is considered to have an impact on the exchange rate. When import increases the demand for the foreign currency increases, and when export increases the demand for the domestic currency increases.

The design of the exchange rate system is shown in the grey area of figure 3.11. There is assumed to be only two currencies in the whole economy, a domestic currency and a foreign currency. The exchange rate is designed to be a function of import and export. Import is divided by total export, then sent through an integrator, with a delay T_c. Then the signal is multiplied with an exchange gain, to make the initial effect of the exchange rate to be close to 1. The gain "Dollar gain" has been added to get results that can easily be compared with a familiar exchange rate, the exchange rate from NOK to USD.

3.1.4   Initial Values

This section will give an overview of which initial values have been chosen for the model, and why.

Oil prices

From 2000 – 2008 the oil prices had an enormous growth from under \$25 to \$150 per barrel. After the financial crisis in 2008 there was a global recession and the prices of oil fell to \$40. During the recovery that followed the prices rised again and reached a stable level between \$100 and \$125 per barrel. Then suddenly again in 2014 the prices of oil fell drastically and had by January 2016 fallen to \$30.7 per barrel (DePersio, 2016).

The block "Petroleum export" in figure 3.11 has been set to be linear dependent of the oil prices. The values for oil prices for the period January 2013 - February 2016, are

collected from the U.S. Energy Information Administration (2016). It is assumed that after the oil export has started to fall, it will not recover, and the oil prices are kept at a low level. The simulation time will start at year 2013 when the oil prices still are at a high, stable level.

When the simulation starts the country exports oil for 45,2 billion of NOK per month.

Other Foreign Trade

The export of petroleum is set to be 75% of the county's total export when the simulations start. The initial value for other exports are then 15 billion of NOK per month.

At the beginning of the simulation the total import is set to be 44 billion of NOK per month, and it counts for 44% of all households' consumption.

Population

The workforce consists of all people that potentially could work, they are either in work or unemployed and searching for work. Students, retired people and others that for some reason are not able to work, are not part of the workforce. During the first quarter of 2013 the workforce in Norway consisted of 2 680 000 people where 2 582 000 were employed and 98 000 unemployed, and the unemployment rate was at $3,6\%$ (AKU, 2013). Of the employed approximately 30% were employed in the Public sector and 70% in the Private sector (KommuneProfilen, 2015).

Wages

It is assumed 8 different wage levels, ranging from 25.000 NOK per month to 70.000 NOK per month. The distribution of private and public employees in the different wage levels W, D_{priv} and D_{pub} are given by

$$D_{priv} = \begin{bmatrix} 0.01 & 0.04 & 0.16 & 0.22 & 0.25 & 0.15 & 0.1 & 0.07 \end{bmatrix}^T \tag{3.17}$$

$$D_{pub} = \begin{bmatrix} 0.005 & 0.04 & 0.1 & 0.20 & 0.205 & 0.22 & 0.12 & 0.11 \end{bmatrix}^T \tag{3.18}$$

where the wage levels are

$$W = \begin{bmatrix} 70.000 & 60.000 & 50.000 & 45.000 & 40.000 & 35.000 & 30.000 & 25.000 \end{bmatrix}^T \quad (3.19)$$

The average wage for Private sector is $D_{priv}^T W$ and is 41.000 NOK per month and for the Public sector $D_{pub}^T W$ is 39.000 NOK per month.

Those that are not in the workforce receives either unemployment benefits, or other benefits. People that have had their work time reduced by at least 50%, can receive unemployment benefits from the government for up to 2 years depending on previous income. The unemployment benefits can be up to 62.4% of the wage level the unemployed had before they became unemployed (NAV, 2016). When the simulation starts everyone which is unemployed start their period of receiving unemployment benefits.

Other benefits include all pensions, sickness benefits, parental benefits and other social benefits.

Taxes

There is applied a progressive tax rate regime, where the tax rates, tr, for private and public employees are

$$tr = \begin{bmatrix} 0.33 & 0.3 & 0.3 & 0.28 & 0.28 & 0.28 & 0.25 & 0.25 \end{bmatrix}^T \quad (3.20)$$

Those not working, have a lower tax rate, $tr_{nw} = 0.2$ that apply to all which has received governmental benefits. The Value Added Tax (VAT), is set to be 20% of all purchases.

Economic mood

The economic mood function, m, is designed to be an s-shaped function of private employment. Data from the Federal Reserve Bank of St. Louis, FRED, show that there are some correlation between civilian employment rate and M2 money velocity (figure 3.12). Since the number of public employees are constant only the private employment rate is used to decide the economic mood.

The logistic mood function f, in 3.15 has been set to have a minimum tolerance for unemployment at 25%, where f is close to 0 for any unemployment rate under 25%. E'_{priv}
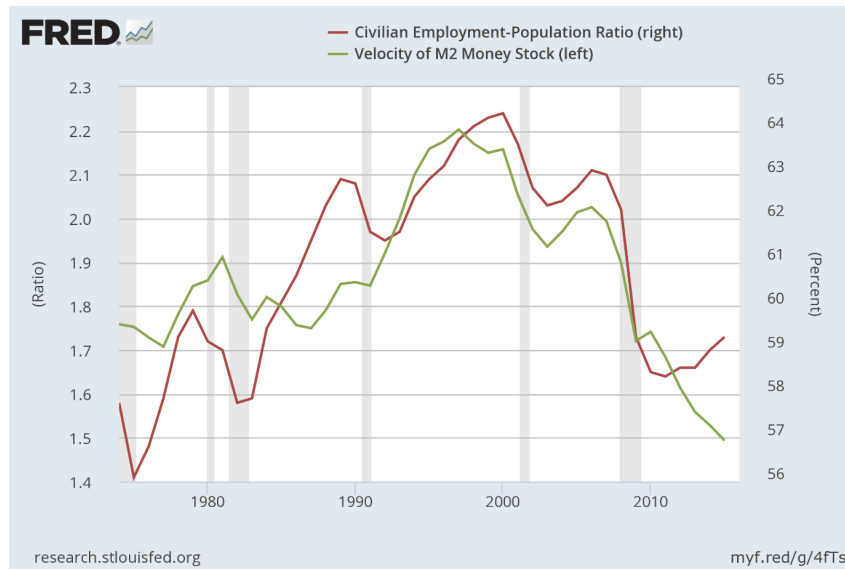
Figure 3.12: Civilian Employment Rate and M2 Money Velocity

is the maximum number of possible private employees and is found to be

$$E'_{priv} = wf - E_{pub} = 1.905.400 \tag{3.21}$$

where wf is the workforce. The private employment rate when total unemployment is at 25% is

$$h_{min} = \frac{E'_{priv} - 0.25wf}{E'_{priv}} = 0.6484 \tag{3.22}$$

The point h where private employment is at half of its carrying capacity is

$$h = 1 - 0.5(1 - h_{min}) = 0.8284 \tag{3.23}$$

The logistic growth rate of f is sat to be $g = 10$.

Time constants

As described in section 3.1.2, the time constants are dependent on the economic mood and can be described by

$$T = T_{max} - m(T_{max} - T_{min}) \tag{3.24}$$

where $T_{max} < T_{min}$. The time constants for households, T_p and T_{nw}, and firms, T_f, is based on the M1 money velocity in figure 3.13. In the period from 1980 - 2015 we see
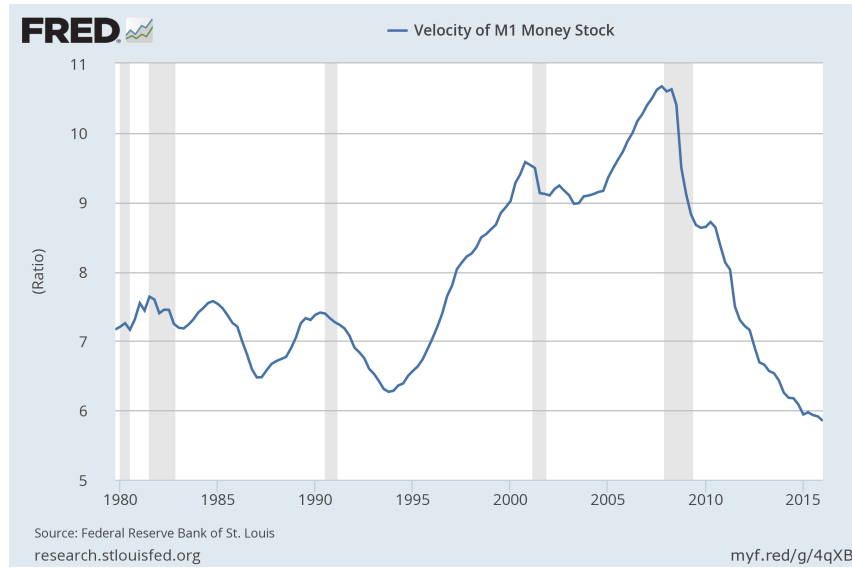
Figure 3.13: Velocity of M1 Money Stock

that the highest peak of how many times one money unit was spent per year was close to 11 and the lowest close to 6 times per year. This gives $v_{max} = 11/12\ [1/month]$ and $v_{min} = 6/12\ [1/month]$, for $v_{max} = 1/T_{max}$ and $v_{min} = 1/T_{min}$, we get the time lags

$$T_{min} = 2 \tag{3.25}$$

and

$$T_{max} = 1.09 \approx 1 \tag{3.26}$$

T_p, T_{nw} and T_f are defined to be somewhere within the range of T_{min} and T_{max}. The households that are employed have the most flexible economy of the households and choose to save more, the time lags are chosen to be

$$T_{p,min} = 1.8 \tag{3.27}$$

$$T_{p,max} = 1.4 \tag{3.28}$$

The households that are not working have to spend most of their monthly income every month, no matter if the economy is good or not, and the time lags are chosen to be

$$T_{nw,min} = 1.2 \tag{3.29}$$

$$T_{nw,max} = 1 \tag{3.30}$$

The firms sector would want to expand their businesses in good times, but carry more responsibility than households, and will also have to be careful in bad times. The time lags are chosen to be

$$T_{f,min} = 1.5 \tag{3.31}$$

$$T_{f,max} = 1 \tag{3.32}$$

3.2 Job Guarantee Regime

At t_{crisis}, the oil export has fallen by a third and the government decides to introduce one of the two alternative regimes. This section will cover the implementation of the JG regime.
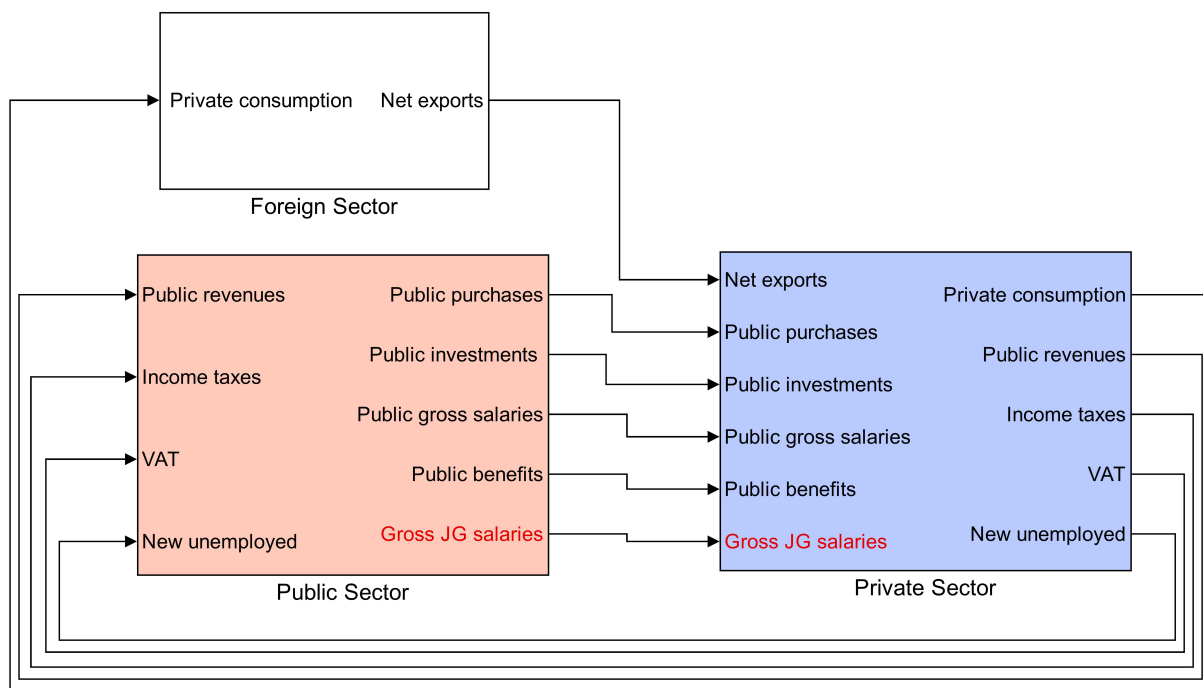

Figure 3.14: All Sectors - JG Regime

As seen in figure 3.14 there has been added one additional flow, "Gross JG salaries", from the Public sector to the Private sector.

The design of the Foreign sector is the same as in figure 3.11.

3.2.1 Public Sector with JG

The only part in the model of the Public sector that has changed is the "Public Salaries & Benefits" system, shown in figure 3.16. The switches (figure 3.15) that are seen in the

model are used to change from the lower input signal to the upper input signal, when the new regimes are introduced at $t = t_{crisis}$.
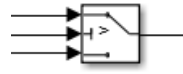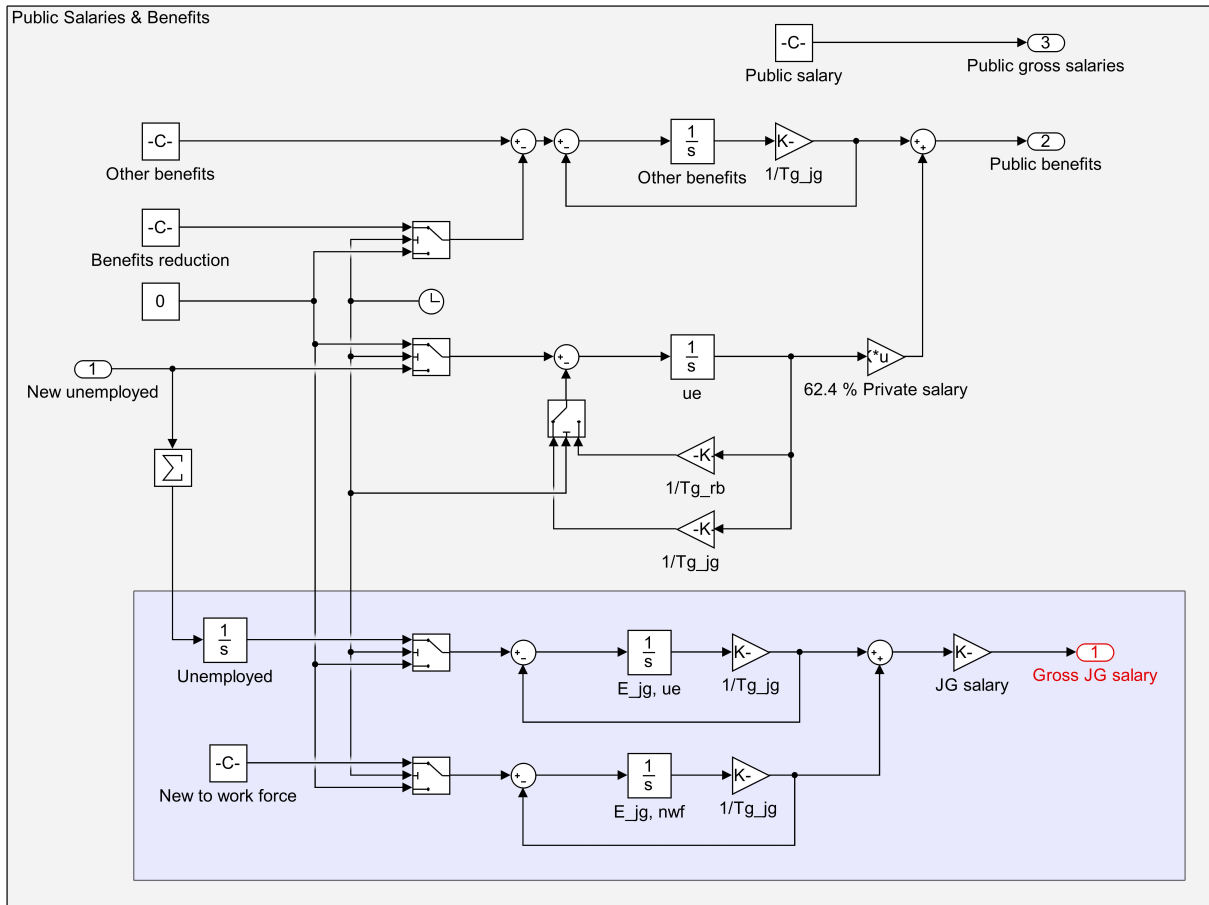

Figure 3.15: Switch

Figure 3.16: Public Salaries & Benefits - JG Regime

At t_{crisis} there is a gradual change from unemployment to full employment via the Job Guarantee. All unemployed will gradually get a job through the JG and stop receiving unemployment benefits. The integrator "$Unemployed$" contains all that are unemployed, and the integrator ue holds all unemployed that are entitled to receiving unemployment benefits (as in the Regular model). From $t = t_{crisis}$ there will be no new unemployed added to the stock, ue, and it will be emptied at the same pace $1/T_{g,JG}$ as people start getting JG jobs.

