Household Debt and Macroeconomic Stability: An Empirical Stock-flow consistent (SFC) model for the Danish Economy

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Abstract

This paper addresses the issue of household debt in the Danish economy. We develop a large scale stock-flow consistent model. The model has five main sectors namely, household, firms, financial corporations, government, and the rest of the world (RoW) sectors. We use the model to explore the macroeconomic stability of the Danish economy, given the current level of household debt. We fit the model to annual data from 1995-2016, estimate the structural parameters, and simulate the model for a baseline scenario, against which we compare and contrast the effects of different economic shocks. To assess the macroeconomic risks associated with high household debt, we introduce two shocks separately, i.e., a fall in house prices and a rise in interest rates, finding that these shocks have adverse effects on the economy which tend to be stronger in the case of higher debt. Focusing on macroeconomic stability, we find that private domestic demand seems to be relatively sensitive to the changes in interest rates and house prices, but the overall output is less affected mainly due to strong current account surplus. Overall, it can be concluded that in the absence of global shocks, domestic shocks to the economy may not pose a serious risk to macroeconomic stability, when purely focusing on the sensitivity of output growth and unemployment.

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1 Introduction

In the aftermath of the global financial crisis (GFC), the issue of household debt from being a widely ignored topic (see e.g. Eggertsson and Krugman (2012), Keen (2009), BIS (2017)) has become a central aspect in macroeconomic analysis (OECD (2016), IMF (2017), Eggertsson and Krugman (2012)). Before the crisis, households in most western economies accumulated debt with a much faster pace than the growth in both GDP and disposable income. This had the effect of increasing aggregate demand and fuelling asset prices. However, high levels of household debt were also closely linked to the sharp recessions during the GFC (Mian and Sufi (2010), Reinhart and Rogoff (2010), Cecchetti et al. (2011))). In particular, countries which experienced a high increase in household debt before the crisis demonstrated a sharp relative fall in consumption of durables in the years following the boom (Mian and Sufi (2010)).

In general, there seems to be consensus on the argument that accumulation of household debt can stimulate economic growth in the short run, but can also lead to financial and macroeconomic instability in the medium to long term, especially when an economy is hit by unexpected adverse shocks. Hence, a high level of household debt is usually perceived as a potential risk for the economy. For these reasons, Denmark - which currently has the highest debt to income ratio amongst OECD countries - has received considerable attention in recent times (see e.g. IMF (2018), OECD (2016), European commission (2018)). Denmark was one of those countries where the level of household debt to income ratio was high but the impact of the crisis was not extreme as compared to other European countries such as GIIPS and Iceland.

Nonetheless, the existing high stock of debt in the household sector combined with the prevailing asset price boom still remains a concern. The real house prices have reached the pre-crisis levels, whereas the stock prices have increased more aggressively than almost all European countries in the post-crisis period. Given the high level of debt, several studies since the crisis, such as OECD (2016), Igan et al. (2013), Nationalbanken (2012), Cecchetti et al. (2011) have expressed concerns about the vulnerability of the Danish economy to adverse shocks. Interestingly, despite concerns outside Denmark, the authorities in Denmark do not seem to share the view that high household debt is a major concern for the Danish economy as it was for other countries. This narrative is usually backed by three main arguments: i) the gross wealth exceeds the gross debt, ii) the wealthy part of the population holds the majority of the debt, and iii) the Danish mortgage system is built on a balanced principle that involves a complete match between loans and bonds. Overall, the Danish central bank agrees with the warning from IMF (2017) that a negative shock to the economy could result in financial vulnerability, but does not see this as a major issue that needs some sort of policy reaction at current. Thus, it is important to analyze how resilient is the Danish economy to adverse shocks, not only in the short run, but also in the medium run. Specifically, the economy may be vulnerable two fundamental shocks which are quite recurrent, as is evident from the history of asset price bubbles. First, the economy might experience a decline in asset prices at some point. Most recently, the house prices around the capital region have shown a tendency of declining, but not to the extend to have any major impact on the economy at the moment. However, one cannot completely rule out a sharp

decline in the house prices in the event of a major adverse shock to the economy. Second, there might be an increase in interest rates for various reasons. Interest rates have been at historically low levels for a long period, and some in the markets are expecting an increase in the near future.

How should these scenarios affect macroeconomic stability in Denmark? The aim of this paper is to address this question by investigating the effects of the two aforementioned shocks to a small open economy with a high debt-income ratio. To do so, we adopt a stock-flow consistent (SFC) approach, using annual data on Danish national accounts 1995-2016.

Our paper has two main contributions. First, from a policy perspective, our paper contributes to the debate on household debt by investigating the macroeconomic risks associated with high household debt in the Danish economy. We explicitly assess whether the current household debt poses a risk to macroeconomic stability in Denmark. Second, from a modeling perspective, our paper contributes to the scarce empirical literature on SFC as well as the literature on household debt in general. Our investigation of household debt diverges from the majority of other analyses in one central aspect; almost all analyses of household debt are either carried out as purely theoretical (Hein (2012), Kumhof et al. (2015), Eggertsson and Krugman (2012)) or purely empirical where the results are based on only a few variables of interest as in Cecchetti et al. (2011), Reinhart and Rogoff (2010) or Lombardi et al. (2017). These empirical models usually explore interesting correlations but neglect important feedback effects. Our paper adds to the literature by building a large scale empirical macroeconomic model for a small open economy that can explore a broad variety of feedback mechanism related to the household sector as will be discussed. In particular, all our parameters in the housing sector are estimated and the structure of the model is confronted with the actual data. In contrast, with the exception of Burgess et al. (2016), almost all other models of household debt following the SFC approach are theoretical with calibrated parameters, solved for hypothetical data. Hence, our model attempts to capture the actual development in the Danish housing sector where the interpretation of results is more relevant in policy discussions.

The rest of the paper is structured as follows. Section two provides a review of the literature on the effect of household debt. Section three gives an empirical presentation of the situation among the Danish households. The model used in this paper is presented in section 4, while the simulation results are presented and discussed in section 5. Section 6 concludes this paper.

2 Literature Review

The macroeconomic effects of household debt (private debt in general) were widely ignored in the literature before the GFC, as recognized by several authors (see, amongst other, Eggertsson and Krugman (2012), Keen (2009), BIS (2017)). After the GFC, this issue has become central in macroeconomic debates. Broadly, household debt is typically related to two types of risks, namely *financial stability risk* and *macroeconomic risk* (Svensson (2019)). Financial stability risks may occur in a situation, where indebted households are unable to fulfil their payment obligations - and the losses incurred by financial institutions, as a result

of loan defaults, exceed their capital buffer. The macroeconomic risk on the other hand occurs when the servicing of debt suppresses consumption and investment decisions, thereby leading to a fall in the aggregate demand.

Focusing on the macroeconomic risks associated with household debt, the literature on this topic can be split into two main strands. The first group consists of purely econometric analysis, exploring the relationship between household debt and a set of macroeconomic variables. Overall, the empirical literature seems to suggest that the pre-crisis growth to some extent was driven by the accumulation (flow) of household debt, but the stock of debt eventually led to a fall in GDP, thereby exhibiting a negative relationship. In order to understand why the role of private debt in the economy is so complex, one needs to understand the dual nature of it. An expansion of private credit in itself fuels the boom, but the private deleveraging [during negative events] dampens the growth in the medium to long term, as discussed in Reinhart and Rogoff (2010) and IMF (2017). Stockhammer and Wildauer (2015), using panel data for OECD countries, find that both the accumulation of debt and property prices were the main drivers of high growth rates before GFC. Cecchetti et al. (2011) analyse the link between the size of household debt and the growth rate of the economy for a panel of OECD countries using data from 1980-2010. They find that household debt to GDP above 85% results in a lower growth rate in GDP (and higher level of unemployment). This result is in line with other empirical studies such as, Reinhart and Rogoff (2010), Mian et al. (2017) and Jordà et al. (2016), which also conclude that a higher level of household debt eventually leads to a lower growth in economic activity. Alter et al. (2018) adopts a VAR approach for a panel of 80 countries from 1950 - 2016, finding evidence of a negative relationship between level of household debt and GDP growth. IMF (2017) argues that the effect of household debt on the economy may not be the same for all countries. The effects may vary due to various factors such as, phases of development, financial and institutional characteristics (i.e., openness of capital account, choice of exchange rate regime, degree of inequality). For countries with open capital account, fixed exchange rate regimes, and high degree of inequality, the negative effects of high levels of household debt on the economy are relatively stronger. Andersen et al. (2016), while using data for individual households in Denmark, also confirm a negative correlation between the level of debt before the crisis and the growth in consumption during the crisis. To sum up, the focus of most empirical studies is to establish correlations between household debt and some key macroeconomic variables, but the channels through which the stock of debt interacts with the real and the financial side of the economy are not well-described. In most cases, the transmission channels which bind this correlation are implicit to these empirical models.

The second strand of the literature is related to the theoretical models in which the transmission channels of household debt plays a central role. In a typical DSGE model of private debt (see, e.g., Korinek and Simsek (2016); Eggertsson and Krugman (2012)), a fraction of the population is usually assumed to be impatient, which requires credit to finance the desired level of consumption. Therefore, more credit availability induces the households to increase their accumulation of debt to finance consumption. Constraints on the credit forces households to lower the level of consumption in order to respect the constraint, which has a negative effect on the macroeconomic stability of the economy. Under normal circumstances monetary policy could be used to stimulate aggregate demand, but for different reasons,

this may not be an option. For example, in an open economy with a fixed exchange rate regime, monetary policy cannot be used to stimulate the economy, as it can reinforce the debt hanging problems. A zero-lower bound on interest rate is another rigidity, which can impede full adjustment after the shock.

Dutt (2006) adopts a Steindlian approach, where the accumulation of debt in the short run stimulates aggregate demand. The population in the model is split up into two groups; workers and rentiers, where the working group borrows to finance their expenditures, while the rentiers save a proportion of their income. Within this framework, the overall effect of the increase in the stock of debt seems to be ambiguous. The overall effect basically depends on the level of interest rate, level of debt, and the differences in propensity to consume out of income between the two groups of population. While most combinations in this framework result in a negative effect of high debt on income ratio, a combination of low level of interest rate, high propensity to invest, and high wage share may result in a positive effect even in the long run.

Hein (2012) adopts a Kaleckian approach to analyse the different channels related to both the accumulation of debt and the medium effects of the stock of debt. Following the traditions in Kaleckian models, households are grouped into workers and rentier, where the workers receive wage income, while the rentiers receive profit income. Since workers spend more than their income, the group as a whole becomes indebted. The rentiers on the other hand are assumed to save a proportion of their income. In this model, the debt-led economy in the short run turns into a debt-burdened economy in the long run if the level of interest rate is large relative to the share of profit (income of the rentiers). This result can be explained through the redistribution channel, i.e., higher interest rate (or higher debt-income ratio) leads to larger redistribution of income, which, given differences in propensity to consume amongst the two different types of households, results in a fall in aggregate demand. In the framework of Hein (2012), a workers' debt-capital ratio exceeding a certain threshold will result in a unstable solution, where the debt-ratio will keep on increasing and affect the goods market equilibrium negatively.

There are a number of SFC models that include a housing market. Zezza (2008) splits the household sector into workers and capitalists in which workers need to borrow to finance their housing investments. He assumes that mortgages have variable interest rates. The demand for housing is positively determined by population and expected real income, and it falls with debt repayment ratio. The financing of housing take place through savings and new loans. Caverzasi and Godin (2015) also split the household sector into working class and rentier class. The working class borrows loans for various purposes. The demand for loans plays a passive role, and is determined by the banking sector in the model. Meijers et al. (2014) include a simple housing market in their model, where demand for mortgage loans is a fixed proportion of the housing value. Burgess et al. (2016) considers a housing market, where mortgage loans are determined by loan to value ratio whereas nominal investment in housing is determined by mortgage demand and house prices. With the exception of Zezza (2008) and Burgess et al. (2016), most of these models assume that the supply of housing (i.e., construction of new houses) is given.

We now proceed to discussing the main channels through which household debt interacts

with the rest of the economy.

