Working Paper Series
Department of Business & Management

Macroeconomic Methodology, Theory and Economic Policy
(MaMTEP)

No. 1, 2019

An empirical stock-flow consistent macroeconomic model for Denmark

By
Mikael Randrup Byrialsen & Hamid Raza

An empirical stock-flow consistent macroeconomic model for Denmark

Mikael Randrup Byrialsen* Hamid Raza†

Abstract

This paper emphasises the need for understanding the interdependencies between the real and financial side of the economy in macroeconomic models. While the real side of the economy is generally well-explained in macroeconomic models, the financial side of the economy and its interaction with the real economy remains poorly-understood. This paper makes an attempt to model the interdependencies between the real and financial side of the economy in Denmark while adopting a stock-flow-consistent approach. The model is estimated using Danish data for the period 1995-2016. The model is simulated to create a baseline scenario for the period 2017-2030, against which the effects of two standard shocks (fiscal shocks and interest rate shocks) are analysed. Overall, our model is able to replicate the stylized facts as will be discussed. While the model structure is fairly simple due to different constraints, the use of stock-flow approach makes it possible to explain several transmission mechanism through which real economic behaviour can affect the balance sheets, and at the same time capture the feedback effects from the balance sheets to the real economy. Finally, we discuss certain limitations of our model.

*Aalborg University, randrup@business.aau.dk, MaMTEP, Department of Business and Management.
†Aalborg University, raza@business.aau.dk, MaMTEP, Department of Business and Management.

Contents

1 Introduction

The global financial crisis (GFC) revealed the fact that economic growth in many countries to a certain extent was driven by a sharp expansion in balance sheets, occurring due to new credit creation along with asset price booms. This resulted in an extremely heavy reliance on debt-led growth. The expansions in balance sheets prior to GFC did not receive considerable attention, or at least were not considered harmful by policy makers as well as macroeconomic modellers. Most macroeconomic models prior to the GFC had a tendency of focusing on the real side of the economy while overlooking the important role played by the balance sheet structures.[1] The GFC, however, revived interest in re-examining the link between finance and real economy, where a key lesson from the crises is that finance matters, and balance sheets do play an important role in the economy (Borio (2014)).

Appropriate understanding of the link between financial and real sector is essential for adopting correct macroprudential measures. These measures can minimise risks in the economy and ensure stability of the financial system. Given the history of recurrent financial crises, there are reasons to believe that none of the measures will guarantee a full-prevention of the crisis in open economies. That is, in practice, there might be situations where the effects of crisis are inevitable and adverse global shocks will eventually propagate in the economy through different channels. However, a good understanding of the interaction between real and financial sector can enable policy makers to react to early signs and take preventive measures to reduce the adverse effects of shocks.

The ultimate goal of this paper is to propose a framework - linking financial and real sector of the economy - that can be useful for macroeconomic discussions of policy relevance. In this regard, we attempt to address a broader question. What are the structural linkages through which financial sector interacts with the real sector in a small open economy with a fixed exchange rate? The transmission channel explaining the positive relationship between financing and economic growth is obvious, but what exactly are the driving forces behind this interaction that eventually makes it unsustainable. What measures can be taken in the future to achieve a stable growth. To do so, this paper attempts to develop a benchmark macroeconomic model for the Danish economy following a stock-flow consistent approach. The focal point of this study is the macroeconomic system as a whole from a sectoral perspective rather than the direct actions of individual agents. Due to the fact that Denmark is a small open economy with a fixed exchange rate regime, the rest of the world is treated exogenous. We model the structural linkages between real and financial sector of the economy. The model is first simulated to obtain a baseline scenario, and is then analysed for a standard fiscal shock and interest rate shocks. While the model proposed in this paper has a more elaborative household sector, the framework can easily be extended in various directions as data becomes available.