It is assumed that the workforce will increase with a JG regime. Some of those that have fallen out of the workforce due to difficulties finding jobs where they live or they have not been employed for a long time, will find it easier to go back to work through the JG. There are two stocks for JG employees, one that holds those that are moving from unemployment to JG employment, $E_{JG,ue}$, and one for those that are new to the workforce, $E_{JG,nwf}$. The change in JG employment happens at the same pace, $1/T_{g,JG}$, for both stocks. The total number of employees in JG are multiplied with the JG salary before it is sent to the Private sector as "Gross JG salary".

Since those that are new to the workforce, received other benefits before the JG was introduced, the integrator that holds other benefits will be reduced as more people join the workforce.

3.2.2   Private Sector with JG

In the Private sector, figure 3.20, the "Firms sector", and the "GDP & VAT" system are not changed in the JG regime. The "Gross JG salaries" from the Public sector are first subtracted taxes before the "Net JG salaries" are sent to the households.

Taxes

The JG tax rate, tr_{JG} is higher than tr_{nw} since the income through JG work is higher than income through public benefits, thus the subsystem "taxes" has been change accordingly (figure 3.17). Before t_{crisis} the Gross JG salaries flow will be 0, and will have no impact on the rest of the system.
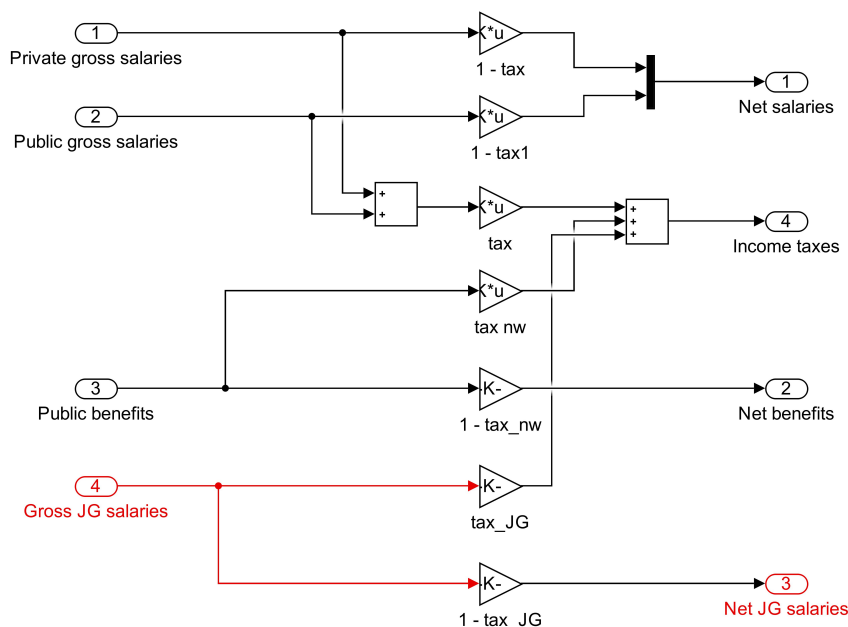

Figure 3.17: Taxes - JG Regime

Households

In the household system, the households are now divided into three groups; those employed in Private or Public sector, those not working, and those employed in the JG, which have time constants T_p, T_{nw} and T_{JG}, respectively (figure 3.18). T_p and T_{nw} are defined as in equations 3.13 and 3.14 and T_{JG} is defined by

$$T_{JG} = T_{JG,max} - m(T_{JG,max} - T_{JG,min}) \tag{3.33}$$
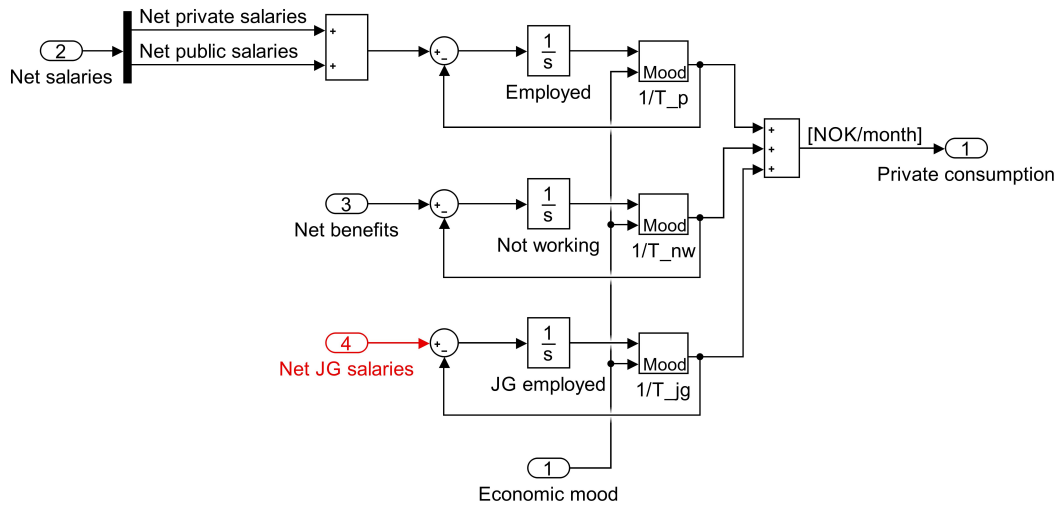
where $T_{JG,max} = 1.2$ and $T_{JG,min} = 1.4$ and m is the economic mood.

Figure 3.18: Households - JG Regime

Economic mood

When the new regime with JG is introduced, at t_{crisis}, it is assumed to be a change in economic mood. Both the JG regime and the BI regime, will give a safety which the Regular regime does not offer. The mood changes from the logistic function f (eq. 3.15) to f_2 when $t = t_{crisis}$ in figure 3.19 where

$$f_2 = \frac{1}{1 + e^{-g(u-h_{JG})}}, \quad h_{JG} < h \tag{3.34}$$
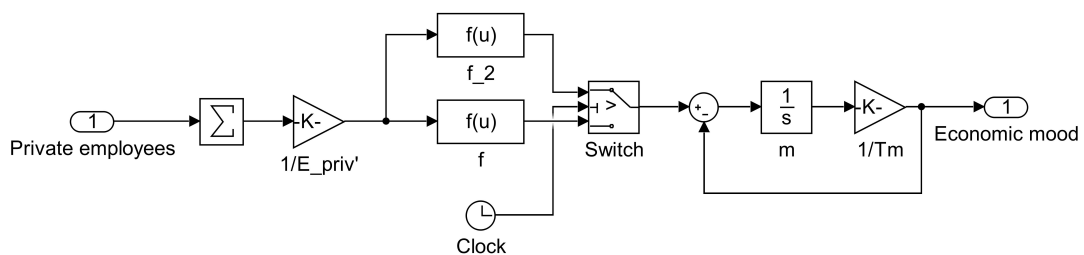

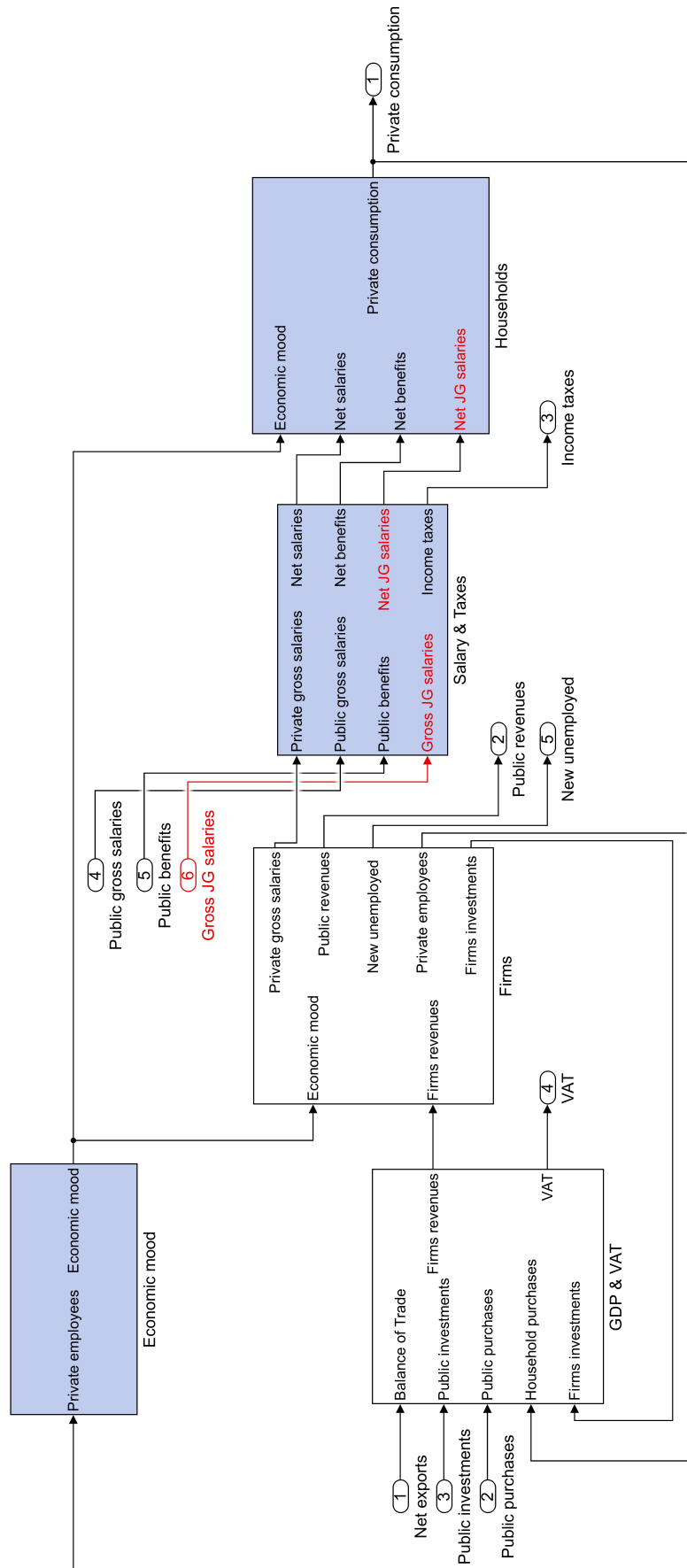Figure 3.19: Economic Mood - JG Regime

Figure 3.20: Private Sector - JG Regime

3.3   Basic Income Regime

The second alternative regime is the Basic Income regime. As in the model with JG, BI is introduced to the model at $t = t_{crisis}$. From figure 3.21 we see that also in this model there is a new outgoing flow "Basic income" from the Public sector to the Private sector. Again the Foreign sector is as in the Regular model.
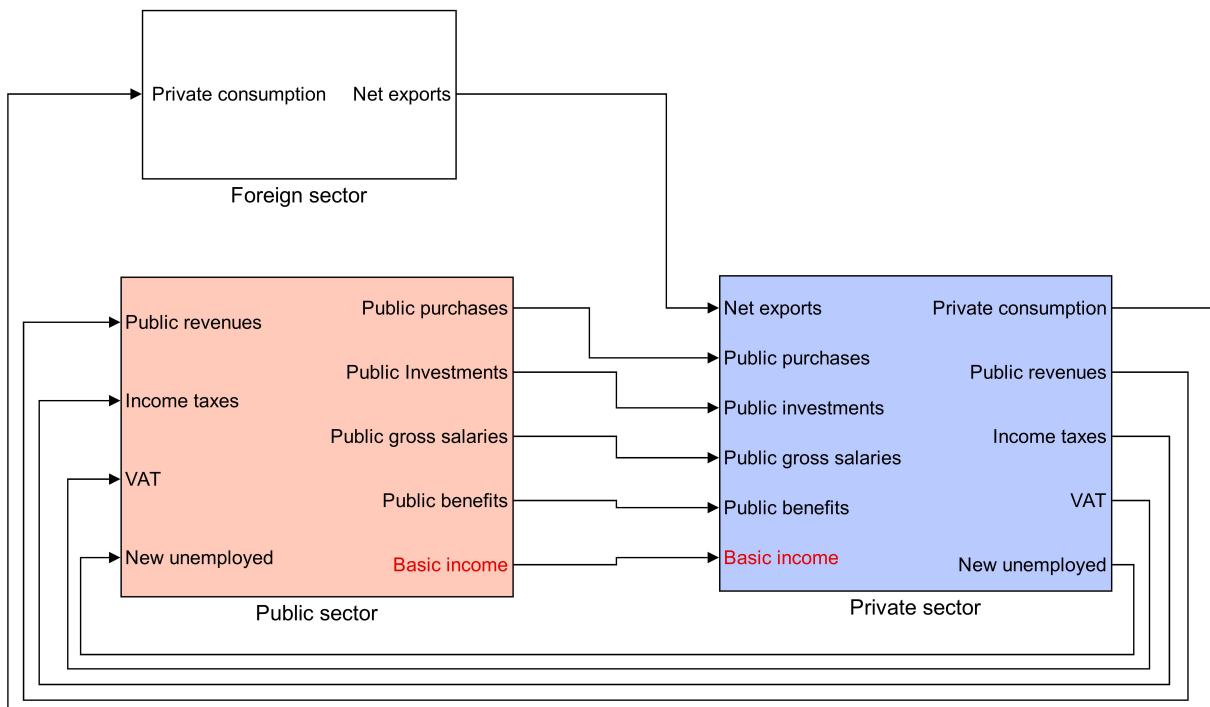

Figure 3.21: All Sectors - BI Regime

The definition of BI in section 2.3.1 says that BI should be an income unconditionally granted to all. For simplicity, only the workforce receives a basic income and other public benefits, except unemployment benefits, are kept constant. The level of BI is set to be 15.000 NOK per person per month.