2.1 Transmission channels of household debt

In general, household debt interacts with the economy and the financial system through various channels. Figure 1, inspired by IMF (2017), presents these channels in a systematic way. The right side of the figure deals with the balance sheet channel through which household debt interacts with the financial system as a whole. The left-hand side of the figure deals with the cash flow view, presenting different channels through which household debt can interact with the real side of the economy.

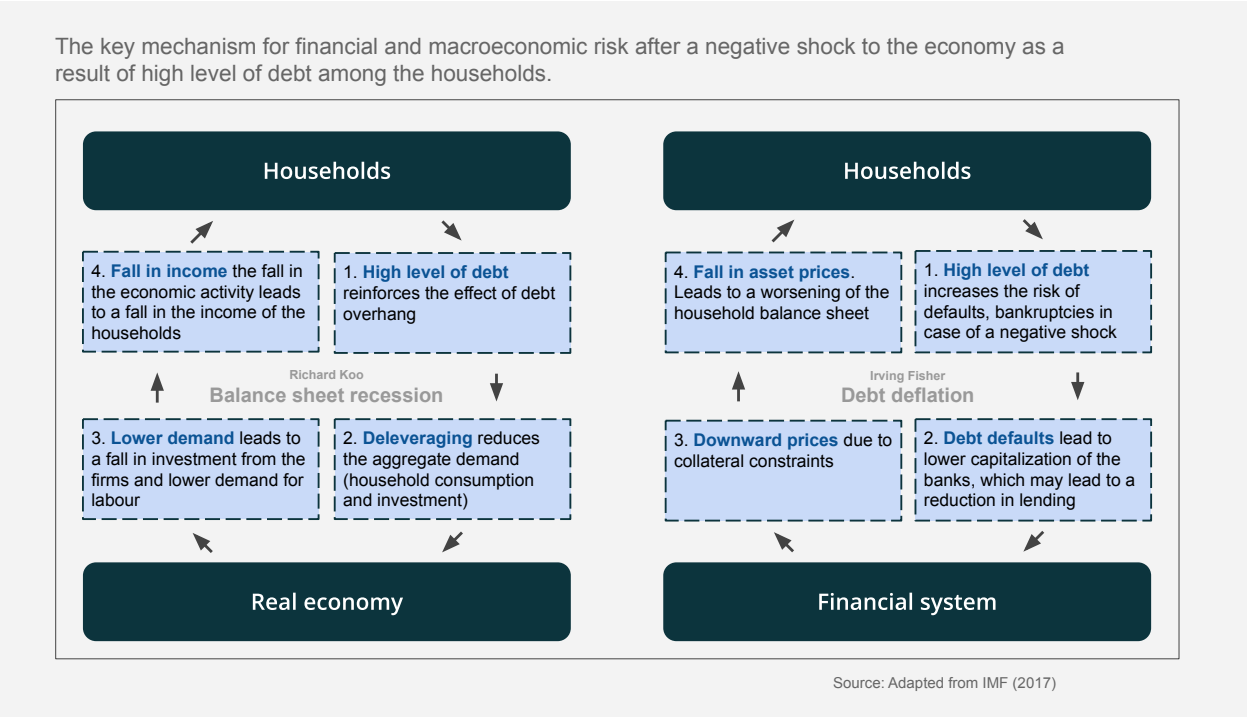

Figure 1: Effect of Household Debt

Focusing on the interaction of household debt with the real economy, we can identify three important transmission channels, namely deleveraging, debt overhang, and collateral. Although these channels separately described here can be sometimes closely interlinked and cause each other. The debt overhang channel works by suppressing consumption (or investment) in order to service the debt burden, while the deleveraging channel works through repayment (or faster repayment) of the debt, which results in a lower propensity to consume and thereby affects aggregate consumption. In both cases, a fall in consumption affects other demand components, e.g. investment, which leads to a fall in the overall economic activity. The size of the household debt is therefore an important factor in determining the magnitude of these two effects: a high level of debt extends the duration of the deleverage phase, just like a higher level of debt increases the debt burden, and thereby the effect on disposable income.

A third channel often discussed in the literature (see e.g. Mian et al. (2013), Aladangady (2017) and Stefani and Hviid (2018)) is the collateral channel, which links together house prices, debt accumulation and expenditures. According to this channel, an increase in house prices may affect the real economy by easier access to credit, which as explained by Eggertsson and Krugman (2012) and Korinek and Simsek (2016) would lead to an increase in aggregate demand. A fall in house prices on the other hand would lead to a fall in collateral which will reduce access to credit, leading to a fall in aggregated demand. Moreover, a fall in house prices contracts the asset side of the balance sheet, which in turn can lead to forced deleveraging and debt overhangs. Due to contagious effects, the negative price shocks may eventually lead to a fall in general asset prices, and the overall economy can experience a Fisher debt-deflation as shown in the Figure 1.

The question of whether a negative shock can affect financial stability depends on a number of factors such as the level of household debt, nature and magnitude of the shock. In general, household debt can threaten financial stability, if households are unable to match their obligation, leading to debt defaults, which in turn can adversely affect the balance sheet of the financial sector. However, if households are able to meet their payment obligations, a negative shock such as an increase in interest rates will not *directly* affect the balance sheets of the households. It will affect their income, since the interest payment increases, but the adverse effects are likely to be limited to the real side of the economy. The households balance sheet structure, due to income reductions, will contract in the next few periods without having any major impact on the financial system as a whole. For example, in Eggertsson and Krugman (2012), the increase in interest rate results in a redistribution of income from borrower-household to lending-household, which has the implication, that if the propensity to consume is higher for the borrowers compared to the lenders, an increase in the interest rate leads to a fall in aggregate consumption. In that sense, an increase in the interest rate only affects the macroeconomic stability.

3 Households balance sheet and house prices in Denmark

Denmark has the highest debt to disposable income ratio in 2017 as compared to other OECD countries as shown in Figure 2. The overall balance sheet structure of the Danish households shows that both assets and liabilities have expanded significantly since the 1990s (see Figure 3). Regarding the composition of assets, the stock of interest-bearing assets as a percentage of GDP seems to be quite stable over the period 1995-2016, while the stock of equities and pension have increased. The increase in the wealth of pension as a percentage of GDP can be explained by the introduction of Danish labour market pension system in 1991, as a result of which, the economy started building up pension stocks by accumulating a constant share of the gross income. Thus, the build-up of the pension stock is relatively new as compared to the traditional financial assets held by the households.

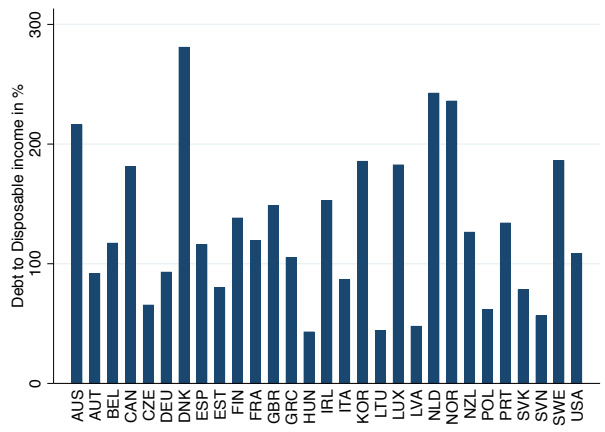

Figure 2: Debt to disposable income for different countries

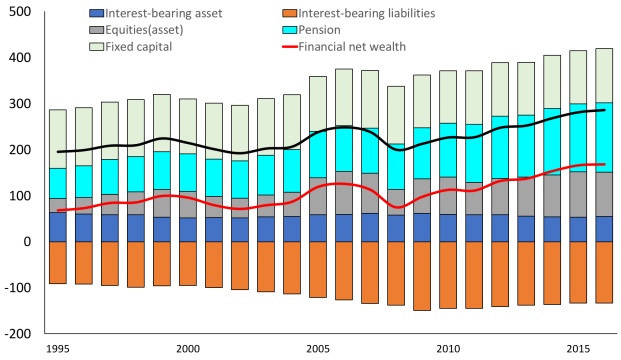

Figure 3: Household balance sheet

On the liability side, interest-bearing liabilities, which are mostly mortgage loans, have increased in general but more so during the period 2000-2009, which has garnered some attention (see, e.g., OECD (2016) and IMF (2017)). In the post-crisis period, the stock of debt as a share of GDP has fallen because the debt level has stabilized while GDP has increased. Overall, the net financial wealth of the household sector has mostly been positive. When the value of fixed assets, which for the households mostly consists of housing, is added to the balance sheet, the net wealth of the households becomes even more positive. The net wealth experienced a fall during the crisis, mainly due to a sharp fall in the asset prices. An important point to highlight here is that the asset side of the households' balance sheet seems to be more sensitive to the conditions in the financial market than its liability side. Thus, a positive net financial wealth as an indication of financial stability can be misleading, as we can see that the GFC had a strong contractionary effect on the asset side of the balance sheet as compared to the liability side. From an accounting perspective, the change in the value of houses occurs due to two main factors: i) investment in new houses, ii) changes in the house prices. While new investments in housing has remained stable after the crisis, the prices of households have increased aggressively surpassing their pre-crisis levels as shown in Figure 5. Specifically, the prices of flats are more than 20% higher when compared with the price peak before the crash. Overall, it apparently seems that the increase in the value of housing has been mostly driven by capital gains rather than new investments. Interestingly, this recent hike in housing prices did not have the same booming effect on the real economy as it had in period before the crisis. That is, most real economic indicators, such as consumption and investment, have grown slowly after the crisis.

Focusing on debt maturity, Figure 4 shows that both short term and long-term debt increased aggressively during 2003-2008. The increase in debt during this period also coincides with high economic growth as was the case in most countries. After the crisis, the short-term debt has relatively remained stable whereas the long-term debt has increased. Thus, the overall increase in debt in the post-crisis period is due to accumulation of long-term debt.

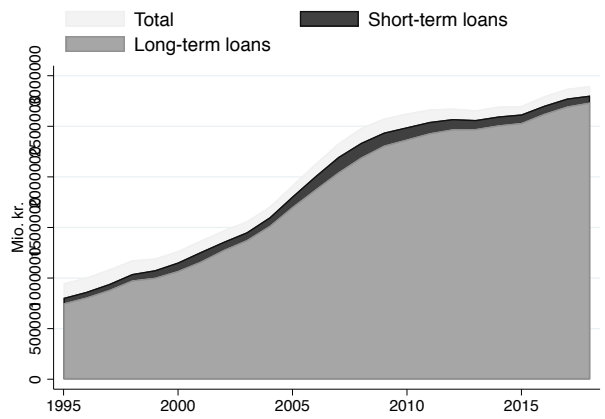

Figure 4: Liabilities

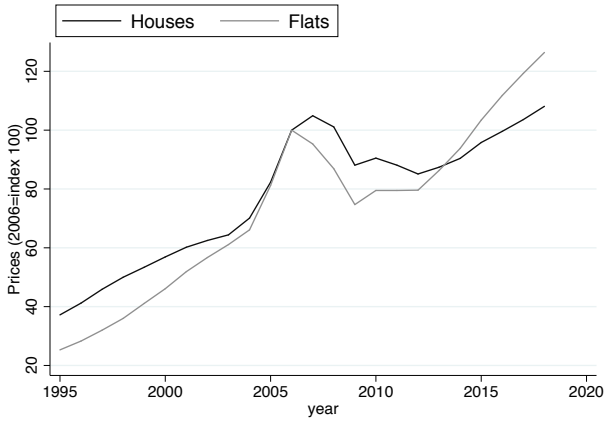

Figure 5: Change in house prices

We now turn to discussing the cost of debt, which is a central aspect of the housing market. Figure 4 shows that the vast majority of the household debt is held as long term debt, which is mostly mortgages loans with a house as a collateral. All mortgage loans are categorised into four types of loans as follows: i) fixed interest rate with installment, ii) fixed interest rate without instalments, iii) flexible interest rate with instalment, and iv) flexible interest rate without instalments. Loans with delayed instalments were introduced in 2003, and since then, these loans have gained much popularity. As can be seen in Figure 6, these loans currently account for almost 50% of the total mortgage loans. Another interesting pattern that can be identified is the increase in loans with flexible interest rates. In 2003, these loans constituted less than 30% of all mortgage loans, but their share has almost doubled, reaching 60% in 2018. To understand the popularity of loans with flexible interest rate, it is important to take a look into the development of the interest rate over time. In the period from 1995-2017, both the short rate and the long rate have fallen, which gives an incentive to switch from fixed interest loans to flexible interest loans. This transformation makes households sensitive to interest rate decisions, which can be a double-edged sword. That is, when the interest rates fall, households' expenditures on debt servicing automatically fall. On the other hand, when the interest rates increase, the cost of debt servicing increases, leading to an adverse effect on household's income.