Our model, largely linked to the post-Keynesians, is inspired by the recent work in SFC modelling. The SFC framework is up to a greater extent capable of detecting instabilities in

[1] For example, some of the famous mainstream macro models such as Christiano et al. (2005) and Smets and Wouters (2007) assumed frictionless financial markets, in which balance sheets do not affect the real economic behaviour.

the balance sheet structures, and their subsequent adverse effects on the economy. In this framework, the real and financial sector are linked through standard accounting principles, and the dynamics of the data are explained through behavioural equations. This allows us to understand the whole economy as one system. Like any large scale macro model, this has the advantage of setting up several scenarios within one framework. Our model is greatly influenced by studies in the post-Keynesian SFC tradition, which amongst others, include Godley and Zezza (1992), Godley (1999), Godley et al. (2007), Papadimitriou et al. (2013), and Burgess et al. (2016). Despite the recent popularity of SFC models, the number of empirical SFC models are very limited in the existing literature. Thus, our paper also contributes to the scarce literature on empirical SFC models.

The rest of the paper is organised as follows. Section 2 provides a brief review of the current macro models used at various policy institution in Denmark. Section 3 explains the process of data construction to be used in our model. Section 4 explains the structure of the model. Section 5 explains the results of the model. Section 6 concludes this paper.

2 Tradition of macro modelling in Denmark

In terms of macroeconomic modelling, the objective of policy makers in Denmark recently is to develop a new hybrid macroeconomic model for the Danish economy (MAKRO). The motivation is to switch from the traditional SEM (Structural Econometric Model) to the models based on the foundation of a forward looking overlapping generations (OLG) setup. The underlying objective, as mentioned in Stephensen et al. (2017), is to have a model that can be used to analyse the short run effects of economic policy, and also create medium- and long term fiscal projections. According to the authors, the proposed model in that sense is a hybrid between the short-run model and the long-run OLG model. Within the short-run, it is described to be a hybrid between DSGE and structural econometric model (SEM).

While the performance of this model is yet to be seen, the move towards DSGE modelling is perceived as a positive development by those involved in building the MAKRO model. At the first seminar on the development of the model in Copenhagen on December, 06 2017, Olivier Blanchard praised the model for being ambitious, but also cast doubts that a single model can be capable of carrying out too many objectives as described above.[2]

In order to understand the motivation behind building MAKRO, a review of current macro models used at various policy institution in Denmark is needed. Currently, there are different types of models used at various institutions in Denmark which can broadly be classified into General Equilibrium models (including DSGE and OLG) and SEMs. A key difference between SEMs and DSGE (including OLG) models, amongst other things, is the choice of expectations. While the expectations in SEMs are usually backward-looking, the expectations in a standard OLG or DSGE model are forward looking. According to (Danish Rational Economic Agents Model) (DREAM (2016)) - which is a model used by Ministry of Finance - forward looking expectations are a necessity for analysing the long term structural effects of changes in economic policy, e.g., how changes in life expectancy affect the choice of consump-

[2] One of us attended the conference and made notes of these comments.

tion, saving and supply of labour made by the households. According to DREAM (2008) the short run effects as well as the business cycle depended effects must be interpreted cautiously, since the model is unsuited to analyse these effects.

On the other hand, (Annual Danish Aggregated Model) ADAM (2012) - a model used by Statistics Denmark - argues that forward looking expectations (despite immune to the Lucas-critique) should not be implemented in ADAM. Apart from the complexity associated with integrating forward looking expectations in ADAM, another reason cited for not including this feature in the model is the lack of empirical support for such a choice. In particular, ADAM points out the period before the crisis, where forward looking expectations failed to foresee the crises, and predicted that the pre-crisis trends will continue. ADAM follows the traditions of SEMs models (incl. adaptive expectations), since all the behavioural equations are estimated individually (ADAM (2012)). ADAM is demand-led in the short run due to sticky prices and wages, while in the long run it is a neoclassical equilibrium model determined by the supply side.

Following the tradition of SEMs, ADAM is not stochastic like many DSGE models. DSGE models are typically log-linearised around a steady state path, which has the implication, that the model path must therefore be interpreted as being close to a steady state (Stephensen et al. (2017)). In the last decade, ADAM has deviated from the traditional SEMs in one central aspect: the model up to some extent has become more micro-founded. This can be observed by the large disaggregation of goods and services in the production sectors. However, the micro-foundation in ADAM is still not as stringent as in DSGE models, where rational agents use intertemporal optimization under different kinds of uncertainty. The behavioural equations in ADAM are typically estimated individually whereas the strategy of estimation differs when it comes to DSGE models. Estimation in these model is often carried out by different approaches to system estimation, such as a SVAR approach.

