A Stock Flow Consistent Empirical Model of the Danish Economy

- An Analysis of the Danish Households Reaction to an Interest Rate Increase -

10^{th} Semester
Master's Thesis

Frederik Kiel

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Aalborg University
Department of Business and Management
Fibigerstræde 2, DK - 9220 Aalborg Øst
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The data, program code and estimations made in Eviews used for this thesis may be issued by the author upon request.

AALBORG UNIVERSITY
DENMARK

Department for Business and Management
Fibigerstræde 2, DK - 9220 Aalborg Øst
http://www2.business.aau.dk/

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Author:
Frederik Kiel
fkiel13@student.aau.dk
Study No.: 20134811

Supervisor:
Mikael Randrup Byrialsen
randrup@business.aau.dk

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Preface

Prelude

In your hand you are holding the master's thesis with the name of *"A Stock-Flow Consistent Empirical Model of the Danish Economy - An Analysis of the Danish Households Reaction to an Interest Rate Increase"*, this thesis uses a Stock-flow-consistent model to explain an interest raise shock. This model is a subsequently of my $9.^{th}$ semester project where a much smaller model of this type was used. This continuation has made progress in terms of several endogenous equations added as well as more stocks and interests. The choice of working with these model types comes after courses where Post-Keynesian theory and these model types were explained. This thesis did not come along without difficulty since this is a first compared to other model types of the Danish economy. A lot of the difficulties came when making the model and the behavior equations especially for the financial sector and its portfolio. I would like for this model to continue its progress towards being a full cable empirical SFC model for the Danish economy.

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Frederik Kiel
fkiel13@student.aau.dk
Study No.: 20134811

Department for Business and Management
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Abstract

In recent years several articles and papers have been published with the statements that the QE hasn't helped. And that the interest rates are held unnaturally low. What have also been published, is information that the ECB now wants to stop the QE, and that will cause the interest rates to go up. This has been a topic in Denmark with the larger banks stating that the loans for mortgages in banks will likely increase, within the end of next year. After the financial crisis in the period 2007-2009 the Danish economy has been doing quite well, however, it still hasn't reached its potential GDP. This doesn't mean that the economy is bad because the numbers state that it has been a boom phase for quite some years.

This master's thesis is aiming to find out how the Danish economy and especially the households, would have reacted to increased interest rates during the period 2009 until the end of the data available 2016. The problem definition, therefore, is: *How would the Danish economy and especially the household sector have reacted, if the rates for interest, yield, and dividends have continued the interest increase from just before the financial crises, instead of decreasing again after this short period?*

To answer the master's thesis problem definition a stock-flow consistent empirical model of the Danish economy is made and then shocked with an interest increase. This model has a Post-Keynesian theoretical foundation, all five sectors, five interest rates and four stocks which all are a part of the model being small but complex and one of the first of its size of the Danish economy.

Based on this model given equations and parameters, the results are not a very different outlook for the whole economy because the employment rate, GDP, and investment are about the same as the models' baseline. However, when looking at the household they would benefit from an interest increase. The households reaction would be to loan less, and the fact that they have a much larger deposit of assets that will give the households disposable income a lift because of the net interest will increase.

The results of this thesis are more or less what would be expected except for the households. They would be spending more on consumption due to the larger disposable income. The model used in this thesis have been underway for about a year however, it still can be improved. The assumptions that this thesis has put on both the data but also the equations may seem too much. However, one may need to keep the model simpler. In the future, this model could be taken up consideration once again and be improved both in the equations but also in the details and the models' complexness.

Keywords: Macroeconomy, Post-Keynesian theory, SFC-model, Stock-Flow-Consistent, Danish Households and Interest Rate Shock

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1

Introduction

For the last 5 years the European Central Bank (ECB) have been buying bonds to make sure that the inflation level would be above 0%. And to ensure that the economy would grow yet again after the financial crisis. However, this programme called "quantitative easing" (QE) is nearing its end. From 2018 ECB will half their bond buying so that the European economy may normalize itself with ECB holding back on their expansive monetary policy. (Richard Partington, 2017) Even though the ECB left the interest rates unchanged for now. Which it doesn't seem to be the case for the future. This issue has been investigated by two Dutch economists who concludes that the QE that the ECB has been doing does not really influence the real economy. But however, has been fluctuated within the financial side of the economy. (Meijers & Muysken, 2016)

The QE is an unconventional monetary policy from the ECB. The two economists Meijers and Muysken shows in their paper from 2016 that this policy has not been contributing to the real economy of the Netherlands. The conventional monetary policy has already been used by the ECB. Since the interest rate for deposits have been near zero and even below which is the reason to try the unconventional monetary policy. What was to be expected with these low interest rates is that the investments should have risen to boost the economy. Then this should have helped to create more jobs and get the unemployment down and therefore the private consumption up. This might just have worked for Denmark's economy which have become more stable and is showing a growth trend that is positive. (World Databank, 2018) This could indicate that the economic crisis of the years 2007-2009 now has passed.

But if the QE didn't directly help what did help the European economies? How did Denmark come out of the crisis if not from the help of the ECB? Has it had any cost for the Household sector to maintain a growth change per year in GDP? There are several factors which could give an answer to this question. On one hand the interest rates are still extremely low, both on the central bank level and on the mortgage bonds which is used to borrow money to buy houses in Denmark. (Danmarks Statistik, 2017), (Danmarks Statistik, 2018a) & (Danmarks Statistik, 2018d) Alongside the very low interest rates come the Danish household's huge debt compared to their disposable income which is the biggest in the world with around 290% which has fallen with around 45%-points since 2009. (OECD, 2017)

Business Insider had an article in September 2015. This article describes how the financial crisis hurt economies have handled wrong since before the crisis. The abnormal low interest rates that both the FED and ECB have made has not helped at all, rather the contrary has happened. According to Moshinsky who wrote this article these low rates have helped creating bubbles in the European housing market, private tech equities and Chinese stocks.(Ben Moshinsky, 2015)

In a newer working paper by the Danish national bank. This paper has some good data provided that indeed tell a new story about how the Danish households spend their money in the form of household private consumption. One of the more interesting figures that they have in the paper is one where savers come to a point where they have a higher consumption to income ratio than the borrowers which is interesting. Here the savers are defined as having a net surplus in financial assets and the borrowers is the opposite. (Hviid & Kuchler, 2017) Along with all this there is still a problem with high housing prices. This is especially true for the condominiums where these are well over the index level of that just before the crisis hit in 2008. Which is described more in-depth in section 2.2 (Danmarks Statistik, 2018b)

One might question what would happen when the interest rates were to rise, would the consumption fall due to the household's disposable income falls, would the economy stop growing? And isn't this what really ought to happen? This thesis therefore takes these questions into account with an empirical SFC model for the Danish economy. Where the main focus will be on the households and how they would act according to a shock in higher interest rates.

Just before the financial crisis in Denmark the interest rates were rising, what if this tendency had not stopped is what this thesis will analyse. This will be done by the authors knowledge the first SFC model made of the Danish economy that is rather big, having all five sectors included as well as a big portion of the equations endogenous. Knowingly that this analysis will be a Ceteris paribus analysis which means that everything else than what parameter or exogenous variables that are shocked will be equal to the ones that the data provide.

Problem definition:

How would the Danish economy and especially the household sector have reacted, if the rates for interest, yield, and dividends have continued the interest increase from just before the financial crises, instead of decreasing again after this short period?

2

Stylized Facts

In this chapter, the stylized facts for the Danish economy will be shown. First, the annual GDP growth and consumer confidence are represented then the actual versus the potential GDP will be explained, then the Danish policy rate and interest rates are shown. The last to be explained is the real-estate prices, the net lending of the five sectors and the total debt to disposable income.

2.1 GDP and expectations

The four figures in this section are shown because of their ability to show how well the Danish economy is doing. The first two shows how the GDP growth has been over the period as well as how the consumer confidence towards the economy. Which is an indicator of prosperity for the economy. The next two figures are of the real GDP and where the potential GDP is which shows if the economy is in a boom or bust period. Most of the data go from 1995 through the newest possible to get in 2017.

As it can be seen in figure 2.1 the growth in GDP has been positive from 1995 through 2016 with the exception of the years 2008 and 2009. Whereas many other countries Denmark was hit by the financial and economic crisis that started in the US. Since 2010 there has been a somewhat positive growth, and 8 years after Denmark seems to have gotten out of the crisis with a steady growth. This indeed seems to be right if the consumers are truly right as well, at figure 2.2 the consumer confidence indicator is shown which shows that since 2013 the average has been positive and over 5 which would indicate that the consumers are positive for the present as well as for the future.

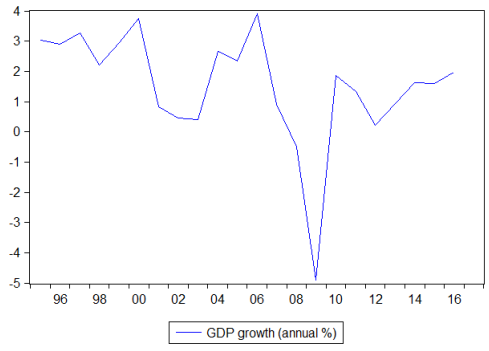

Figure 2.1: GDP Growth on an annual basis (World Databank, 2018)

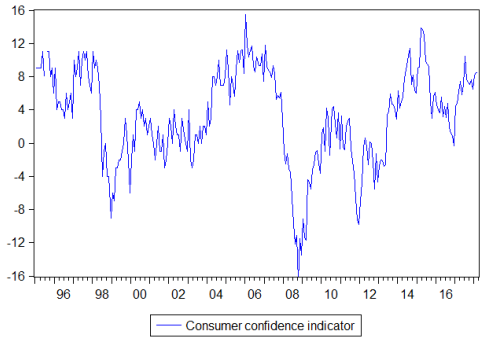

Figure 2.2: Consumer confidence indicator (Danmarks Statistik, 2018c)

Both figure 2.3 and 2.4 shows the Danish economy's output gap. Figure 2.3 shows the real GDP as the blue line which is above the red line which is the potential GDP which means the economy is producing more than expected until 2009. Where the financial crisis has hit, and the production hasn't returned to the optimum production level in terms of real GDP. However, it is almost there with the newest 2017 data included. And the projections for 2018-2019 shows that the gap becomes smaller every year.

It is easier to see in figure 2.4 that the difference between real GDP and the potential have been positive from 1996 until 2008. After 2008 the gap between the actual and potential GDP has been negative. The actual GDP has risen more than the potential hence that the curve on the figure slowly goes towards 0% gap between the two, however, the economy isn't there just yet.

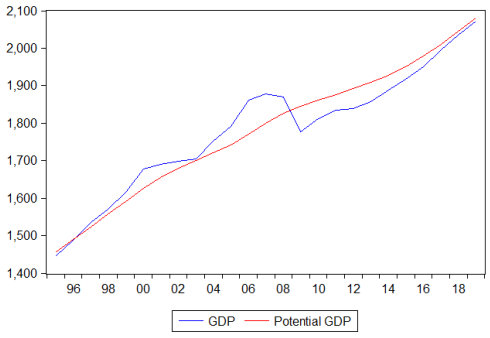

Figure 2.3: The actual GDP growth compared with the potential GDP growth (Ameco, 2018)

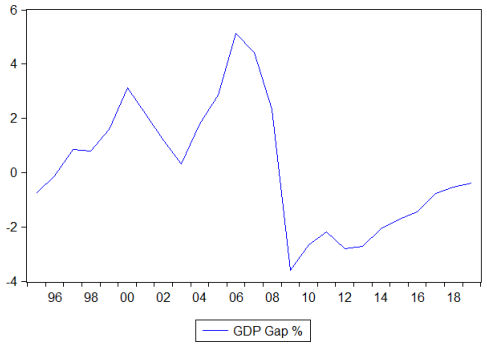

Figure 2.4: GDP gap as a percentage of actual to potential GDP (Ameco, 2018)

2.2 Interest rates and debt

In this next section, there are six figures three which are different ways to see the interest rates policy rates, bond rates and deposit and lending rates. Unfortunately, the first two doesn't really have any new data and stops in 2012 besides two policy rates which do continue. Then there is the house price index of Denmark which is another way of seeing the financial crises and an important measure for the households. The last two figures show how the financial sector has progressed throughout this period in two different perspectives the first would be net lending of all five sectors and the last is households' debt accumulation.

Figure 2.5 the Danish national bank's interest rates is shown from 1995 where the rates top at 7% until today where the rates are 0% or even negative. And it has been around zero since mid-2012. On the other figure, 2.6 shows the bond rates for both mortgages and treasury bonds which in Denmark is issued when buying a house.

This figure shows that at the start of the period 1995 the mean of all these bonds where around 9% at the latest data ultimo 2012 the mean bond rate is around just 1,5% which implies that it is much easier to repay the borrowed loan when the interest is that much lower than it was 10-15 years ago. These two figures cannot, however, tell the full story of what the household sector would have to pay and receive in interest since these interest rates are closely related to policy rates that tend to lean on the European Central Banks interest rate.

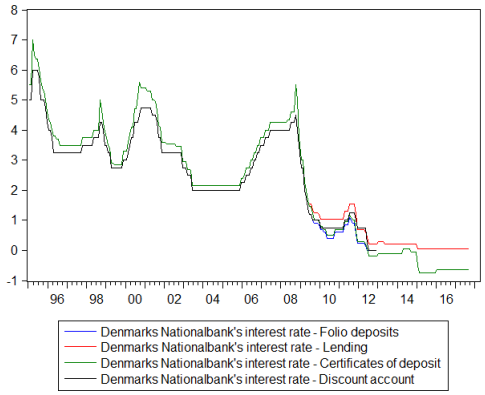

Figure 2.5: Danish national bank's interest rates (Danmarks Statistik, 2017)

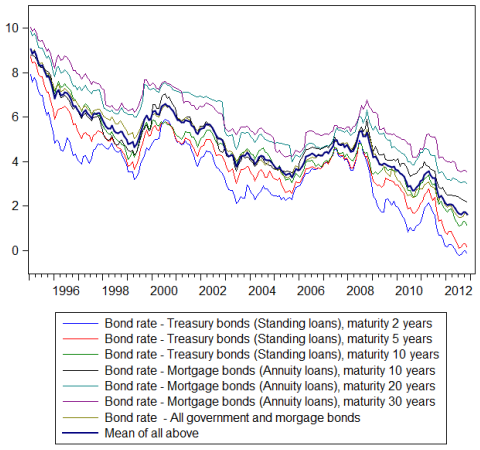

Figure 2.6: Bond rates for mortgage and treasury bonds from Denmark (Danmarks Statistik, 2018a)

Because the figures 2.5 and 2.6 cannot indeed fulfil the full story of what the households have had as an interest rate figure 2.7 is introduced. This figure shows the average deposit and lending rate where the mortgage rate is also included. The mortgage rate is the banks' mortgage loan lending rate which is the second part of the house buying in Denmark where both a bond and a bank loan is needed to obtain money enough. This mortgage rate has fallen as well, however, when comparing the figure 2.7 with figure 2.8 it is quite obvious that there is a housing bubble in Denmark from 2005-2010. Both the house price index and the mortgage rate suggest this.

After the bubble the lending and deposit rates have fallen the deposit rate is nearly zero, in hope of the economy would again rise. The prices for both Condominiums and single-family houses have only risen since 2011 which would imply that the Danes would have to invest more in housing, given that they have the same demand to buy houses, therefore get more indebted. However, this is not the case since the house price index rises and debt falls. Since 2011 the single-family houses have risen with about 25%-point which is about the same as the before the crisis hit and the condominiums have risen with almost 60%-point which is higher than even before the crisis at an index above 100% once again. The figure also shows holiday cottages which seems to have a more stable price index development in recent years.

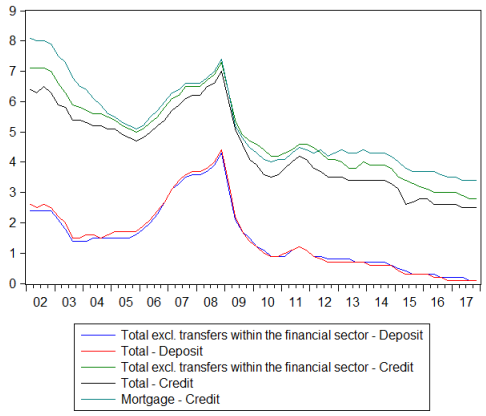

Figure 2.7: The bank's average deposit and lending interest rates (Danmarks Statistik, 2018d)

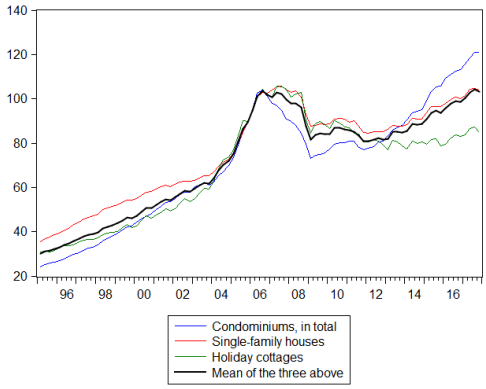

Figure 2.8: Price Index for Real-Estate 2006 = 100 (Danmarks Statistik, 2018b)

In figure 2.9 Net lending is shown. This shows that the principles of sectoral balances is valid this is more explained in section 5.1 in chapter 5. This basically states that if one sector is in deficit some other sector must be in surplus. It can be seen on the figure that especially the government and the households look to be the opposites of each other. Also, the deficit of the rest of the world shows that there is a surplus on the current account balance which in the 1980's was a deficit. Figure 2.10 show that the Danish households still have nearly 270% of net disposable income in debt. Which is still the highest in the world, even though that the debt to disposable income ratio has fallen from about 315% to the 270%. This huge household debt has without a doubt come from the high-interest rates for mortgages as well as the housing bubble which was stated earlier.