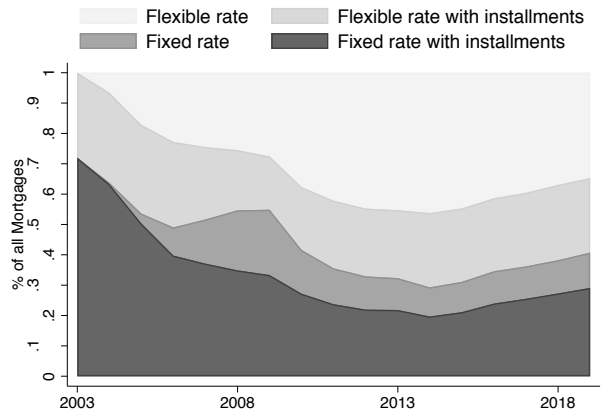

Figure 6: Mortgages loans

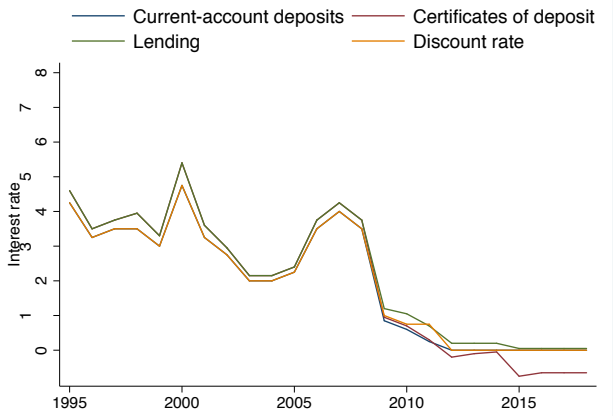

Figure 7: Interest rates

Given the overall development in the housing market combined with the balance sheet structure of the households, we can highlight three main characteristics of the Danish economy at current. i) higher debt to income ratio as compared to other countries, ii) increased vulnerability to interest rate changes, and iii) high household prices surpassing the pre-crisis boom. The aforementioned characteristics of the Danish households raises concerns about the macroeconomic stability. In particular, it is crucial to analyse the macroeconomic effects of two shocks in particular: i) an increase in the level of interest rate, and ii) a fall in the house prices. We now proceed to presenting our data and model used to address the issue of household debt as will be discussed.

4 Data and Methodology

To explore the macroeconomic effects of changes in interest rates and house prices, we adopt a stock flow consistent approach to modelling. Since the analysis is centered around the issue of household debt, we will mostly present our model with a focus on household sector. A complete description of the model and the data used in the model can be found in Byrialsen and Raza (2019). We now proceed to explaining the data used in the model.

4.1 Balance sheet and transaction flow matrix

The balance sheet of the economy consists of five assets: three financial assets (interest-bearing assets, equities and pension) and two fixed assets (fixed capital and housing). It is assumed, that all fixed capital in the household sector consists of housing.

The non-financial corporations partly finance their investment through loans (net interest-bearing assets) and issuing equities (net equities). The balance sheet of the financial corporation is more complex. With the exception of the household sector, the interaction between financial sector and all other sectors take place on net basis. Specifically, the interest-bearing stock for the financial corporation is split into two components: i) net interest-bearing stocks, which involves the interaction between the financial corporations on the one side, and NFC,

Table 1 Balance sheet matrix

	NFC	FC		G	H		W	$\sum$
		A	L		A	L		
Interes bearing (IB)		$+IBA^F$	$-IBL^F$		$+IBA^H$	$-IBL^H$		0
Net interest bearing (NIB)	NIB^N	NIB^F		NIB^G			NIB^W	0
Net equities (NEQ)	NEQ^N	NEQ^F			NEQ^H		NEQ^W	0
Pension (PEN)		$-PEN^F$			$+PEN^H$		$NPEN$	0
Financial net wealth (FNW)	FNW^H	FNW^F		FNW^G	FNW^H		FNW^W	**0**
Fixed assets (K)	K^N	K^F		K^G	K^H			K^T

Table 2 Transaction flow matrix

	NFC		FC		G		H		ROW		
	Current	Capital	Current	Capital	Current	Capital	Current	Capital	Current	Capital	$\sum$
Private Consumption	$+C$						-C				0
Government Consumption	$+G$				$-G$						0
Investment	$+I$	$-I^N$		$-I^F$		$-I^G$		$-I^H$			0
Exports	$+X$								$-X$		0
Imports	$-M$								$+M$		0
[GDP]	[Y]										
Taxes	$-T^N$		$-T^G$		$+T^G$		$-T^H$		$-T^W$		0
Gross Operating Surplus	$-B2^N$		$+B2^F$		$+B2^G$		$+B2^H$				0
Wages	$-WB^N$						$+WB^H$		WB^W		0
Capital Income	rK^N		rK^F		rK^G		rK^H		rK^W		0
Transfers	STR^N		STR^F		STR^G		STR^H		STR^W		0
Pension adjustments			$-CPEN^F$				$+CPEN^H$				0
Savings	$-S^N$	$+S^N$	$-S^F$	$+S^F$	$-S^G$	$+S^G$	$-S^H$	$+S^H$	$-S^W$	$+S^W$	0
Capital transfers		KTR^N		KTR^F		KTR^G		KTR^H		KTR^W	0
Acquisitions - disposals of...		NP^N		NP^F		NP^G		NP^H		NP^W	0
Net lending		NL^N		NL^F		NL^G		NL^H		NL^W	0

government, and rest of the world on the other side. ii) gross interest-bearing stocks, which involves the interaction between financial corporation and the households. This choice, apart from data limitations, is mainly explained by our initial interest in macroeconomic effects of household gross debt. The portfolio allocation of the households consists of three financial assets: interest-bearing asset, equities, and pension. The stock of pension is an asset for the households and a liability for the financial corporation. Households also hold interest bearing assets, which are liabilities for the financial corporation. Since interest rates domestically and abroad are assumed to be equal, households do not have any preferences regarding holding financial assets domestically or abroad. The government sector finances its budget deficit by taking loans from the financial institutions. Finally, the rest of the world (RoW) interacts with the domestic economy through three financial assets namely, pensions, interest bearing stocks, and equities. The current account deficit of the RoW vis-à-vis Denmark is financed through taking loans and issuing equities.

We now turn to explaining our data regarding flows on the real side of the economy. Our constructed transaction flow matrix is presented in Table 2. In our model, all production takes place in the non-financial sector (NFC), which means that all wages are paid by NFC to domestic and foreign labour force. The gross operating surplus is shared amongst the domestic sectors. Most economic transactions on the real side such as consumption (C), government expenditure (G), investment (I), net export ($X - M$), wages (WB) and gross operating surplus are reported in a standard way.

The real economic transactions for the Danish economy in 2015 are visualized in Figure 8.

The diagram clearly shows the origin and destination of different flows. The width of the flow represents the magnitude of a flow relative to other flows in the economy.

For the household sector, it clearly gives an idea about the importance of each component of income; wages are by far the largest source of income, followed by social transfers. Inflows associated with financial assets and gross operating surplus from production also contribute to the income. On the expenditure side, consumption accounts for more than 50% of the total outflow of the households, while taxes, investment and costs related to the stock of debt account for the rest of the expenditures.

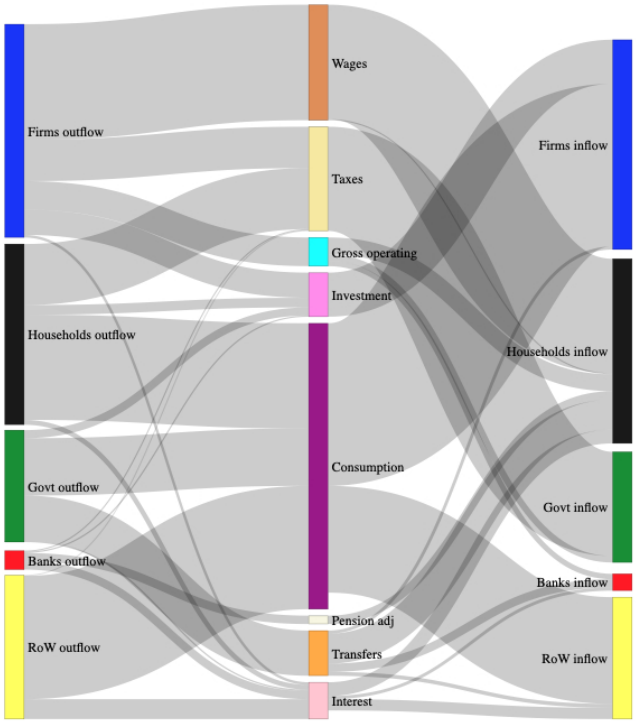

Figure 8: Real side flows, 2015

The transactions of financial assets for the Danish economy in 2015 are illustrated in Figure 9. Focusing on the financial transactions between the households and the rest of the economy, some interesting features can be identified. In 2015, the transaction of pension accounts for around 50% of the total accumulation of financial assets; the transactions of equities accounted for 40%, whereas the transactions related to interest bearing assets only accounted for 10% of the total accumulation of financial assets. On the liability side, the households

only accumulated one financial liability, i.e., interest bearing liability. Since the transaction of financial assets exceed the transactions of financial liabilities in 2015, the net lending of the household is positive, which can also be seen in Figure 9.

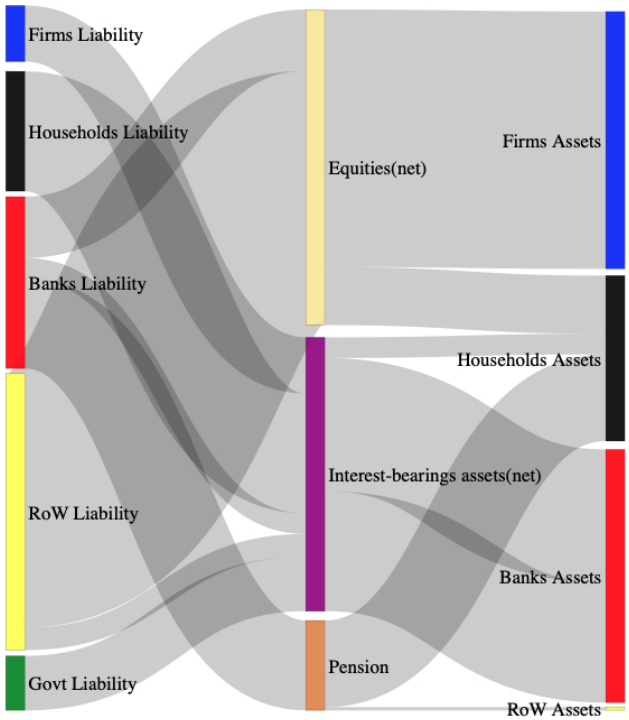

Figure 9: Financial transactions, 2015

4.2 Model structure

The model presented in this paper describes a small open economy with a fixed exchange rate regime. Since the central bank is expected to fulfill its objective of keeping the exchange rate fixed, movements in the exchange rate do not play any role in the model. Due to the fact that Denmark is a small economy, we adopt "small country assumptions", where we allow global shocks to affect the Danish economy but not the other way around.

The model from a sectoral perspective is presented as follows, where the household sector is covered in more detail whereas for other sectors, we only consider equations that are relevant of importance for the household sector.