3.3.1   Public Sector with BI

In the Public sector only the "Public Salaries & Benefits" system is modified (figure 3.22). The constant "Basic income" is the total amount the government would pay in BI every month. It is added a delay, T_{BI}, where $T_{BI} < T_{g,JG}$. To introduce a BI regime, can be done a lot faster than to introduce a JG regime. While the BI program only includes money transaction from the public account to the accounts of the receiveres, the JG program includes, job creation, hiring and money transactions.
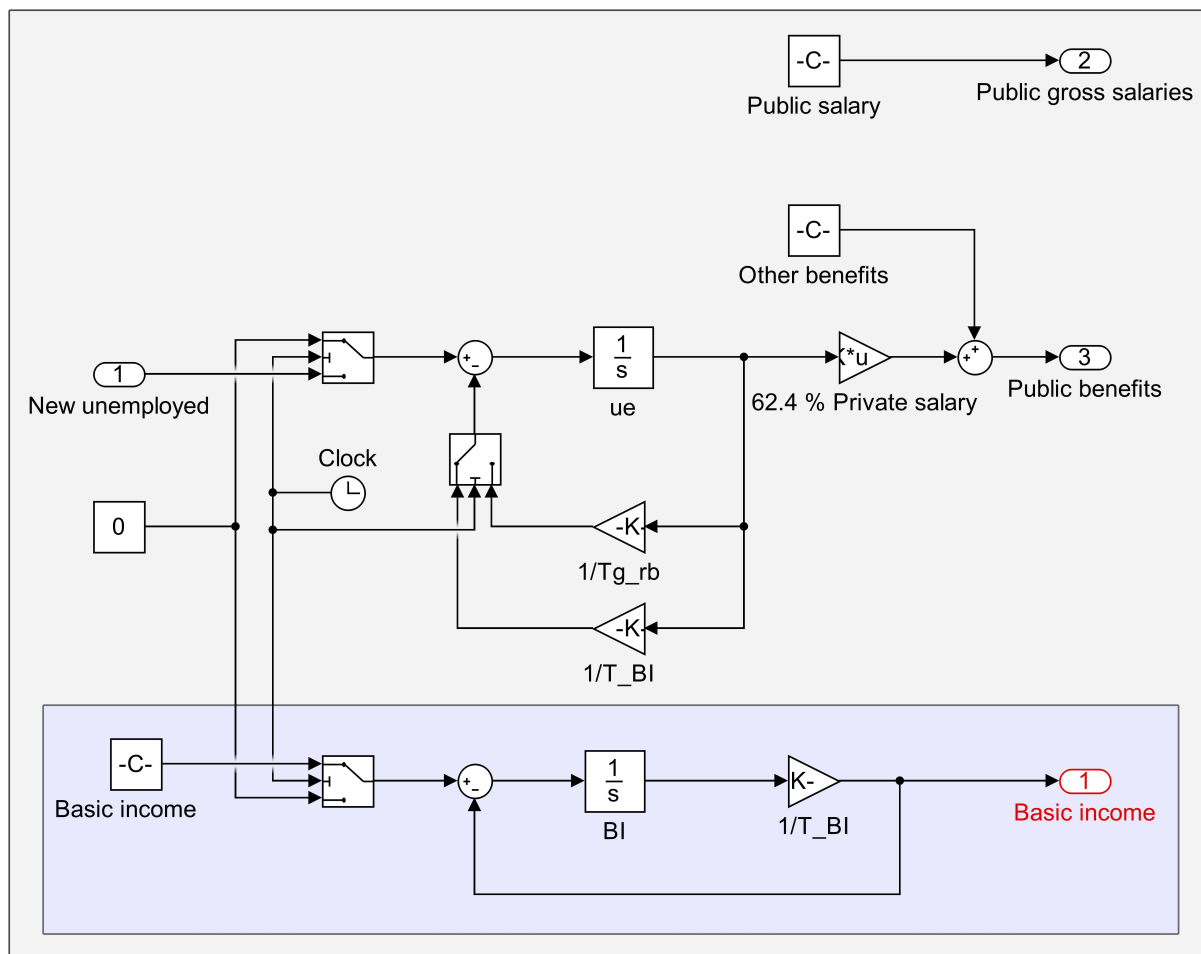
Figure 3.22: Public Salaries & Benefits - BI Regime

3.3.2 Private Sector with BI

As in the model with JG, only the subsystems "Salary & Taxes", "Households" and "Economic mood" are modified in the Private sector. Since the BI is a tax free income, the total amount of BI that the Private sector receives is sent directly to the households sector figure 3.23.

Households

The households are again divided into the two groups employed and not working, (figure 3.24). The incoming flow "Basic income" is divided by these two groups, depending on the number of people in each group.
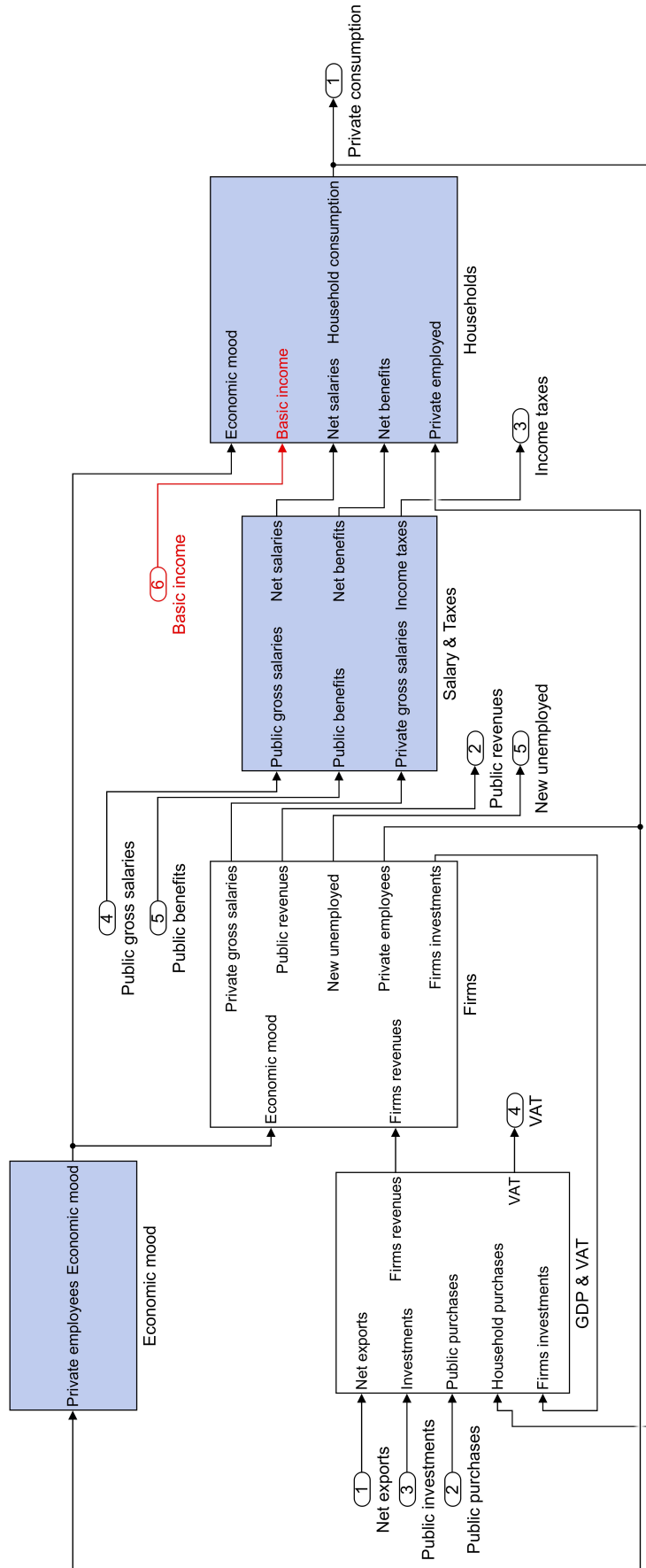
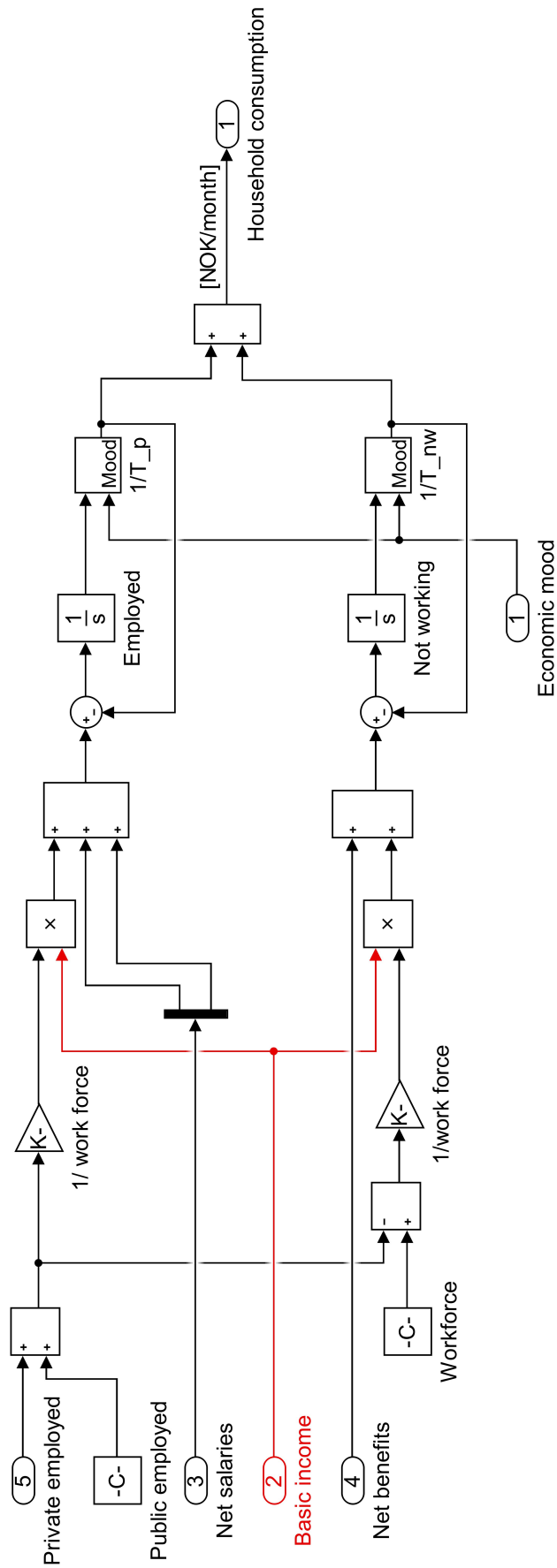Figure 3.23: Private Sector - BI Regime

Figure 3.24: Households - BI Regime

Economic mood

The economic mood, is as in the model with the JG regime, figure 3.19 where

$$f_2 = \frac{1}{1 + e^{-g(u-h_{BI})}}. \tag{3.35}$$

With a BI everyone is guaranteed to have a minimum income which they can survive on, this extra safety will strengthen the economic mood, and $h_{BI} < h$.

BI tax rates

After the BI regime is introduced a new tax rate tr_{BI} will be implemented (figure 3.25). The BI model will be simulated three times, with three different income taxes, $tr_{BI,1}$, $tr_{BI,2}$, $tr_{BI,3}$.
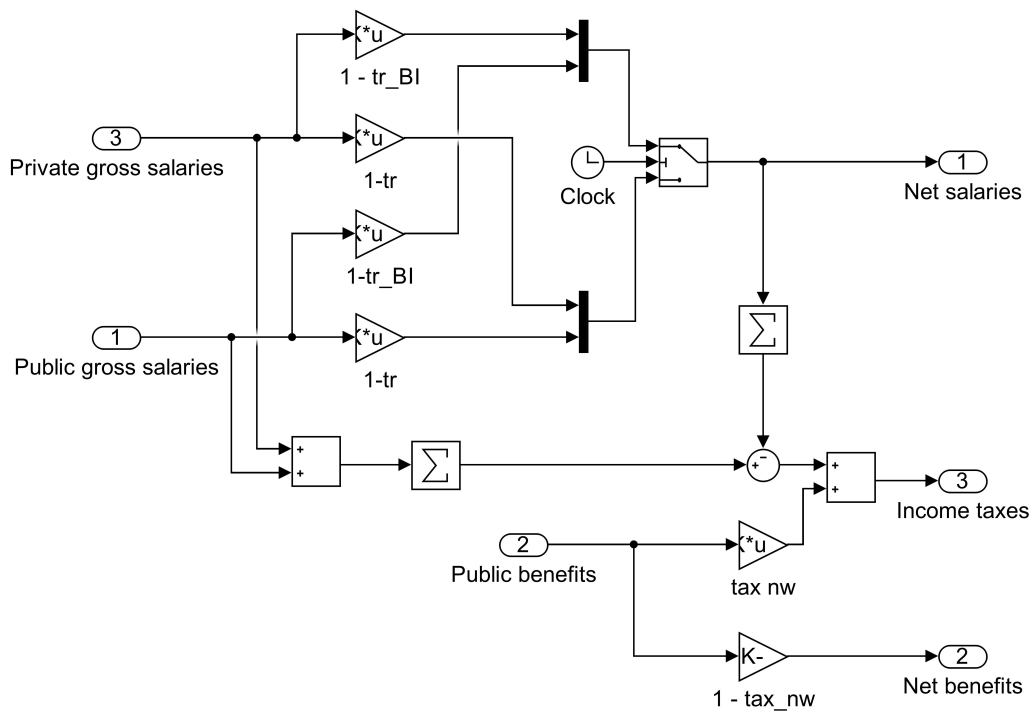

Figure 3.25: Taxes - BI Regime

Alternative 1: $tr_{BI,1}$ In the first tax regime, $tr_{BI,1}$ is a flat tax rate where most of the BI is funded by income taxes. To avoid punishing those that are employed, the tax rate is calculated for an economy at full employment. By letting the net income with and without BI be the same, we get

$$NI_{priv} + NI_{pub} = NI^*_{priv} + NI^*_{pub} + BI \tag{3.36}$$

where $NI_{priv} = GI_{priv}(1-tr')$ and $NI_{pub} = GI_{pub}(1-tr')$ are net income from private and public employees at full employment and tr' is the average tax rate at full employment before the BI regime is introduced. $NI^*_{priv} = GI_{priv}(1-tr_{BI,1})$ and $NI^*_{pub} = GI_{pub}(1-tr_{BI,1})$ are net income after Basic Income is introduced and BI is the total amount of basic income paid by the government. Equation 3.36 can be written as

$$(GI_{priv} + GI_{pub})(1-tr') = (GI_{priv} + GI_{pub})(1-tr_{BI,1}) + BI \tag{3.37}$$

which gives

$$tr_{BI,1} = tr' + \frac{BI}{GI_{priv} + GI_{pub}} \tag{3.38}$$

Alternative 2: $tr_{BI,2}$ With the second tax rate regime, $tr_{BI,2}$, the BI is funded by using MMT described in section 2.1, and the tax rate does not change, $tr_{BI,2} = tr$.

Alternative 3: $tr_{BI,3}$ The third tax rate, $tr_{BI,3}$, is a progressive taxation, where the tax rate is higher than the existing progressive tax rate, but not high enough to cover everyone's BI.

3.4   Summary of Chapter 3

In this chapter the design of the three models of the economy have been presented. The models are based on the Current regime, the JG regime and the BI regime. All three models include the main sectors; Public sector, Private sector and Foreign sector.

The design of the Foreign sector is the same for all three models. The economy is exposed to an export crisis, which is implemented in the Foreign sector. The Foreign sector also updates import and other export, and calculate the exchange rate. The output from the Foreign sector is the net export.

The Public sector receives taxes from the Private sector, and provide the Private sector with salaries, benefits and firms' income through purchases and investments.

The Private sector is built of two main aggregated sectors; "Firms" and "Households". The firms pay the households salaries, and the government taxes and fees, and make

purchases and investments in other firms. Before the households receives their salaries, taxes on the income is paid to the government.

In the JG and BI regime, one additional money flow is sent from the Public sector to the Private sector for each regime; "Gross JG salaries" and "Basic Income".

The next chapter will show results of the simulations of the models.

Chapter 4

Results of the Simulations

In this chapter the results of the simulations will be presented. We will see how the introduction of JG and BI affects the economic development during the crisis, with regards to employment, households' spending and savings, foreign trade, government spending and GDP.

All three models are hit by the same export crisis as shown in figure 4.1. The simulation starts at $t_0 = 2013$, and when $t = t_{crisis} = 2015$, the government decides to introduce the alternative regimes as a respond to the crisis. The black dotted line shows the point where JG and BI are introduced. The graphs which will be presented will show the results of applying the new regimes in comparison with the results of keeping "today's" regime. "Today's" regime will be referred to as the Regular regime.
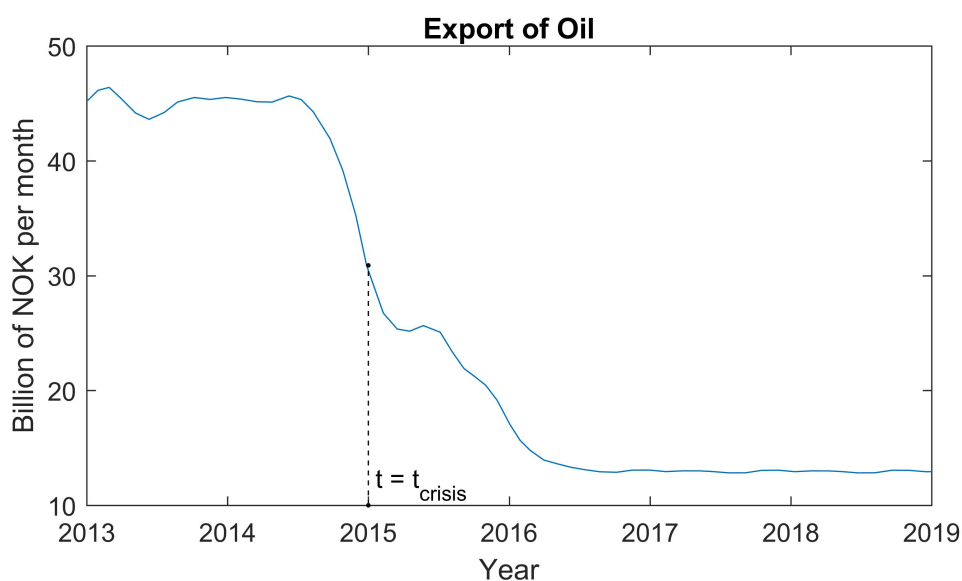

Figure 4.1: Export of Oil

4.1   Job Guarantee

The JG salary is set to be 25.000 NOK/month, which is the same as the minimum wage in the society. Taxes have to be paid of the JG income, and the JG tax rates is sat to be 25% of gross JG salary. It is assumed that 140.000 of those that are not in the workforce at t_0 will gradually join the workforce as the JG regime is introduced.