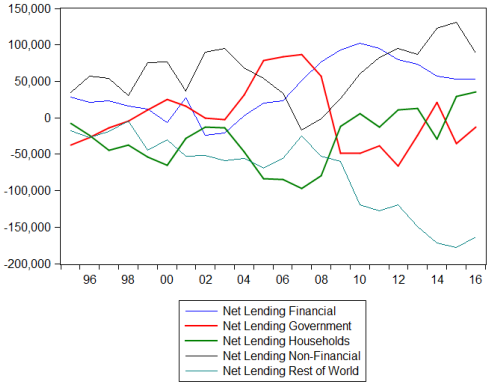

Figure 2.9: Net Lending for the Danish economy (Eurostat, 2018)

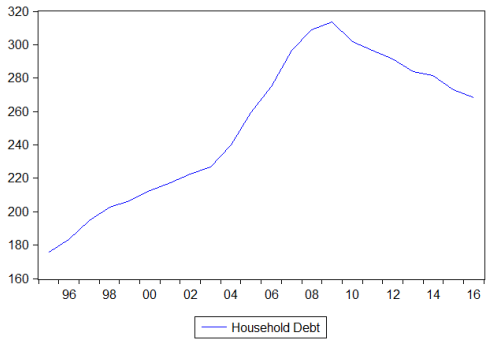

Figure 2.10: Household total debt to disposable income (Eurostat, 2018)

3

Method

In this chapter, The History and the theory behind SFC-models is explained. As well as the comparison between SFC and DSGE models.

3.1 SFC-Models Past, Present and Future

3.1.1 History of the SFC-models

Caverzasi and Godin made a survey in 2014 about the Stock-flow-consistent models, or more correctly they did a survey about the Post-Keynesian stock-flow-consistent models. This paper gives a historical overview which starts in 1949 with the very first steps of an accounting model. (Caverzasi & Godin, 2015)

Already in the years 1970-1990 these models were taken into consideration by several economists both Tobin and Godley worked a lot with these from 1970's and 1980's. Where after Godley spent time in Denmark to evaluate his previous work. Where his and Gennaro Zezza worked on models for the Danish economy. (Byrialsen, 2018) The preliminary work for today's models essentially comes from the work done by Wynne Godley who also has written one of the only books that are still used today as the main reference by nearly all economists using the SFC models. (Caverzasi & Godin, 2015) In the paper they describe how this type of model has changed the economic debate they write:

"The economic debate (in particular the heterodox one, which lacks a universally accepted modeling framework) can largely benefit from the development of such common ground" (Caverzasi & Godin, 2015)

Which of course implies the lack of an all-economy model for the PK economists. They go on to describe the development of SFC models with a more theoretical perspective for each equation to make sure what several authors have done is indeed a correct way to make their model. This type of model has the ability to take a certain matter and analyze that with a smaller model. Or it can recreate the whole economy with empirical data. (Caverzasi & Godin, 2015)

3.1.2 Godleys Foresight with SFC-Models

In mid-2009 Bezemer wrote a paper called "No One Saw This Coming", where he writes about the possibilities of the accounting method had given economists in the mid-2000s. He made a list in the paper of all the economists who did see the financial crisis in 2007-2008 coming. (Bezemer, 2009)

In this list, one name to be aware of is Wynne Godley. Godley already in 1999 saw the American economy as unstable. He wrote his famous "Seven Unsustainable Processes" which gives an answer to the instability which the US saw in the late 1990s and start of the 2000s. This is the first paper who saw a crisis looming already seen in 1999 by Godley. (Godley, 1999)

Godley wrote another paper in 2006 this time with help from Gennaro Zezza. Again, this paper goes into analyzing what is going to happen. The analyses were about the debt and lending habits of the American households.(Godley & Zezza, 2006) He repeated the warnings not only in these two papers but in the years 2000, 2001, 2004, 2007 as well. (Byrialsen, 2018) This analysis predicted the financial crisis. This is why many see the SFC-models as a framework with the accounting principles incorporated as an opportunity to analyze another aspect of the economy the financial side.

3.1.3 Recent Major SFC Research

Besides the model for the US, the Levy Institute has also been a part of making a Greece model which routinely also have been used for the same purposes as the US model. The Greece model was made by Papadimitriou, Nikiforos, and Zezza in 2013. Also, Ireland has been completely modeled as an SFC model by Kinsella and Tiou-Tagba Aliti in 2012, lastly the UK has been made into one of the most complete and most complex models yet developed by Burgess et al. in 2016. (Nikiforos & Zezza, 2017)

Even though there are not more complete models published in papers, yet it is known that there will be coming more SFC models with complete countries in the near future since the work is already somewhat progressed. The models speaking of is an Italian model which is made by Marco Veronese Passarella, the first draft version of this model, has been published in march 2018 at Marco Passarellas own homepage. The Netherlands has a duo of authors working on a model for the country as seen in the paper (Meijers & Muysken, 2016). Also, Denmark is working on an SFC model for the whole country where the author is Mikael R. Byrialsen with assistance from MaMTEP Group from AAU, which happens to be the supervisor of this master's thesis.

3.1.4 Provisional Future for SFC-Models

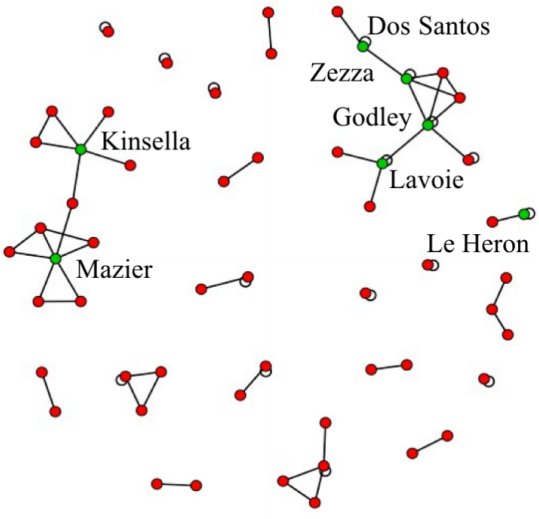

Figure 3.1: Network of SFC-Researchers in 2013 (Godin, 2016)

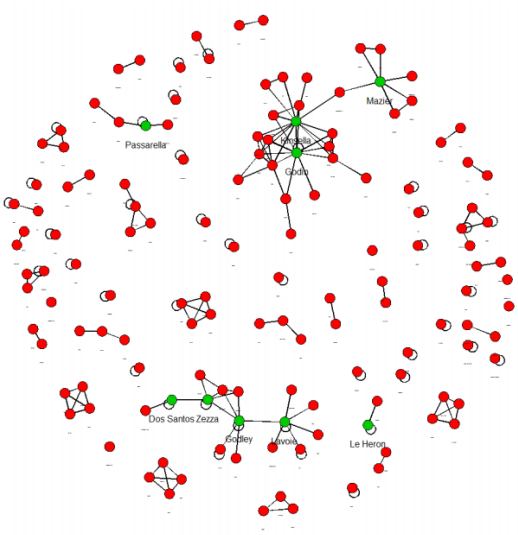

Figure 3.2: Network of SFC-Researchers in 2016 (Godin, 2016)

As seen on the two figures 3.1 and 3.2 the growth of researchers making SFC models and writing papers about them seem to have grown to a rather big community in just three years.

"Their ability to better project the trajectories of these economies relative to other neoclassical oriented Dynamic Stochastic General Equilibrium (DSGE)-type models have contributed to spreading the interest in the SFC approach." (Nikiforos & Zezza, 2017)

As long as the above quotation is true for these types of models it will have interested researchers. As Godin writes the value of the SFC models lies in the ability to "answer pertinent policy questions" and as said before looking at the areas that e.g. the DSGE models cannot look at yet. (Godin, 2016)

Caverzasi and Godin suggest that the PK-SFC models should go toward having economy-specific analysis, and it seems to them that this is already happening. Another suggestion that they make is that these models do handle the financial side of the economy very well and that this has been the case to why the real side of the economy has somehow been neglected and there could be more research put into that and the link between the two sides even more. (Caverzasi & Godin, 2015)

3.2 SFC vs. DSGE Approaches

In the newer paper from the Bank of England, 5 economists helped each other make probably the largest and most complex model yet. They also use some space in their working paper to discuss the pros and cons of the SFC modeling approach versus the DSGE approach which is still the mainstream model selection. (Burgess *et al.*, 2016)

In this section, they specify what they think are the positives of the SFC models contrary to the DSGE models as well as the negative parts. They state that it is a pro that the models come from the national accounts but however is a con that they equations do not have any optimization problems of agents, as the DSGE models very often have. Also, a very important notice is that the SFC models are more realistic behavior assumptions than the DSGE models. However, the SFC models do not have a specific theoretical foundation.(Burgess *et al.*, 2016) Even though this group has this opinion on this topic it is obviously not necessary an objective statement but a statement coming from PK economists.

Another paper describes the general differences between SFC models and DSGE but also the Danish model ADAM. One of the main differences is that the DSGE models use a microeconomic foundation where representative agents use utility optimization. This is opposite of what the SFC models do, they have an aggregated macro level where the individual sector has behaviors. These behaviors are trying to satisfy norms and goals.(Byrialsen, 2018)

A general DSGE model uses some kind of monetary policy to close the model. Often the Taylor rule is used for this purpose. This way is not accepted by the Post-Keynesian economists who among other things don't approve of the natural interest rate. Instead, they suggest lowering the focus on monetary policy and inflation targeting and instead focusses on key variables in macroeconomics such as the unemployment.(Byrialsen, 2018)

4

Review of Literature

In this chapter, a review of some similar literature to the one of this paper is shown. More specific SFC-models of the Danish economy will be mentioned as well as one of few papers that predicted the financial crises.

As already mentioned Wynne Godley was more or less famous for predicting the financial crises with a paper already in 1999. (Godley, 1999) Godleys main focus was on the households' debt and lending habits prior to the financial crisis that hit the USA in 2007.(Godley & Zezza, 2006) These papers were a forecast and predicted the worldwide crisis, and the paper also gave some policy advise how to make the economy stabilize. These papers are a big reason to why many Post-Keynesian economists now have taken their focus on these type of models since they did a great effort toward predicting the financial collapse in the USA.

In table A.22 the next papers will be shown sorted by year. These papers are all SFC models of Danish economy and the ADAM model papers used is also in this table. There is some early work done by Godley and Zezza in the late 1980's and early 1990's. Since then there has been a renaissance/revival from 2015 and forward SFC models have been made on the Danish economy yet again. The older papers by Godley and Zezza are about the deficit on the current account and the foreign debt that Denmark had in the 1980s and what consequences that had.

The first of the newer papers from 2015 is about the household's debt and that leading to a crisis in Denmark, the second one and the newest paper of the Danish economy that will be published in print later on in 2018 is how the social benefits will impact the real economy if the unemployment benefits are reduced like the policy discussion were at the time.

In a working paper from the Danish national bank, they investigate a similar shock to the interest rate to see what would happen to the consumption of the households. Hviid & Kuchler (2017) However it is not an SFC model that is used for their analysis. However, the results could be comparable just with two different types of approaches.

There are multiple different models made for the Danish economy which is true for most countries as well. In Denmark the model called Annual Danish Aggregate Model (ADAM) is used often since it has econometrics, is quite big, and it has a Keynesian short-term theory and on the long-term, it has a theoretical background from Neoclassic theory. This model has produced something like what this paper will analyze which is the interest shock.

5

Theory

In this chapter, the theory behind the model is explained. These theories cover accounting principles and Post-Keynesian Theory. As well as the rate of interest theory.

5.1 Accounting Principles

This is a model based on accounting principles which means that a lot of the equations in the model are identities which is an exact value, for instance, $y = c + i + g + nx$ this is how GDP is calculated before any equations have been endogenized and all these numbers can be found within Eurostat data. This can be found a little more about in section 6.1.

What this type of model does well is it keeps track of the stocks and flows of the model and economy. You cannot just have an outflow from a sector the sector needs to finance that outflow with an inflow, it also keeps an eye out for stocks in the same manner. Every sector must sum to zero and the individual variables as well and both have an inflow and an outflow, this is better shown with the use of matrices which can be found in section 6.3. There are a few exceptions to the stocks, both buildings and gold do not have a counterpart. (Godley & Lavoie, 2007)

In a paper from 2017 Nikiforos and Zezza describe the accounting principles in a bit different way nonetheless the same basics in the two explanations where, however, the newer version is more in depth. They describe the accounting principles via four points, firstly the flow consistency which already has been mentioned above if there is an income in one sector e.g. wages to the households it must be an outflow of typically the Non-financial firm sector.(Nikiforos & Zezza, 2017)

Secondly, the stock consistency which again is more or less the same as Godley and Lavoie have explained it where one liability says a loan must be an asset to another sector which is very basic accounting methods with a debtor and creditor.(Nikiforos & Zezza, 2017)

Thirdly they combine the two into Stock-Flow consistency which is that both a flow and a stock is consistent with the equation $\Delta\Omega_t = F_t + CG_t$ shows. The difference(Δ) in current periods stock(Ω_t) is the last period(Ω_{t-1}) plus the flow(F_t) and possible capital gains (CG_t). (Nikiforos & Zezza, 2017)

This states that both the flow and the stock have to have consistency. These two are seen in different matrices as the explanation is not the same the stock is shown in the balanced matrix and the flow of funds, is seen at the end of the transaction flow matrix in the financial part.(Nikiforos & Zezza, 2017)

The fourth point they have is quite important, it is the Quadruple entry which is implied by the first three consistencies. This is when one flow is determined to increase then at least three other places in the economy it also must change due to the consistencies of the accounting principles.(Nikiforos & Zezza, 2017)

A newer paper has just explored and contributed to the sectoral balances identity which is that all the sectors must sum to zero in the net lending variable since the sectors cannot borrow or lend more than there are in the system on the macro level. The paper sees that all five sectors contribute to the total net lending being zero.(Glötzl & Rezai, 2017) The authors mention that:

"A general feature, however, is the mutually offsetting relationship between the public sector and the private sector (mostly household and non-financial corporations) during the crisis." (Glötzl & Rezai, 2017)

Which implies that this relationship does exactly what has been suggested that if the net lending should always be equal to zero one sector must help the other to achieve this. Further on in the paper, they explain how this will act with PK theory they state that the government is passive where the private sector is the one reacting to any cases where the sum of net lending is not equal to zero as it should be. When the current account balances' net lending is negative the current account balance is in the surplus and vice versa. (Glötzl & Rezai, 2017)

Often this can be expressed via a figure that shows the development of the sectors which support each other. This is seen several times where the government budget balance is nearly the mirror of the private savings surplus where then the balance of payments then takes what little is left of what the two other sectors can't mirror exactly. (Svensson *et al.*, 2012) This exactly is what is shown on figure 2.9 chapter 2.

5.2 Post-Keynesian Theory

In this model, just as well as accounting principles have been used to have the Post-Keynesian (PK) theory, to have behavior structured within the model. One of the PK theories is the effective demand which comes from John Maynard Keynes published book from 1936 The General Theory of Employment, Interest, and Money also known just as GT. Besides effective demand, one of eight Keynesian paradoxes and uncertainty is explained in this section.

This theory explains how supply and demand are determined. The effective demand is an equation with three variables the firms cost conditions (FCC), which would be the production and labour costs, the firms sales expectations (FSE), which is the expected value of the firms' production sales within the coming period, and competitive conditions (CC), which would be how good conditions the labour has, and how good conditions the products are in sales, for example, could the VAT be applied here. These three sums up to be the effective demand (ED). This effective demand is equal to the exact point where aggregated demand and aggregated supply, is equal. This can be summed up to the equation: $FCC + FSE + CC = ED$ (Jespersen, 2009)

In GT Keynes explains this connection with two equations: $Z = \varphi(N)$ and $D = f(N)$ with these two equations the effective demand can be determined with the equations being equal. As follows $Z = D$ hence the two functions are equal $\varphi(N) = f(N)$ which is the point of effective demand. (Keynes, 1936) This theory will be used in the model made for this paper in the sense that the supply is equal to the demand as an example the household consumption is the exact of both demanded and supplied as follows $c_s^h = c_d^h$.

Keynes has the first of eight paradoxes that is well known and in the book by Marc Lavoie from 2014. This paradox states that when all consumers save more or its equal spend less money on consumption then the output will fall. The output will fall due to the lesser household consumption which is a part of the definition of the GDP. (Lavoie, 2014)

As it was just ten years ago and still is today with households over-indebted the paradox also shows itself in the way that the willingness to save is much higher when the household have uncertainty about their future and therefore have the propensity to save more and spend less money. But this has the effect that it keeps the GDP low. Lavoie comes with a quote from the governor of the Bank of England in which he states that the individual would want to save more because of the crisis however if all consumers save more it is a bad for the economy as a whole. (Lavoie, 2014)

Uncertainty is a part of why PK theorists are known as being critical realists. Therefore, an explanation is due. In the model there is uncertainty, the consumer does not know their income or whether or not they do have a job in the coming period, this is an uncertainty.

"... the conclusion is that the acknowledgement of the fact that macroeconomics by its nature is open, and therefore unpredictable, will influence microeconomic behaviour in such a way that expectations-formation will be context-dependent." (Jespersen, 2009)

In some manner it is possible to say that this is a "rule of thumb" where the households cannot be modelled into having an intertemporal choice and this may lead the model not to be as realistic as the real economy.(Olesen, 2010) However, it is not completely possible to have this within a model, as it is a model of the real world not the exact real world itself. The households can only do what they think is best for themselves and this behaviour is not necessary easy to create within a model as these agents often just gets reduced to a rational agent. (Olesen, 2010) Which is why the model creation often, is quite difficult and the results of most models must be considered when looking at these results.

5.3 Rate of Interest Theory

If one would hold cash, there would be no interest on the capital as who would give it for what. Say the savings of a household is held merely in cash then this amount would not create a profit since there would be no interest in the saving. Keynes explains the whole idea behind interest rate very simple as a sum of money given in exchange for parting with the control over your savings for a period of time. As an example, when the bank receives a deposit the debtor gives control over the money to the bank and then the bank guarantees a certain interest rate for the money now held by the bank. (Keynes, 1936)

Keynes states that if the determined rate of interest gets lower than the sum of money given in return would be reduced and the overall amount of cash which would be held would exceed the supply of cash which is available, and on the other hand if the interest rate were to be raised then there would be a surplus of amount of cash that no one would want to hold. (Keynes, 1936) Keynes comes up with a rule where he sets up the liquidity-preference as follows:

"...a smooth curve which shows the rate of interest falling as the quantity of money is increased."(Keynes, 1936)

Which is a summation of his previous statement. Keynes then follow along and says that if interest rates are falling then the income would rise as would the GDP. Later on, in GT Keynes describes that there indeed is more than just the money interest rate and comes up with a few examples e.g. wheat and copper which have returns of value at a later period of time. (Keynes, 1936) This can be derived into the models' different interest rates and how they would work from a theoretical perspective which would be used in the analysis of this thesis.