Non-financial corporations (NFC)

It is assumed that all domestic production takes place in the non-financial corporations (NFC). The total production in nominal terms is the sum of household consumption (C_t), investment (I_t), public consumption (G_t) and net export ($X_t - M_t$).

$$Y_t = C_t + I_t + G_t + X_t - M_t$$

The value of real output can be written as the sum of the real value of each individual component as follows.[1]

$$y_t = c_t + i_t + g_t + x_t - m_t$$

The ratio between the nominal term and the real term expresses the GDP deflator (P_t^y).

$$P_t^y = \frac{Y_t}{y_t}$$

The wage (WB_t^H) bill paid to the households is assumed to be a product of the wage rate (W_t) and the level of employment (N_t). The wage rate is assumed to be the same for Denmark and RoW.

$$WB_t^H = W_t(N_t)$$

The number of individuals employed domestically is explained by the level of economic activity as well as the participation in the labour force (LF_t), which is exogenous in the model.

$$ln(N_t) = \beta_i + \beta_i ln(y_{t-1}) + \beta_i ln(LF_t)$$

The wage rate is modeled as a function of the change in the unemployment rate (UR_t). The changes in the rate of unemployment can roughly be interpreted as a measure of the change in the bargaining power of the labour union, i.e., a higher unemployment rate will imply a weaker bargaining power and vice versa.

$$W_t = \beta_0 + \beta_i UR_{t-i}$$

The number of unemployed individuals (UN_t) is defined as the difference between the total labour force (LF_t) and the number of employed individuals.

$$UN_t = LF_t - N_t$$

The rate of unemployment is described as the ratio between the number of unemployed and the total labour force.

$$UR_t = \frac{UN_t}{LF_t}$$

[1] Nominal variables in the model are denoted by capital letters whereas real variables which are deflated using their respective price indices are denoted by small letters.

Household sector

The household sector receives income from mainly four sources: wages from the firms (WB^H), gross operating surplus from production ($B^H_{2_t}$), social transfers (STR^H), and capital income. The capital income of the households originates from interest bearing assets (IBA^H), pensions ($PENA^H$), and equities (EQA^H).

The total income (Y^H) for the households can be written as

$$Y^H_t = WB^H_t + B^H_{2_t} + r^H_{A_{t-1}}(IBA^H_{t-1}) - r^H_{L_{t-1}}(IBL^H_{t-1}) + \chi_t(EQA^H_{t-1}) + \psi_t(PENA^H_{t-1}) + STR^H_t + \epsilon^H$$

where (r^H_A) and (r^H_L) represents interest rates on assets and liabilities, respectively. (χ_t) and (ψ_t) represents returns on equities and pensions, respectively.

Social transfers (STR^H_t) received by the households in the above equation is the sum of social contribution ($SCON^H$) paid by the households, social benefits ($SBEN^H_t$), and other transfers (OTR^H) received by the households.

$$STR^H_t = SBEN^H_t + OTR^H_t - SCON^H_t$$

The households are assumed to pay a constant proportion of their income in taxes (T^H). Subtracting this tax payment from the gross income gives us the disposable income (YD^H_t) as follows:

$$YD^H_t = Y^H_t - T^H_t$$

The aggregate level of taxes (T^H_t) paid by the households are determined as a fraction of their disposable income

$$T^H_t = \beta_i(YD^H_t)$$

Social contributions paid by the households are assumed to be a time varying fraction of the previous disposable income of the households.[2]

Social contributions:

$$SCON^H_t = \beta_i(YD^H_{t-i})$$

The level of benefits received by the household sector is determined by two main indicators; namely, the level of unemployment UN_t and the wage rate W^H.

Social benefits received by the households are modeled as follows:

$$ln(SBEN^H_t) = \beta_i + \beta_i ln(UN_t) + \beta_i ln(W^H_{t-i})$$

The equation implies that a higher level of unemployment increases the level of social benefits through an increase in unemployment benefits which is a major component of social benefits in a welfare state like Denmark. The level of social benefits is also directly affected by a change in the wage rate, since the compensation rate (ratio of unemployment benefits to wage rate) is legally determined as a share of the wage rate. Thus, theoretically the effect of an increase in wage rate on social benefits is expected to be positive. This feature is

[2] In that sense, it can simply be thought of as an exogenous variable in the model.

consistent with our theoretical SFC model for Denmark proposed in Byrialsen and Raza (2018), and also in line with empirical SFC model for Denmark by Godley and Zezza (1992).

Real disposable income (yd_t^H) is calculated as follows:

$$yd_t^H = \frac{YD_t^H}{P_t^c}$$

where (P^c) represents price index for consumption.

The real consumption for the households follows a standard consumption function, where the real consumption depends on real disposable income (yd^H) and real net wealth (nw^H) in last period.

$$ln(c_t) = \beta_0 + \beta_i ln(yd_{t-i}^H) + \beta_i ln(nw_{t-1}^H)$$

Nominal consumption can be written as:

$$C_t = c_t(P_t^c)$$

The consumption price index (P^c) in the model is assumed to be determined by the wage rate and import prices P^m. This setting is based on the fact that Denmark is a small open economy with a high degree of trade openness with the rest of the world.

$$ln(P_t^c) = \beta_0 + \beta_i ln(W_{t-i}) + \beta_i ln(P_{t-i}^m)$$

The level of housing investment is determined by the incentive to invest in new housing and real disposable income. The incentive to invest in new housing - known as Tobins q for housing - is usually defined as the ratio of house prices to construction cost. The argument is that an increase in the house prices relative to construction costs would induce investments in housing (Kohlscheen et al. (2018)).

Real investment (i_t^H) in fixed assets (housing) is represented as follows:

$$ln(i_t^H) = \beta_i + \beta_i ln(i_{t-i}^H) + \beta_i ln\left(\frac{P_{t-i}^H}{P_{t-i}^i}\right) + \beta_i ln(yd_{t-i}^H)$$

The intuition behind the above equation is straight forward, i.e., an increase in the house prices (P^H) motivates the households to invest more in the construction of new houses, while an increase in the construction costs (P^i) would lower housing investment. Finally, an increase in the real disposable income - which like house prices is a procyclical indicator - will increase the level of investment in housing.[3] Our model of housing investment in this regard is in line with the theoretical arguments and empirical evidence presented in several studies such as Gattini and Ganoulis (2012); Caldera and Johansson (2013); Kohlscheen et al. (2018).

[3]This behaviour is similar to the model proposed in Zezza (2008) where an increase in expected disposable income positively affects the demand for houses.

Nominal investment (I^H) in housing can be written as:

$$I_t^H = i_t^H(P_t^i)$$

where (P_t^i) represents price deflator for investment.

The change in nominal stock of housing (K^H) follows the basic accounting rule:

$$K_t^H = K_{t-1}^H + I_t^H - D_t^H + K_{CG_t}^H$$

The equation simply implies that a change in the stock of housing can occur due to new investments in housing (I^H), depreciation (D^H) of capital, and capital gains on housing (K_{CG}^H). Capital gains in the above equation reflects the change in housing stock occurring due to the change in house prices, i.e., we can express realized capital gains as follows:

$$K_{CG}^H = \Delta P_t^H(K_{t-1}^H)$$

From the above equation of capital gains, we calculate our housing price index which we also used in the housing investment function. The change in house prices can be written as follows:

$$\Delta P_t^H = \frac{K_{CG}^H}{K_{t-1}^H}$$

Our measure of change in house prices is similar to the one provided by Statistics Denmark.

The nominal stock of capital can be re-written as follows:

$$K_t^H = K_{t-1}^H(1 + \Delta P_t^H) + I_t^H - D_t^H$$

We adjust the nominal stock of capital for investment price deflator to obtain the real stock of capital as follows:

$$k_t^H = \frac{K_t^H}{P_t^i}$$

The household's savings S^H can be defined as the difference between disposable income and consumption plus the adjustment for the change in pension entitlements $CPEN^H$:

$$S_t^H = YD_t^H - C_t^H + CPEN_t^H$$

Net lending/borrowing is written as the difference between savings and investment adjusted for 'net acquisition of non-produced non-financial assets' (NP) and capital transfers (KTR^H)

$$NL_t^H = S_t^H - I_t^H - NP_t^H + KTR_t^H$$

We now turn to explaining the households' investment decision in the financial markets. The overall development in the financial markets in our model is primarily driven by the demand for credit (loans) as well as assets (interest bearing, equities and pensions) by the households. In our behavioural equations, we attempt to explain the financial transactions aimed at acquiring particular stocks, and then let those transactions (along with capital

gains) determine the stocks in the model. It should be highlighted that capital gains on financial assets in our model are exogenous.

We begin by describing the financial balance of the households, which can be written as the difference between the accumulation of financial assets and financial liabilities:

$$FNL_t^H = FATR_t^H - FLTR_t^H$$

The total transaction of financial assets $FATR^H$ is the sum of three financial transactions; interest-bearing assets transactions $IBATR^H$, equities transactions $EQATR^H$, and pension transactions $PENATR^H$.

$$FATR_t^H = IBATR_t^H + EQATR_t^H + PENATR_t^H$$

The demand for new equities is inspired by Tobin's portfolio theory in the sense that a household is faced with the choice of investing in different financial assets. The investment decision amongst other things is determined by the relative return on each financial asset. In our model, the households invest in three financial assets namely, interest bearing assets, equities, and pensions. After the introduction of the Danish pension system, a portion of wealth since the 1990s is held in pensions regardless of the return on other financial assets. Thus, the households in our model are typically faced with a choice of allocating their savings in interest bearing stocks and equities. The transaction of equities is determined by the return on equities χ_t, return on interest bearing assets r_A^H as well as the credit available to the households.

Equities transactions:

$$EQAHTR_t = \beta_i + \beta_i(\chi_t) + \beta_i(r_{A_{t-1}}^H) + \beta_i(IBLTR_t^H)$$

An increase in the return on equities would induce investment in equities whereas an increase in the interest rate on interest-bearing assets would reduce the demand for new equities as households would allocate their savings in interest bearing assets. Finally, the link between demand for equities and accumulation of new loans needs to be explained with caution: an important element of the Danish tax system is that households which are subject to interest payments on loans, are entitled to reduction in taxation. This reduces the cost of loans, which according to the Nationalbanken (2016), may have created an incentive to increase the stock of loans and the stock of financial assets at the same time. Since, a part of the accumulation of equities is financed through new loans, the demand for new equities is therefore expected to have a positive relationship with the accumulation of loans.

The transaction of pension wealth ($PENATR_t^H$) is determined by the wage bill (WB^H) in the economy along with the return on pensions (ψ_t). That is, an increase in the wage bill (either due to an increase in employment or wage rate) would increase pension transactions. Similarly, an increase in the rate of return on pensions would induce the households to allocate more savings into pension funds.

Pension transactions:

$$PENATR_t^H = \beta_i + \beta_i(\psi_t) + \beta_i WB_t^H$$

The demand for new loans ($IBLTR^H$) by the households is assumed be a function of investment in housing (I^H), the stock of debt (IBL^H) last period, the transaction of financial assets ($FATR^H$) and the interest rate on interest-bearing liabilities (r_L^H)

$$IBLTR_t^H = \beta_i(I_{t-i}^H) + \beta_i(IBL_{t-i}^H) + \beta_i(FATR_t^H) + \beta_i(r_{L_{t-1}}^H)$$

The above equation shows the relationship between the decision to invest in housing and the demand for new loans by the households. This relationship also captures the effect of house prices on household debt as widely mentioned in the literature, i.e., an increase in house prices create an incentive to invest in housing, which in turn, would induce the demand for loans. The stock of loan last period is expected to contribute negatively to the transaction of new loans due to two main reasons: i) as presented in Godley and Lavoie (2012), agents are driven by stock-flow-norms such as wealth (or debt) to income ratios. For a given desired norm for wealth to income, a higher level of debt would lead to higher savings and thereby lower net accumulation of financial liabilities, ii) from the supply side, a high level of debt may result in low collateral or creditworthiness, and thereby lower access to credit for the households.