Overall, the modelling tradition in Denmark is slowly shifting towards General Equilibrium models. This at some point might lead to a complete loss of interest in SEMs thereby following the same trajectory as many countries did prior to the crisis. While using DSGE models has advantages, it is important to point out that these models have also received harsh criticism for various reasons from some notable academics (see, for example, Hendry and Mizon (2014); Romer (2016); Hendry and Muellbauer (2018); and Stiglitz (2018), amongst others). Overall, the critiques have mostly pointed at the lack of attention paid to the financial sector in these models.[3] Some have stepped forward to write in defence of the models, while accepting the most common criticism (see, e.g., Lindé (2018); Christiano et al. (2018)). Some academics such as Blanchard (2018) and Wren-Lewis (2018) seem to support a more pluralistic approach to modelling. The former argues that different macroeconomic models should serve different purposes. Wren-Lewis (2018) in particular argues that if SEMs had coexisted alongside micro-founded DSGE models, this would have improved the understand-

[3] Of course this might include some exceptions, but the criticism is usually aimed at some of the benchmark models, which became very famous and inspired a whole generation of academics. Moreover, models which did include a financial sector, modelled the banking sector in a way that was not reflecting the crucial aspects of a banking sector in practice. These issues have been raised in BIS (2011) and Jakab and Kumhof (2019), and are beyond the scope of this paper.

ing of the links between the financial and real sides of the economy before the financial crisis. SEMs were largely replaced by DSGE models, however, those which existed or still exist also lacked some important features. For example, Hendry and Muellbauer (2018) argue, that the Medium-Term Macro Model (MTMM) of 1999 by the Bank of England lacked some important features, and if in use, would have failed to identify the credit boom prior to the crisis. The same argument applies to the Quarterly Macro Model (QMM), still actively used by the Central Bank of Iceland, which also failed to identify financial instabilities in the Icelandic economy prior to the crisis.

The above discrepancies in SEMs can to a certain extent be overcome by the use of empirical Stock-Flow consistent (SFC) approach to modelling.[4] The structure of SFC models is built around the notion of stock-flow interactions. The behavioural equations in a dynamic empirical SFC model are usually estimated using time series data on transaction flows and balance sheets. In that sense, some empirical SFC models are also SEMs, however, the theoretical foundation is largely based on post-Keynesian theory in which the linkages between balance sheets and transaction flows play a central role. This feature is central to the case of Denmark, where the ratio of household debt to income has reached a very high level. In this paper, we propose a benchmark model that can co-exist alongside other macro models in Denmark. This model can be re-estimated for quarterly data and can easily be extended in several different directions to study other issues. While studying the interaction of financial and real sector remains a core component in SFC models, their application is not only limited to these issues. Most recently, the models have been extended to study climate and economic growth.[5]

3 Data

Before explaining the structure of our model, we first explain the key steps involved in developing an empirical SFC model using Danish data. In developing a large scale empirical model, access to data plays a central role. In this section, we describe the steps in constructing the dataset that we use in our model. The primary data source is the sectoral national account from Eurostat. Some of our exogenous price deflators are taken from Statistics Denmark.

3.1 Balance sheets of the economy

Following the sectoral national account, financial assets are divided into several groups: Monetary gold and special drawing rights (F_1), Currency and deposits (F_2), Debt securities (F_3), Loans (F_4), Equity and investment fund shares (F_5), Insurance, pensions and standardized guarantee schemes (F_6), Financial derivatives and employees stock options (F_7) and Other accounts (F_8). Due to the use of non-consolidated data, a particular stock can often appear as an asset as well as a liability for a given sector, e.g., equities appear on both the asset and

[4] See Caverzasi and Godin (2014), Byrialsen (2018) and Nikiforos and Zezza (2017) for comprehensive surveys on SFC approach to modelling.