The model which will be described in greater detail in chapter 6 have 4 different assets and 4 different liabilities per sector of the economy which gives a lot of different interest rates. As an example, Other Interest-Bearing Assets (*oiba*) and Other Interest-Bearing Liabilities (*oibl*) are two of them. This variable contains currency and deposits. Which makes this variable a good example as Keynes used money. The interest rate of this variable is therefore quite similar to the one Keynes used as his example. However, there also is a negative side with the liabilities as for the side with the asset there is also a side where the money is a liability to one and therefore the interest rate is seen as an expense and not a profit and the two interest rates may have the same behaviour but not the same level of interest rate.

5.4 Interest shock expectations

The analysis for this thesis demands for a shock to the model, the interesting thing from the start has been the interest and how an interest shock would affect the real economy. Literature has been found on this specific subject to find out what would happen in the model. To find out what the expectations are the Danish model ADAM has made some suggestions on what would happen during an interest shock.

The ADAM model as of 2012, describes what would happen if the interest is lowered by 0,5%. For this all the key interest rates are all lowered by 0,5%. For this to work with this model the effects must be seen in the reverse aspect. With that in mind according to ADAM if the interest would rise both the investments and the housing price will fall due to this. Just as the private consumption will rise with interest rates going down. Both employment and production rise via the higher demand that makes the wage go up as well. Svensson *et al.* (2012) This must be the opposite with the model that this thesis presents an interest rise which means that the employment, production, and wage fall due to a rise in interest rates.

In a newer version of the ADAM model, the ADAM group has analysed a shock to an increase in interest rates with the help of the multiplier. In their paper they describe how an interest shock will influence GDP, household consumption, private investment, and employment. These variables will fall according to the ADAM model and how they shocked the interest. Both exports and imports will fall because of the competitiveness gets aggravated.Knudsen & Nagel (2017)

However, it is always necessary to be aware of how any given model is constructed, what are the variables and the parameters. This must be considered so it is not certain that the model created and used in this thesis have the same effects as the ADAM model does. And, the model makes the shock in 2009 and therefore only have an eight-year period where the effects are measured since the model stops at its current state in 2016.

This gives an impression of what to expect for the model when the model is affected with an interest shock. The overall expectations are therefore a fall in disposable income thereby the household consumption will fall, likewise will the imports fall due to the households lowered disposable income which makes the GDP fall as well. So, the implications are that if the interest rises that will have a negative effect on the Danish households and the aggregated economy. However, this may be neutralised by the fact that the households hold a large amount of assets which also has an interaction with the shocks.

6

Model

In this chapter the data used for this model is described as well as the model made for this analysis is described with the structure of the model, the matrices which can be found in the appendix sections A.3 and A.4, the accounting identities as well as the behavior of the model.

6.1 Data used for the model

The data for the model is mostly ESA 2010 European Sector Accounts data from Eurostat. This data are the national accounting aggregates for the whole economy. Also knows as the sector accounts, these are shown with stocks and flows from the different sectors to one another on an annual basis. The data stretches from 1995 until 2015. More precisely the data comes from the NSA - National Sectoral Accounts with the format of ESA 2010 based on an annual basis.

Some of the data come from AMECO the European Commission's data bank the values that come from here are the different deflators, the foreign GDP, the real values, and the labor data. The variable HPI comes from the data bank Statistikbanken which is a part of Denmark's Statistics. Where the variable $LTGBY$ is from FRED. The last variable not from Ameco or Eurostat is $CPEQ$ which is from NASDAQ NORDIC which has the equity prices as used in the model. If somehow the data have not been available in annual terms but e.g. quarterly the data have been annualized to make it fit the rest of the annual data that the model is based upon.

In this model there has been made some assumptions regarding the data. as can be seen in equation 6.18 this is the accumulated houses however it is the capital accumulations that is assumed all to be houses. The households are assumed not to hold bond liabilities. As well as the pension assets has been removed from financial, non-financial and government sectors just as the liabilities now only exists in the financial sector. This is where the double accounting has been used to make these transactions prior to the model being made.

6.2 Structure of the Model

According to the theory in chapter 5 there is a need for all the sectors in the model to keep it consistent therefore all five sectors is included into this model, which makes that the model is both as true and realistic as it can be with the current amount of equations endogenous. There is not taken anything away, so it is still an open economy as Denmark which is the reason to have imports and exports in the model.

Since this model is nowhere near a complete model for every transaction of the Danish economy there are some assumptions about the model which is a way to limit it. There are only four assets and four liabilities in the model which is a way to simplify the eight main stocks which is found in the data used. This also means that there are two interest rates, the deposit rate ($iroib_t^{dep}$) and the borrowing rate ($iroib_t^{bor}$), domestic yield rate for the bonds (irb_t^{dom}), domestic dividend rate ($ireq_t^{dom}$) and a domestic rate for the pension stocks ($irpen_t^{dom}$).

All values are in nominal prices unless the lettering is capital then the variable is at constant prices as an example the equation below for GDP (y_t) is current, and exports (X_t) that is described further down in the chapter is in constant prices. The rest of the equations not mentioned in this chapter can be viewed in the Appendix section A.1 where all the equations are listed.

6.3 Matrices

In these types of models two matrices are very important the first one is the balance sheet. Both the theoretical and actual matrices can be found in appendix from table A.16 to table A.21.

This balance sheet shows the stocks of the economy which are present in the model. The reason to why the net wealth nw is present in the sum of sectors is primarily because of buildings, houses which is one of the assets which doesn't have a counterpart to equal zero. As seen on the table A.16 in the right Sum column net gold (ng), capital (k_t) is present these does not have a counterpart which is why they are in the sum column. Net Wealth which is also present, is the sum of FNW and the capital, which is present on the liability side as to why the balance sheet equals to zero. Godley & Lavoie (2007)

The other very important matrix is the transaction-flow matrix, which shows the flows from the economy that are present in this model going from one sector shown with to another which is shown with always to have a counterpart to make the sum of sectors equal to zero. As seen on table A.19 GDP comes from the same five variables as is seen in equation 6.1 in section 6.4 previously in this chapter.

Both the balance sheet matrix and the transaction-flow matrix are added to the appendix where actual data from the year 2015 is used in the matrices and one where this year has the values compared to GDP so it is easier to compare Denmark with e.g. other countries and how they are different in their income and expenses.

6.4 Accounting Identities

6.4.1 Total Economy

GDP is calculated as per usual, this knowledge comes from Eurostat where the data is found in the national accounts. GDP (y_t), comes together via the private consumption (c_t^h), exports (x_t), imports (m_t), investment (i_t), and government expenditure (c_t^g), which are all endogenous. As shown below in the following equation:

$$y_t = c_t^h + c_t^g + i_t + x_t - m_t \tag{6.1}$$

The wage estimation in section 6.5.6 needs GDP at factor costs (yf_t), which is the GDP - the non-financial sectors production taxes ($prodtax_t^{nf}$) added with the subsidies ($subs_t^{nf}$) that the sector receives gives the GDP at factor costs as the equation bellow shows:

$$yf_t = y_t - prodtax_t^{nf} + subs_t^{nf} \tag{6.2}$$

The total capital (k_t) is the sum of the capital from the financial sector (k_t^f), government (k_t^g), non-financial sector (k_t^{nf}) and the households capital which in this case is entirely houses (h_t^h)

$$k_t = k_t^f + k_t^g + k_t^{nf} + h_t^h \tag{6.3}$$

More or less is the same case for the total investment of the economy (i_t) which is the sum of the sectors investment as seen below:

$$i_t = i_t^f + i_t^g + i_t^{nf} + i_t^h \tag{6.4}$$

The last equation for the total economy in this section is taxes. The total taxes (tax_t^g) goes into the government sector. This is a sum of all the other sectors as follows:

$$tax_t^g = tax_t^f + tax_t^h + tax_t^{nf} + tax_t^{row} \tag{6.5}$$

6.4.2 Household Income

Household income (yh_t^h), is determined by the wage received from the non-financial firms (w_t^h), ($b2_t^h$) which is the gross operating surplus belonging to the households, (int_t^h) which is the net interest from the households assets and the interest paid for holding loans, (tra_t^h) which is all other transfers to the household, as shown:

$$yh_t^h = w_t^h + b2_t^h + int_t^h + tra_t^h \tag{6.6}$$

The households wage (w_t^h) is the subtraction of the wage from the non-financial sector (w_t^{nf}) and the wage coming from the rest of the world (w_t^{row}) as follows:

$$w_t^h = w_t^{nf} - w_t^{row} \tag{6.7}$$

The disposable income of the households is total household income yh_t^h as shown in eq. 6.6, and subtracted all taxes (tax_t^h).

$$yd_t^h = yh_t^h - tax_t^h \tag{6.8}$$

The households savings (s_t^h) is the remainder of the households' disposable income (yd_t^h) and pension adjustments ($cpen_t^h$) subtracted with the households' consumption (c_t^h) as shown below:

$$s_t^h = yd_t^h + cpen_t^h - c_t^h \tag{6.9}$$

Net lending (nl_t^h) is the sum of savings (s_t^h) and NP and capital transfers (s_t^h) subtracted with the households' investments(i_t^h):

$$nl_t^h = s_t^h + npctr_t^h - i_t^h \tag{6.10}$$

The households financial net wealth (fnw_t^h) is the financial net wealth from the previous period added with net lending (nl_t^h), net revaluation of the households stocks where the only liability is ($oibl_t^h$) this revaluation ($oibarv_t^h$) is subtracted from the assets revaluation($oibarv_t^h$) where the rest of the assets revaluations are summed as follows:

$$fnw_t^h = fnw_{t-1}^h + nl_t^h + (oibarv_t^h - oiblrv_t^h) + eqarv_t^h + barv_t^h + penarv_t^h \tag{6.11}$$

The interest received by the household ($intr_t^h$) is the sum of all the assets multiplied with the given rate of interest for that asset. Equity (eqa_t^h) multiplied with the domestic dividend rate ($ireq_t^{dom}$) added with the domestic yield rate (irb_t^{dom}) multiplied with bonds held by the households (ba_t^h), then other interest bearing assets ($oiba_t^h$) is multiplied with the interest rate for deposits ($iroib_t^{dep}$) added to the last asset pension($pena_t^h$) that is multiplied with the domestic interest rate ($irpen_t^{dom}$), all this is then added with an error correction variable (ξ_{intR}^h)[1] which gives the equation below:

$$\begin{aligned} intr_t^h = (ireq_t^{dom} \cdot eqa_t^h) + (irb_t^{dom} \cdot ba_t^h) + (iroib_t^{dep} \cdot oiba_t^h) \\ + (irpen_t^{dom} \cdot pena_t^h) + \xi_{intR}^h \end{aligned} \tag{6.12}$$

On the contrary the interest paid by the households ($intp_t^h$) is only the liability, other interest-bearing liability ($oibl_t^h$) times the borrowing interest rate ($iroib_t^{bor}$), yet again an error variable (ξ_{intP}^h) is added as seen below:

$$intp_t^h = (iroib_t^{bor} \cdot oibl_t^h) + \xi_{intP}^h \tag{6.13}$$

The net interest received or paid by the households (int_t^h) is the interest received ($intr_t^h$) subtracted with the interest paid ($intp_t^h$) as follows:

$$int_t^h = intr_t^h - intp_t^h \tag{6.14}$$

[1] The calculation for this error variable can be found in equation A.159

6.5 Behaviour of the Model

6.5.1 Household Expenses

The household taxes are calculated as follows where a tax rate (θ_1), applies to all the household income (yh_t^h), which makes the taxes paid to the government from the households (t_t^h). However, since something happens in 2014, the calculation has an additional parameter (θ_2) multiplied with a dummy (δ_2) to take regard for the event in 2014.

$$t_t^h = \theta_1 \cdot yh_t^h + \theta_2 \cdot \delta_2 \tag{6.15}$$

The household's consumption function is a behaviour equation. This equations' design is very common and is based on disposable income and net wealth like in most literature of this topic, especially Godley & Lavoie (2007) has been helpful in this case. Here the consumption function is a log of the variables. According to a paper from earlier this year the net wealth of the households is quite important since they have effect on the consumption which is why this is included into the consumption function. The paper also suggests that housing should be included into the net wealth which is also the case for this model. Knudsen (2017)

The disposable income (yd^h) is the amount the households can spend from their income, the propensity to consume is (α_1). Besides the disposable income the households have a net wealth to spend from which is shown by the propensity to consume from wealth (α_2). At the end of the equation the trend of the model is shown by $\mathcal{T}$ and (α_3). To take the financial crisis into account in the model a dummy (δ_1) has been made and with that the parameter (α_4), has been estimated. The dummy is one in the years 2007-2010 and zero in the rest which makes sure that the financial crisis is taken care of not just with one year. These variables make up for the household consumption function:

$$log(c_t^h) = \alpha_1 \cdot log(yd_t^h) + \alpha_2 \cdot log(nw_{t-1}^h) + \alpha_3 \cdot \mathcal{T} + \alpha_4 \cdot \delta_1 \tag{6.16}$$

6.5.2 Household Investment

The households' investments start with capital accumulation, which in this thesis is houses for the household sector. The first thing needed is the depreciation (af_t^h) which is a parameter (κ_1) multiplied by the previous periods house stock (h_{t-1}^h):

$$af_t^h = \kappa_1 \cdot h_{t-1}^h \tag{6.17}$$

The house accumulation is the previous periods stock (h_{t-1}^h) added with the households investment (i_t^h) subtracted from the depreciation (af_t^h), added with the capital gains for the houses (cgh_t^h) which is the same as revaluations which is mentioned throughout the portfolio section.

$$h_t^h = h_{t-1}^h + (i_t^h - af_t^h) + cgh_t^h \tag{6.18}$$

This next section has had great inspiration of a paper by Shaotang Cao from 2015, where the idea for the equations for Investment and capital accumulation used in this thesis comes from. Although in the paper by Cao the investment is for the whole economy it has the same principles in this thesis. (Cao, 2015)

The households investment (i_t^h) is a parameter (κ_2) multiplied with the houses in current period subtracted from the last period (Δh_t^h) added with the depreciation (af_t^h), the part of the equation that is $iroib_t^{bor} \cdot oibltr_t^h$ is a resembling of the loan importance of the investments, the borrowing ($oibltr_t^h$) is multiplied with the given interest rate ($iroib_t^{bor}$) to have the investments being able to be affected by an interest rate shock, and of course have the money to buy new investments. At the end an error correction is needed which is ξ_i^h[2]:

$$i_t^h = \kappa 2 \cdot \Delta h_t^h + \kappa 3 \cdot oibltr_t^h + af_t^h + \xi_i^h \tag{6.19}$$

6.5.3 Household Portfolio

The households' portfolio is made out of one liability which is other interest-bearing liabilities ($oibl_t^h$), and four assets which are other interest bearing assets ($oibl_t^h$), equities (eqa_t^h), pension ($pena_t^h$) and bonds (ba_t^h). Both the transactions or the flows and the stocks.

The amount of other interest bearing assets demanded by the households is determined by a constant (η_0), which is an autonomous buying of this stock which helps the model being stable. And the households consider disposable income to financial net wealth ratio which is the variable (vr_t^h) before demanding any stock, the parameter for this variable is (η_1). To this is added a parameter (η_2) multiplied with the last periods stock ($oiba_{t-1}^h$). Then the deposit interest rate for this asset ($iroib_t^{dep}$) and the multiplied parameter (η_3). The last variable is an error correction variable (ξ_{oiba}^h), which also includes capital gains, the calculation for this variable is in equation A.159, which is valid for all equations in the different sectors portfolio.

$$oibatr_t^h = \eta_0 + \eta_1 \cdot vr_t^h + \eta_2 \cdot oiba_{t-1}^h + \eta_3 \cdot iroib_t^{dep} + \xi_{oiba}^h \tag{6.20}$$

The transaction has to go into a stock which is ($oiba_t^h$) this is made from the previous year's stock ($oiba_{t-1}^h$) added with the flow ($oibatr_t^h$) and the revaluation ($oibarv_t^h$):

$$oiba_t^h = oiba_{t-1}^h + oibatr_t^h + oibarv_t^h \tag{6.21}$$

The demand for consumption loans, which this essentially is for the households due to only loans is in this variable, is the parameter (ζ_1), which is multiplied with a variable called ($expen^h$), which is the household consumption (c^h), added with investment (i^h), subtracted from the households disposable income (yd^h), which is the need for consumption loans in the sense that the gap between expenses and disposable income is funded by the loans. To this is added the deflation on consumption ($defc_t^h$), with the parameter (ζ_2). Since most of the households liabilities are long-term loans this is taken into account in this equation in the fashion that for the households in this model the parameter (ζ_3), which is multiplied with the Danish house price index (hpi_t), which is a combined index for all types of residential buildings, Another variable is added which is the flow of homes (Δh_t^h), which is both dwellings and other buildings as for the data which is a proxy for the demand for mortgages multiplied with the parameter (ζ_4).

[2]The calculation for this error variable can be found in equation A.160

To this is added the stock from the previous period ($oibl^h_{t-1}$) multiplied with a parameter (ζ_5) and the last is the borrowing interest on the consumption loans ($iroib^{bor}_t$), which has the parameter (ζ_6), to round it all off (ξ^h_{oibl}), is added which is an error correction variable which also includes capital gains and is calculated in equation A.160:

$$\begin{aligned} oibltr^h_t = \zeta_1 \cdot expen^h_t + \zeta_2 \cdot defc^h_t + \zeta_3 \cdot hpi_t + \zeta_4 \cdot \Delta h^h_t \\ +\zeta_5 \cdot oibl^h_{t-1} + \zeta_6 \cdot iroib^{bor}_t + \xi^h_{oibl} \end{aligned} \tag{6.22}$$

The flow is just one part of the stock equation. The stock which is ($oibl^h_t$) is summed up by the previous year's stock ($oibl^h_{t-1}$) added with the flow ($oibltr^h_t$) and the revaluation ($oiblrv^h_t$):

$$oibl^h_t = oibl^h_{t-1} + oibltr^h_t + oiblrv^h_t \tag{6.23}$$

The stock equation doesn't change so to sum this up for the three remaining assets the equations for the stock is the former periods stock added together with the flow and revaluations, as seen below[3]:

$$stock^h_t = stock^h_{t-1} + flow^h_t + revaluation^h_t \tag{6.24}$$

The households flow of equities ($eqatr^h_t$) is defined by the equation below. The flow comes from an autonomous buying of stock given by the parameter (ψ_0), added with another parameter (ψ_1) multiplied by the households wealth ratio (vr^h_t), which is the households disposable income (yd^h_t) divided by financial net wealth (fnw^h_t). Then a variable called closing price of equities ($cpeq_t$) is added with its given parameter (ψ_2).