In our model, the demand for new loans is also linked to the accumulation of financial assets. This relationship can be explained from different theoretical perspectives. First, as explained earlier, the lower cost of loans via reduced taxation creates an incentive to borrow new loans while acquiring new financial assets. Second, this also captures the transmission channel of households savings to investment, i.e., an increase in gross savings (implying an increase financial asset transactions) will induce credit supply - a portion of which is then assumed to finance household investment, leading to a positive relationship between savings and investment.[4] Third, an increase in the accumulation of financial assets is an indication of better creditworthiness. This implies that households have more collateral to borrow against to finance their expenditures. Following these arguments, the relationship between the demand for loans and the transactions of financial assets should be positive, resulting in a positive relationship between household debt and financial assets at a macroeconomic level. Our assumption of a positive relationship in this regard is also in line with the empirical evidence found for individual households in the literature (see, e.g., Brown and Taylor (2008); Brown et al. (2013)). Finally, a high level of interest rate on loans is expected to contribute negatively to the demand for new loans.

The demand for deposits by the households (interest bearing assets) is modelled as a residual in this model:

$$IBATR_t^H = NL^H + IBLTR_t^H - EQATR_t^H - PENATR_t^H$$

These transactions of financial assets and liabilities lead to changes in the stock of each financial asset.

[4] At this point, it is important to highlight that investment is not constrained by savings, however, an increase in savings can induce investment. Similarly, an increase in investment can also lead to an increase in savings, implying a bi-directional causality. This is in line with the empirical evidence in Raza et al. (2018) while using national savings (gross) and investment for 17 OECD countries.

The stock of interest-bearing assets at time t, can be written as the sum of the stock in period $t-1$, the transaction of interest-bearing assets in period t and capital gains in period t

$$IBA_t^H = IBA_{t-1}^H + IBATR_t^H + IBA_{CG_t}^H$$

The stock of equities, pensions and interest-bearing liabilities can be written in the same way

$$EQA_t^H = EQA_{t-1}^H + EQATR_t^H + EQA_{CG_t}^H$$

Pension assets

$$PENA_t^H = PENA_{t-1}^H + PENATR_t^H + PENA_{CG_t}^H$$

Interest bearing liabilities

$$IBL_t^H = IBL_{t-1}^H + IBLTR_t^H + IBL_{CG_t}^H$$

Total financial assets in this model are the sum of the three financial assets

$$FA_t^H = IBA_t^H + EQA_t^H + PENA_t^H$$

Note that the total stock of financial liabilities in the household sector is equal to the stock of interest-bearing liabilities.

$$FL^H = IBL_t^H$$

The difference between total financial assets and total financial liabilities determines the financial net wealth as follows:

$$FNW_t^H = FA_t^H - FL_t^H$$

We now obtain total net wealth by simply adding the housing to the financial net wealth:

$$NW_t^H = FNW_t^H + K_t^H$$

Real net wealth for the household sector is simply calculated by deflating net wealth with consumption prices

$$nw_t^H = \frac{NW_t^H}{P_t^c}$$

Financial sector

The financial sector in this model acts as a financial intermediate, which provides credit to the rest of the economy. The difference between accumulation of financial assets and accumulation of financial liabilities determines the financial sector balance

$$FNL_t^F = IBATR_t^{F\sim H} + NIBTR_t^F + NEQTR_t^F - IBLTR_t^{F\sim H} - PENLTR_t^F$$

Note that from the perspective of the financial corporations the development in both ($IBATR_t^{F\sim H}$) and ($IBLTR_t^{F\sim H}$) is entirely determined by households' demand for new loans and their allocation of savings, respectively.

$$IBATR_t^{F\sim H} = IBLTR_t^H$$

$$IBLTR_t^{F\sim H} = IBATR_t^H$$

The interactions of FC with all other sectors that involve transactions with the purpose of acquiring interest-bearing stocks are captured through net interest bearing transactions ($NIBTR^F$). Hence, the transactions involving net interest-bearing stocks are determined as follows:

$$NIBTR_t^F = -(NIBTR_t^N + NIBTR_t^G + NIBTR_t^W)$$

where $NIBTR^N$, $NIBTR^G$, and $NIBTR^W$ represent net interest-bearing stock of NFC, Government sector, and the rest of the world, respectively.

The transaction of pensions received by the financial corporation is the sum of the new pension paid by the households and the rest of the world.

$$PENLTR_t^F = PENATR_t^H + NPENTR^W$$

Finally, the transaction of net equities is modeled as a residual between net lending and the transaction of the other financial assets

$$NEQTR_t^F = NL_t^F + IBLTR_t^{F\sim H} + PENLTR_t^F - IBATR_t^{F\sim H} - NIBTR_t^F$$

Government sector

Since, Denmark is characterized as a welfare state, the government sector plays a crucial role in the economy. The government expenditures are relatively higher as compared to other OECD countries, and are financed through higher taxes.

Taxes received by government sector is this model as the sum of the taxes paid by the other sectors:

$$T_t^G = T_t^{NF} + T_t^H + T_t^F + T_t^W$$

A major expenditure for the government sector apart from consumption is the social transfers (STR^G). The social transfers paid by the government sector is simply the sum recieved by the other sectors:

$$STR_t^G = -(STR_t^H + STR_t^{NF} + STR_t^F + STR_t^W)$$

The net lending of the government sector (NL^G) is simply the difference between its expenditures and revenues. On the revenue side, apart from taxes (T^G), the government sector also receives a share of the gross operating surplus (B_2^G) from the production sector.[5] On the expenditure side, the net lending is also affected by interest rate (r^N) on public interest-bearing debt (NIB^G).

$$NL_t^G = B_{2_t}^G + r_{N_t-1}(NIB_{t-1}^G) + T_t^G + STR_t^G - G_t - I_t^G + \epsilon^G$$

On the financial side of the economy, we make some simplifications, where the government sector is assumed to hold only net interesting bearing stock. Thus, net lending in our model is equal to the transactions of net interest-bearing stocks.

$$NIBTR_t^G = NL_t^G$$

[5]Gross operating suplus received by the government is exogenous in the model.

Balance of payments and trade

Denmark is a small open economy with a trade openness of roughly 100% of GDP. Thus, the interaction with the rest of the world plays a big role in the economy. During 1950s to 1989, the economy experienced persistent deficits and accumulated a large stock of foreign debt. Since 1989, the economy has been running persistent surpluses resulting in the accumulation of external wealth.

Focusing on trade flows, the import equation in our model is pretty standard, that is, imports are affected by relative prices ($\frac{P^y_{t-1}}{P^m_{t-1}}$) and private demand.

Real imports

$$ln(m_t) = \beta_i + \beta_i ln\left(\frac{P^y_{t-1}}{P^m_{t-1}}\right) + \beta_i ln(c_{t-1} + i_{t-1} + x_{t-1})$$

The export function is based on the Armington (1969) model where the market share of the Danish exports is explained by relative prices. This relationship is formulated in the equation below, where β indicates the price elasticity, x_t is real exports, and $\frac{P^x_t}{P^m_t}$ indicates the relative prices of tradeables. m^W_t is an index representing the weighted import of the trading partners. Thus, $\frac{x_t}{m^W_t}$ represents the share of Danish exports in the market.

$$\frac{x_t}{m^W_t} = \left(\frac{P^x_t}{P^m_t}\right)^{\beta}$$

The equation above can be transformed to express the real level of export as a function of relative prices $\left(\frac{P^x_{t-1}}{P^m_{t-1}}\right)$ and the export market index (m^W):

$$ln(x_t) = \beta_i + \beta_i ln\left(\frac{P^x_{t-1}}{P^m_{t-1}}\right) + \beta_i ln(m^W_t)$$

Nominal imports

$$M_t = m_t(P^m_t)$$

Nominal exports

$$X_t = x_t(P^x_t)$$

While the prices of import are kept as exogenous, export prices are determined within the model as a function of import prices (P^m), since the Danish economy is a small open economy which import a high degree of semi-manufactured goods, and the domestic unit labour cost (ULC). Our export price equation is inline with several other studies (see, e.g., Onaran and Obst (2016)). The export price equation can be expressed as follows:

$$ln(P^x_t) = \beta_i + \beta_i ln(P^m_t) + \beta_i ln(ULC_{t-1})$$

The savings of the foreign sector vis-à-vis Denmark can be expressed as an identity containing net trade, net capital income (net equity, pension and interest-bearing assets), net wages, net taxes, and net social transfers:

$$S_t^W = M_t - X_t + \chi_t(NEQ_{t-1}^W) + \psi_t(NPEN_{t-1}^W) + r_{N_{t-1}}(NIB_{t-1}^W) + WB_t^W - T_t^W + STR_t^W + \epsilon^W$$

Net lending of the rest of the world can be expressed as follows:

$$NL_t^W = S_t^W - NP_t^W + KTR_t^W$$

Current account balance

$$CAB_t = -NL_t^W$$

The transaction of net equities ($NEQTR_t^W$) and net pension ($NPENTR_t^W$) are exogenous in the model, whereas the transaction of net interest-bearing asset ($NIBTR_t^W$) is the remainder of the difference between net lending (NL_t^W) and the transaction of the other two assets.

5 Estimation and simulation

Our model has a number of structural parameters which are estimated using annual Danish data from 1995-2016.[6] While our model selection for each equation is purely econometric in nature aimed at obtaining statistically valid estimators, our choice of variables in every equation is purely theoretical as discussed earlier. Overall, we did not encounter any contradictions between our theoretical and empirical relationships, that are worthy of consideration.

After estimating the structural parameters, we numerically solve the model and compare the overall performance of our model with the actual data. Here, we only focus on our key variables which are presented in the figures below. The overall performance of the model is satisfactory, and it is able to explain the macroeconomic dynamics of the Danish economy to a reasonable extent. Specifically, the performance of the model is good when it comes to explaining the real side of the economy and labour market, as shown in Figure 10 and Figure 11.

[6] To estimate the equations, in most cases, we start our estimation by including 2 lags due to small sample. We then follow general-to-specific methodology and fit a parsimonious model. We also test for unit roots and account for any significant structural breaks in our estimations.

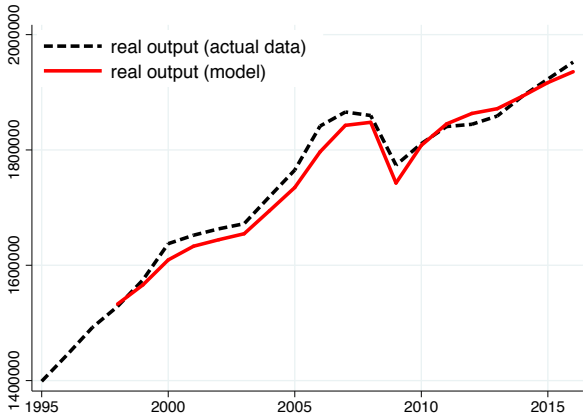

Figure 10: Real output

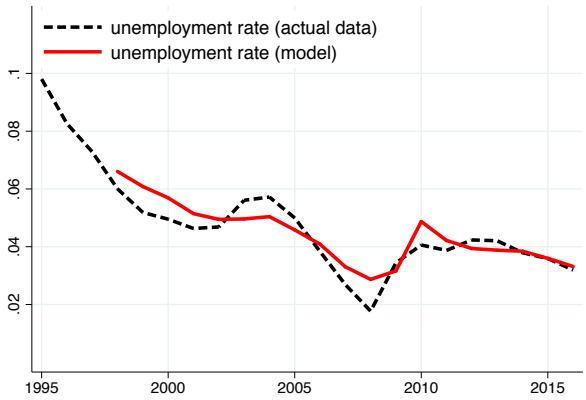

Figure 11: Unemployment rate

The consumption and investment in housing are presented in Figure 12 and Figure 13, respectively. Our model slightly underestimates these two variables, especially during the crisis for various reasons, however, the overall trend and fluctuations are quite similar to the actual data.