4.1.1   Employment

First we will look at the export crisis' effects on employment. In figure 4.2 we see that at t_{crisic} the number of private employees has just started to fall. In both models, private employment continues to fall, but under the JG regime it ends up at a higher level.
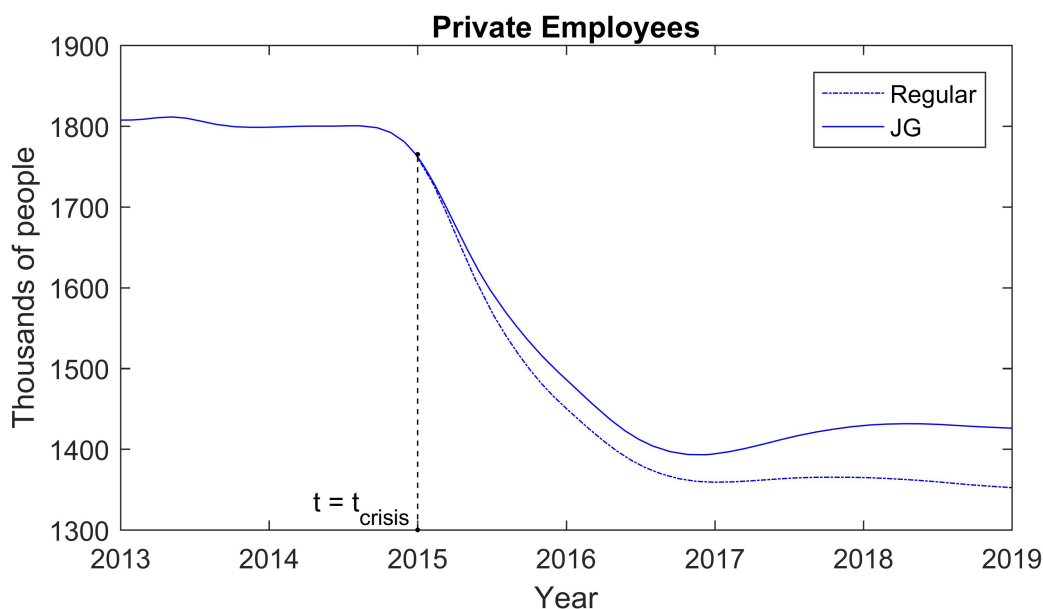

Figure 4.2: Private Employment in the Regular and JG Regimes

Figure 4.3 shows that at t_{crisis} the number of employees in JG grows rapidly and is higher than that of unemployed in the Regular model. Since the workforce has increased with 140.000 extra people, this is not unexpected. The JG model has been designed to keep some unemployment after t_{crisis} too. The time, $T_{g,jg}$, it takes for people to get work in the JG, will result in some unemployment as long as new people are losing their jobs. The blue, dotted line shows that unemployment in the JG model falls rapidly as the JG is introduced, and by 2017 all unemployed has joined the JG program.

To see the effect JG has had on the initial workforce, figure 4.4 shows the unemployment rate in the Regular model and the JG employment rate of JG employees in the initial
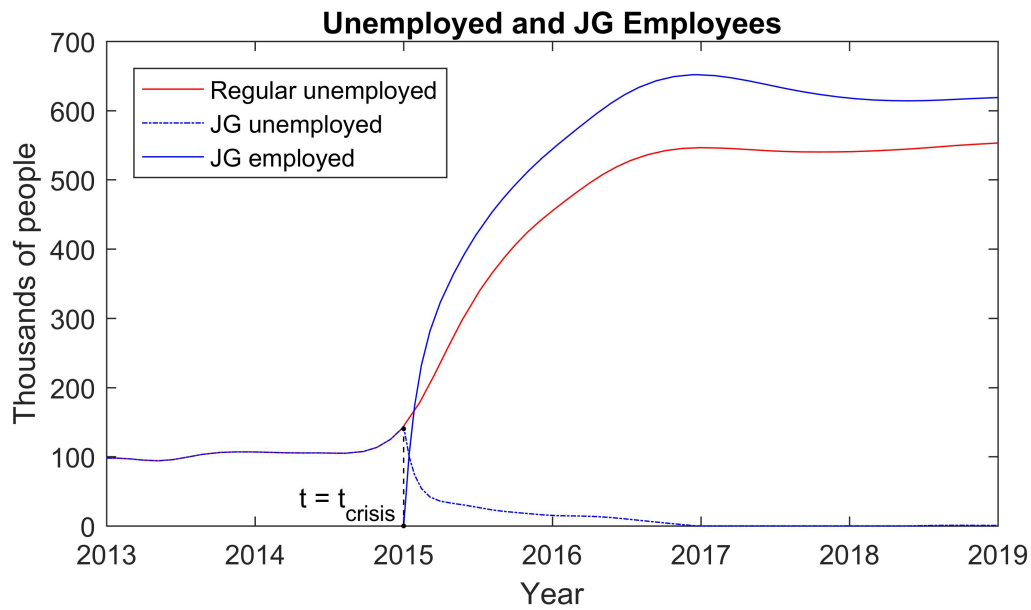
Figure 4.3: Unemployment and JG Employment

workforce. When the simulation starts the unemployment rate is at 3.6%. While the unemployment rate has reached over 20% by the end of the simulation, the JG employment rate* ends up at 18%.
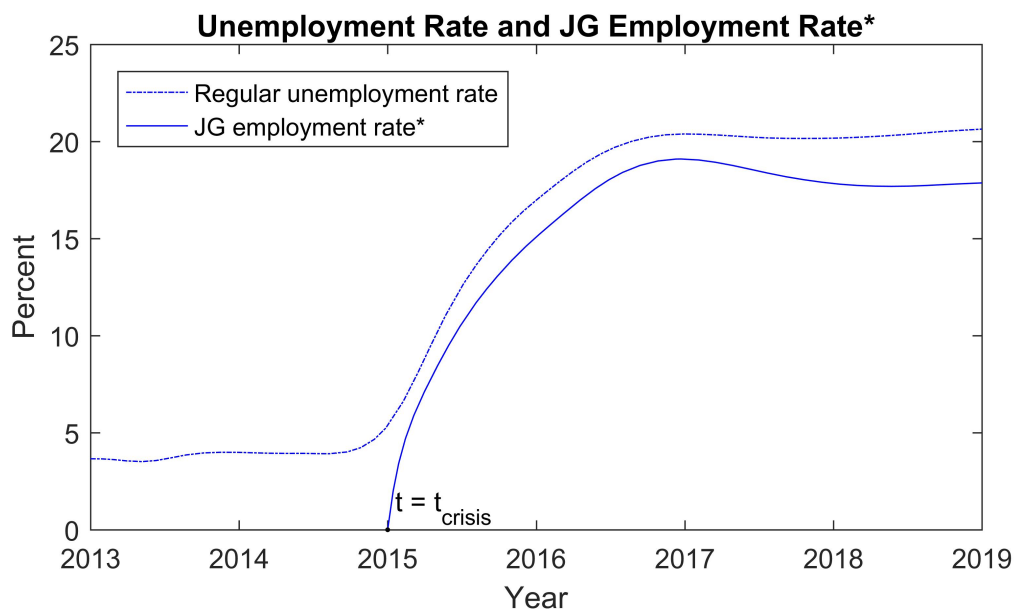

Figure 4.4: Unemployment Rate and JG Employment Rate*

From viewing how employment and unemployment changes in the two models, it is clear that the export crises have a great impact on employment in the model, even though the results of introducing a JG are not stunning, it has some positive effect on the economy.

4.1.2 Households' Consumption

Now we will look at the changes in the households' consumption. From figure 4.5 we see that there is a great difference between households' consumption in the two regimes. While the consumption continues to drop in the Regular regime, it ends up at a level only 4% below the initial spending in the JG regime.
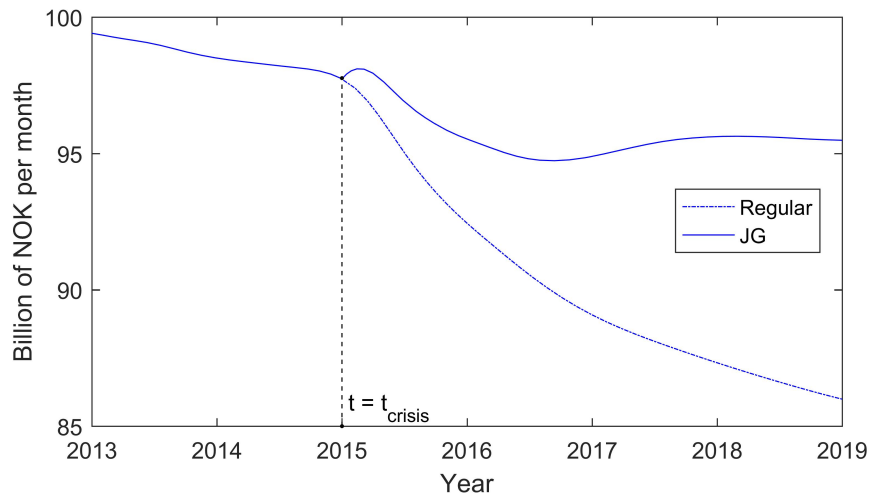
Figure 4.5: Households' Consumption

At t_{crisis} we see that the consumption in the JG model has a small peak. At t_{crisis} the rule for the economic mood is changed, and the same dynamic can be seen in the economic mood, figure 4.6.
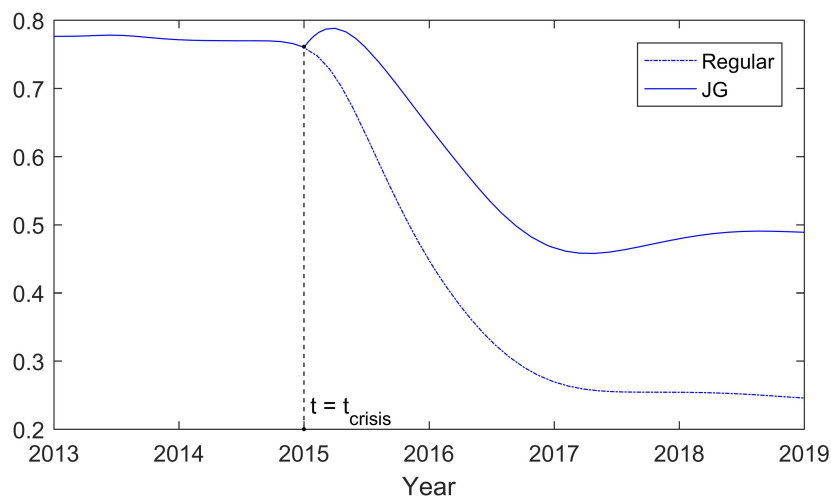

Figure 4.6: Economic Mood

As discussed in section 3.1.2 the money velocity is linearly dependent of the economic mood, when the mood drops the money velocity decreases. Spending can be defined as

$Y = Mv$ where M is the amount of money and v is the money velocity. A drop (or growth) in either money stock or velocity will cause spending to decrease (or increase).

In the Regular regime, an unemployed would receive approximately 20.467 NOK per month in net unemployment benefits for a time period of 2 years, and a person receiving other benefits would get 16.000 [$NOK/month$] net. In JG employment the net income would be 18.000 [$NOK/month$].

Figure 4.7 shows that households' money stock will in the beginning be lower with JG, but after a year the money stock start to increase beyond the money stock under the Regular regime. Since unemployment stays high over several years, it will be more profitable to be in JG work than to be unemployed.
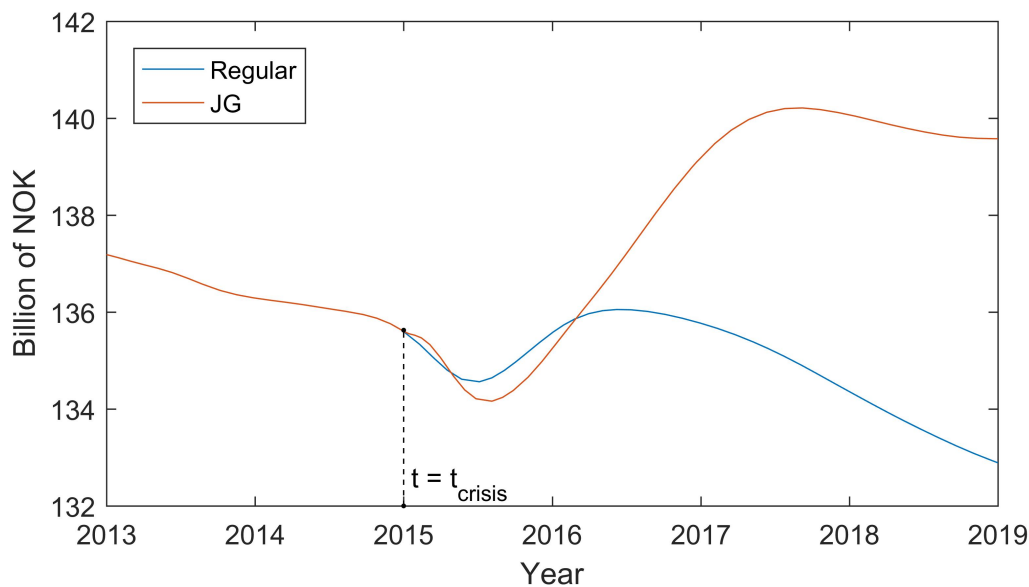
Figure 4.7: Households' Money stock

When the simulation starts, the households' income is at its highest, but we see in figure 4.7 that the money stock starts to increase a while after the crisis hits. As the economic mood is falling, households would want to save more, and start to accumulate money. With JG, the income will be higher over time than in the Regular model with high unemployment, and the ability to save is higher under a JG regime.

Figure 4.8 shows the accumulated amount of money for the whole Private sector, including both the households sector and the firms sector. In the Regular regime the Private sectors stock of money is 334 billion NOK, and in the JG regime the Private money stock is 333 billion NOK.
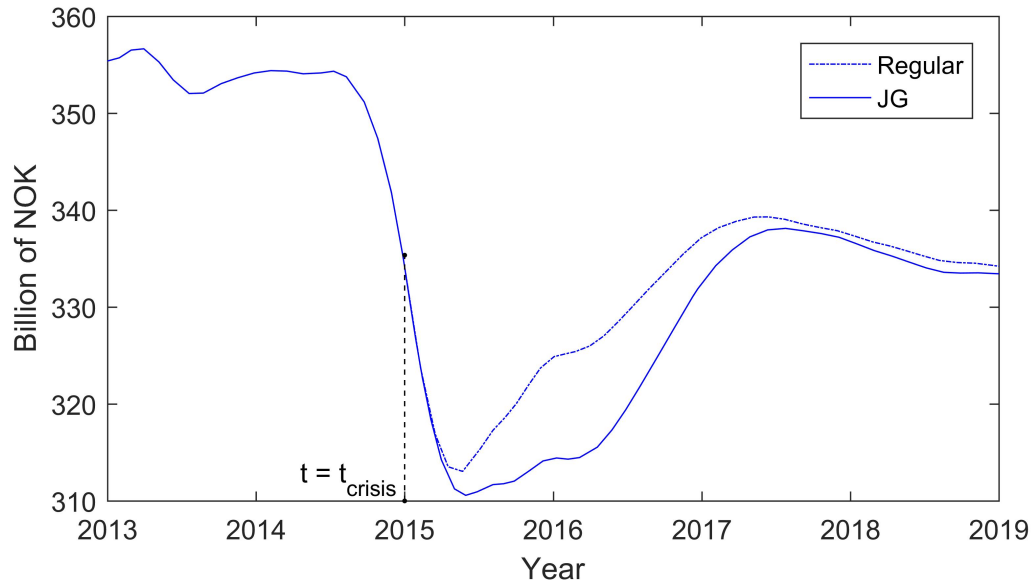
Figure 4.8: Private Sector's Money Stock