The equation also has the stock itself (eqa_t) and the parameter for it(ψ_3), as well as the domestic dividend rate for the equity stocks ($ireq^{dom}_t$) and its parameter (ψ_4). As the data has a huge rise in equities from 2014 and forward that cannot be explained in any other way, the equation had a dummy for this event (δ_2) with a parameter (ψ_5) attached to it. This equation also need an error correction variable (ξ^h_{eqa}) which is the last variable in the equation:

$$eqatr^h_t = \psi_0 + \psi_1 \cdot vr^h_t + \psi_2 \cdot cpeq_t + \psi_3 \cdot eqa^h_t + \psi_4 \cdot ireq^{dom}_t + \psi_5 \cdot \delta_2 + \xi^h_{eqa} \tag{6.25}$$

The households acquisitions of government bonds ($batr^h_t$) is given by an autonomous parameter (μ_0) added with the households wealth ratio (vr^h_t) multiplied with the belonging parameter (μ_1), in addition is the parameter (μ_2) multiplied with the variable Long-Term Government Bond Yield ($ltgby_t$), added with the bond in the current period(ba^h_t) and its given parameter (μ_3), the equation also contains the calculated domestic yield for the bonds (irb^{dom}_t) multiplied with the parameter (μ_4) the last variable is an error correction variable (ξ^h_{ba}) as follows:

$$batr^h_t = \mu_0 + \mu_1 \cdot vr^h_t + \mu_2 \cdot ltgby_t + \mu_3 \cdot ba^h_t + \mu_4 \cdot irb^{dom}_t + \xi^h_{ba} \tag{6.26}$$

The pension flow for the households is in this thesis a residual. which means that this flow gets what is left of the other flows compared to the financial net wealth's flow. Every sector has an equation which is a residual of all the other flows.

[3]The equations for the stock of the assets equities, bonds and pensions can be found in appendix in section A.1

Therefore, the pension flow ($penatr_t^h$) is equal to the financial net wealth's flow ($fnwf_t^h$) subtracted with the flows in a parenthesis other interest-bearing asset ($oibatr_t^h$) subtracted with other interest-bearing liabilities ($oibltr_t^h$) so that these get in to a net flow. in addition to this is bond assets flow ($batr_t^h$) and equity asset flow ($eqatr_t^h$). This gives the residual for pensions as shown below:

$$penatr_t^h = fnwf_t^h - ((oibatr_t^h - oibltr_t^h) + batr_t^h + eqatr_t^h) \tag{6.27}$$

The papers Burgess *et al.* (2016), Byrialsen & Raza (2018) and Meijers & Muysken (2016) have given inspiration to make equations in the section above.

6.5.4 GDP of the EU

The domestic expenditure on domestic goods is calculated as household-, government consumption and the investments added together. So, it is the GDP without import and export.

$$DEDG_t = C_t^h + C_t^g + I_t \tag{6.28}$$

Equation 6.28 above is used in the equation below. the GDP for the EU (Y_t^{eu}) is a parameter (λ) multiplied with the domestic expenditure on domestic goods ($DEDG_t$). The general idea behind this, is that the EU GDP and the $DEDG_t$ has the same trends. Hence the GDP without net export can be used for Denmark to calculate the GDP for EU. This is shown in appendix section A.6 where both the DEDG and GDP for EU is shown in figure A.1 and A.2. The trends are similar which is why this assumption has been made.

$$Y_t^{eu} = \lambda \cdot DEDG_t \tag{6.29}$$

6.5.5 Import and Export

The next two equations 6.30 and 6.31 are the nominal import and export that is endogenized. The conversion to real import and export can be found in appendix A.1.

The imports (mk^{row}), is decided by an autonomous expenditure parameter (γ_0), this is added to the parameter (γ_1), and variable (my^{row}), lagged which is a ratio of prices in the form of the deflator for imports ($defm^{row}$), divided by the deflator for GDP ($defy$), which makes for a de facto price difference in import prices and domestic prices. This is then added to parameter (γ_2), and the variables nominal disposable income (ydk^h), and nominal investment (ik). The variables in this equation is logged to get the results compared in a smaller scale to hold the model more stable. Just as the consumption equation the import equation takes regard of the financial crisis with a dummy (δ_1), and the parameter (γ_3).

$$log(M_t) = \gamma_0 + \gamma_1 \cdot log(my_{t-1}^{row}) + \gamma_2 \cdot log(YD_t^h + I_t) + \gamma_3 \cdot \delta_1 \tag{6.30}$$

Just as the imports equation 6.30 the exports equation below is calculated in a similar way with an autonomous parameter (ϵ_0), added to (ϵ_1), and with a de facto price difference as variable (ey^{row}), which contains the export deflator (e^{row}), divided by the deflator for GDP for EU (def^{eu}). To this the GDP of EU (y^{eu}), is added with a parameter (ϵ_2). As with the imports this equation has the variables logged to make a better fir for the model. And has the parameter (ϵ_3), multiplied to the dummy (δ_1).

$$log(X_t) = \epsilon_0 + \epsilon_1 \cdot log(xy_{t-1}^{row}) + \epsilon_2 \cdot log(Y_t^{eu}) + \epsilon_3 \cdot \delta_1 \tag{6.31}$$

The two equations above, equation 6.30 and 6.31 have been found with the help and inspiration of Byrialsen & Raza (2018).

6.5.6 Labour Market

Wage rate (wr_t) is one way to describe the country's average wage, the wage rate is the households wage (w_t^h) divided by the total employment (ete_t), as seen below:

$$wr_t = \frac{w_t^h}{ete_t} \tag{6.32}$$

The wage that the non-financial sector pays (w_t^{nf}) can described as the wage share which is ω_1 multiplied by the GDP at factor costs (yf_t) as shown below:

$$w_t^{nf} = \omega_1 \cdot yf_t \tag{6.33}$$

The total employment of the economy (ete_t) is the GDP (y_t) divided by the labour productivity ($prod_t$).

$$ete_t = \frac{y_t}{prod_t} \tag{6.34}$$

On the other side the total unemployment (tue_t) is described as the total labour force (tlf_t) subtracted the total employment (ete_t).

$$tue_t = tlf_t - ete_t \tag{6.35}$$

The total labour force (tlf_t) is estimated by a parameter (ω_2) multiplied by the total population of the country (pop_t).

$$tlf_t = \omega_2 \cdot pop_t \tag{6.36}$$

The employment ratio (er_t) is the employment (ete_t) divided by the total labour force(tlf_t).

$$er_t = \frac{ete_t}{tlf_t} \tag{6.37}$$

6.6 Calculated data

6.6.1 Interest Rates

As mentioned earlier the model has 5 variables which gives a rate return of the stocks, two interest rates, a yield, a dividend, and a pension rate. These must be calculated. which is done below. In equation 6.38 the interest rate for the loans are defined as the interest paid ($d41p_t^h$), divided by the amount of loans held by the households ($oibl_t^h$), which gives the equation:

$$iroib_t^{bor} = \frac{d41p_t^h}{oibl_t^h} \tag{6.38}$$

The same thing is true for the deposit interest rate, where however it is the financial sector whose stock and flow is used to calculate the interest rate as follows:

$$iroib_t^{dep} = \frac{d41p_t^f}{oibl_t^f} \tag{6.39}$$

In equation 6.40 the equity dividend is calculated as the two flows of payment from non-financial ($d42p_t^{nf}$) and financial ($d42p_t^f$) sectors, as well as the two stocks from the non-financial (eql_t^{nf}) and financial sector (eql_t^f). This is done given the assumption that it doesn't matter who is supplying the equity stocks, which also means that the rate will be the same whether it is an equity from the financial sector or the production firms.

$$ireq_t^{dom} = \frac{d42p_t^{nf} + d42p_t^f}{eql_t^{nf} + eql_t^f} \tag{6.40}$$

The assumption is that the government supply bonds, and since the interest have two stocks connected the calculation for the bonds are a little different. The bond yield (irb_t^{dom}) is equal to the interest paid by the government ($d41p_t^g$) subtracted the interest again divided by the other interest-bearing liabilities for the government ($oibl_t^g$), which essentially is the rate of interest subtracted. All this is divided by the government bond liabilities (bl_t^g). Which would give the correct bond yield.

$$irb_t^{dom} = \frac{d41p_t^g - (\frac{d41p_t^g}{oibl_t^g})}{bl_t^g} \tag{6.41}$$

The last rate is the pensions which more or less have the same calculation as the borrowing- and deposit interest rates. Which is the paid flow ($d44p_t^f$) subtracted with the pension stock ($penl_t^f$) gives the pension rate ($irpen_t^{dom}$) as the equation below shows:

$$irpen_t^{dom} = \frac{d44p_t^f}{penl_t^f} \tag{6.42}$$

The five interest rates have been calculated in a way that is very similar to the method used by ADAM (Svensson *et al.*, 2012).

7

Empirical Results

In this chapter, the empirical results on the three different shocks will be analyzed. However, first the model will be looked at against the data, and how well it performs with a shock to the propensity to consume to generate the Paradox of Thrift.

7.1 Model Versus Data

Below are six figures these are representing the model and how good a fit it does against the real data.

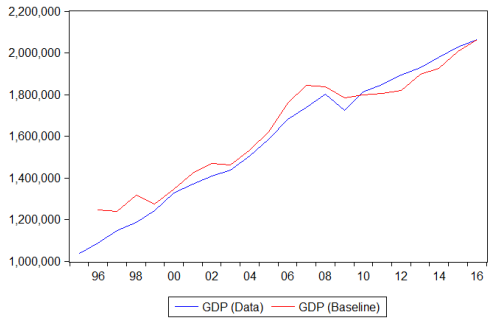

Figure 7.1: GDP data against the model

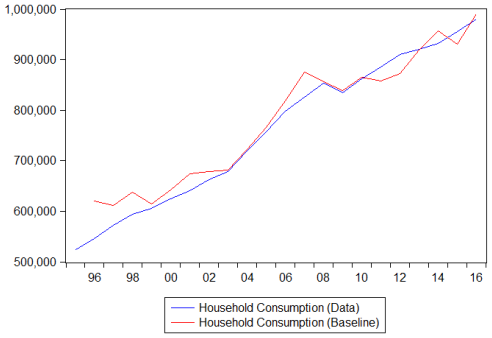

Figure 7.2: Household consumption data against the model

The GDP in figure 7.1 which is the overall production in a country looks to be quite a good fit, however, it is hard to make a perfect fit with all the endogenous equations in the model which is also shown below some of the major GDP contributors isn't that well a fit. Next to GDP in figure 7.2 is the household consumption which may not be as good a fit as wanted however it does follow good along with the data. The residual for the estimation of the household consumption in figure 7.2 can be found in appendix section A.6 figure A.3, where this actually shows that the estimation is correct.

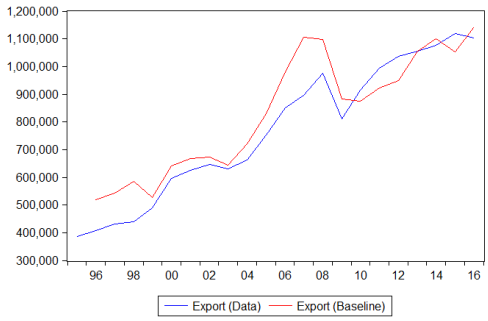

Figure 7.3: Export data against the model

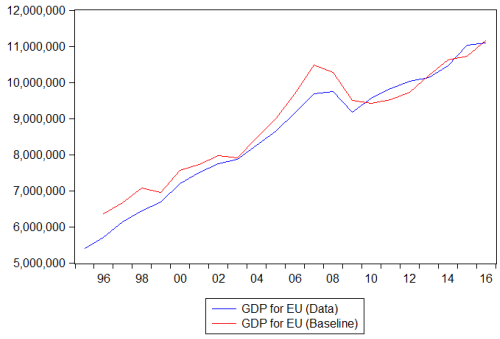

Figure 7.4: GDP for EU data against the model

Figure 7.3 shows the export which doesn't seem to be a good fit at all. Although if looking at the residual in figure A.5 it seems that the estimation of the variables and parameters is good. The next figure is 7.4 which also seems bad, but again the estimation in figure A.4 tells a different story. This variable is more than likely the one to blame for the exports to be as bad a fit as it is. Again the fit on figure 7.5 is much different than what was originally found in the estimated results on the residuals as seen in figure A.6. The last big contributor to the GDP is the investment which has four sectors with endogenous equations, where all may have a minor separation from the model to the data which causes the figure to look as it does.

Figure 7.5: Import data against the model

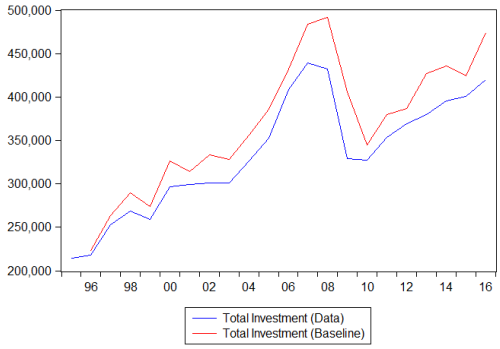

Figure 7.6: Investment data against the model

The conclusion to the model fit shown above is that the model equations should work better. However, because this model has as many endogenous equations as it has caused every equation holding an endogenous variable to change with it. Even after applying the error correction term the model fit is a little off because of this reason exactly.

7.2 Paradox of Thrift

Recall in chapter 5 that in section 5.2 the Paradox of Thrift is explained. A shock to resemble this paradox has been made to show that the model does indeed follow Post-Keynesian theory and the model can handle a simpler shock in the form of the propensity to consume is lowered or the propensity to save is raised.

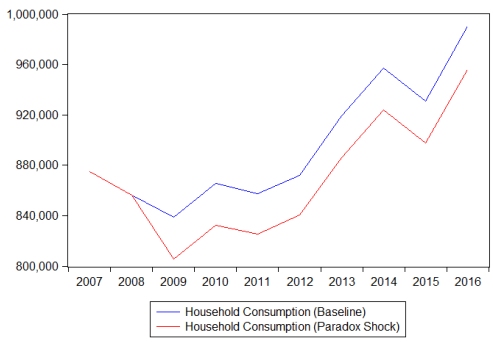

Figure 7.7: Applied paradox shock shown on Household Consumption

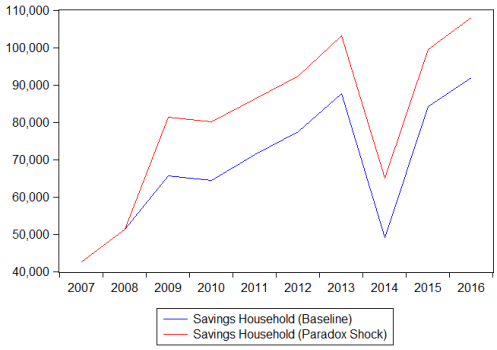

Figure 7.8: Applied paradox shock shown on Household Savings

The "Paradox Shock" is directly applied to the households Consumption function. When the propensity to consume is lowered the consumption should be lower which is indeed the case as seen in figure 7.7. And this should directly affect the household savings as the propensity to consume is the reverse of the propensity to save which has just been raised. This is true for this model as well as seen in figure 7.8. Figure 7.9 shows that as the theory suggests the employment rate is lowered which is resulting in the lower GDP shown in figure 7.10. So the lower propensity to consume is lowering the GDP as the theory is saying it will.

That means that the model can control a smaller shock to it and come off with the correct results, as-well telling that it does indeed have a Post-Keynesian theoretical foundation.

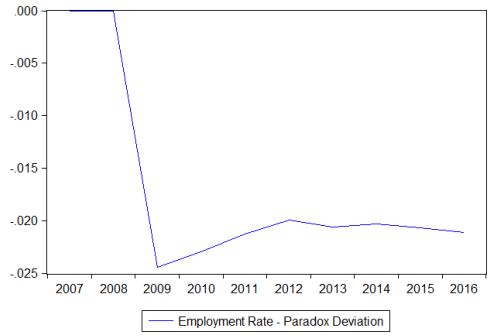

Figure 7.9: Applied paradox shock shown on Employment Rate

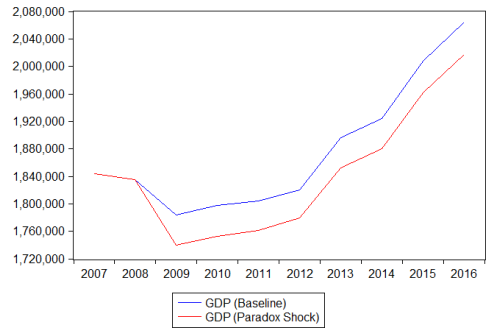

Figure 7.10: Applied paradox shock shown on GDP

7.3 Explanation of the shocks

The first shock will be on the yield rate, dividend rate, and the three different interest rates that the model has. These shocks are taking place from 2009 after 2008 where there was an interest increase that fell in 2009. As it can be seen in figure 7.11. This shock makes sure that from 2009 the interest rates grow continues at a steady pace that matches the mean fall that the interest rates took from 1995 to 2016. This shock is shown in figure 7.12.