[5] See, e.g., Dafermos et al. (2017); Ponta et al. (2018); Bovari et al. (2018); Naqvi and Stockhammer (2018).

liability side of the non-financial corporations.[6] However, the problem is that the counter party of a particular asset or liability is not always clear, e.g., the stock of equities held by the households can be found in the data, but it is not clear which sector issues these equities. The same is the case for the capital income associated with these assets, i.e., one cannot see what proportion of the outflow from sector x is an inflow in sector y? This issue is not limited to the domestic economy, but is also a problem when dealing with the foreign sector.

To overcome these challenges, we make a few simplifying assumptions. First, we reduce the number of financial assets by aggregating them into fewer subcategories. As shown in Table 1, we consider three financial assets in our model namely interest-bearing asset (IB), equity (EQ) and pension (PEN).

Table 1: Data aggregation

Assets	Description
Interest bearing (IB)	F_1, F_2, F_3, F_4, F_7 or F_8
Net interest bearing (NIB)	F_1, F_2, F_3, F_4, F_7 or F_8
Net equities (NEQ)	F_5
Pension (PEN)	F_6

Second, with the exception of household sector, we determine the net value for every financial asset as well as the net capital income associated with that financial asset for each sector. In the case of household sector, we consider gross position on all financial assets and liabilities. This choice is mainly explained by our initial interest in the effect of household gross debt. While considering gross positions for the households, we make some assumptions regarding the counter parties. In particular, it is assumed, that the stock of interest bearing assets in the household sector is placed as a liability on the balance sheet of financial sectors, just like the stock of loans for the households is placed as an asset in the financial sector. All the financial assets in our dataset evolve according to the following identity:

$$\text{Financial asset}_t = \text{Financial asset}_{t-1} + \text{Transactions}_t + \text{Capital gains}_t$$

The identity simply implies that changes in the stock of an asset can be traced back to its transactions as well as changes in the price of that asset, i.e., capital gains.

Regarding the accumulation of fixed assets, the identity presented above for the financial stocks is augmented by including capital depreciations as follows:

$$\text{Fixed asset}_t = \text{Fixed asset}_{t-1} + \underbrace{\text{Transactions}_t - \text{Depreciation}_t}_{\text{Net investment}} + \text{Capital gains}_t$$

The identity implies that changes in fixed assets are due to net investments and capital gains. Regarding the household sector, the total stock of fixed assets is assumed to be in dwellings.

[6] The combination of five sectors and 8 financial stocks (which can be held as both an asset and a liability by each sector) leads to potentially 40 financial gross positions, which can be quite difficult to explain within a single model.

Thus, capital gains in the above identity for the household sector also represent changes in house prices. Our constructed data for changes in house prices closely resembles the data published by Statistics Denmark as shown in the Figure 1.

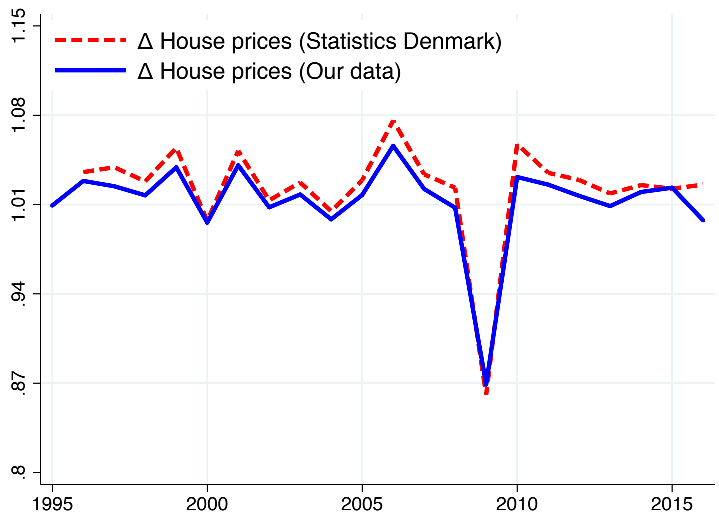


Figure 1: Change in house prices

The balance sheet matrix of the economy is presented in Table 2. It can be seen that there are some simplifying assumptions dealing with the distribution of financial assets, primarily due to lack of information in the data. Since, the government sector only holds one net asset, namely net interest bearing asset, the financial net wealth is equal to net interest bearing asset in this case. This is a strong assumption as the government sector also hold a significant part of its wealth as equities. In our dataset, this stock of equities is integrated into the stock of net interest-bearing asset of the government. As a result, we also make adjustments to the balance sheets of the financial and non-financial corporations accordingly.[7]