4.1.3 Foreign Trade

In figure 4.9 the net export for the Regular and the JG regimes are shown. We see that the net exports start to fall drastically at the end of 2014, and reaches a lower limit during 2016. Even though the economic mood is higher in the model with JG, the introduction of JG has a slightly more negative effect on the balance of trade. Which can easily be explained by the increased import due to more private consumption with JG (figure 4.10).
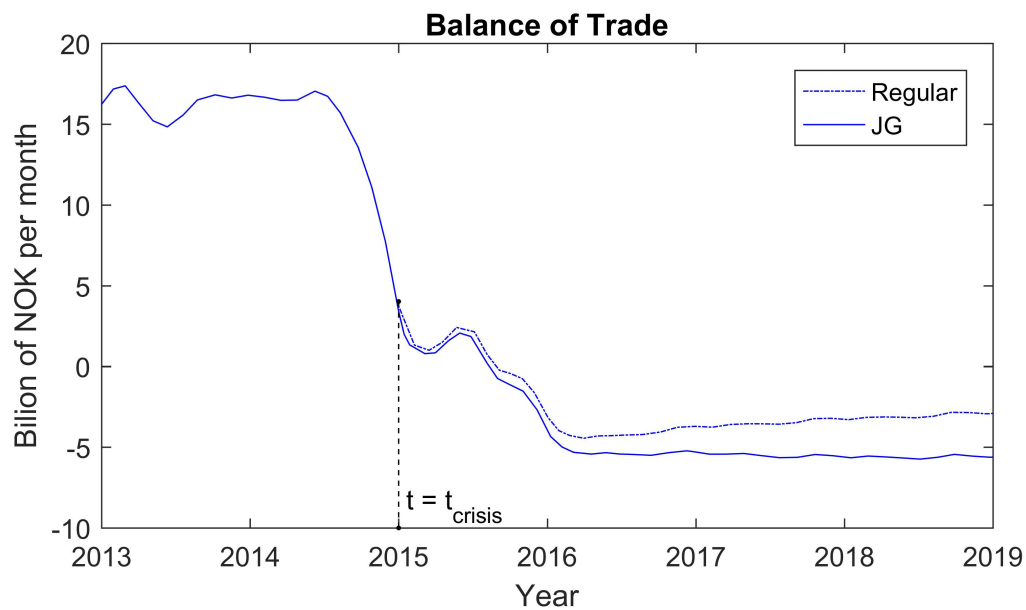
Figure 4.9: Net Export
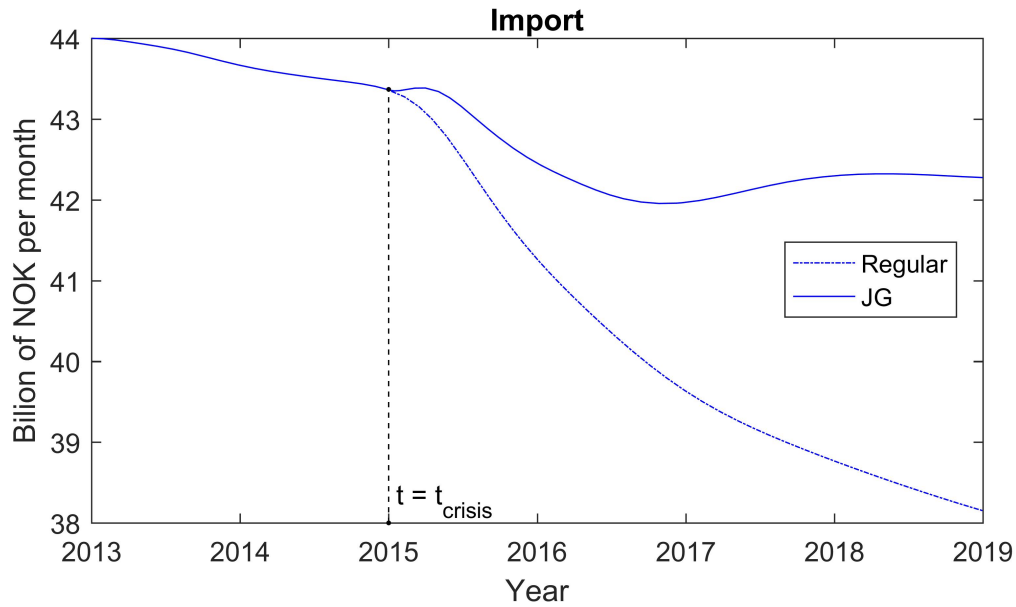
Figure 4.10: Import

Figure 4.11 shows that while export of oil is falling other exports are increasing in both models. This is caused by changes in the exchange rate between the domestic currency, NOK, and the foreign currency, $. As the dollar gets more expensive, the price of NOK falls and makes domestic goods more attractive on the foreign market, which increases other exports.
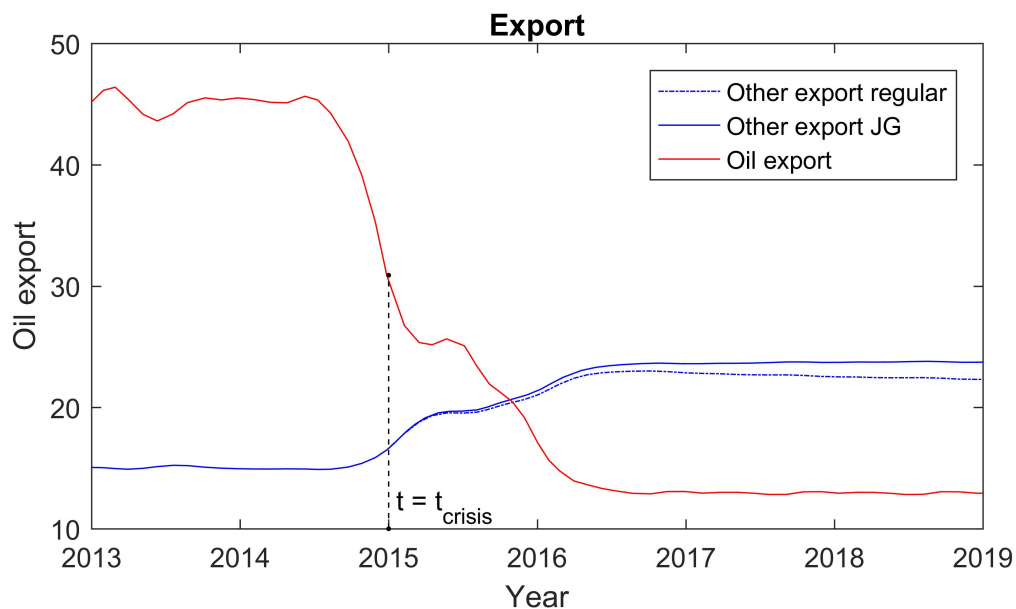
Figure 4.11: Export

In figure 4.12 we see that in the JG regime the exchange rate increases more than in the model without, which is due to the increase in import, this again causes other exports

to grow more in the JG model than in the model without JG as is seen in figure 4.11.
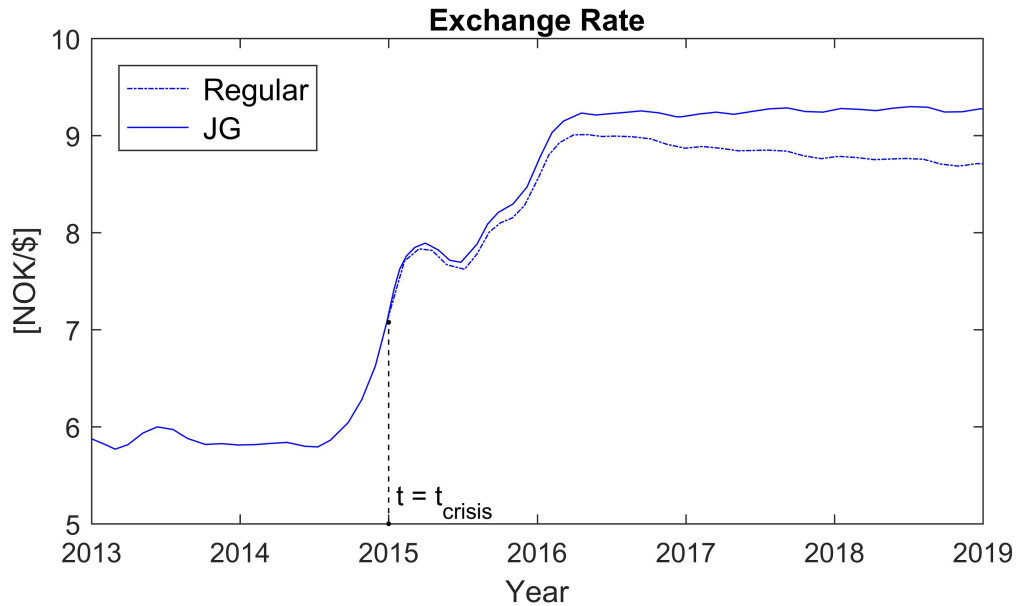
Figure 4.12: Exchange Rate

In both models all employees which lose their job in the petroleum sector, will either start working in industries that make products for domestic purchases, or they will start working in the Job Guarantee. In this "worst case" scenario the loss of labour in the oil export industry will not increase labour in other export industries, and this will not affect other exports.

4.1.4   Government Spending

The government sector has been designed to have the same premises for budgetary decissions in all models. The government's revenues have no direct impact on its spending. The budget deficits that we see occurring in figure 4.13 after the crisis, will be covered either by money creation, loans or savings from the time before the crisis. The decision to ease governmental budget constraints in all models, has been made to better detect the effects of the alternative regimes.

We see from figure 4.13, that the government ends up running with deficit in both models, and that the additional income from taxes on JG income is not enough to cover the additional spending in the JG regime. The Public sector ends up with a deficit of 2.74 billion NOK/month or 32.9 billion NOK/year in the Regular regime and 5.58 billion NOK/month or 67 billion NOK/year in the JG regime.
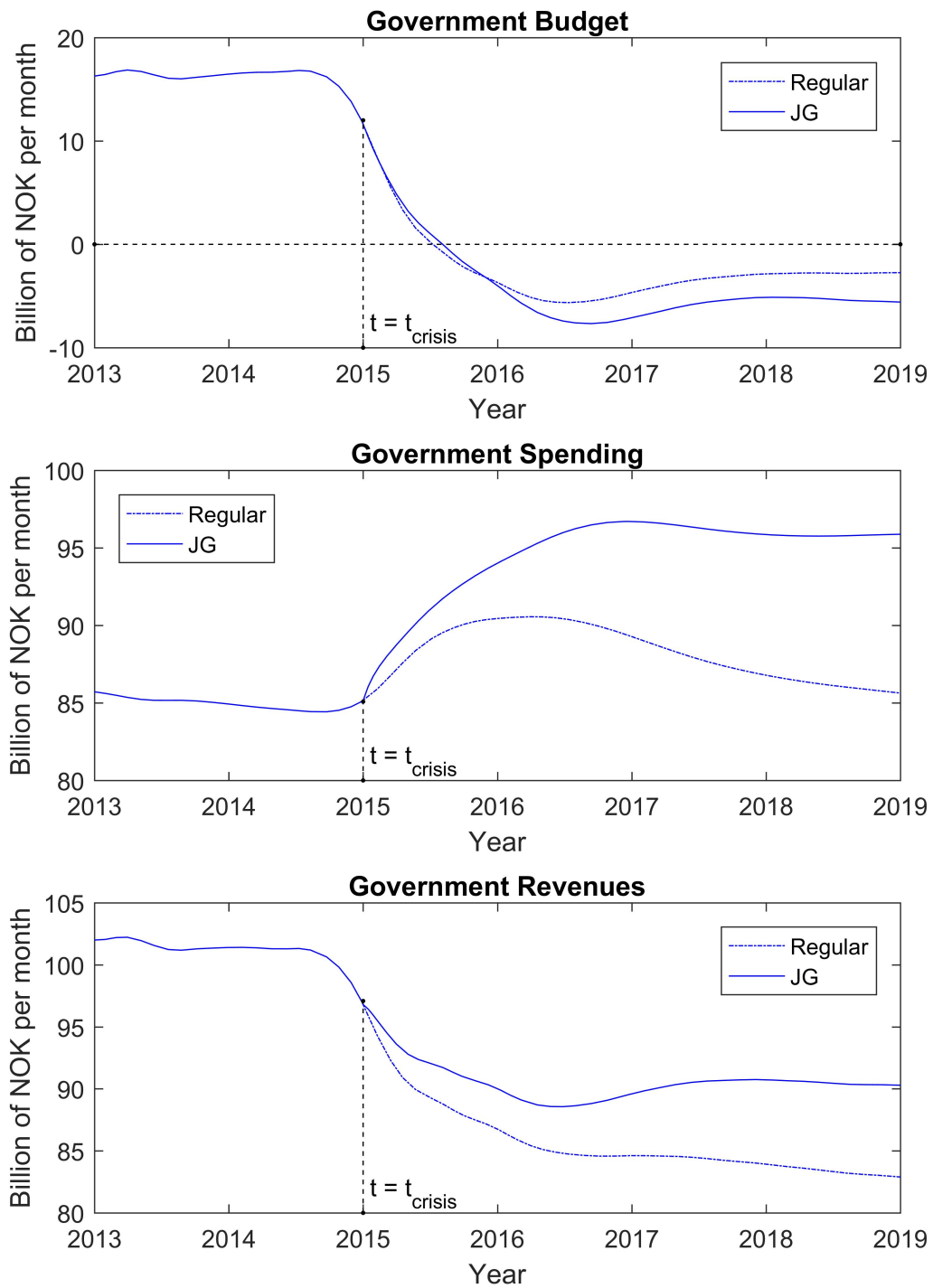
Figure 4.13: Government Budget

4.1.5   GDP

As seen in figure 4.14, after the crisis, GDP has been reduced by almost 20% in the JG model and close to 25% in the Regular regime.

Even though there has been a great reduction in GDP under both regimes, under the JG regime the households' consumption is only reduced by 3 % which suggest that the population can keep almost the same standard of living as they did before the crisis.
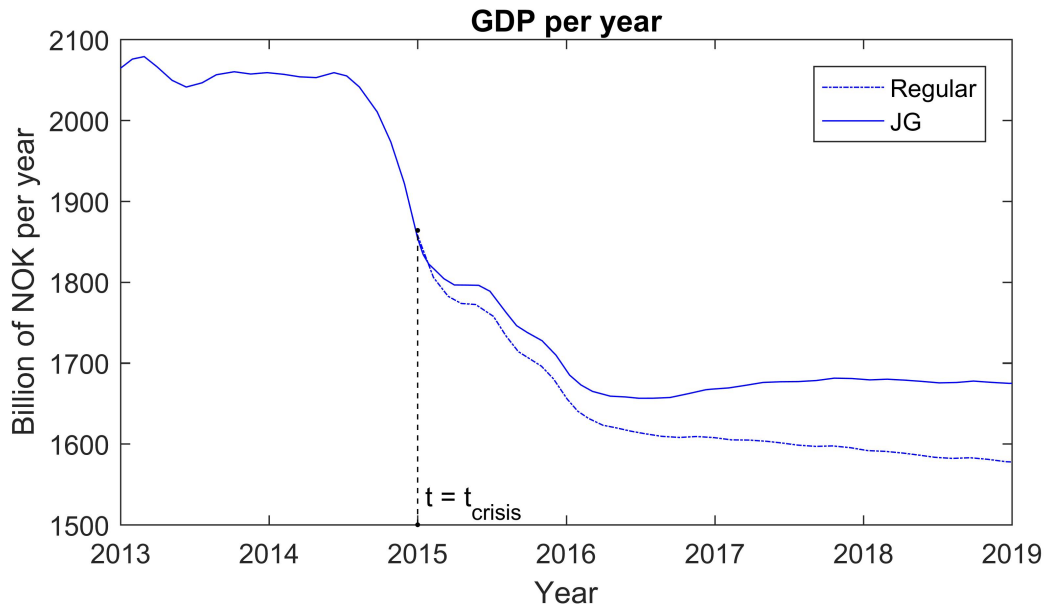
Figure 4.14: GDP

4.2   Basic Income

As in the model with JG, the BI is introduced at $t = t_{crisis}$. Everyone in the workforce will receive 15.000 NOK per month in basic income and payment of unemployment benefits will be stopped after t_{crisis}.

The model with Basic Income is simulated for the three income taxes described in chapter 3.3.2. With a basic income level at 15.000 NOK per person per month. We get the following tax rates

$$tr_{BI,1} = 0.65 \tag{4.1}$$

$$tr_{BI,2} = \begin{bmatrix} 0.33 & 0.3 & 0.3 & 0.28 & 0.28 & 0.28 & 0.25 & 0.25 \end{bmatrix}^T \tag{4.2}$$

$$tr_{BI,3} = \begin{bmatrix} 0.48 & 0.45 & 0.45 & 0.43 & 0.43 & 0.43 & 0.40 & 0.40 \end{bmatrix}^{T} \quad (4.3)$$

Since the new tax rates are higher than the initial tax rate, and it is desirable to avoid a negative economic shock for the households, the new tax rates are applied one month after BI is introduced to the economy.

The export of oil has the same course as in figure 4.1.