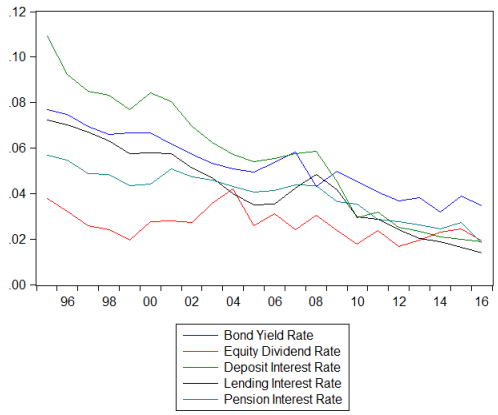

Figure 7.11: Calculated Interest rates

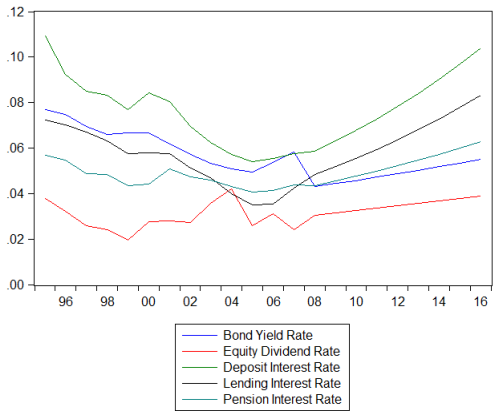

Figure 7.12: Interest rates shock 1

The second shock will be a shock where it has a constant interest rate as the rate was in 2008 throughout the period. Which means that the shock still has a higher rate than the data suggests. This shock is shown in figure 7.13. This third shock is once again a constant value shock, however, this time the shock is of the end value of shock 1 which would imply that the economy will have a very high shock value and will have much higher rates to both paid and received over the entire period. The last two types of shock are made as the common shocks are made in most models with just a rise in the rates that will be constant over the rest of the period. This shock uses the 2016 rate from shock 1 as the value shocked in shock 3 which is shown in figure 7.14.

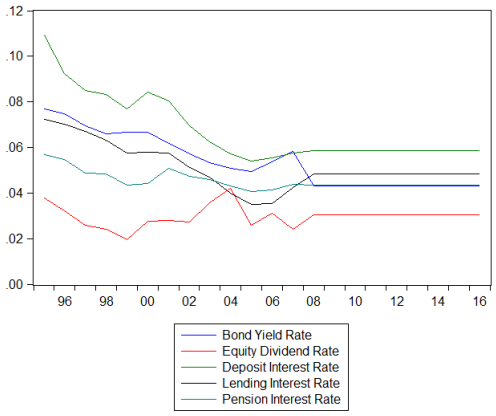

Figure 7.13: Interest rates shock 2

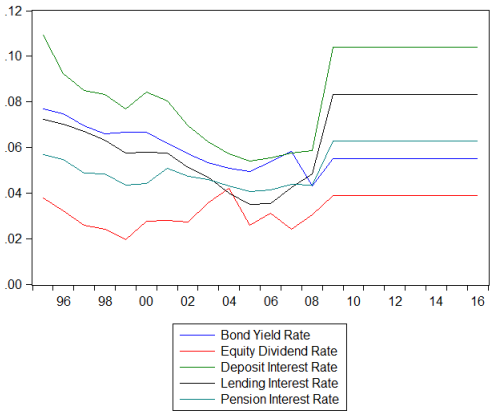

Figure 7.14: Interest rates shock 3

To both make the shock simple and to see the effects of the intended shock and not everything else only the interest rates are given a shock in the three different scenarios. That means that everything else is constant and the assumption is that these variables do not change even after the shock.

These shocks used in this analysis are "what if" or "ceteris paribus" scenarios which are as described with only the interest rate changing so that everything else stays where it really was according to the data. Otherwise, the model would have to change a lot of parameters to find new values for the behaviors in the different sectors which would be close to impossible, since no one would know what the behaviors would be instead.

7.4 Introducing the shocks

As the three shocks have been described on the previous page the effects of these shocks come next. All of these analyses are based on the model presented in chapter 6. And cannot conclude anything other than what the model says as it is not exactly how the actual economy works. It is based upon assumptions and estimations, as well as selections of variables which isn't certainly the correct ones according to the real economy of Denmark.

7.4.1 Shock impact on Household Lending and Household Debt

The shocks in this thesis are on the interest rates, this immediately directs the lending of the households it is in that equation, see equation 6.22. Because of the interest rate increase, the households will tend to loan less money. However also the $expen_t^h$ that consists of household consumption and investment subtracted from the households' disposable income and Δh_t^h are affected by the shock through the disposable income as seen more detailed later in the analysis. The figure 7.15 shows that all three shocks will lower the number of loans taken by the households. It seems that the constant high shock 3 is giving a much lower amount of loans from the start of the shock until 2012 where the shocks are more or less the same.

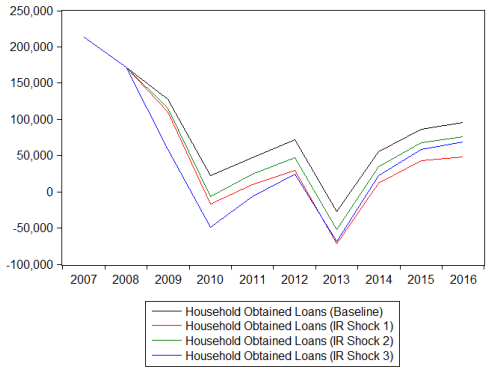

Figure 7.15: Applied shocks shown on Household Lending

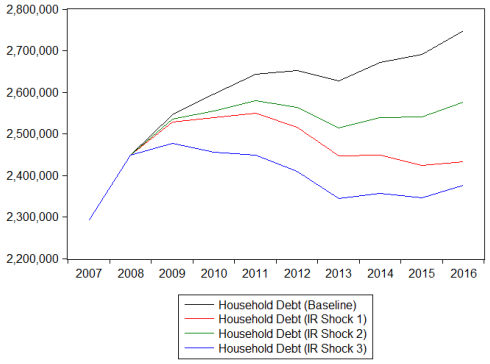

Figure 7.16: Applied shocks shown on Household Debt

Due to the lower obtained loans by the households the household debt is falling as seen in figure 7.16. The constant shock 3 affects the debt the most since it gives lower lending early, the other two shocks 1 and 2 still gives a lower household debt since again it affects the households obtained loans compared to the baseline of the model.

7.4.2 Shock impact on Household Net Interest and Household Consumption

The effects on households net interest is in the model determined by the interest received shown in equation 6.12 subtracted from the interest paid shown in equation 6.13 as shown in equation 6.14.

The increased net interest means that the amount received is larger than the amount paid, which is equivalent to that the households are affected more positively than negative due that their expenses on their debt is smaller than the gain on assets due to the interest shocks no matter how this shock is made the net interest are the same positive outcome for the households. All this is seen in figure 7.17.

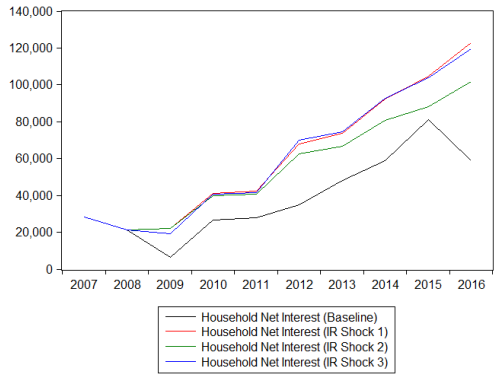

Figure 7.17: Applied shocks shown on Household Net Interest

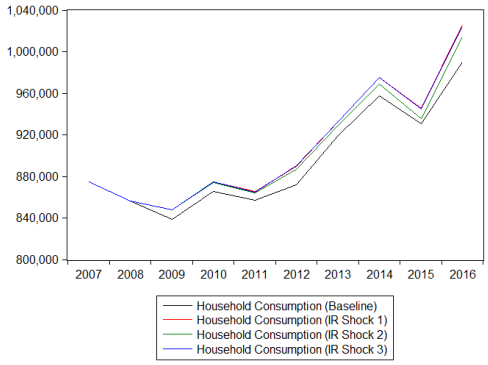

Figure 7.18: Applied shocks shown on Household Consumption

Due to the net interest raise for the households, the income for the households has raised as the interest is an important variable for the income as seen in equation 6.6, The other endogenous variable in the income equation is the household's wage which is described in the next section. Due to the higher income, the disposable income is raised and that leads to a higher household consumption, given the propensity to consume doesn't change, which in this case it does not. The equation for household consumption is equation 6.16 as seen here the disposable income has a big lead to why the consumption raises in figure 7.18. The three shocks come up with about the same in consumption due to the net interest has raised in the same manner for all three shocks. The more household consumption is affecting the GDP, which does influence even more in the model.

This rise in disposable income and household consumption was not expected but can be described to the households having a larger amount of asset than they do of liabilities which makes the impact of a higher interest rate affect the positive stocks more, and thereby making the net interest become higher as well as the household incomes. Which is shown in the two figures below figure 7.19 and 7.20. The results that can be seen on these two figures are that both the assets and the liabilities fall the same amount and that there is a much larger pool of assets which justifies the previous statement above.

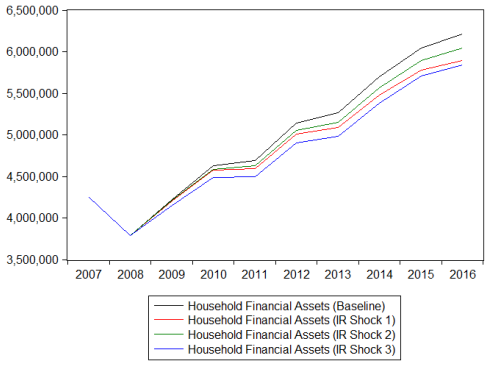

Figure 7.19: Applied shocks shown on Household Financial Assets

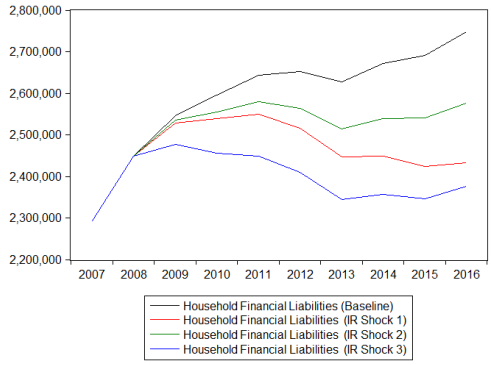

Figure 7.20: Applied shocks shown on Household Financial Liabilities

As the equation for pension assets, equation 6.27, suggest the financial net wealth can be described as the assets subtracted from the liabilities. It also states that the pension is a residual and will make up for the value that is left to add up to financial net wealth flow. This can be seen in the two financial assets and financial liabilities fall the same amount, which gives the model consistency.

7.4.3 Shock impact on Household Wage and Employment Rate

The net interest is not the only endogenous variable that is in the household income equation 6.6. Also, the household wage is endogenous and goes through a few different equations to find its source. The received household wage is the subtraction of the paid wage by the non-financial sector and the received wage from the rest of the world as equation 6.7 shows. Where the endogenous comes from equation 6.33 where the wage share ω_1 is constant and the GDP at factor costs is the one defining the wage. This obviously comes from the GDP which is subtracted from production taxes and added subsidies. As shown in equation 6.2. So, when GDP changes so do the wage which corresponds to the real world as well. The figure 7.21 shows that the household wage is raised by the shocks at first but after 2010 it is lowered again only yet again in 2014 to go up.

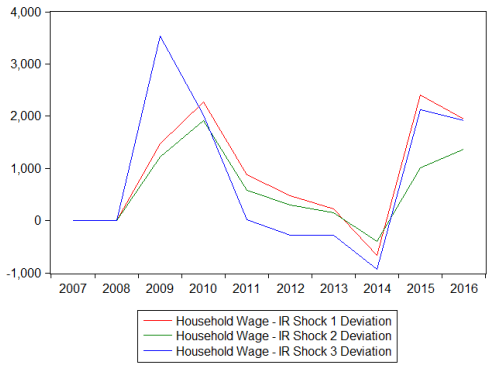

Figure 7.21: Applied shocks shown on Household Wage

Figure 7.22: Applied shocks shown on Employment Rate

Not only the wage is determined by GDP, the employment is also determined by the GDP as it is in most theory. On figure 7.22 it is possible to see almost the same adjustment the model have as it has on the household wage. The employment rate has the same trends going up a bit until 2010 then fall only to be raised again in 2014.

That means that according to the model both the wage and employment rate have the same pattern. Both these two figures are measures of the deviation of the shocks to the models' baseline.

7.4.4 Shock impact on Household Investment and Total Investment

The household investment in this model can be seen in equation 6.19 which consists of houses and household borrowing. The houses equation 6.18 is then again using the investment to find the endogenous house value. When given the shock the investment falls which is expected. This can be seen in figure 7.23. The total investment is the sum of all four sectors having fixed capital which excludes the rest of the world. Figure 7.24 shows that in investment are quite a difference to what shock is made to the economy. However, they all end up by having a higher investment than the baseline in the short run. In longer terms, the shocks seem to find a steady state point just below the baseline.

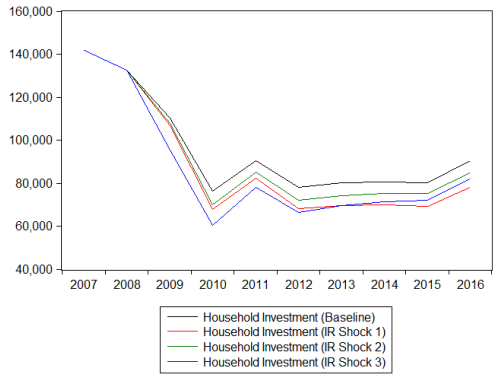

Figure 7.23: Applied shocks shown on Household Investment

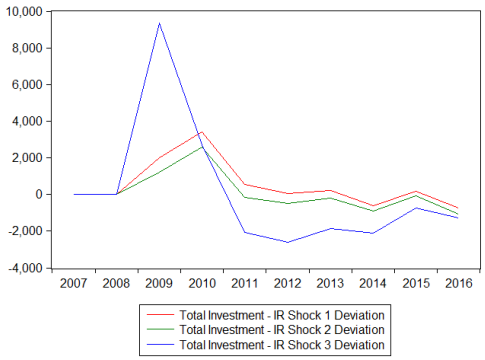

Figure 7.24: Applied shocks shown on Total Investment

The explanation to why the shock doesn't affect the total investment more is that the non-financial sector would see the interest raise as the economy is in a boom period since the interest rate goes up to slow down the economy. With this, the Non-Financial sector will demand more loans and invest more which could be the reason that the household investment alone doesn't affect the total economy to have a more negative outcome of the shocks.

7.4.5 Shock impact on Import and Export

In the model, government consumption is exogenous which means that in order to get to the total economy and the GDP the next parts of this analysis must be the import and export. The imports are shown in figure 7.25, in this figure it is easy to see a separation from the three shocks and the baseline. The imports with the shocks are higher. This is because both the households' disposable income and the investments are higher than the baseline scenario which causes the import to rise as well. Those are the only variables in equation 6.30 that are endogenous and therefore the only possibility.

It is the same picture that is seen in figure 7.26 where the export shock values are bigger than the baseline. which has only one plausible explanation as well. In equation 6.31 the only variable that is endogenous is the GDP for EU which if recalled is equation 6.28 where the GDP for EU comes from the domestic expenditure of domestic goods multiplied up. Where it contains household consumption and investment which as shown earlier have raised due to the shocks. Which would indicate that if the assumptions made are correct the exports, as well as the imports, will benefit from a rise in interest rates.

Figure 7.25: Applied shocks shown on Import

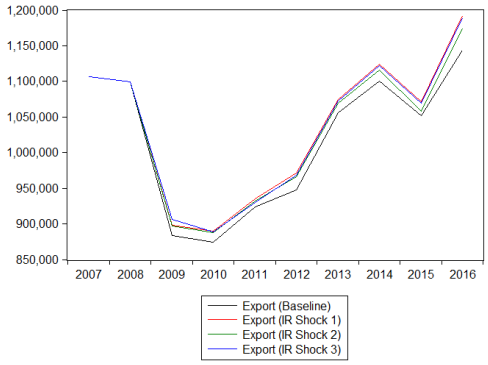

Figure 7.26: Applied shocks shown on Export

To sum up this. The import raises because the economy is in a small boom phase at least for the households, so the households start to import more goods from the foreign sector. In the meanwhile, the economy is going quite well so the firms produce more goods that they now can export.

7.4.6 Shock impact on GDP and Household Debt-to-Output Ratio

The easiest way to see the economy as a whole is through an economy's GDP. As seen on figure 7.27 here it shows that in the start of the period after the shocks it has a positive effect until 2010 where it falls only to rise again in 2014. The equation for the GDP is $y_t = c_t^h + c_t^g + i_t + x_t - m_t$. The only exogenous variable here is the government consumption. Three of the remaining variables import, export and household consumption all has a positive effect from the shocks only the investment has a small negative effect on the long run. The imports are negative so that do drag the GDP down a bit although it does signal a running economy. However, as seen on the y-axis it is not much that the total economy has been affected by the shocks.

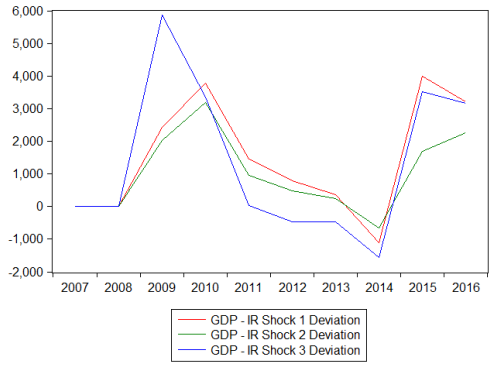

Figure 7.27: Applied shocks shown on GDP

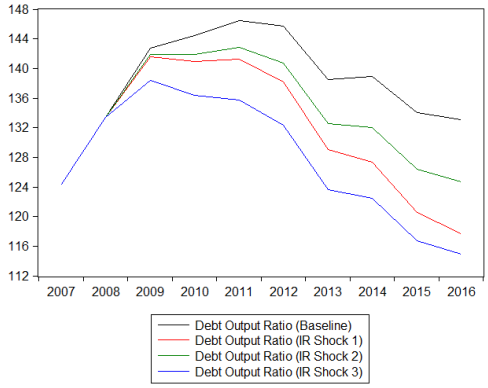

Figure 7.28: Applied shocks shown on Household Debt-to-Output Ratio

The purpose of this paper has been to look at the households' situation with an interest shock. The sector has an enormous problem with debt which has been the highest within the OECD and still is. but how would it look when it is shocked with an interest rate increase. On figure 7.28 the household debt to GDP ratio is shown. Given a shock of a continues to rise in interest rates the model shows that the debt to GDP ratio will fall since the lending for the households falls as explained in section 7.4.1. However, this is only about the half fall as if the shock was at a high constant value as shock three is.