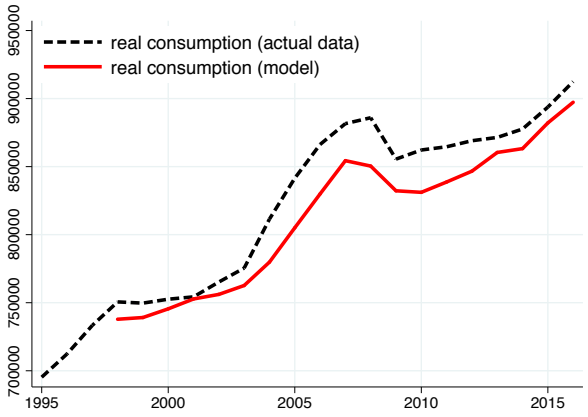

Figure 12: Household consumption

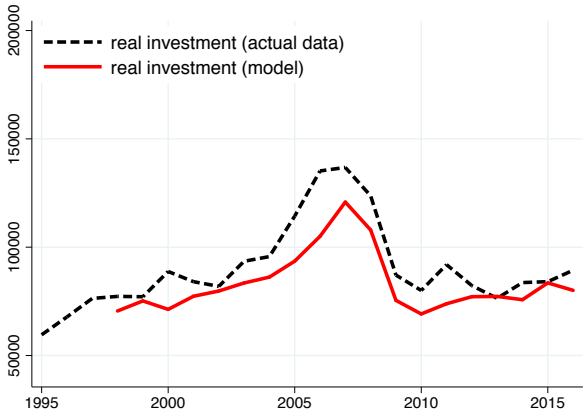

Figure 13: Household investment

Focusing on the financial side of the household sector, Figure 14 presents household financial balance whereas Figure 15 presents the stock of debt. The model slightly overestimates the financial balance when compared with the actual data. This is largely due to underestimating consumption and investment as that effect is then carried into the financial balance, i.e., the expenditure side of the household is underestimated, leading to a slightly higher financial balance in the model. Figure 15 shows the development of household debt. The model is able to explain the debt accumulation process up to a great extent.

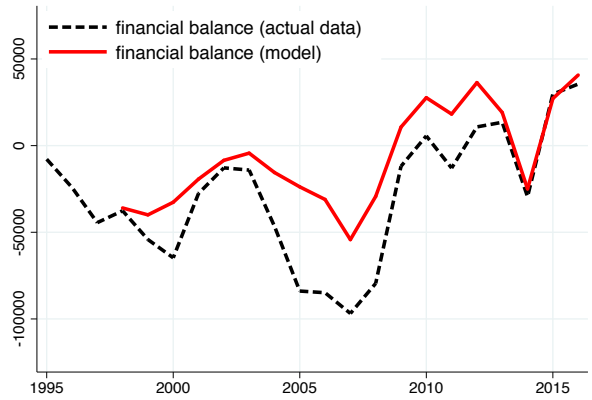

Figure 14: Financial balance for households

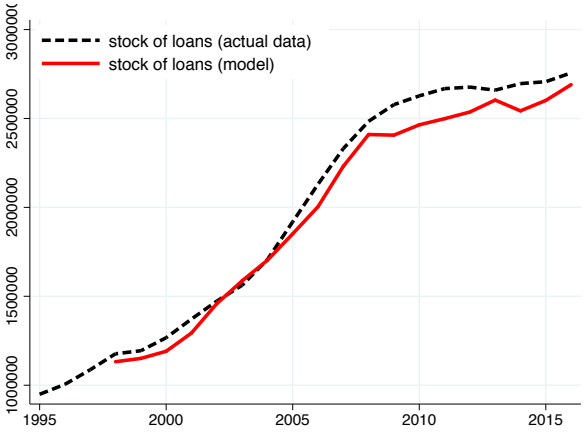

Figure 15: Household debt

We now proceed to performing simulations on the model for several periods ahead. The result from this simulation is used as our baseline simulations, against which different scenarios are compared. It is important to make it clear that the primary objective of the simulations is not to forecast the economy by pin-pointing the future growth rates, but to explore the structural linkages between financial and real side of the economy in order to assess the macroeconomic implications of Danish household debt in short to medium run. The baseline scenario is created based on a few very important assumptions. i) For projecting some of the key real economic variables, in some cases, we first determine their ratios to GDP, and then use the mean of the last 12 years of their ratios. ii) We refrain from forecasting capital gains, but set these to zero in the baseline scenario. iii) We allow the prices to grow at an average growth rate of the last 12 years.[7] iv) Regarding the financial side of the economy, we let the rate of returns on stocks (namely, interest rate, return on equities, and return on pension) to remain constant, using their latest values. The implication of these assumptions, is a slightly low growth rate in real variables (around 0.9 %) in the baseline scenario.

5.1 Results and discussion

We use simulations to analayse two main scenarios in the model. First, we discuss the macroeconomic implications of a fall in house prices. Second, we explore the effects of an increase in interest rates on the households' balance sheet and the rest of the economy.

A drop in house prices

Denmark like many other EU countries experienced a sharp fall in house prices in 2007-08. Since the crisis, the house prices have increased continuously, slightly surpassing the pre-crisis levels. Most recent data on house prices reveals a fall in the prices for the last quarter of 2018. There are concerns that the booming household market may have reached its peak

[7]However, we do not strictly bind ourselves by the aforementioned criteria, and in some cases when a variable shows a mean reverting tendency, we either keep its value constant or zero, depending on how far has it been oscillating from zero.

and a price correction is due in the following years. We use this as a motivation to ask, *what are the macroeconomic effects of a sudden drop in house prices?*

In order to address this question, we introduce a temporary drop of 5% in the house prices in 2017 and then let the prices grow with the pre-shock level, as shown in Figure 16. This creates a temporary *growth effect* and a permanent *level effect* in prices. After introducing the shock, we compare our results with the baseline scenario. The effects of the shock in the model are analysed as percentage deviations from the baseline.

Figure 17 shows the effect of a drop in the house prices on real output and other demand components. Overall, a decline in house prices contracts the real economy and increases unemployment. The effect of the shock reaches its maximum in the next year. The initial negative effect on real GDP is mainly driven by a large drop of almost 5% in the level of real investment, which is mostly due a big drop in the investment in housing as a result of the fall in the house prices. Real consumption also falls as a result of decreasing housing wealth. The effects on real export seem to be negligible, since only small changes in the relative prices occur (i.e., a small drop in export prices due to a fall in unit labour costs relatively to prices abroad). There is a relatively sharp fall in imports (around 1%), which is explained by the combination of a fall in domestic activity and lower domestic prices.

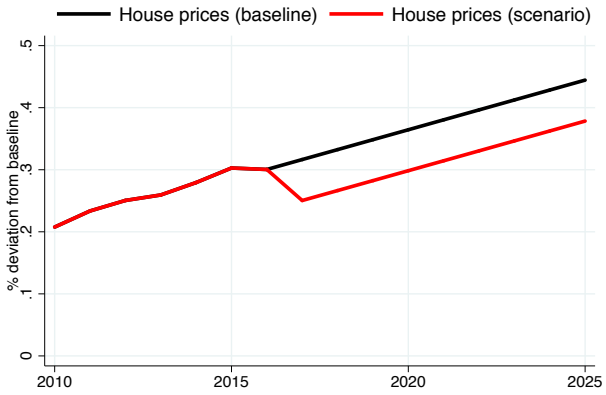

Figure 16: House price index

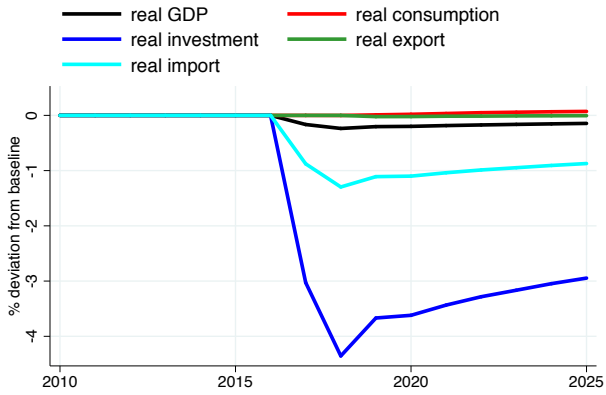

Figure 17: Demand components

In the medium term, the process of a sluggish economic recovery is underway as the variables trend towards the baseline. The effects of the shock seem persistent, as most variables are considerably below their baseline for several years. This result is also reflected in the labour market, where aggregate demand contraction leads to an increase of 1.5% in unemployment rate, which then slowly reduces in the medium term.

Figure 18 shows the response of financial balances of each sector to the shock. The most notable effect of the shock is on the external balance, primarily due to the fall in Danish imports. Despite a fall in imports, the financial balance of NFC is adversely affected by the shock due to a fall in overall economic activity. The lower economic activity also lowers tax revenues, leading to a fall in government net lending. Unlike the rest of the sectors, the financial balance of the financial corporations is not greatly affected.

Figure 18: Unemployment rate

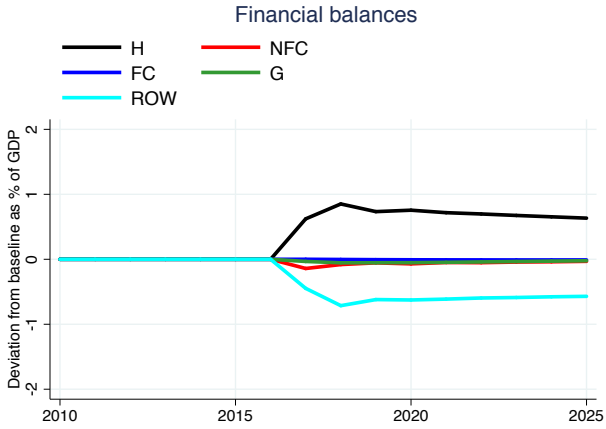

Figure 19: Financial balances

For households, the fall in house prices triggers a deleveraging process. Specifically, a fall in house prices results in capital loses, leading to a fall in the total net wealth, which in turn negatively affects investment and consumption. Moreover, a fall in prices also directly reduces the incentive to invest in new housing, leading to a slowdown in accumulation of loans. The slowdown in accumulation of loans combined with a fall in consumption leads to an improvement in the financial balance of household sector. This is also reflected in the balance sheets of the households where a fall in house prices leads to balance sheet contractions. The contraction in the balance sheet is mainly dominated by a fall in the demand for loans, leading to an improvement in financial net wealth. The housing wealth on the other hand decreases significantly as shown in Figure 21.

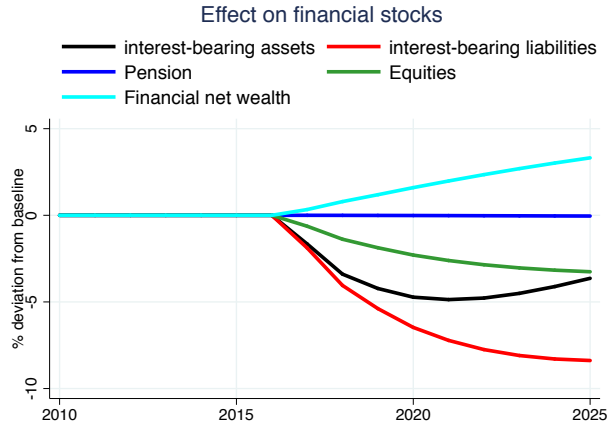

Figure 20: Financial stocks

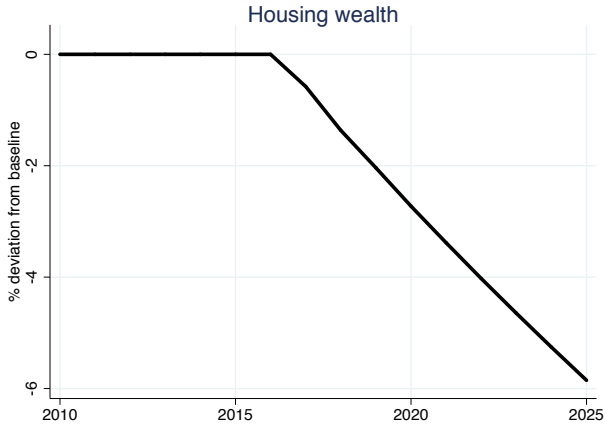

Figure 21: Housing wealth

An increase in interest rates

We now discuss the macroeconomic effects of interest rate changes in Denmark, given the high household debt. Over the last few years, interest rates in Denmark have decreased to

historical low levels, which has resulted in a speculative shift from loans with fixed interest rates towards loans with flexible interest rates. At current, more than 60% of the mortgage loans are loans with flexible interest rate, making households sensitive to interest rate changes. There are increasing expectations of a rise in interest rates of mortgages loans at some point in the future (see, e.g., Olsen (2019), Nykredit (2018), Juel (2019)). To assess the macroeconomic consequences of an increase in interest rates, given high household debt, we introduce an increase of 1 percentage point in all interest-bearing assets in our model. We then compare our results with the baseline scenario.