4.2.1   Employment

We see in Figure 4.15 that private employment will end up at a higher level for all tax rate regimes. With $tr_{BI,1}$, the level of private employment is almost the same as in the Regular model, but since the tax rate is chosen to cover BI when there is full employment, there will be some discrepancy between the two regimes, and in figure 4.16 we see that the unemployment rate ends up at 18.5 % in the first BI regime compared to over 20% in the Regular regime.
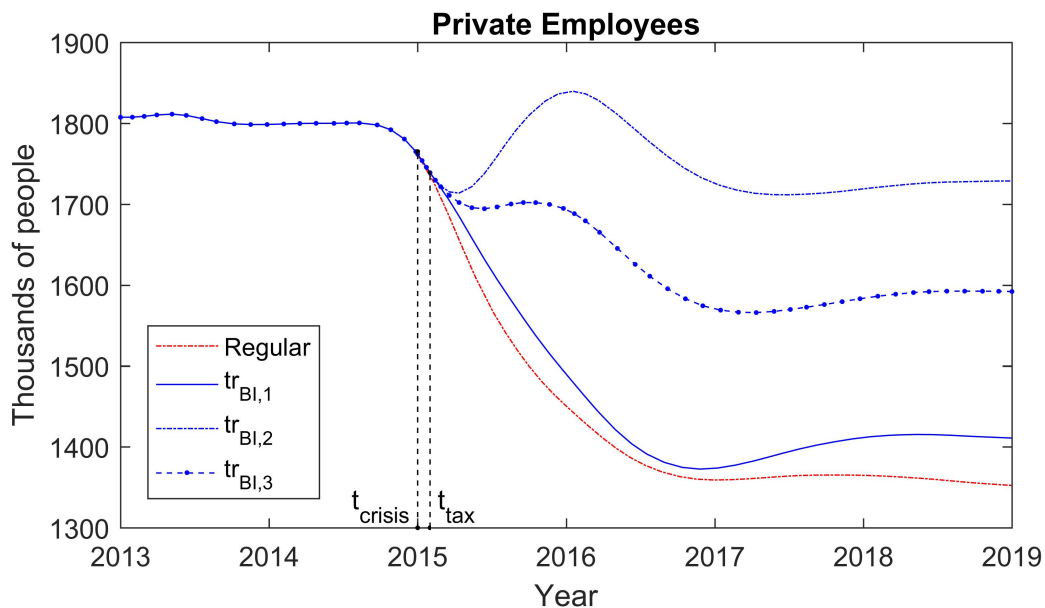
Figure 4.15: Private Employment

With the second tax rate, $tr_{BI,2}$, private employment rises after it has been introduced, and at $t = 2016$ the unemployment rate is even lower than before the crisis, and it ends up at 6.5 % towards the end of the simulation.

With the third tax rate, $tr_{BI,3}$, not as many lose their jobs as in the Regular model and the BI model with $tr_{BI,1}$, but still unemployment reaches 11.7 % towards the end of
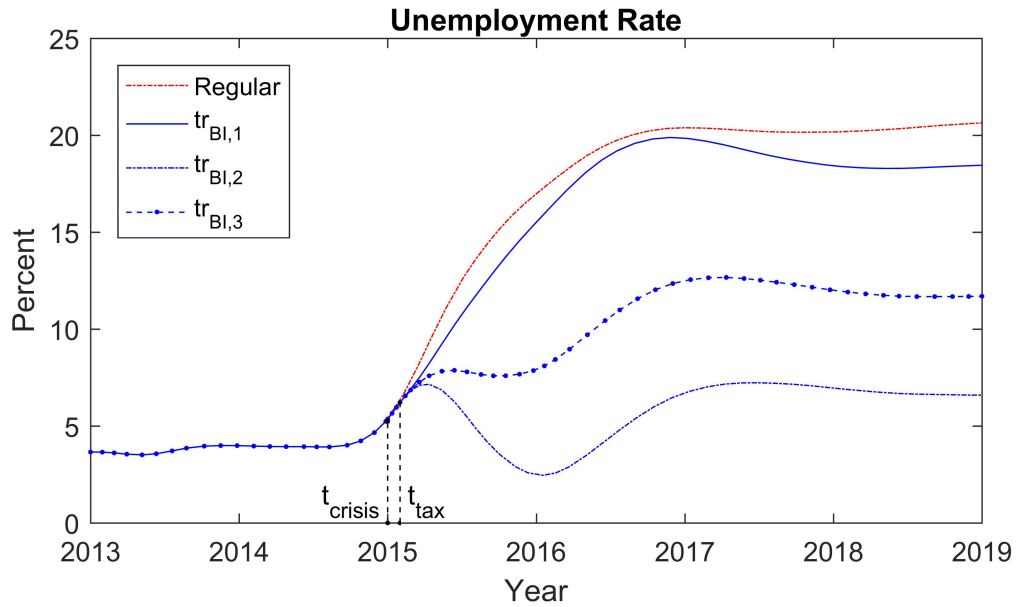
Figure 4.16: Unemployment Rate

the simulation.

4.2.2   Households' Consumption

As we see from figure 4.17 households' consumption increases rapidly, when the BI regime is introduced. And in the cases with $tr_{BI,2}$ and $tr_{BI,3}$ the spending ends up at a level $17 - 35\%$ higher than what it was before the crisis.
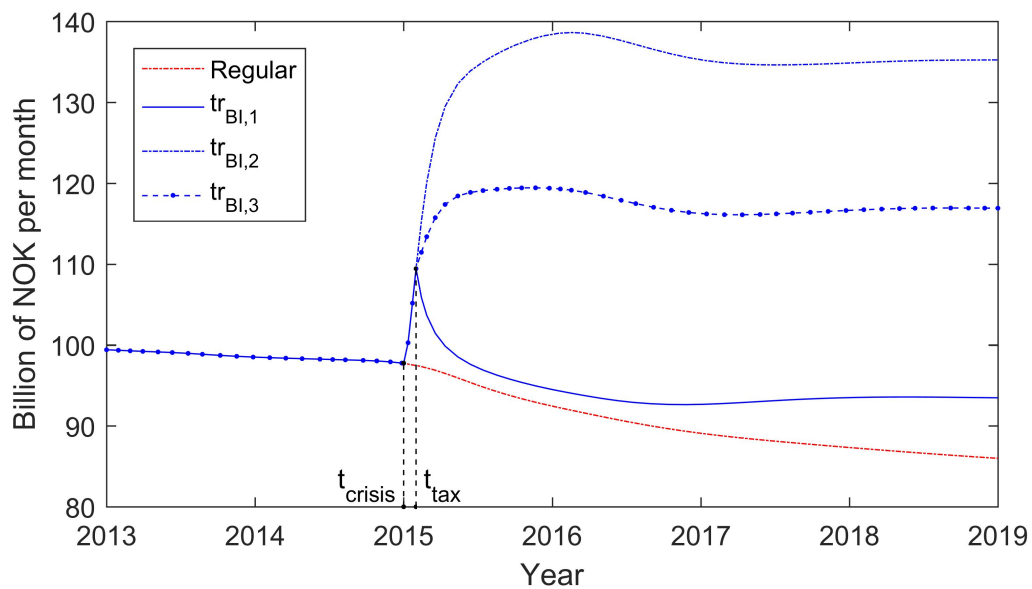
Figure 4.17: Households' Consumption

In the simulation with $tr_{BI,1}$ the consumption increases rapidly after t_{crisis}, but as the new tax rate takes place, the consumption drops and ends up at a level 6% below what it was before the crisis.

In figure 4.18 we see that the money stocks for the BI regimes with $tr_{BI,2}$ and $tr_{BI,3}$ starts increasing rapidly as BI is introduced, and reaches a level far above the initial level. In the first tax regime, $tr_{BI,1}$ the savings fall below that of the Regular model, after the tax rate regime has changed. This is due to the higher money velocity, with BI, because of the mood changes. But we see that it manages to reach a level slightly higher than with the Regular model.
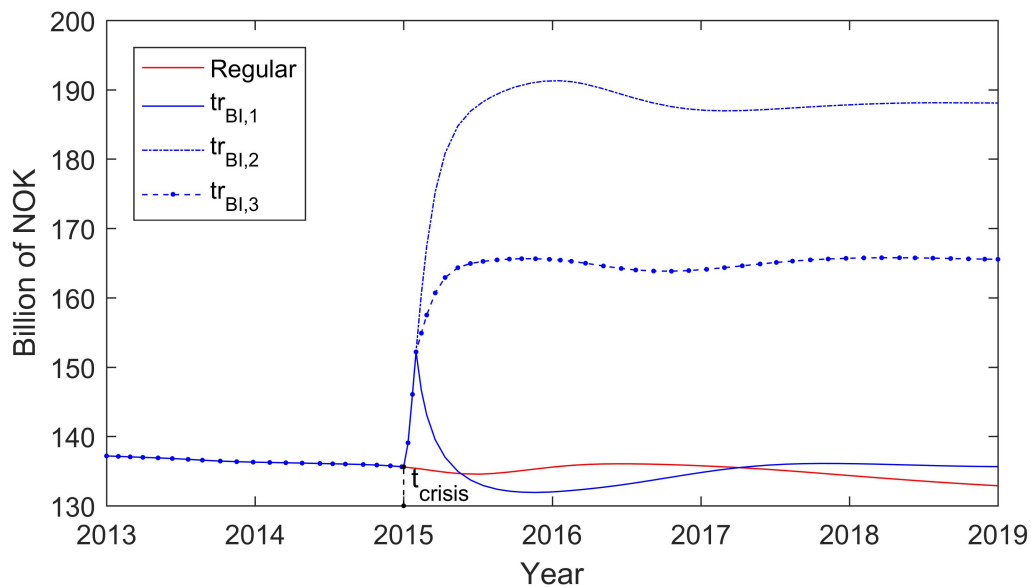
Figure 4.18: Households' Money Stock

Figure 4.19 shows the total amount of money accumulated in the Private sector. We see that the money stock ends up at 329 billion NOK, 392.5 billion NOK and 364.7 billion NOK, for the tax regimes, $tr_{BI,1}$, $tr_{BI,2}$ and $tr_{BI,3}$, respectively.

Also here the economic mood rule changes at t_{crisis} for the BI regime. From figure 4.20 we see that the economic mood rises when the BI regime is introduced.

For $tr_{BI,2}$ the economic mood ends up at a level slightly lower than it was before the crisis. Since the households' consumption for the same tax rate is much higher than it was before the crisis, we know from the identity $Y = Mv$ that the households have accumulated more money due to the increased income.
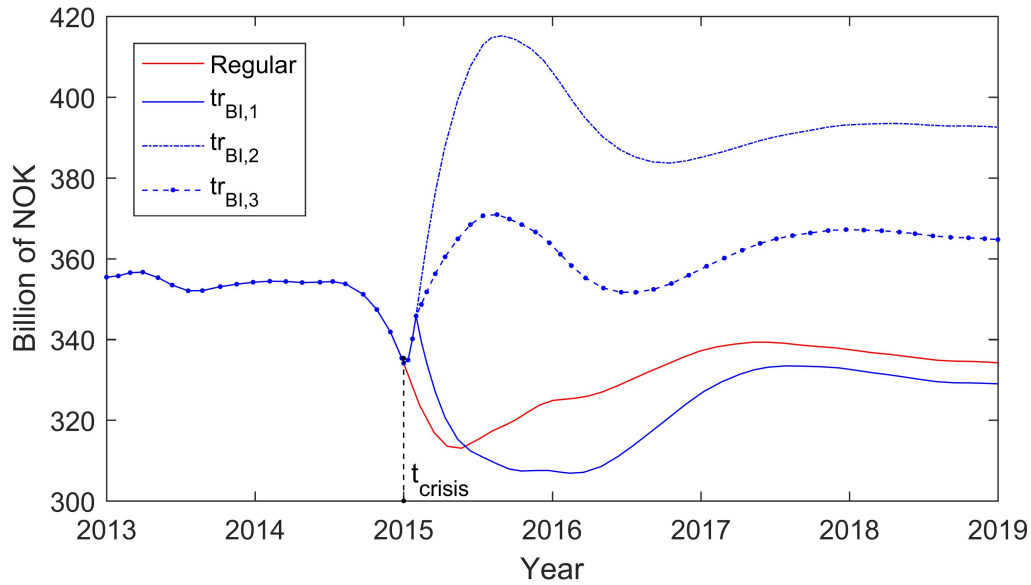
Figure 4.19: Private Sector's Money Stock
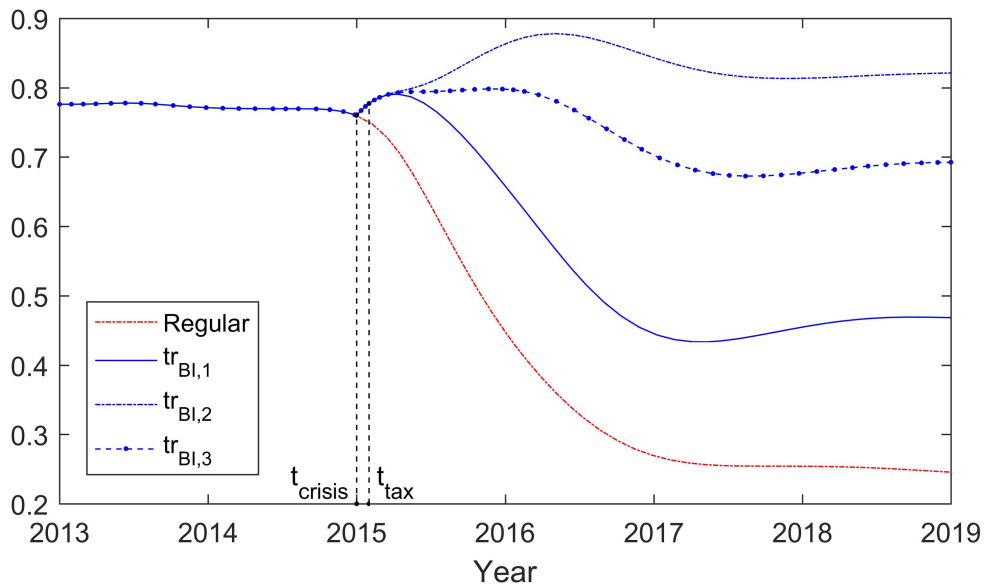
Figure 4.20: Economic Mood

4.2.3   Foreign Trade

The increased household consumption in the BI regime, will cause imports to increase, which we can see the result of in figure 4.21. The Net exports falls far below 0 in the BI regimes with $tr_{BI,2}$ and $tr_{BI,3}$. This has great impact on the exchange rate (figure 4.22) which has almost doubled for $tr_{BI,2}$ where the price for 1 \$ reaches 11.40 NOK.