7.4.7 Shock impact on Household Debt-to-Income Ratio and Household Obtained loans-to-Income Ratio

This last section of the analysis is on the ratio between households' debt and obtained loans to their disposable income. Figure 7.29 shows the ratio between households debt and the households disposable income which in these shocks fall rather drastically both because the disposable income is increasing and because the debt itself is falling. The last figure 7.30 shows that the lending ratio to the households disposable income is falling compared to the baseline. It is especially this one that is important compared to the other two ratios that this is the foundation of the debt if the households loan less the debt will decrease.

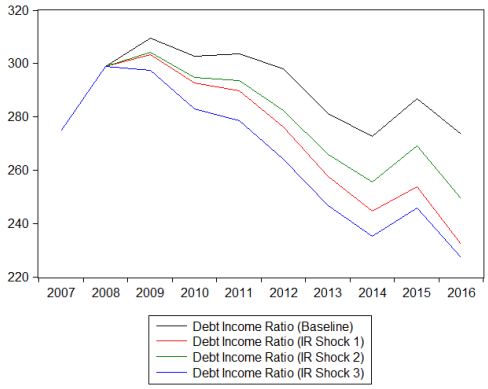

Figure 7.29: Applied shocks shown on Household Debt-to-Income Ratio

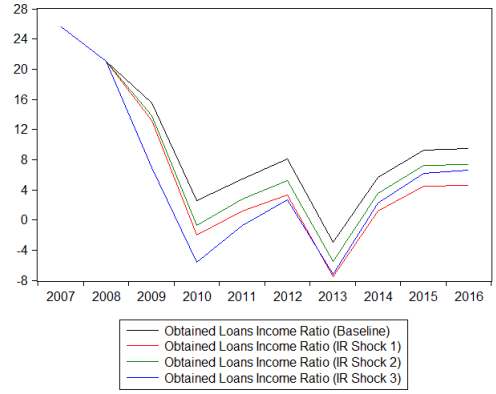

Figure 7.30: Applied shocks shown on Household Obtained loans-to-Income Ratio

Is the economy back to what it was without the interest shock? No, just because the GDP seems to be not that far off as well as the wage and employment rate does that not mean that the economy is back to steady state however when looking at the figures above it looks like the households are better off after their portfolio change so that they have allocated their debt away which means a bigger disposable income due to a smaller paid interest.

8

Conclusion

In this chapter, a discussion of the results in chapter 7 will be made and a perspectivation to this thesis is assessed. And lastly, overall conclusion to this thesis will be made.

8.1 Discussion

The discussion is split up into a few different parts to better keep track of the different areas of discussing. Firstly, the model is discussed. After that, the results are discussed.

8.1.1 Discussion of the Model

The first thing to have in the discussion is the discussion of the model itself. As this thesis is based upon the Post-Keynesian theory the model is too. Although this specific type of model is now well known throughout the PK community as the answer to mainstreams DSGE models. When this is said the model used in this thesis looks to be the first of its kind of the Danish economy. As the model is at least one of the first of its kind of the Danish economy. The different parameters and variables that have been put in to model the economy's behaviour could be more off than what was hoped for.

There have been made plenty of assumptions for the model to be even made. Some of these have been described in the section 6.1 and 6.2. Others are as shortly mentioned in the analysis that the estimated values for the parameters do not change. One of the assumptions in this model is that the trends of the GDP for EU and the domestic production are similar. However, the way that this is presented in the model is that the Danish production affects the GDP of EU. This is highly unlikely and would have to be the reverse causality. Because in reality, it is the GDP for EU that would affect the Danish economy. A small economy like Denmark would not have that effect on a much bigger economy as the EU.

In the shocks that is made only the interest rates change and nothing else. This is done to see the real effect of an interest rate increase, and hopefully exclude all other factors to why a variable change. As it is now only the interest shock will make value changes to the model. One could argue that this is not a realistic take where some of the parameters don't change which they actually do. But that is the way the model is built the parameters does not change during any shocks to the interest rates.

This model still has potential and can be developed further on with even more endogenous equations. And a more detailed financial sector. And including the interest rates for the foreign sectors stocks which have been left out in this thesis to simplify the model. If there is a continuous development with the model it could be used to forecast the Danish economy which could be interesting for many economists.

8.1.2 Discussion of the Results

The results in the previous chapter do not show what was expected. The expectations were quite clear that an increase in the interest rates would slow down the economy as an increase in interest rates is seen as a contraction policy. Normally this type of policy is used within the boom phase of the economic cycle. It is used to cool down the economy, so it does not overheat and create a bust phase.

The surprises in this analysis are actually the four main parts of the GDP that have all risen, against what was believed. However, there can be found some explanation for these rises. The import and export were supposed to be lower than the baseline level however they were not. That could be an indication that the economy did not get aggravated as expected. Both the GDP for EU rose which made the exports higher and the income and investment which lead to a rise in imports which makes clearly good sense. If the assumption of the GDP for EU is correct then this could be an actual thing. The trade would not be in problems due to an interest increase if both the European GDP rise and the demand for imports does as well.

The investments have been explained a bit in the previous chapter. It would make sense that even though the interest rate rises the demand for both investments as capital and houses would rise. This rise would come due to the non-financial sector would see this as an effect of a boom phase and therefore create investments and jobs. The reason that the households have a larger disposable income to spend is, of course, the higher interest rates. Which have given them a higher net interest. The households get a higher net interest because as showed earlier on. The Households hold a bigger portion of assets compared to their liabilities which gives them a net positive outcome given the shock is plausible at all.

All of this, of course, have something to do with how the model is set up in the end. Does it fit the model in a manner that is usable? And do the shocks made even give any sense to the real world's economy? The three shocks are of different variants where one is a continuous rise and the other two are constant over the entire period. The model may not be as got a fit as showed earlier where the estimated parameters do look good however when the number of endogenous variables is as high as they are in this model then the results more than likely will differ from the data.

8.2 Perspectivation

To perspective this master thesis. The model needs to be mentioned. As said a few times already this model is one of the first larger ones of this type of the Danish economy. Because of this, there is not much literature on this specific model type as to how to model it properly, as shown in chapter 4. Even though the different parts of the model, the different equations estimate with variables and parameters fit very well where together with the rest of the models' equations it seems like the model doesn't fit at all.

Even though this model has five interest rates, four different stocks and all sectors open to some degree. This specific model could have been larger, more detailed and more realistic. For simplified reasons, there are no foreign interest rates in the model which could have put the interest rates up to eight instead of five. If all available stock options were used the stock amount could go as high as 14 stocks, instead of the four aggregated used in this model, in the portfolio this is as many stock options that the data provided. Given that the behavior equations for all these stocks can be made correctly the realism will be better and correct analysis can be made.

As mentioned a continuation of this model should provide more endogenous equations to determine the sectors different behavior. A more detailed portfolio with more than just the four accumulated stocks so the distinction between each asset and liability is easier to analyze and use for economic purposes.

There are some limitations to this type of model. With too many endogenous variables the model will not necessarily fit because of the number of other endogenous equations that affects the first variable. These model types are open in that way that one variable affects another. The main advantage of this type of model is that it is possible to have a very small model that still can provide a good answer to a given problem. This specific model used in this thesis will by many still be seen as a relatively small model compared to other models such as the one made in the UK by (Burgess *et al.*, 2016) and the ADAM model for Denmark made by (Svensson *et al.*, 2012).

8.3 Conclusion

This thesis analyses how three different shocks on the different types of interest rate affect the household sector and the economy as a whole. Even though the arguments from the discussion can be made and must be taken into consideration in this conclusion. The conclusion must be made given the current state of this thesis Stock-Flow Consistent model with the Post Keynesian theoretical foundation. The three different shocks are as explained all higher than the data from 2009 and forward. One is continues rising and the other two are stagnant shocks. The thesis looks at how these shocks affect the economy proposed as being as the model suggests. Which is important to understand.

When this model is shocked with these different shocks almost all of the economy is affected. However, the households have a main focus as this sector is one of the more important ones for the everyday person and that it actually has a great impact on the GDP in itself via the household consumption.

The households loan a lot less after given this shock which makes the household debt fall. Which cannot be disputed as being a positive as the Danish households hold the largest debt in the OECD countries. This is one of the reasons for the net interest going up which is also a positive because the disposable income then raises to make the household consumption raise compared to the baseline in the model. Because of the disposable income rises as well as the investment the import of the country rises, however so does the exports because of the model behavior of the GDP for EU that rises along with the Danish GDP. The net export is falling compared to the models' baseline, so the import rises more than the export. The household investment is lower than the baseline due to the higher interest rates and the household loan less while the total investment is just about status quo. The reason for this would be especially the non-financial sector seeing the rise in interest as a good sign and therefore loan more to invest more and thereby get the total investment to be almost status quo.

With this in place, the GDP is almost the same as has the shock to the interest not been there. This causes for both the employment rate and the household wage not to change substantially. Because the GDP doesn't change all that much the debt to output ratio is only affected by the fall in household debt. Where the debt to income ratio falls both because the income raises and the debt falls.

Due to the almost status quo of the GDP the increase in interest doesn't really change the general economy. However, it does change the net exports which will fall, and the investments will rise. As for the household, they will spend more money due to an increase in disposable income due to the net interest is higher after the shock. And of course, the household debt will be lower due to a lower demand for loans. Which again is a positive effect of an increased interest rate.

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A

Appendix

A.1 Complete list of Equations

A.1.1 Households Real Economy

$$yh_t^h = w_t^h + b2_t^h + int_t^h + tra_t^h \tag{A.1}$$

$$yd_t^h = yh_t^h - tax_t^h \tag{A.2}$$

$$s_t^h = yd_t^h + cpen_t^h - c_t^h \tag{A.3}$$

$$fnw_t^h = fnw_{t-1}^h + nl_t^h + (oibarv_t^h - oiblrv_t^h) + eqarv_t^h + barv_t^h + penarv_t^h \tag{A.4}$$

$$nl_t^h = s_t^h + npctr_t^h - i_t^h \tag{A.5}$$

$$nw_t^h = fnw_t^h + h_t^h \tag{A.6}$$

$$expen_t^h = (c_t^h + i_t^h) - yd_t^h \tag{A.7}$$

$$tax_t^h = t_t^h \tag{A.8}$$

$$\begin{aligned} intr_t^h = (ireq_t^{dom} \cdot eqa_t^h) + (irb_t^{dom} \cdot ba_t^h) + (iroib_t^{dep} \cdot oiba_t^h) \\ +(irpen_t^{dom} \cdot pena_t^h) + \xi_{intr}^h \end{aligned} \tag{A.9}$$

$$intp_t^h = (iroib_t^{bor} \cdot oibl_t^h)) + \xi_{intp}^h \tag{A.10}$$

$$int_t^h = intr_t^h - intp_t^h \tag{A.11}$$

$$t_t^h = \theta_1 \cdot yh_t^h + \theta_2 \cdot \delta_2 \tag{A.12}$$

$$log(c_t^h) = \alpha_1 \cdot log(yd_t^h) + \alpha_2 \cdot log(nw_{t-1}^h) + \alpha_3 \cdot \mathcal{T} + \alpha_4 \cdot \delta_1 \tag{A.13}$$

$$af_t^h = \kappa_1 \cdot h_{t-1}^h \tag{A.14}$$

$$h_t^h = h_{t-1}^h + (i_t^h - af_t^h) + cgh_t^h \tag{A.15}$$

$$i_t^h = \kappa 2 \cdot \Delta h_t^h + \kappa 3 \cdot oibltr_t^h + af_t^h + \xi_i^h \tag{A.16}$$

A.1.2 Households Financial Economy

$$oibatr_t^h = \eta_0 + \eta_1 \cdot vr_t^h + \eta_2 \cdot oiba_{t-1}^h + \eta_3 \cdot iroib_t^{dep} + \xi_{oiba}^h \tag{A.17}$$

$$oiba_t^h = oiba_{t-1}^h + oibatr_t^h + oibarv_t^h \tag{A.18}$$

$$\begin{aligned} oibltr_t^h = \zeta_1 \cdot expen_t^h + \zeta_2 \cdot defc_t^h + \zeta_3 \cdot hpi_t + \zeta_4 \cdot \Delta h_t^h \\ +\zeta_5 \cdot oibl_{t-1}^h + \zeta_6 \cdot iroib_t^{bor} + \xi_{oibl}^h \end{aligned} \tag{A.19}$$

$$oibl_t^h = oibl_{t-1}^h + oibltr_t^h + oiblrv_t^h \tag{A.20}$$

$$eqatr_t^h = \psi_0 + \psi_1 \cdot vr_t^h + \psi_2 \cdot cpeq_t + \psi_3 \cdot eqa_t^h + \psi_4 \cdot ireq_t^{dom} + \psi_5 \cdot \delta_2 + \xi_{eqa}^h \tag{A.21}$$

$$eqa_t^h = eqa_{t-1}^h + eqatr_t^h + eqarv_t^h \tag{A.22}$$

$$penatr_t^h = fnwf_t^h - ((oibatr_t^h - oibltr_t^h) + batr_t^h + eqatr_t^h) \tag{A.23}$$

$$pena_t^h = pena_{t-1}^h + penatr_t^h + penarv_t^h \tag{A.24}$$

$$batr_t^h = \mu_0 + \mu_1 \cdot vr_t^h + \mu_2 \cdot ltgby_t + \mu_3 \cdot ba_t^h + \mu_4 \cdot irb_t^{dom} + \xi_{ba}^h \tag{A.25}$$

$$ba_t^h = ba_{t-1}^h + batr_t^h + barv_t^h \tag{A.26}$$

A.1.3 Non-Financial Coorporations Real Economy

$$fnw_t^{nf} = fnw_{t-1}^{nf} + nl_t^{nf} + (oibarv_t^h - oiblrv_t^h) + (eqarv_t^h - eqlrv_t^h) + (barv_t^h - blrv_t^h) \tag{A.27}$$

$$s_t^{nf} = y_t + int_t^{nf} - w_t^h - w_t^{row} - b2_t^{nf} - tax_t^{nf} + tra_t^{nf} \tag{A.28}$$

$$nl_t^{nf} = s_t^{nf} + npctr_t^{nf} - i_t^{nf} \tag{A.29}$$

$$nw_t^{nf} = fnw_t^{nf} + k_t^{nf} \tag{A.30}$$

$$intr_t^{nf} = (ireq_t^{dom} \cdot eqa_t^{nf}) + (irb_t^{dom} \cdot ba_t^{nf}) + (iroib_t^{dep} \cdot oiba_t^{nf}) + \xi_{intr}^{nf} \tag{A.31}$$

$$intp_t^{nf} = (ireq_t^{dom} \cdot eql_t^{nf}) + (irb_t^{dom} \cdot bl_t^{nf}) + (iroib_t^{bor} \cdot oibl_t^{nf})) + \xi_{intp}^{nf} \tag{A.32}$$

$$int_t^{nf} = intr_t^{nf} - intp_t^{nf} \tag{A.33}$$

$$tax_t^{nf} = \theta_{11} \cdot yh_t^{nf} \tag{A.34}$$

$$prodtax_t^{nf} = tax_t^{nf} - t_t^{nf} \tag{A.35}$$

$$af_t^{nf} = \kappa_{11} \cdot k_t^{nf} \tag{A.36}$$

$$k_t^{nf} = k_{t-1}^{nf} + (i_t^{nf} - af_t^{nf}) + cgk_t^{nf} \tag{A.37}$$

$$i_t^{nf} = \kappa 12 \cdot \Delta k_t^{nf} + \kappa 13 \cdot oibltr_t^{nf} + af_t^{nf} + \xi_i^{nf} \tag{A.38}$$

A.1.4 Non-Financial Coorporations Financial Economy

$$oibatr_t^{nf} = fnwf_t^{nf} - ((eqatr_t^{nf} - eqltr_t^{nf}) + (batr_t^{nf} - bltr_t^{nf}) - oibltr_t^{nf}) \tag{A.39}$$

$$oiba_t^{nf} = oiba_{t-1}^{nf} + oibatr_t^{nf} + oibarv_t^{nf} \tag{A.40}$$

$$oibltr_t^{nf} = \zeta_{11} \cdot oibl_{t-1}^{nf} + \zeta_{12} \cdot iroib_t^{bor} + \zeta_{23} \cdot \mathcal{T} + \xi_{oibl}^{nf} \tag{A.41}$$

$$oibl_t^{nf} = oibl_{t-1}^{nf} + oibltr_t^{nf} + oiblrv_t^{nf} \tag{A.42}$$

$$eqatr_t^{nf} = \psi_{11} \cdot cpeq_t + \psi_{12} \cdot eqa_t^{nf} + \psi_{13} \cdot ireq_t^{dom} + \psi_{14} \cdot \delta_2 + \psi_{15} \cdot \mathcal{T} + \xi_{eqa}^{nf} \tag{A.43}$$

$$eqa_t^{nf} = eqa_{t-1}^{nf} + eqatr_t^{nf} + eqarv_t^{nf} \tag{A.44}$$

$$eqltr_t^{nf} = \phi_{10} + \phi_{11} \cdot cpeq_t + \phi_{12} \cdot eql_{t-1}^{nf} + \psi_{13} \cdot ireq_t^{dom} + \psi_{15} \cdot \delta_2 + \xi_{eql}^{nf} \tag{A.45}$$

$$eql_t^{nf} = eql_{t-1}^{nf} + eqltr_t^{nf} + eqlrv_t^{nf} \tag{A.46}$$

$$batr_t^{nf} = \mu_{11} \cdot ltgby_t + \mu_{12} \cdot ba_{t-1}^{nf} + \mu_{13} \cdot irb_t^{dom} + \xi_{ba}^{nf} \tag{A.47}$$

$$ba_t^{nf} = ba_{t-1}^{nf} + batr_t^{nf} + barv_t^{nf} \tag{A.48}$$

$$bltr_t^{nf} = \upsilon_{10} + \upsilon_{11} \cdot ltgby_t + \upsilon_{12} \cdot nl_t^{nf} + \upsilon 13 \cdot bl_{t-1}^{nf} + \upsilon_{14} \cdot irb_t^{dom} + \xi_{bl}^{nf} \tag{A.49}$$

$$bl_t^{nf} = bl_{t-1}^{nf} + bltr_t^{nf} + blrv_t^{nf} \tag{A.50}$$

A.1.5 Financial Coorporations Real Economy

$$\begin{aligned} fnw_t^f = fnw_{t-1}^f + nl_t^f + (oibarv_t^h - oiblrv_t^h) + (eqarv_t^h - eqlrv_t^h) \\ +(barv_t^h - blrv_t^h) - penlrv_t^h \end{aligned} \tag{A.51}$$

$$nl_t^f = s_t^f + npctr_t^f - i_t^f \tag{A.52}$$

$$nw_t^f = fnw_t^f + k_t^f \tag{A.53}$$

$$s_t^f = b2_t^f + int_t^f - tax_t^f + tra_t^f - cpen_t^f \tag{A.54}$$

$$tax_t^f = t_t^f \tag{A.55}$$

$$intr_t^f = (ireq_t^{dom} * eqa_t^f) + (irb_t^{dom} \cdot ba_t^f) + (iroib_t^{bor} \cdot oiba_t^f) + \xi_{intr}^f \tag{A.56}$$

$$\begin{aligned} intp_t^f = (ireq_t^{dom} \cdot eql_t^f) + (irb_t^{dom} \cdot bl_t^f) + (iroib_t^{dep} \cdot oibl_t^f) \\ +(irpen_t^{dom} \cdot penl_t^f) + \xi_{intp}^f \end{aligned} \tag{A.57}$$

$$int_t^f = intr_t^f - intp_t^f \tag{A.58}$$

$$t_t^f = \theta_{21} \cdot yh_t^f + \theta_{22} \cdot \delta_2 \tag{A.59}$$

$$af_t^f = \kappa_{21} \cdot k_t^f \tag{A.60}$$

$$k_t^f = k_{t-1}^f + (i_t^f - af_t^f) + cgk_t^f \tag{A.61}$$

$$i_t^f = \kappa 22 \cdot \Delta k_t^f + \kappa 23 \cdot oibatr_t^f + af_t^f + \xi_i^f \tag{A.62}$$