The overall effect of an increase in the level of interest rate on the real GDP along with aggregate demand components is presented in Figure 22. An increase in interest rates leads to contraction in aggregate demand, clearly driven by large falls in consumption and investment. The fall in consumption is due to a fall in disposable income as a result of higher interest payments. The fall in investment is due to the accelerator mechanism built into the investment function as well as due to the increase in the cost of investment (i.e., higher interest rate). The effects of the shock on real exports are relatively weaker, since we assume that there are no interest rate differentials and the exchange rate is fixed. Imports on the other hand fall mainly due to contraction in private demand as well as lower domestic prices. The fall in the economic activity adversely affects the labour market, leading to an increase in unemployment rate by 1% as shown in Figure 23.

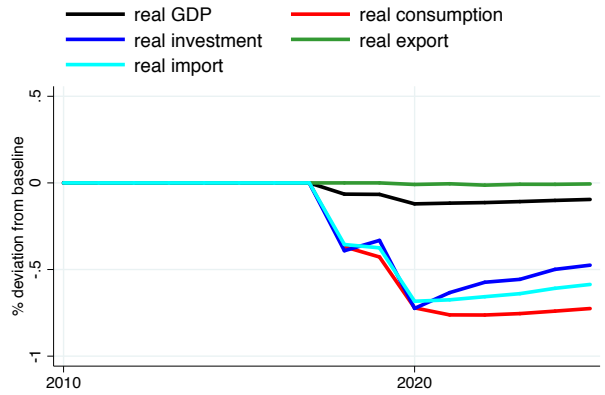

Figure 22: Demand components

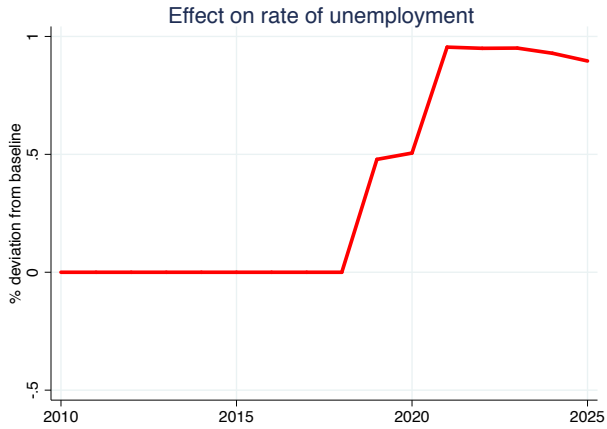

Figure 23: rate of unemployment

The response of financial balances to the shock is presented in Figure 22. The financial balance of financial corporations significantly improves, while the balances of NFC and government sector are adversely affected by the shock. The adverse effects on financial balances of NFC and government can be explained by a fall in these sectors' income through two main channels. i) An increase in interest rates lowers economic activity, leading to a fall in the income of these sectors. ii) An increase in interest rate affects capital income, i.e., a sector with a negative net interest bearing stock will experience a deterioration in its financial balance and vice versa.[8]

[8]Note that NFC, government, and the rest of the world have negative net interest bearing stocks whereas

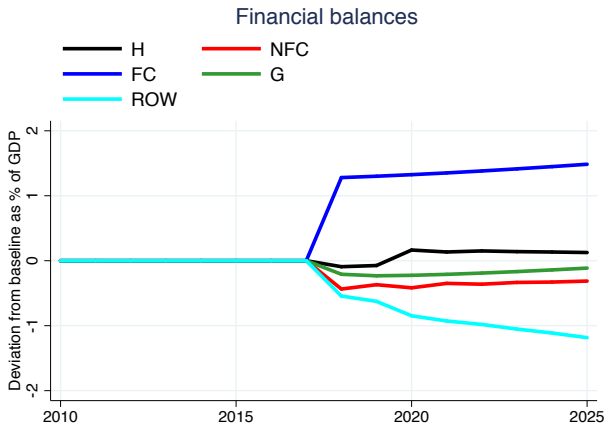

Figure 24: Sectoral balances

Turning to the financial balance of the household sector, a rise in the interest rates negatively affects the net lending in the short run, however, the effect turns positive in the medium run. In order to explain this result, we explore the impact of the shock on household's income and expenditures. Figure 25 and 26 present the response of household disposable income and expenditures (i.e., consumption, and investment) to the shock.

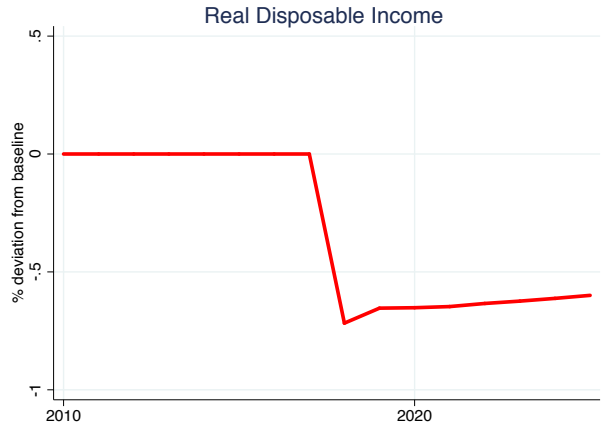

Figure 25: Real disposable income

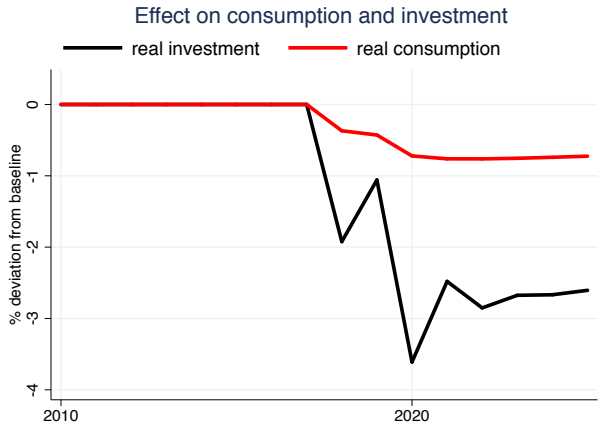

Figure 26: real consumption and investment

Focusing on the income side of the household, an increase in interest rate leads to a fall in real disposable income due to increased net interest payments on loans as well as due to rising unemployment.[9] The fall in households income affects its expenditures, i.e., a fall in disposable income leads to a fall in consumption as well as investments. It is through this channel that a high level of household debt poses a direct risk to macroeconomic stability

FC has positive a net interest bearing stock.

[9]Note that an increase in interest rate also increases the capital income received on interest bearing assets, but the stock of interest bearing assets is much lower than the stock of interest bearing liabilities. Thus, the net effect is an outflow for the households.

by magnifying the impact of negative shocks, i.e., a relatively higher household debt would induce a stronger fall in income.

In the short run, the fall in household's disposable income exceeds its expenditures reductions (consumption and investment), which generates a negative impact on net lending. However, in the next few years, the effect on net lending turns positive as investment falls further while disposable income stabilizes. The further fall in housing investment in this case is due to an increase in the cost of financing. Thus, interest rate in our model affects housing investment via two main channels (i.e., disposable income and cost of financing) as discussed in Section 4.2.

Turning to the households' balance sheets, an increase in interest rate leads to balance sheet contractions in general. In particular, an increase in interest rate reduces the debt accumulation process, which leads to a consistent reduction in interest bearing liabilities. At the same time, a rise in interest rates improves capital income associated with interest bearing assets (e.g., deposits). Thus, the stock of interest-bearing assets initially falls, as household's disposable income drops, but in the medium term this variable rebound towards its baseline scenario due to asset re-allocations. These adjustments related to interest bearing stocks leads to a fall in the stock of equities fall for two main reasons: i) an increase in interest rate leads to asset re-allocations as more financial investments flow in interest bearing assets, leading to a fall in equities. ii) The debt deleveraging process also adversely affects investment in equities for the reasons discussed in Section 4.2.

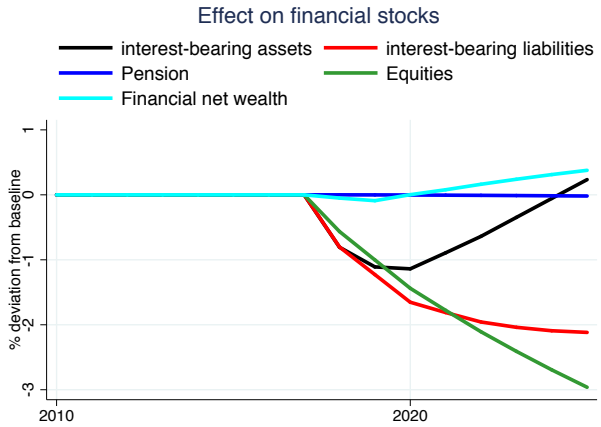

Figure 27: Effects on financial stocks

5.2 Is household debt a risk to macroeconomic stability?

The overall results of our model indicate that higher household debt can magnify the effects of negative shocks, leading to adverse effects on the economy. In this regard, our model was able to capture the important transmission channels through which household debt interacts with the economy. We now turn to discussing the most interesting aspect of our results, where we ask whether the adverse effects of household debt pose a potential risk to macroeconomic stability in Denmark. Macroeconomic stability in this context refers to the sensitivity of key macroeconomic variables to adverse shocks in the economy.

Focusing on key macroeconomic variables, private domestic demand seems to be relatively sensitive to changes in interest rates and house prices. That is, a 1 percentage point increase in interest rates has the strongest impact on consumption and investment as they fall by roughly 0.7 percent. A drop of 5% in house prices has the strongest impact on real investment as it falls by roughly 4 percent. While the debt overhang and the balance sheet contractions unquestionably reinforce the impact of negative shocks, the overall impact of these negative shocks on output seems limited. Specifically, a 1 percentage point increase in the interest rate is associated with a 0.1 percent fall in output, whereas a 5 percent fall in house prices is associated with a 0.2 percent fall in output as compared to the baseline. These limited effects on output are explained by a strong current account surplus, primarily due to a sharp fall in imports and robust exports.

Given the magnitude of the adverse shocks in the model, our estimates for output imply that economic growth in response to these shocks will slightly slow down but will not turn negative. This further raises an interesting question of how resilient is the economy, if shocks of the same nature but even bigger magnitude hit the economy? In order to address this question, we increase the magnitude of our shocks and introduce: i) an increase in the level of interest rate of 3 percentage points and ii) a fall in the household prices of 15 percent. The magnitude of these shocks are similar to the shocks experienced by the Danish economy during GFC. Moreover, these extreme shocks also prove to be an interesting exercise to test the robustness of the model.

Once again, private domestic demand seems to be sensitive to the shocks, but the effects on output are still limited. In particular, an increase in the level of interest rate of 3 percentage points results in a fall of GDP by 0.3 percent in the medium term compared to the baseline, while a fall of 15 percent in house prices leads to a decrease in GDP by 0.4 - 0.5 percent in the medium run. Overall, these results apparently suggest that the current level of household debt does not seem to pose a serious macroeconomic risk, if the economy is hit by strong interest rate and house price shocks. Since the magnitude of these extreme shocks is comparable with the shocks experienced by the Danish economy during GFC, the question of why output is so resilient at current needs to be explained with great caution.