When the price of the foreign currency rises, the price of foreign goods would have to increases since there are only two currencies in the economy, and in the cases where the

change is so big as in $tr_{BI,2}$, it would be difficult to keep price stability over time.
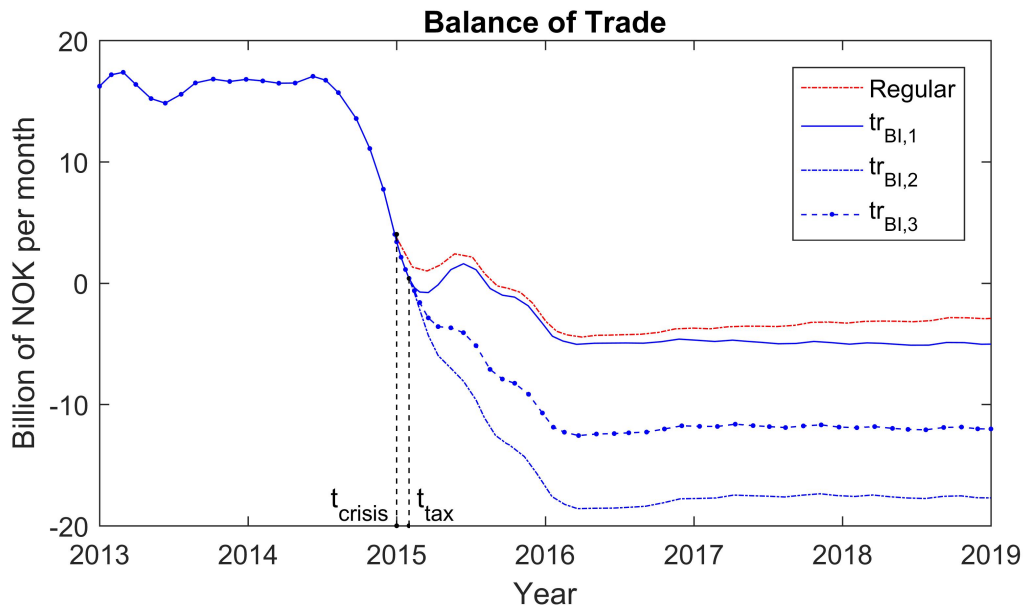
Figure 4.21: Net Export
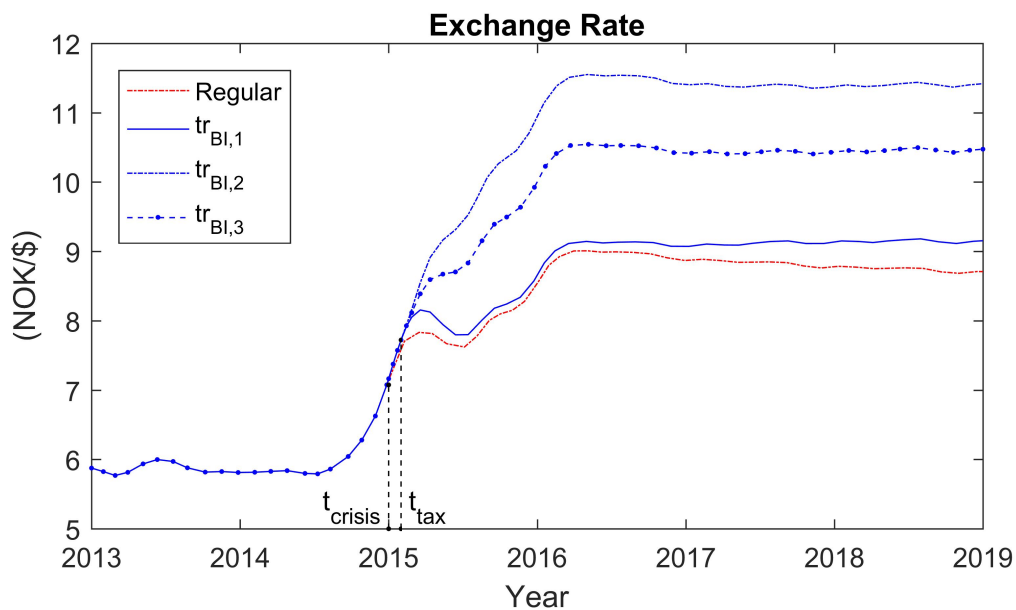
Figure 4.22: Exchange Rate

4.2.4   Government Spending

As we see in figure 4.23, the government spending increases rapidly when the BI regimes are introduced, and when the new tax rates are applied, there will be a jump in government's revenues. Even if the increased taxes cover some of the extra spending, the govern-
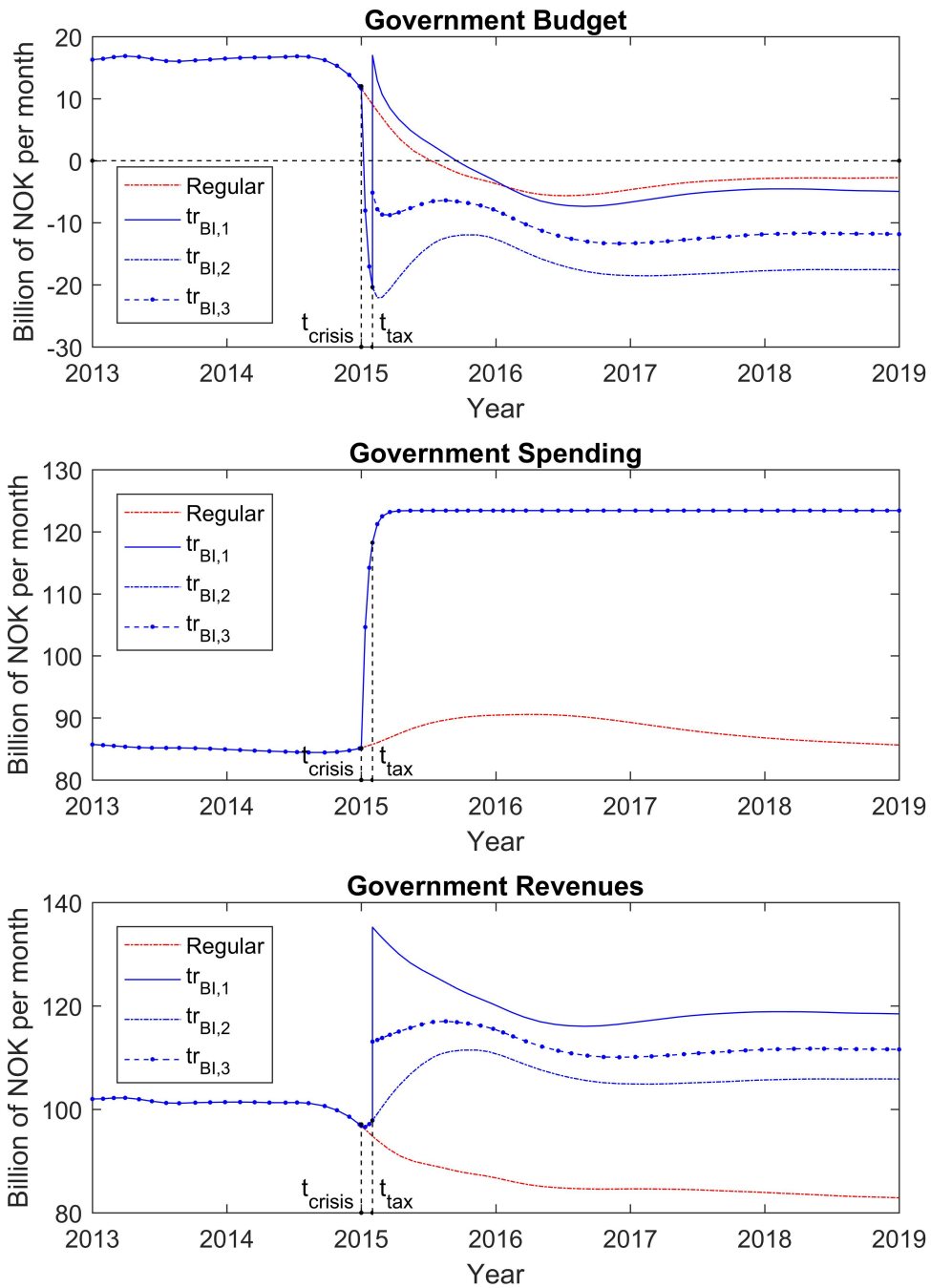
Figure 4.23: Government Budget

ment starts running a deficit budget at t_{crisis} for the BI regime with $tr_{BI,2}$ and $tr_{BI,3}$. The government's deficits ends up at 59.37 billion NOK/year, 210.7 billion NOK/year and 142 billion NOK/year, for the BI regime with tax rates $tr_{BI,1}$, $tr_{BI,2}$ and $tr_{BI,3}$, respectively.

4.2.5   GDP

Even though the net exports (figure 4.21) has dropped drastically in the BI regimes with $tr_{BI,2}$ and $tr_{BI,3}$, we see in figure 4.24 that the GDP ends up at a higher level in the BI regimes. Which is caused by the increased money supply to households and their increased consumption.
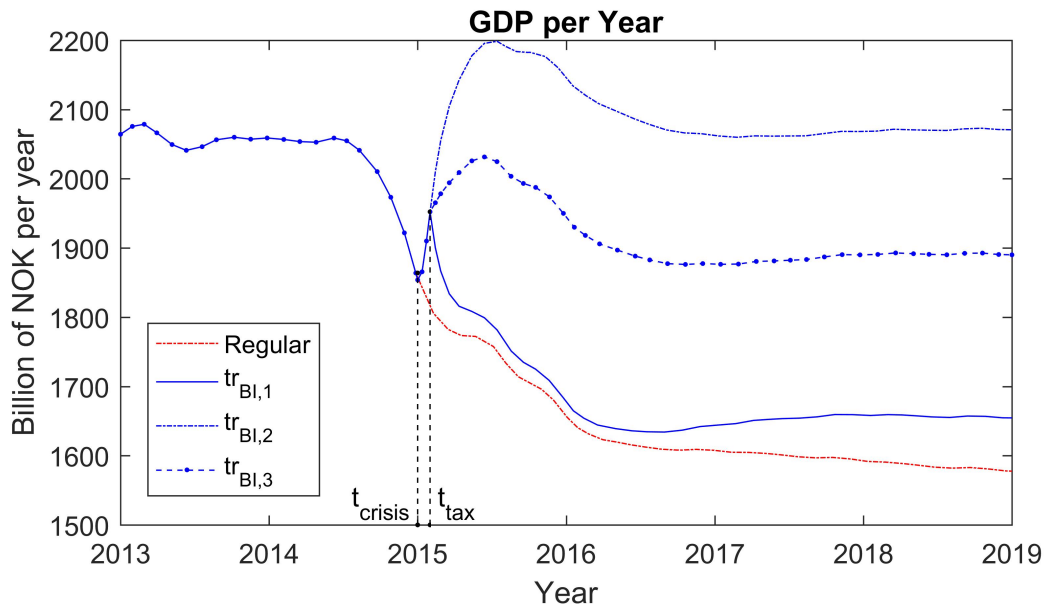
Figure 4.24: GDP

For all three tax rates, there is a sudden rise in GDP at t_{crisis}, that is caused by the increased household consumption. In the model with $tr_{BI,1}$, GDP drops quickly as the new tax rate is introduced, and ends up at a level close to the one of the Regular model. With the other two tax rates, the GDP ends up at a higher level than in the Regular model, in the case with $tr_{BI,2}$ the GDP even reaches a level that is higher than the initial GDP.

Even though the net export has fallen drastically, the increased household consumption, gives the GDP a lift.

In the simulations of the Regular model, we see that GDP is still falling when the simulation ends. This is due to the slow reduction in public payment of unemployment benefits after unemployment has reached its final value. Which will also cause the same kind of behaviour in other results of the Regular regime.

4.3   Summary of Chapter 4

In this chapter the results of the simulations have been represented. The simulation has started at $t_0 = 2013$ and at $t_{crisis} = 2015$ the two regimes JG and BI has been introduced.

The results of the JG regime show that private employment is higher under the JG regime than under the Regular regime. The households' consumption only falls by 4% from what it was before the crisis hit, and the households are able to save more than before the regime was introduced, which suggest that people can keep the same standard of living in spite of the crisis.

While export is falling due to the export crisis, the higher household consumption in the JG regime, causes increased import. Which has a negative effect on the value of the domestic currency, and the exchange rate from NOK to $ ends up at a slightly higher level in the JG regime than in the Regular regime.

The BI regime is simulated for three different tax rates, $tr_{BI,1}$, $tr_{BI,2}$ and $tr_{BI,3}$. The first tax regime, $tr_{BI,1}$, is meant to cover most of the additional expenses of a BI program with taxes on income. The results are close to the results of the Regular model, but we see a slight improvement in the economy, with respect to private employment, households' spending and GDP.

Under the two other tax regimes, $tr_{BI,2}$ and $tr_{BI,3}$, we see an economic growth right away after BI is introduced. Private employment, households' consumption, GDP and import rises. But the increased import causes the value of the foreign currency to rise, which could affect prices on foreign product.

The next chapter will continue the discussion of the results.

Chapter 5

Discussion

This chapter will give a discussion of the results found in chapter 4 and the literature in chapter 2, which the models are based on.

5.1   Households' Spending Power

Gross Domestic Product (GDP) is commonly used to discuss a countrys economic "health". By the production approach to GDP, GDP is directly dependent on net export (NX) and we saw in figure 4.14 that the export crisis has great impact on GDP. It was reduced by almost 20% under the JG regime and close to 25% in the Regular regime, while households' consumption was reduced by only 4% under the JG regime and 13,5% in the Regular regime. Since the results of the JG regime, show that households' spending power almost remains the same, one can assume that the standard of living is maintained and in the models of this thesis, households' consumption is a better measure of economic "health" than the GDP. Although, a very high spending power does not necessarily correspond to a healthy economy, which will be discussed in the following sections.

For the BI model with $tr_{BI,1}$, households' consumption is reduced by 6% towards the end of the simulation, while with both $tr_{BI,2}$ and $tr_{BI,3}$ it has increase by 36% and 17% respectively.

We see that both the JG regime and the BI regime with $tr_{BI,1}$ manage to reduce the negative effect of the export crisis, and that the standard of living is better than under the Regular regime. In the BI regimes with $tr_{BI,2}$ and $tr_{BI,3}$ it is apparently even higher than it was initially, but one can imagine that such an increase in spending may cause

prices to change.

5.2   MMT and Government Spending

From the results of the simulations we have seen that both regimes are very costly, and that the government will have to increase their spending notably to pay for the additional expenses. As discussed in chapter 2.1, MMT explains how a sovereign government which has monopoly on its own currency can never run out of it and can always pay for what it wants. By removing restrictions on the government's budget, the government can run the deficits seen in figure 4.13 and figure 4.23.

Although, MMT also claims that for a government to run a deficit budget, the Private sector must want to accumulate the government's currency, and to avoid demand-led inflation, the Private sector must save more than the government's deficit. In the JG regime the government ends up with a deficit of 67 billion NOK per year and the Private sector has accumulated 333 billion NOK. From the theory discussed it can be concluded that the government can run with the deficit, that follows from introducing the JG regime, for some years before it could lead to inflation.

Over time one can imagine that other export industries and domestic industries will be established, and more people would get jobs in the private market, which will lead to a reduction in JG employment and government spending.

Under the Basic Income regime the government ends up running deficits of 60, 211, and 142 billion NOK per year for the tax rates $tr_{BI,1}$, $tr_{BI,2}$ and $tr_{BI,3}$, respectively. And the Private sector ends up having accumulated, for the respective tax rates, 329, 393 and 365 billion NOK. For $tr_{BI,2}$ and $tr_{BI,3}$ the BI regime can only be run for approximately two years (with the final values for private money stock and government's budget deficit) before the government's deficits exceed the Private savings, which according to MMT can lead to demand-lead inflation.

We saw that in the BI regime the government's spending reaches a constant level short after BI is introduced. To reduce the government's deficit and at the same time keep the BI program, the government can either reduce its other spending or it must increase its revenues. By expanding other industries, more people can be employed in the Private sector, which will lead to more tax income from private employees and VAT income as

households' consumption will increase.

The results of the simulation showed that the unemployment rate would end up at 6.5% for $tr_{BI,2}$ and 11.7 % for $tr_{BI,3}$. In theory full employment could be reached under the BI regime due to industrial changes, but in a Basic Income regime full employment is not likely to happen, which will be discussed further in section 5.4.

A government has other options than to reduce its deficit to promote price stability, as mentioned in section 3.1.3, numerous factors play a role in determining the exchange rate, such as the interest rate. By increasing the interest rate, the domestic currency will be more attractive on the foreign market, and it is possible to slow down the money flow in the economy, by motivating people to save.

5.3   JG and Employment

In chapter 2.2 the movement of employees between the JG program to private employment was discussed. When private activity is low, the stock of JG employed will increase and when private activity is high, it will decrease. This is a clear case, and we saw in figure 4.2 and figure 4.3, that when private employment is falling, the number of people in JG is rising. The results also showed that the number of private employees actually was higher in the JG regime than in the Regular regime. In the JG regime, the workforce was increased by 5.2%, but in figure 4.4 the rate of JG employment in the initial workforce was compared with the unemployment rate in the Regular model, and it showed that JG employment was lower than unemployment. In figure 5.1 the JG model has been simulated with no changes in the workforce. It is seen that private employment still is higher in the JG model than in the Regular model.