A.1.6 Financial Coorporations Financial Economy

$$oibatr_t^f = \eta_{21} \cdot oiba_{t-1}^f + \eta_{22} \cdot hpi_t + \eta_{23} \cdot \Delta h_t^h + \eta_{24} \cdot iroib_t^{bor} + \eta_{25} \cdot \mathcal{T} + \xi_{oiba}^f \tag{A.63}$$

$$oiba_t^f = oiba_{t-1}^f + oibatr_t^f + oibarv_t^f \tag{A.64}$$

$$oibltr_t^f = \zeta_{21} \cdot nl_t^f + \zeta_{22} \cdot oibl_{t-1}^f + \zeta_{23} \cdot iroib_t^{dep} + \zeta_{24} \cdot \mathcal{T} + \xi_{oibl}^f \tag{A.65}$$

$$oibl_t^f = oibl_{t-1}^f + oibltr_t^f + oiblrv_t^f \tag{A.66}$$

$$eqatr_t^f = \psi_{21} \cdot cpeq_t + \psi_{22} \cdot eqa_{t-1}^f + \psi_{23} \cdot ireq_t^{dom} + \psi_{24} \cdot \mathcal{T} + \xi_{eqa}^f \tag{A.67}$$

$$eqa_f = eqa_{t-1}^f + eqatr_t^f + eqarv_t^f \tag{A.68}$$

$$eqltr_t^f = \phi 21 \cdot cpeq_t + \phi 22 \cdot eql_{t-1}^f + \phi 23 \cdot ireq_t^{dom} + \phi 24 \cdot \mathcal{T} + \xi_{eql}^f \tag{A.69}$$

$$eql_t^f = eql_{t-1}^f + eqltr_t^f + eqlrv_t^f \tag{A.70}$$

$$penltr_t^f = fnwf_t^f - ((eqatr_t^f - eqltr_t^f) + (batr_t^f - bltr_t^f) + (oibatr_t^f - oibltr_t^f)) \tag{A.71}$$

$$penl_t^f = penl_{t-1}^f + penltr_t^f + penlrv_t^f \tag{A.72}$$

$$batr_t^f = \mu_{21} \cdot ltgby_t + \mu_{22} \cdot ba_{t-1}^f + \mu_{23} \cdot irb_t^{dom} + \mu_{24} \cdot \mathcal{T} + \xi_{ba}^f \tag{A.73}$$

$$ba_t^f = ba_{t-1}^f + batr_t^f + barv_t^f \tag{A.74}$$

$$bltr_t^f = \upsilon_{21} \cdot ltgby_t + \upsilon_{22} \cdot bl_t^f + \upsilon_{23} \cdot irb_t^{dom} + \upsilon_{24} \cdot \mathcal{T} + \xi_{bl}^f \tag{A.75}$$

$$bl_t^f = bl_{t-1}^f + bltr_t^f + blrv_t^f \tag{A.76}$$

A.1.7 Government Real Economy

$$fnw_t^g = fnw_{t-1}^g + nl_t^g + (oibarv_t^h - oiblrv_t^h) + eqarv_t^h + (barv_t^h - blrv_t^h) \tag{A.77}$$

$$nl_t^g = s_t^g + npctr_t^g - i_t^g \tag{A.78}$$

$$nw_t^g = fnw_t^g + k_t^g \tag{A.79}$$

$$s_t^g = b2_t^g + int_t^g + tax_t^g + tra_t^g - c_t^g \tag{A.80}$$

$$tax_t^g = tax_t^f + tax_t^h + tax_t^{nf} + tax_t^{row} \tag{A.81}$$

$$intr_t^g = (ireq_t^{dom} \cdot eqa_t^g) + (irb_t^{dom} \cdot ba_t^g) + (iroib_t^{dep} \cdot oiba_t^g) + \xi_{intr}^g \tag{A.82}$$

$$intp_t^g = (irb_t^{dom} \cdot bl_t^g) + (iroib_t^{bor} \cdot oibl_t^g)) + \xi_{intp}^g \tag{A.83}$$

$$int_t^g = intr_t^g - intp_t^g \tag{A.84}$$

$$af_t^g = \kappa_{31} \cdot yh_t^g \tag{A.85}$$

$$k_t^g = k_{t-1}^g + (i_t^g - af_t^g) + cgk_t^g \tag{A.86}$$

$$i_t^g = \kappa 32 \cdot \Delta k_t^g + \kappa 33 \cdot oibltr_t^g + af_t^g + \xi_i^g \tag{A.87}$$

A.1.8 Government Financial Economy

$$oibatr_t^g = fnwf_t^g - ((batr_t^g - bltr_t^g) + eqatr_t^g - oibltr_t^g) \tag{A.88}$$

$$oiba_t^g = oiba_{t-1}^g + oibatr_t^g + oibarv_t^g \tag{A.89}$$

$$oibltr_t^g = \zeta_{31} \cdot nl_t^g + \zeta_{32} \cdot oibl_{t-1}^g + \zeta_{33} \cdot iroib_t^{bor} + \zeta_{34} \cdot \mathcal{T} + \xi_{oibl}^g \tag{A.90}$$

$$oibl_t^g = oibl_{t-1}^g + oibltr_t^g + oiblrv_t^g \tag{A.91}$$

$$eqatr_t^g = \psi_{30} + \psi_{31} \cdot eqa_{t-1}^g + \psi_{32} \cdot ireq_t^{dom} + \xi_{eqa}^g \tag{A.92}$$

$$eqa_t^g = eqa_{t-1}^g + eqatr_t^g + eqarv_t^g \tag{A.93}$$

$$batr_t^g = \mu_{31} \cdot ltgby_t + \mu_{32} \cdot nl_t^g + \mu_{33} \cdot ba_{t-1}^g + \mu_{34} \cdot irb_t^{dom} + \xi_{ba}^g \tag{A.94}$$

$$ba_t^g = ba_{t-1}^g + batr_t^g + barv_t^g \tag{A.95}$$

$$bltr_t^g = \upsilon_{31} \cdot ltgby_t + \upsilon_{32} \cdot nl_t^g + \upsilon_{33} \cdot bl_t^g + \upsilon_{34} \cdot irb_t^{dom} + \xi_{bl}^g \tag{A.96}$$

$$bl_t^g = bl_{t-1}^g + bltr_t^g + blrv_t^g \tag{A.97}$$

A.1.9 Rest of the World Real Economy

$$cab_t^{row} = m_t - x_t + w_t^{row} + tra_t^{row} + tax_t^{row} + int_t^{row} + npctr_t^{row} \tag{A.98}$$

$$\begin{aligned} fab_t^{row} = (oibatr_t^{row} - oibltr_t^{row}) + (eqatr_t^{row} - eqltr_t^{row}) \\ +(batr_t^{row} - bltr_t^{row}) + (penatr_t^{row} - penltr_t^{row}) \end{aligned} \tag{A.99}$$

$$bop_t^{row} = cab_t^{row} + fab_t^{row} \tag{A.100}$$

$$nw_t^{row} = fnw_t^{row} \tag{A.101}$$

$$\begin{aligned} fnw_t^{row} = (oiba_t^{row} - oibl_t^{row}) + (eqa_t^{row} - eql_t^{row}) \\ +(ba_t^{row} - bl_t^{row}) + (pena_t^{row} - penl_t^{row}) \end{aligned} \tag{A.102}$$

$$nl_t^{row} = s_t^{row} + ctr_t^{row} - np_t^{row} \tag{A.103}$$

$$\begin{aligned} intr_t^{row} = (ireq_t^{dom} * eqa_t^{row}) + (irb_t^{dom} \cdot ba_t^{row}) + (iroib_t^{dep} \cdot oiba_t^{row}) \\ +(irpen_t^{dom} \cdot pena_t^{row}) + \xi_{intr}^{row} \end{aligned} \tag{A.104}$$

$$\begin{aligned} intp_t^{row} = (ireq_t^{dom} \cdot eql_t^{row}) + (irb_t^{dom} \cdot bl_t^{row}) + (iroib_t^{bor} \cdot oibl_t^{row}) \\ +(irpen_t^{dom} \cdot penl_t^{row}) + \xi_{intp}^{row} \end{aligned} \tag{A.105}$$

$$int_t^{row} = intr_t^{row} - intp_t^{row} \tag{A.106}$$

$$tax_t^{row} = \theta_{41} \cdot w_t^{row} \tag{A.107}$$

$$log(M_t) = \gamma_0 + \gamma_1 \cdot log(my_{t-1}^{row}) + \gamma_2 \cdot log(YD_t^h + I_t) + \gamma_3 \cdot \delta_1 \tag{A.108}$$

$$log(X_t) = \epsilon_0 + \epsilon_1 \cdot log(xy_{t-1}^{row}) + \epsilon_2 \cdot log(Y_t^{eu}) + \epsilon_3 \cdot \delta_1 \tag{A.109}$$

A.1.10 Rest of the World Financial Economy

$$oibatr_t^{row} = \eta_{41} \cdot nl_t^{row} + \eta_{42} \cdot oiba_{t-1}^{row} + \eta_{43} \cdot iroib_t^{dep} + \xi_{oiba}^{row} \tag{A.110}$$

$$oiba_t^{row} = oiba_{t-1}^{row} + oibatr_t^{row} + oibarv_t^{row} \tag{A.111}$$

$$oibltr_t^{row} = \zeta_{41} \cdot oibl_t^{row} + \zeta_{42} \cdot nl_t^{row} + \zeta_{43} \cdot iroib_t^{bor} + \xi_{oibl}^{row} \tag{A.112}$$

$$oibl_t^{row} = oibl_{t-1}^{row} + oibltr_t^{row} + oiblrv_t^{row} \tag{A.113}$$

$$eqatr_t^{row} = \psi_{41} \cdot cpeq_t + \psi_{42} \cdot vr_t^{row} + \psi_{43} \cdot eqa_t^{row} + \psi_{44} \cdot ireq_t^{dom} + \xi_{eqa}^{row} \tag{A.114}$$

$$eqa_{row} = eqa_{t-1}^{row} + eqatr_t^{row} + eqarv_t^{row} \tag{A.115}$$

$$eqltr_t^{row} = \phi_{41} \cdot cpeq_t + \phi_{42} \cdot eql_{t-1}^{row} + \phi_{43} \cdot ireq_t^{dom} + \xi_{eql}^{row} \tag{A.116}$$

$$eql_t^{row} = eql_{t-1}^{row} + eqltr_t^{row} + eqlrv_t^{row} \tag{A.117}$$

$$penatr_t^{row} = \beta_{41} \cdot nl_t^{row} + \beta_{42} \cdot pena_t^{row} + \beta_{43} \cdot irpen_t^{dom} + \beta_{44} \cdot \mathcal{T} + \beta_{45} \cdot \delta_2 + \xi_{pena}^{row} \tag{A.118}$$

$$pena_t^{row} = pena_{t-1}^{row} + penatr_t^{row} + penarv_t^{row} \tag{A.119}$$

$$\begin{aligned} penltr_t^{row} = fnwf_t^{row} - ((oibatr_t^{row} - oibltr_t^{row}) + (eqatr_t^{row} - eqltr_t^{row}) \\ +(batr_t^{row} - bltr_t^{row}) + penatr_t^{row}) \end{aligned} \tag{A.120}$$

$$penl_t^{row} = penl_{t-1}^{row} + penltr_t^{row} + penlrv_t^{row} \tag{A.121}$$

$$batr_t^{row} = \mu_{41} \cdot ba_{t-1}^{row} + \mu_{42} \cdot irb_t^{dom} + \mu_{43} \cdot \mathcal{T} + \xi_{ba}^{row} \tag{A.122}$$

$$ba_t^{row} = ba_{t-1}^{row} + batr_t^{row} + barv_t^{row} \tag{A.123}$$

$$bltr_t^{row} = \upsilon_{41} \cdot ltgby_t + \upsilon_{42} \cdot bl_t^{row} + \upsilon_{43} \cdot irb_t^{dom} + \upsilon_{44} \cdot \mathcal{T} + \xi_{bl}^{row} \tag{A.124}$$

$$bl_t^{row} = bl_{t-1}^{row} + bltr_t^{row} + blrv_t^{row} \tag{A.125}$$

A.1.11 Total Economy

$$y_t = c_t^h + c_t^g + i_t + x_t - m_t \tag{A.126}$$

$$DEDG_t = C_t^h + C_t^g + I_t \tag{A.127}$$

$$i_t = i_t^f + i_t^g + i_t^{nf} + i_t^h \tag{A.128}$$

$$k_t = k_t^f + k_t^g + k_t^{nf} + h_t^h \tag{A.129}$$

$$Y_t^{eu} = \lambda \cdot DEDG_t \tag{A.130}$$

A.1.12 Labour Market

$$w_t^h = w_t^{nf} - w_t^{row} \tag{A.131}$$

$$wr_t = \frac{w_t^h}{ete_t} \tag{A.132}$$

$$w_t^{nf} = \omega_1 \cdot yf_t \tag{A.133}$$

$$yf_t = y_t - prodtax_t^{nf} + subs_t^{nf} \tag{A.134}$$

$$ete_t = \frac{y_t}{prod_t} \tag{A.135}$$

$$tue_t = tlf_t - ete_t \tag{A.136}$$

$$tlf_t = \omega_2 \cdot pop_t \tag{A.137}$$

$$er_t = \frac{ete_t}{tlf_t} \tag{A.138}$$

$$uer_t = 1 - er_t \tag{A.139}$$

A.1.13 Deflators

$$YD_t^h = \frac{(yd_t^h \cdot 100)}{defyd_t^h} \tag{A.140}$$

$$C_t^h = \frac{(c_t^h \cdot 100)}{defc_t^h} \tag{A.141}$$

$$m_t = \frac{(M_t^{row} \cdot defm_t)}{100} \tag{A.142}$$

$$x_t = \frac{(X_t \cdot defe_t)}{100} \tag{A.143}$$

$$Y_t = \frac{(y_t \cdot 100)}{defy_t} \tag{A.144}$$

$$I_t = \frac{(i_t \cdot 100)}{defi_t} \tag{A.145}$$

$$y_t^{eu} = \frac{(Y_t^{eu} \cdot defy_t^{eu})}{100} \tag{A.146}$$

A.1.14 Ratios

$$vr_t^h = \frac{ydt^h}{fnwt^h} \tag{A.147}$$

$$vr_t^{nf} = \frac{ydt^{nf}}{fnwt^{nf}} \tag{A.148}$$

$$vr_t^f = \frac{ydt^f}{fnwt^f} \tag{A.149}$$

$$vr_t^g = \frac{ydt^g}{fnwt^g} \tag{A.150}$$

$$loan_t^h = \frac{(oibltr_t^h \cdot 100)}{yd_t^h} \tag{A.151}$$

$$debt_t^h = \frac{(oibl_t^h \cdot 100)}{yd_t^h} \tag{A.152}$$

$$debty_t^h = \frac{(oibl_t^h \cdot 100)}{y_t} \tag{A.153}$$

A.1.15 Interest Rates

$$iroib_t^{bor} = \frac{d41p_t^h}{oibl_t^h} \tag{A.154}$$

$$iroib_t^{dep} = \frac{d41p_t^f}{oibl_t^f} \tag{A.155}$$

$$ireq_t^{dom} = \frac{d42p_t^{nf} + d42p_t^f}{eql_t^{nf} + eql_t^f} \tag{A.156}$$

$$irb_t^{dom} = \frac{d41p_t^g - (\frac{d41p_t^g}{oibl_t^g})}{bl_t^g} \tag{A.157}$$

$$irpen_t^{dom} = \frac{d44p_t^f}{penl_t^f} \tag{A.158}$$

A.1.16 Error Correction Variable

As stated earlier in chapter 6 the calculations for the different ξ variables is calculated below. The first is an example used to calculate the interest error variable for paid interest for the households, and the second has been generalized so that everything can fit in this calculation.