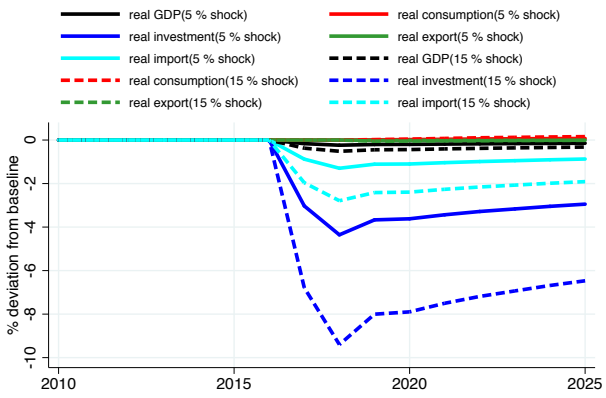

Figure 28: Shocks to house prices

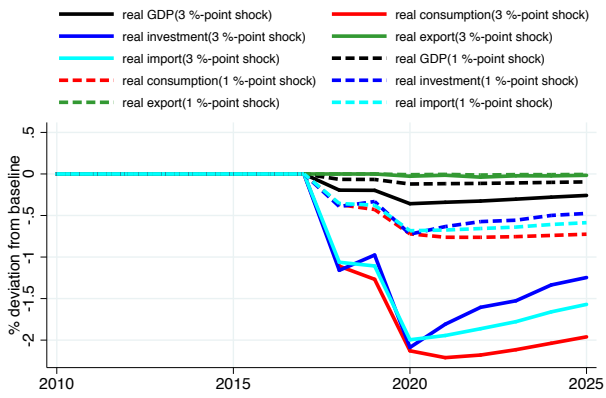

Figure 29: Shocks to interest rate

Why is this time different? The stability in output growth at current is ensured by a strong current account surplus, which reduces the impact of adverse shocks. Comparing this to the situation during GFC, three major impacts are missing in our analysis, which somehow reduce the impact of the shocks. First, there is no effect of interest rate decision on stock prices. Second, there is no contagious effect of house prices to stock prices. This is in sharp contrast to the situation in GFC, where a crash in the stock market coincided with the fall in house prices and rises in interest rates.[10] Third, we do not assume any global shocks to the economy, i.e., output in Denmark's trading partners remain unaffected throughout our analysis. This is also in sharp contrast to the GFC, during which, there was contraction in global output, which deteriorated the Danish current account balance. To supplement our analysis, we introduce a reduction in global output in combination with a rise in interest rate and a fall in house prices. We find that this leads to a serious recession in the Danish economy mimicking the situation in 2009. Overall, our results seem to lend support to the conclusion in Pedersen and Ravn (2013) who find that a large amount of fluctuations (almost 50 percent) in the Danish economy can be attributed to global shocks.

Finally, our model assumes that all household debt is domestic, there are no interest rate differentials, and exchange rate is fixed. These assumptions somewhat reduce the impact of interest rate and house price shocks on current account balance, making output relatively stable. That is, an increase in interest rates apart from reducing imports improves current account balance due to an increase in net interest inflows on Denmark's external wealth.

6 Conclusion

This paper addressed the issue of household debt in the Danish economy by developing a large scale stock-flow consistent model. The model has five main sectors namely, household, firms, financial corporations, government, and the rest of the world (RoW) sectors. We used the model to explore the macroeconomic stability of the Danish economy, given the current level of household debt. We fit the model to annual data from 1995-2016, estimate the structural parameters, and simulate the model for a baseline scenario, against which we compare and contrast the effects of different economic shocks.

To assess the macroeconomic risks associated with high household debt, we introduced two realistic shocks. First, we introduced a fall in house prices, which had the effect of contracting the economy and raising unemployment. The effects of a fall in house prices affected the economy through different channels. Focusing on the flow effect, a fall in house prices reduces consumption via wealth effect. It also reduces the incentive to invest in housing, leading to a fall investment. Focusing on the balance sheet effects, the fall in investment leads to a lower demand for loans, which in turn reduces the stock of debt compared to the baseline scenario. Regarding the asset side of the household balance sheet, the higher net lending affects the stock of interest bearing assets positively, but at the same time, the lower demand for credit reduces the stock of deposits held by households. Overall, a drop in house prices contracts households balance sheet.

[10] Analysing the effect of a shock to the stock market requires modification to the current version of the empirical model and is therefore outside the scope in this paper

Second, we introduced a rise in the interest rates, which also had the effect of contracting the economy and raising unemployment. The effects of the interest rate shock transmits to the economy through various channels. Focusing on the flow effect, a higher level of interest rates gives rise to a re-distribution of capital income amongst the sectors in the economy. Specifically, households net capital income falls due to high existing debt, leading to a fall in income, which in turn leads to contraction in private domestic demand. The reduction in economic activity raises unemployment which further reduces aggregate income of the households. Focusing on the balance sheet effects, an increase in interest rate contracts households balance sheet and leads to assets re-allocation. That is, the debt accumulation process slows down, and households re-allocate their funds to financial assets with higher rates of return. Overall, the high level of household debt can magnify the impact of adverse shocks to the economy. For example, an increase in interest rate in the presence of high household debt can have stronger negative effects on disposable income as compared to a situation with a lower level of household debt.

Does the current level of household debt pose a risk to the macroeconomic stability in Denmark? Providing an answer to this question is not straightforward. Overall, it can be concluded that in the absence of global shocks, domestic shocks to the economy may not pose a serious risk to macroeconomic stability, when purely focusing on the sensitivity of output growth and unemployment. Finally, the question of how to reduce the impact of global shocks remains a concern for small open economies.

Table 3 List of variables

Notation	Description
Y	GDP
C	Consumption
I	Gross fixed capital formation(total)
X	Exports of goods and services
M	Imports of goods and services
S	Sales
y	Real GDP
c	Real Consumption
i	Real Gross fixed capital formation
x	Real Exports of goods and services
m	Real Imports of goods and services
s	Real Sales
WB^N	Wage bill paid by NFC
WB^H	Wage bill received by NFC
W	Wage rate
N	Number of employed individuals
T^N	Taxes paid by NFC
T^H	Taxes paid by Households
T^F	Taxes paid by FC
T^W	Taxes paid by Rest of the world
T^G	Taxes received by Government
B_2	Gross operating surplus
B_2^H	Gross operating surplus received by households
B_2^F	Gross operating surplus received by FC
B_2^G	Gross operating surplus received by government
D^N	Capital depreciation of fixed asset held by NFC
D^H	Capital depreciation of fixed asset held by households
D^F	Capital depreciation of fixed asset held by FC
D^G	Capital depreciation of fixed asset held by government
K^N	Stock of capital owned by NFC
K^H	Stock of capital owned by households
K^F	Stock of capital owned by FC
K^G	Stock of capital owned by government
k^N	Real Stock of capital owned by NFC
k^F	Real Stock of capital owned by FC
k^H	Real Stock of capital owned by households
k^G	Real Stock of capital owned by government
I^N	Gross fixed capital formation by NFC
I^H	Gross fixed capital formation by households
I^F	Gross fixed capital formation by FC
I^G	Gross fixed capital formation by government

Table 3 List of variables *(continued)*

K^N_{CG}	Capital gains on capital stock of NFC
K^H_{CG}	Capital gains on capital stock of households
K^F_{CG}	Capital gains on capital stock of FC
K^G_{CG}	Capital gains on capital stock of government
P^i	Price deflator on fixed assets
P^y	GDP deflator
P^c	Consumption price deflator
P^x	Export prices
P^m	Import prices
P^H	House prices
KTR^N	Capital transfers to NFC
KTR^H	Capital transfers to households
KTR^F	Capital transfers to FC
KTR^G	Capital transfers to government
KTR^W	Capital transfers vis-a-vis Rest of the world
NL^N	Net lending/borrowing by NFC
NL^H	Net lending/borrowing by households
NL^F	Net lending/borrowing by FC
NL^G	Net lending/borrowing by government
NL^W	Net lending/borrowing by Rest of the world
S^N	Savings of NFC
S^H	Savings of households
S^F	Savings of FC
S^G	Savings of government
S^W	Savings of rest of the world vis-a-vis Denmark
NEQ^N	Net stock of equity on NFC's balance sheet
NEQ^F	Net stock of equity on FC's balance sheet
NEQ^W	Net stock of equity on RoW's balance sheet
EQA^H	Stock of equities held by households
$NEQTR^N$	Net transactions for equities by NFC's
$NEQTR^F$	Net transactions for equities FC's
$NEQTR^W$	Net transactions for equities by RoW
$EQATR^H$	Transactions for equities by households
NIB^N	Net value of interest bearing stocks on NFC's balance sheet
NIB^G	Net value of interest bearing stocks on government's balance sheet
NIB^F	Net value of interest bearing stocks on FC's balance sheet (vis-a-vis NFC, G, And RoW)
IBA^H	Stock of interest bearing assets on household's balance sheet
IBL^H	Stock of interest bearing liabilities on household's balance sheet
$IBA^{F\sim H}$	Stock of interest bearing assets on FC's balance sheet (vis-a-vis households)
$IBL^{F\sim H}$	Stock of interest bearing liabilities on FC's balance sheet (vis-a-vis households)
$PENA^H$	Stock of pension assets on households balance sheet
$PENL^F$	Stock of pension liabilities on FC's balance sheet
$NIBTR^N$	Net transactions of interest bearing stocks by NFC

Table 3 List of variables *(continued)*

$NIBTR^G$	Net transactions of interest bearing stocks by government
$NIBTR^F$	Net transactions of interest bearing stocks by FC (vis-a-vis NFC, G, And RoW)
$IBATR^H$	Transaction of interest bearing assets by household
$IBLTR^H$	Transaction of interest bearing liabilities by household
$IBATR^{F\sim H}$	Transaction of interest bearing assets by FC (vis-a-vis households)
$IBLTR^{F\sim H}$	Transaction of interest bearing liabilities by FC (vis-a-vis households)
$PENATR^H$	Pension transactions by households
$PENLTR^F$	Pensions transactions by FC
NEQ^N_{CG}	Capital gains on net stock of equity on NFC's balance sheet
NEQ^F_{CG}	Capital gains on net stock of equity on FC's balance sheet
NEQ^W_{CG}	Capital gains on net stock of equity on RoW's balance sheet
EQA^H_{CG}	Capital gains on stock of equities held by households
NIB^N_{CG}	Net value of interest bearing stocks on NFC's balance sheet
NIB^G_{CG}	Net value of interest bearing stocks on government's balance sheet
NIB^F_{CG}	Net value of interest bearing stocks on FC's balance sheet (vis-a-vis NFC, G, And RoW)
IBA^H_{CG}	Stock of interest bearing assets on household's balance sheet
IBL^H_{CG}	Stock of interest bearing liabilities on household's balance sheet
$IBA^{F\sim H}_{CG}$	Stock of interest bearing assets on FC's balance sheet (vis-a-vis households)
$IBL^{F\sim H}_{CG}$	Stock of interest bearing liabilities on FC's balance sheet (vis-a-vis households)
$PENA^H_{CG}$	Stock of pension assets on households balance sheet
$PENL^F_{CG}$	Stock of pension liabilities on FC's balance sheet
FNW^N	Financial net wealth of NFC
FNW^H	Financial net wealth of household
FNW^F	Financial net wealth of FC
FNW^G	Financial net wealth of government
NW^N	Net wealth of NFC
NW^H	Net wealth of household
NW^F	Net wealth of FC
NW^G	Net wealth of government
STR^N	Social transfers for NFC
STR^H	Social transfers for the households
STR^F	Social transfers for FC
STR^G	Social transfers for government
STR^W	Social transfers for RoW
$SBEN^H$	Social benefits received by households
$SBEN^G$	Social benefits paid by government
OTR^H	Other transfers for households
$SCON^H$	Social contributions by households
FNL^N	Financial balance of NFC
FNL^H	Financial balance of households
FNL^F	Financial balance of FC
FNL^G	Financial balance of government
FNL^W	Financial balance of RoW

Table 3 List of variables *(continued)*

LF	Labour force
UN	Number of unemployed individuals
UR	Unemployment rate
ULC	Unit labour cost
YD^H	Houshold disposable income
yd^H	Real household disposable income
r_A^H	Interest rate on household interest bearing assets
r_L^H	Interest rate on household interest bearing liabilities
r_A^F	Interest rate on household interest bearing assets
r_L^F	Interest rate on FC interest bearing liabilities
r_N	Interest rate on FC net interest bearing stocks
ψ	Rate of return on pension assets
χ	Rate of return on equities

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