The design of the JG model and the Regular model of this thesis differs from the models designed by Flatgård (2013). In Flatgård's models the economy was victim of a financial crisis, where net export was reduced during the financial crisis and went back to its initial state when the crisis had past. His results show that during the financial crisis fewer lose their jobs in the Private sector under the JG regime (Flatgård, 2013, Ch. 4), which is in agreement with the results found in this thesis. As the economy in his model recovers and goes back to its initial state, the JG employment reaches the same level as unemployment in his "Regular" model. The design of the model in chapter 3.2
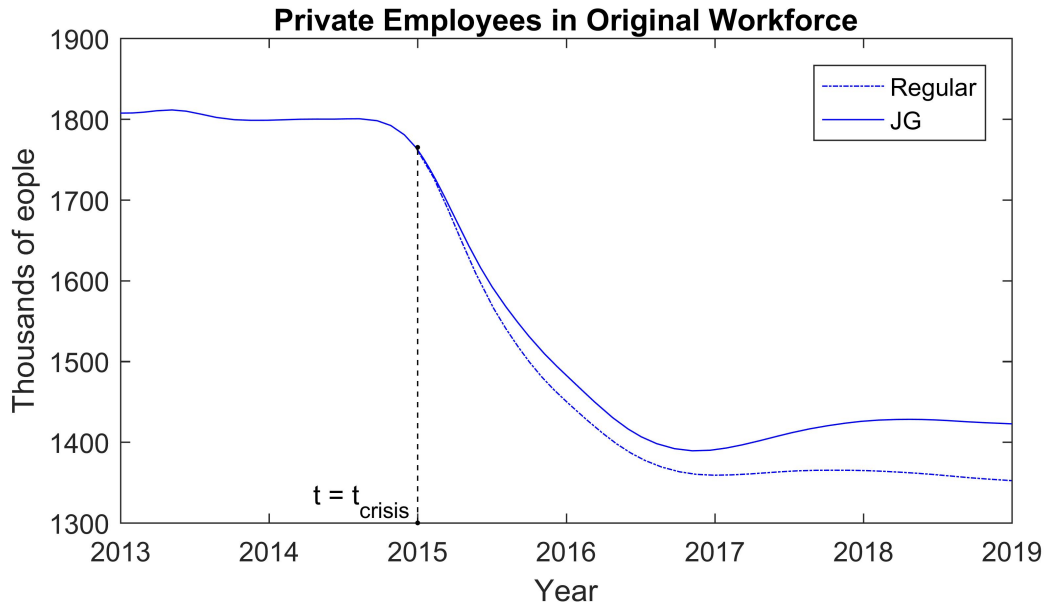
Figure 5.1: Private Employment whith constant Workforce

allows private employment to increase even in a "healthy" economy under the JG regime. Figure 5.2, shows the results of introducing the JG regime at $t0$ with a constant workforce, and we can see that private employment will be higher under the JG regime even when the economy is not in a crisis.
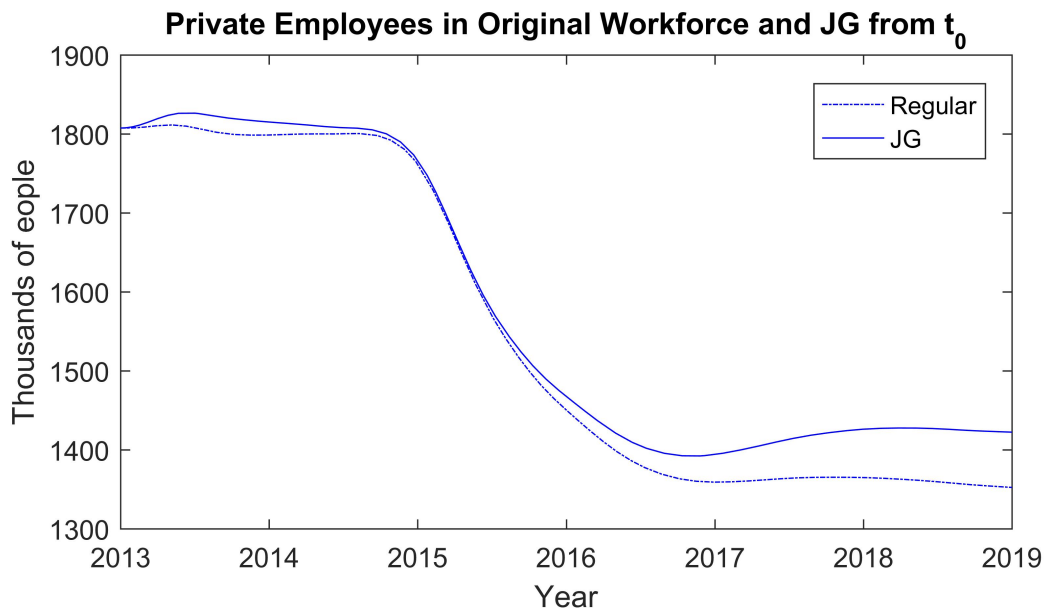
Figure 5.2: Private Employment whith constant Workforce and JG from t_0

As long as full employment is not reached, the JG regime will have a greater stock of private employees than the Regular regime will have. The JG offers safety, and the economic mood will always be higher in the JG regime than in the Regular regime, since

the money velocity is designed as a linear function of the economic mood, this is true for the money velocity too. As discussed earlier the money flows can be described by $Y = Mv$, which means that the money flow will be higher in a JG regime even if the regimes have the same money stock. Increased spending will motivate firms to hire more people, and private employment rises.

5.4   BI and employment

Under a BI regime, it is unlikely for the society to reach full employment, because a persons need to work will be lower and more people will choose not to work. BIEN have published a survey conducted by DemoScope, carried out in Switzerland, which showed that if Swiss were to receive a Basic Income, 2% would stop working, 8% would "rather" stop working, and 53% would spend more time with the family (Jourdan, 2016). While few would stop working, those who want to spend more time with the family, would probably reduce their workload and find part-time jobs. While this would open up for jobs for those that are unwillingly unemployed, the number of people that are not working would probably rise.

In the model in chapter 3.3, everyone which is employed holds a full-time position. To include those that willingly are reducing their work hours, the model will have to be modified. If we in the current BI model consider 3 part-time workers as 2 full-time workers, and 50% of the workforce are working part-time, this would represent an employment of 83.3% in the model. Which means that the BI regimes are not likely to increase the governments revenues by increased employment.

In the BI model, the economic situation is struggling and unemployment is high, consequently, it has not been necessary to considered people's willingness to work, because it is assumed to be no problem to fill every available position.

5.5   Taxation and BI

While the JG regime does not drive the economy past full employment, the BI regime will do so unless what is given in basic income is money which already is in circulation or the government takes back the same amount in taxes.

Rankin (1997) argued that any level of basic income could be funded through taxation. In this economy, to fund the basic income with a flat tax on income, the tax rate would have to increase from the highest level at 33% to 65% for all employees. As a result, those that earn less than 45.000 NOK per month, will be better off with a BI regime than the Regular regime and those earning 45.000 or more will have a lower net income under a BI regime.

With a tax rate at 65% ($tr_{BI,1}$) we see that private employment, households' consumption and GDP will be slightly higher than in the Regular regime and BI will even out differences in net income among people.

Even though a positive effect can be seen in the economy, by introducing a BI regime, the question has to be asked if people are willing to suddenly start paying 65 % of their income to the government.

5.6   Exchange rate

The sudden rise in income in the BI models, will increase Households' spending, which leads to more import. Since export of oil is falling and there is no shift in industry to increase export of other products, export in total will fall. When export is falling the demand for the domestic currency will be reduced, and the increased import will cause the demand for the foreign currency to rise. Thus the change in ratio between import and export will affect the exchange rate.

In the Regular model the exchange rate changes from 5,87 NOK per $ in 2013 to 8,7 NOK per $ at the end of 2019. In the real Norwegian economy, the exchange rate from NOK to USD was in 2013 5,88 and in January 2016 it had risen to 8,83 (Norges Bank, 2016b). The Norwegian Central Bank, Norges Bank, targets an annual consumer price inflation of 2.5%, and even though the exchange rate from NOK to USD has increased the Central Bank has managed to keep the annual inflation close to the target (Norges Bank, 2016a).

In the BI regimes the price for 1$ ends up at 9,15 NOK, 11,42 NOK, 10,47 NOK with the tax rates $tr_{BI,1}$, $tr_{BI,2}$ and $tr_{BI,3}$, respectively. And for the JG regime the price for 1$ ends up at 9,77 NOK. Since it exists only two currencies in the model, the domestic, NOK, and the foreign $, one would assume that any change in the exchange rate could

affect the price of foreign products. With $tr_{BI,2}$ the exchange rate has almost doubled, and it would be difficult to keep price stability over time.

One positive effect of keeping the value of the domestic currency low is that, domestic products will be cheaper and more competitive on the foreign market, which will increase other exports, which again will strengthen the domestic currency. But as long as there is no expansion of other export industries, it will be limited how much of other exports are possible.

As mentioned in chapter 3.1.3, the exchange rate is dependent on many other factors than the import to export ratio. To promote economic stability, the Central Bank could increase the interest rate to increase the demand for the domestic currency, which could raise the price of the domestic currency and this would lower the exchange rate from NOK to $.

Chapter 6

Conclusion

In this report a model for an economy has been developed and simulated under three different regimes, the Regular regime, a regime with Job Guarantee and a regime with Basic Income.

The economy is hit by a big export crisis which causes unemployment to rise in the society. The three regimes have different approaches to handle unemployment. And this report has discussed the different approaches' effect on private employment, households' spending and price stability.

Under the Regular regime those that are unemployed receives unemployment benefits from the government for a period of two years. Where the unemployment benefits depend on their previous salary.

Under the Job Guarantee regime, the government creates jobs which are available for anyone at a minimum wage. These jobs are meant to be temporary, and as soon as job opportunities open up in the Private sector, JG employees will move back to private employment.

Under the Basic Income regime everyone receives a basic income of 15.000 NOK per month, no matter if they are employed or unemployed. This is to assure that everyone can always cover their basic needs, such as food, housing and clothes. Three different approaches to funding of the BI regime has been applied to the model, by taxation, money creation and a mix of taxation and money creation.

Modern Monetary Theory (MMT) has been the foundation of the alternative regimes. MMT claims that a sovereign government which holds its own currency can never run out of it and can always pay for what it wants to purchase. And it can thus afford the

alternative regimes, JG and BI.

The results have shown that both the alternative regimes, will help to reduce the negative effects the crisis has on private employment and households' consumption.

The Basic Income regime offers security and flexibility for the population, evens out differences in net income among people and gives the fastest economic growth of the two alternative regimes. However, by increasing the money supply, the households spend more, and thereby import is increased, which leads to pushing the balance of trade far below 0. As a result, the value of the domestic currency drops and it will be difficult to maintain price stability over time.

It will be less challenging for the government to promote price stability under a JG regime, where the economy is never driven past full employment. The JG regime offers full employment and keeps households' spending close to its initial level, and is considered as the better choice of the two alternative regimes.

Chapter 7

Future work

The results of this report have shown that money velocity has a great impact on money flows in the economy. For future work on this approach to economics, one could create a system to control the money velocity in the economy, such as negative interest rates.

Literature on Basic Income, has suggested that in a regime with BI, more people would reduce their number of working hours and spend more time on hobbies and family. The BI model could be modified to include part-time work and the willingness to work. And one could also study the dynamics of implementing a partial basic income.

In the BI model were the basic income is funded by money creation, one could modified the model to include a governmental tool for price stabilization, such as control of the interest rate, to see if any of these regimes could be viable.

Appendix A

Additional Information

A.1   Matlab Scripts

Script for all Models

```
%***************************
% Population
%***************************
employed = 2582000;                  %persons
unemployed = 98000;                  %persons
work_force = employed + unemployed;  %persons
other_beneficiaries = 1400000;       %persons

%Distribution of private and public employees after pay rate
D_priv = [0.01, 0.04, 0.16, 0.22, 0.25, 0.15, 0.1, 0.07]';
D_pub = [0.005, 0.04, 0.1, 0.20, 0.205, 0.22, 0.12, 0.11]';

%Employees distributed after sector and pay rate
E_priv = 0.7*employed*D_priv;    % private sector
E_pub = 0.3*employed*D_pub;      % public sector

%***************************
% Salaries
%***************************
%all wage levels [NOK/month/person]
```

87

```matlab
wage_levels = [70000,60000,50000,45000,40000,35000,30000,25000]';

mean_priv = wage_levels'*D_priv; %average private salary [NOK/month/person]
mean_pub = wage_levels'*D_pub;   %average public salary  [NOK/month/person]

other_benefits = other_beneficiaries*20000;%NOK/month for all beneficiaries

%***************************
% Gross Incomes (GI)
%***************************

%Employed
GI_priv = E_priv.*wage_levels;  %GI per month for all private employees
GI_pub = E_pub.*wage_levels;    %GI per month for all public employees
GI_e = GI_priv + GI_pub;        %GI for all employees

%Not working
GI_ue = 0.642*unemployed*D_priv'*wage_levels;  %GI per month all unemployed
GI_nw = other_benefits + GI_ue;          %GI per month for all not working

%***************************
% Taxes
%***************************
VAT = 0.20;      %Value Added Taxes

tr = [0.33, 0.3, 0.3, 0.28, 0.28, 0.28, 0.25, 0.25]'; %tax rate employed

tr_nw = 0.20;   %tax rate not working

%***************************
% Net income
%***************************
NI_e = GI_e'*(1-tr);        %net income for all employed
NI_nw = GI_nw*(1-tr_nw);    %net income for all not working

%***************************
% Household consumption
%***************************
C_h = NI_e + NI_nw;         %Households' consumption at t0
```

```matlab
%****************************
% Public expenditures
%****************************
C_pub = 15*10^9;     %Public consumption [NOK/month]
I_pub = 10*10^9;     %Public investments [NOK/month]


%****************************
% Foreign sector
%****************************
export_petroleum = 542/12*10^9; %Export of petroleum at t0 [NOK/month]
export_other = export_petroleum*0.25/0.75; %Other export [NOK/month]
import = 528/12*10^9;    %Import [NOK/month]
import_gain = import/C_h;


NX = export_petroleum + export_other - import;  %Net export [NOK/month]


exchange_gain = (export_other+export_petroleum)/import;
exchange_gain_US = 5.8753;   %price of 1 USD in NOK at t0


oil_prices_data %Retreive oil prices


export_gain_petroleum = mean(export_petroleum./oil_prices(1:12));



%****************************
%Firms
%****************************
%share of firms' income used in firms sector:
firms_purchase_gain = 0.4;


%firms income at t0:
firms_income =((sum(C_h)+C_pub)*(1-VAT)+I_pub+NX)/(1-firms_purchase_gain);


%share of firms' income used as salaries
salary_gain = sum(GI_priv)/firms_income;


%share of firms' income used to pay taxes and fees to the government:
govn_share_firms = 1 - firms_purchase_gain - salary_gain;
```

```matlab
%share of firms' spending in firms sector used for investments:
I_f = 0.4;


%***************************
% Economic mood
%***************************
%Regular model
h_min = (work_force-sum(E_pub)-0.25*work_force)/(sum(E_priv)+unemployed);
h = 1 - 0.5*(1-h_min);
g = 10;


u = sum(E_priv)/(sum(E_priv)+unemployed);
mood = 1/(1+exp(-g*(u-h))); %initial mood


%JG model
h_min_jg=(work_force-sum(E_pub)-0.35*work_force)/(sum(E_priv)+unemployed);
h_jg = 1 - 0.5*(1-h_min_jg);


%BI model
h_bi = h_jg;


%***************************
% Time constants
%***************************


%***** Households ******
%Private and Public employees
Th_p_max = 1.4;
Th_p_min = 1.8;
Th_p = Th_p_min + mood*(Th_p_max-Th_p_min);


%Not working
Th_ni_max = 1;
Th_ni_min = 1.2;
Th_ni = Th_ni_min + mood*(Th_ni_max-Th_ni_min);


%***** Foreign Sector *****
Te_o = 2;    %other export
```

```matlab
Te_p = 2;    %petrolium export
Ti = 2;      %import
T_c = 0.5;   %exchange rate


%***** Firms *****
Tf_max = 1;
Tf_min = 1.5;
Tf = Tf_min + mood*(Tf_max-Tf_min);
Te = 6; %firms employment


%***** Economic Mood *****
Tm = 4;


%***** unemployment benefits *****
Tg_ub = 1;
Tg_rb = 24;


%***************************
% Simulation times
%***************************
t_crisis = 24;  %Time when new regime introduced
t_end = 72;     %End of simulation
```

Script for JG Model

```matlab
%***************************
%       Job Guarantee
%***************************
% population
new_to_workforce = 140000; %People


%Reduction of other benefits
benefits_reduction = new_to_workforce/other_beneficiaries*other_benefits;


% JG salary
JG_level = 25000;   %NOK/month/person


% JG tax rate
```

```
tr_JG = 0.25;


% Time constant
Tg_jg = 1;            %Joining JG
Th_jg_max = 1.2;      %Households' JG employees
Th_jg_min = 1.4;
Th_jg = Th_jg_min + mood*(Th_jg_max-Th_jg_min);
```

Script for BI Model

```
%****************************
%      Basic Income
%****************************


%Population
receiving_BI = work_force;
%BI salary
BI_level = 15000;
%Time constant
T_BI = 0.5; %Delay start receiving BI


%***** Tax rates ******
%(Un)comment tr_BI to change tax rate alternatives
%Alternative 1 — tax income fund the Basic income
tr_mean = (E_pub + E_priv + unemployed*D_priv)'*tr/work_force; %average tax
BI = BI_level*receiving_BI; %Total BI [NOK/month]
GI_priv_ = (E_priv + unemployed*D_priv)'*wage_levels;%private GI full empl.
tr_BI = (tr_mean + BI/(GI_priv_ + sum(GI_pub)))*ones(8,1);


%Alternative 2 — BI funded by money creation
%tr_BI = tr;


%Alternative 3 — BI funded by tax income and money creation
%tr_BI = 0.15 + tr;


% Time to change tr
t_tax = 1;
```

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