The first is ξ_{intp}^h It is equal to the data's value $\underset{data}{pip_t^h}$ subtracted to the data's value of $\underset{data}{intp_t^h}$ as shown below:

$$\xi_{intp}^h = \underset{data}{pip_t^h} - \underset{data}{intp_t^h} \tag{A.159}$$

Just as the equation above the variable ξ_{stock}^{sector} is calculated. It is equal to the data's value $\underset{data}{stock_t^{sector}}$ subtracted to the model's value of $\underset{model}{stock_t^{sector}}$ as follows:

$$\xi_{stock}^{sector} = \underset{data}{stock_t^{sector}} - \underset{model}{stock_t^{sector}} \tag{A.160}$$

A.2 Tables of Parameters and Dummy Variables

Table A.1: Trend and Dummy variable

$\mathcal{T}$ = Trend	$\delta_1 = 1$ when $year > 2007$ and $year < 2010$
$\delta_2 = 1$ when $year > 2014$	$\delta_3 = 1$ when $year = 2015$

Table A.2: Parameter values for Household Consumption

$\alpha_1 = 0.836647 \quad \alpha_2 = 0.150659 \quad \alpha_3 = -0.004914 \quad \alpha_4 = 0.033668$

Table A.3: Parameter values for European GDP

$\lambda = 5.523927$

Table A.4: Parameter values for Labour and Wage

$\omega_1 = 0.603061 \quad \omega_2 = 0.53606$

Table A.5: Parameter values for Tax

$\theta_1 = 0.354577$	$\theta_2 = 43972.28$	$\theta_{11} = 0.548714$
$\theta_{21} = 0.070078$	$\theta_{22} = 2585.676$	$\theta_{41} = 0.185605$

Table A.6: Parameter values for Export

$\epsilon_0 = -24.93105 \quad \epsilon_1 = 0.463633 \quad \epsilon_2 = 2.407387 \quad \epsilon_3 = -0.014766$

Table A.7: Parameter values for Import

$\gamma_0 = -22.99407 \quad \gamma_1 = -0.401536 \quad \gamma_2 = 2.608718 \quad \gamma_3 = 0.038653$

Table A.8: Parameter values for Investment

$\kappa_1 = 0.031982$	$\kappa_2 = 0.192609$	$\kappa_3 = 0.175$
$\kappa_{11} = 0.069837$	$\kappa_{12} = 0.286208$	$\kappa_{13} = 0.05$
$\kappa_{21} = 0.110787$	$\kappa_{22} = 0.489701$	$\kappa_{23} = 0.0003$
$\kappa_{31} = 0.062761$	$\kappa_{32} = -0.271325$	$\kappa_{33} = 0.15$

Table A.9: Parameter values for Other Interest Bearing Assets

η_0 = 190367.6	η_1 = -69705.26	η_2 = -0.120585	η_3 = -775439.4	
η_{21} = -0.138271	η_{22} = 13775.47	η_{23} = 0.758969	η_{24} = -1773362	η_{25} = -17819.66
η_{41} = 1.931997	η_{42} = 0.093178	η_{43} = 1359815		

Table A.10: Parameter values for Other Interest Bearing Liabilities

ζ_1 = 0.552434	ζ_2 = 2583.044	ζ_3 = 4143.47500	
ζ_4 = -0.213248	ζ_5 = -0.237631	ζ_6 = -1449977	
ζ_{11} = -0.545683	ζ_{12} = 5783845	ζ_{13} = 67525.42	
ζ_{21} = 8.486164	ζ_{22} = -0.588781	ζ_{23} = 8834817	ζ_{24} = 116444
ζ_{31} = -0.128392	ζ_{32} = -0.697486	ζ_{33} = 1552072	ζ_{34} = 15121.17
ζ_{41} = 0.117703	ζ_{42} = 1.628094	ζ_{43} = 512797	

Table A.11: Parameter values for Bond Assets

μ_0 = 59324.15	μ_1 = -99992.27	μ_2 = 16719.2	μ_3 = -0.155308	μ_4 = -1154325
μ_{11} = -57503.92	μ_{12} = -0.378197	μ_{13} = 5824685		
μ_{21} = 146521.3	μ_{22} = -0.287675	μ_{23} = -8236635	μ_{24} = 65839.14	
μ_{31} = -2411.443	μ_{32} = -0.158986	μ_{33} = -0.228188	μ_{34} = 950556.2	
μ_{41} = -0.401911	μ_{42} = 2310908	μ_{43} = 31860.51		

Table A.12: Parameter values for Bond Liabilities

υ_{10} = 72558.3	υ_{11} = -7547.215	υ_{12} = 0.136915	υ_{13} = -0.454661	υ_{14} = 75456.44
υ_{21} = -69092.59	υ_{22} = 0.240549	υ_{23} = 5421712	υ_{24} = -47673.53	
υ_{31} = 37977.77	υ_{32} = -0.32906	υ_{33} = 0.14239	υ_{34} = -4959086	
υ_{41} = 44510.93	υ_{42} = -0.433023	υ_{43} = -3739888	υ_{44} = 37642.61	

Table A.13: Parameter values for Equity Assets

ψ_0 = 163882.4	ψ_1 = -263046.8	ψ_2 = -76.56369		
ψ_3 = -0.014584	ψ_4 = 2338729	ψ_5 = 54566.82		
ψ_{11} = -155.4894	ψ_{12} = 0.186943	ψ_{12} = 3999506	ψ_{14} = 585163.6	ψ_{15} = -15640.34
ψ_{21} = 578.1072	ψ_{22} = -0.377871	ψ_{23} = -3362871	ψ_{24} = 47324.02	
ψ_{30} = 27496.87	ψ_{31} = -0.03483	ψ_{32} = -498910.3		
ψ_{41} = 209.5457	ψ_{42} = -101645.7	ψ_{43} = -0.125453	ψ_{44} = -1852212	

Table A.14: Parameter values for Equity Liabilities

ϕ_{10} = 239788.7	ϕ_{11} = -212.7508	ϕ_{12} = 0.058066	ϕ_{13} = -4666166	ϕ_{14} = 355478.5
ϕ_{21} = 328.1726	ϕ_{22} = -0.254543	ϕ_{23} = 3164439	ϕ_{24} = 32570.79	
ϕ_{41} = 360.9211	ϕ_{42} = -0.115563	ϕ_{43} = -3692503		

Table A.15: Parameter values for Pension Assets

β_{41} = -0.001235	β_{42} = -0.076746	β_{43} = 9887.2800	β_{44} = 51.52578	β_{45} = -94.4893200

A.3 Balance Sheet Matrices

Table A.16: Balance Sheet Matrix - Theoretical

Variables	H_{ass}	H_{lia}	NF_{ass}	NF_{lia}	F_{ass}	F_{lia}	G_{ass}	G_{lia}	ROW_{ass}	ROW_{lia}	Σ -Total Sum
Other Interest Bearing	$oiba_t^h$	$oibl_t^h$	$oiba_t^{nf}$	$oibl_t^{nf}$	$oiba_t^f$	$oibl_t^f$	$oiba_t^g$	$oibl_t^g$	$oiba_t^{row}$	$oibl_t^{row}$	ng_t
Equity	eqa_t^h	0	eqa_t^{nf}	eql_t^{nf}	eqa_t^f	eql_t^f	eqa_t^g	0	eqa_t^{row}	eql_t^{row}	0
Bonds	ba_t^h	0	ba_t^{nf}	bl_t^{nf}	ba_t^f	bl_t^f	ba_t^g	bl_t^g	ba_t^{row}	bl_t^{row}	0
Pension	$pena_t^h$	0	0	0	0	$penl_t^f$	0	0	$pena_t^{row}$	$penl_t^{row}$	0
Net Financial Wealth		fnw_t^h		fnw_t^{nf}		fnw_t^f		fnw_t^g		fnw_t^{row}	ng_t
Capital	h_t^h	0	k_t^{nf}	0	k_t^f	0	k_t^g	0	0	0	k_t
Net Wealth		nw_t^h		nw_t^{nf}		nw_t^f		nw_t^g		nw_t^{row}	nw_t
Σ - Sector Sum	0		0		0		0		0		0

Table A.17: Balance Sheet Matrix with actual data from 2015

Variables	H_{ass}	H_{lia}	NF_{ass}	NF_{lia}	F_{ass}	F_{lia}	G_{ass}	G_{lia}	ROW_{ass}	ROW_{lia}	Σ -Total Sum
Other Interest Bearing	1008548	2706809	2104763	2691513	6995599	4581575	619866	480595	1493170	1732217	29237
Equity	2003267	0	2563893	4486889	4892043	4839064	421798	0	2060943	2615992	-1
Bonds	70027	0	383238	176867	3792676	3563678	145807	816314	1690556	1525445	0
Pension	2982018	0	0	0	0	2993180	0	0	17489	6326	1
Net Financial Wealth		3357051		-2303375		-297179		-109438		-617822	29237
Capital	2360004	0	2983899	0	78182	0	961096	0	0	0	6383181
Net Wealth		5717055		680524		-218997		851658		-617822	6412418
Σ - Sector Sum	0		0		0		0		0		0

Table A.18: Balance Sheet Matrix with data from 2015 as a percentage of GDP

Variables	H_{ass}	H_{lia}	NF_{ass}	NF_{lia}	F_{ass}	F_{lia}	G_{ass}	G_{lia}	ROW_{ass}	ROW_{lia}	Σ -Total Sum
Other Interest Bearing	49,75	133,53	103,83	132,77	345,09	226,01	30,58	23,71	73,66	85,45	1,4423
Equity	98,82	0	126,48	221,34	241,32	238,71	20,81	0	101,67	129,05	0
Bonds	3,45	0	18,91	8,72	187,09	175,80	7,19	40,27	83,39	75,25	0
Pension	147,10	0	0	0	0	147,65	0	0	0,86	0,31	0
Net Financial Wealth	0	165,6028355	0	-113,6251523	0	-14,65979666	0	-5,398560555	0	-30,47706902	1,4423
Capital	116,42	0	147,20	0	3,86	0	47,41	0	0	0	314,88
Net Wealth	0	282	0	34	0	-11	0	42	0	-30	316,32
Σ - Sector Sum	0	0	0	0	0	0	0	0	0	0	0

A.4 Transaction-Flow Matrices

Table A.19: Transaction-Flow Matrix - Theoretical

Variables	H	NF_{cur}	NF_{cap}	F	G	ROW	Σ -Total Sum
Household Consumption	c_t^h	c_t^h	0	0	0	0	0
Government Consumption	0	c_t^g	0	0	c_t^g	0	0
Investment	i_t^h	i_t	i_t^{nf}	i_t^f	i_t^g	0	0
Import	0	m_t	0	0	0	m_t	0
Export	0	x_t	0	0	0	x_t	0
GDP		y_t					0
Wages	w_t^h	w_t^{nf}	0	0	0	w_t^{row}	0
Taxes	tax_t^h	tax_t^{nf}	0	tax_t^f	tax_t^g	tax_t^{row}	0
Interest Flows	int_t^h	int_t^{nf}	0	int_t^f	int_t^g	int_t^{row}	0
B2	$b2_t^h$	$b2_t^{nf}$	0	$b2_t^f$	$b2_t^g$	0	0
Pension Adjustments	$cpen_t^h$	0	0	$cpen_t^f$	0	0	0
Transfers	tra_t^h	tra_t^{nf}	0	tra_t^f	tra_t^g	tra_t^{row}	0
Savings	0	s_t^{nf}	s_t^{nf}	0	0	0	0
NP and Capital Transfers	$npctr_t^h$	0	$npctr_t^{nf}$	$npctr_t^f$	$npctr_t^g$	$npctr_t^{row}$	0
Net Lending	nl_t^h	nl_t^{nf}	nl_t^{nf}	nl_t^f	nl_t^g	nl_t^{row}	0
Σ - Sector Sum	0	0	0	0	0	0	0

Table A.20: Transaction-Flow Matrix with actual data from 2015

Variables	H	NF_{cur}	NF_{cap}	F	G	ROW	Σ-Total Sum
Household Consumption	-955867	955867	0	0	0	0	0
Government Consumption	0	520797	0	0	-520797	0	0
Investment	-87460	400467	-228342	-11373	-73292	0	0
Import	0	-969507	0	0	0	969507	0
Export	0	1119546	0	0	0	-1119546	0
GDP		2027170					0
Wages	1038827	-1049056	0	0	0	10229	0
Taxes	-553757	-375821	0	-10359	946462	-6525	0
Interest Flows	81590	-23731	0	28338	-12117	-74078	2
B2	153111	-260493	0	48628	58754	0	0
Pension Adjustments	76423	0	0	-76423	0	0	0
Transfers	271934	28141	0	75533	-410430	34821	-1
Savings	0	-346210	346210	0	0	0	0
NP and Capital Transfers	4928	0	13395	-1330	-24189	7196	0
Net Lending	29729	0	131263	53014	-35609	-178397	0
Σ - Sector Sum	0	0	0	0	0	1	1

Table A.21: Transaction-Flow Matrix with data from 2015 as a percentage of GDP

Variables	H	NF_{cur}	NF_{cap}	F	G	ROW	Σ -Total Sum
Household Consumption	-47,15	47,15	0	0	0	0	0
Government Consumption	0	25,69	0	0	-25,69	0	0
Investment	-4,31	19,75	-11,26	-0,56	-3,62	0	0
Import	0	-47,83	0	0	0	47,83	0
Export	0	55,23	0	0	0	-55,23	0
GDP	0	100,00	0	0	0	0	0
Wages	51,25	-51,75	0	0	0	0,50	0
Taxes	-27,32	-18,54	0	-0,51	46,69	-0,32	0
Interest Flows	4,02	-1,17	0	1,40	-0,60	-3,65	0
B2	7,55	-12,85	0	2,40	2,90	0	0
Pension Adjustments	3,77	0	0	-3,77	0	0	0
Transfers	13,41	1,39	0	3,73	-20,25	1,72	0
Savings	0	-17,08	17,08	0	0	0	0
NP and Capital Transfers	0,24	0	0,66	-0,07	-1,19	0,35	0
Net Lending	1,47	0	6,48	2,62	-1,76	-8,80	0
Σ - Sector Sum	0	0	0	0	0	0	0

A.5 Literature Review Table

Table A.22: Papers explained in Review of Literature

Title	Investigation	Contributors	Year Published
Foreign Debt, Foreign Trade and Living Conditions, with Special Reference to Denmark	Deficit on balance of payments	Wynne Godley and Gennaro Zezza	1989
A Simple Stock Flow Model of the Danish Economy	Deficit on balance of payments	Wynne Godley and Gennaro Zezza	1992
ADAM - en model af dansk økonomi	A broad model used to analyse the Danish economy	The ADAM model group	2012
Macroeconomic Models and the Behaviour of the Danish Households – a Post-Keynesian Analysis	Danish Household Debt, A PhD Thesis	Mikael Randrup Byrialsen	2015
Rentestød til ADAM og til en VAR-model	Interest shock to the ADAM model	Dan Knudsen and Niconline Wiborg Nagel	2017
De private finansielle konti i ADAM	A look at the household portfolio	Dan Knudsen	2017
The effects of a less generous unemployment benefits system in a Stock Flow Consistent Model framework	Danish Social Benefits Analysis	Mikael Randrup Byrialsen and Hamid Raza	2018
Title unknown	An all-purpose makro economic model	Mikael Randrup Byrialsen	Work in Progress

A.6 Figures

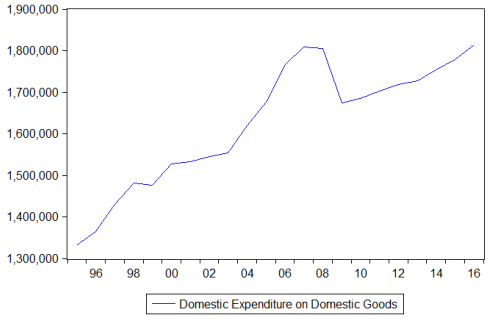

Figure A.1: Data for Domestic Expenditure on Domestic Goods

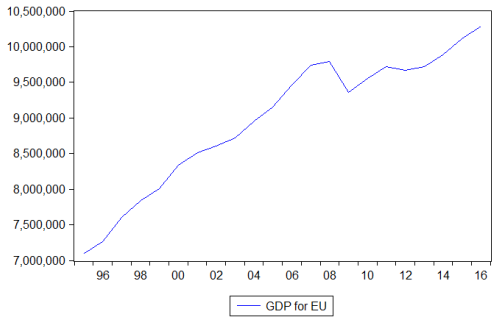

Figure A.2: Data for GDP for EU

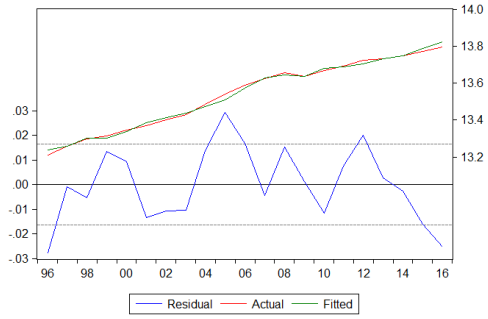

Figure A.3: Residuals for Household Consumption

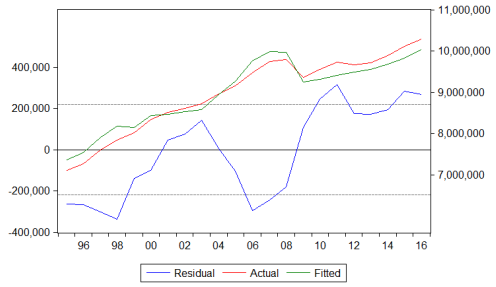

Figure A.4: Residuals for GDP for EU

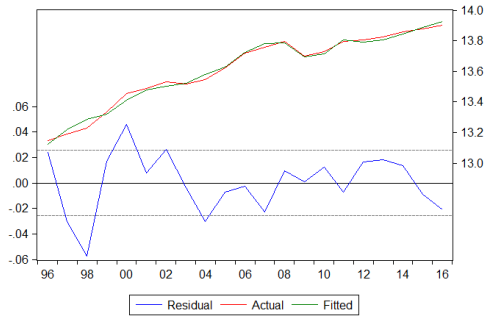

Figure A.5: Residuals for Export

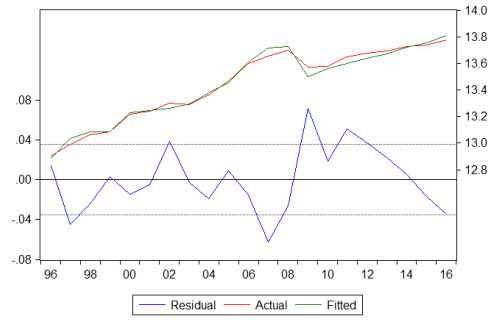

Figure A.6: Residuals for Import