Table 2: 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

Our aggregated balance sheets, consisting of three financial assets, are presented in gross terms for each sector in figures 2 - 6. The development in all financial assets is represented

[7] In order to keep consistency, the adjustment of NIB^G must also be carried out with regards to financial transactions of NIB^G as well as capital gains on NIB^G, just like these adjustments affect NEQ^N, $NEQTR^N$, NEQ^N_{CG}, NIB^N, $NIBTR^N$ and NIB^N_{CG}.

as a percentage of annual GDP over the period 1995-2016. In general, one can clearly observe expansions in the balance sheet of all the sectors. The balance sheet expansion is more pronounced in the years before the GFC, which coincides with high economic growth in that period, as was the case in many other open economies.

For the household sector, Figure 2 shows that both assets and liabilities have expanded significantly since the 1990s. 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.

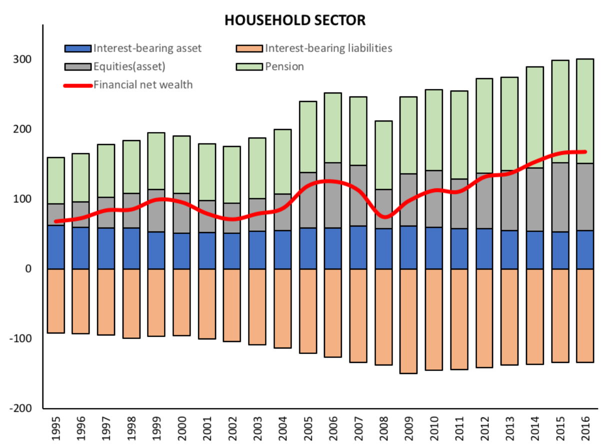


Figure 2: Households balance sheet

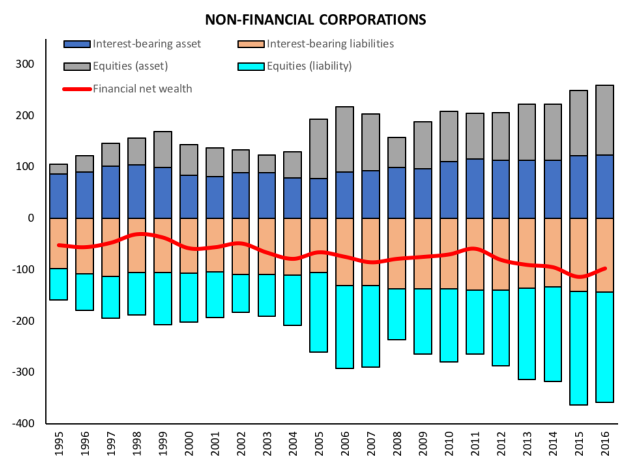


Figure 3: NFC balance sheet

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., Smidova (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 stabilised while GDP has increased. Overall, the net financial wealth of the household sector has mostly been positive. The net financial 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.

Turning to the development in the non-financial corporations, Figure 3 shows that the stock of both financial assets and liabilities have experienced an expansion since the 1990s. In particular, the expansion in assets and liability relative to the size of the economy has been massive since 2004. The balance sheet expansion in the years before the crisis was primarily driven by equities, while interest bearing stocks relatively remained stable. The 2008 crisis had a strong effect on the equities as asset prices collapsed, leading to a balance sheet contraction overall. However, in the post-crisis period, the size of the balance sheet relative to the economy has significantly increased, primarily due to an increase in the stock of equities. It is important to highlight that there have been significant share buy-backs in the Danish economy in 2012 as reported by Friedrichsen (2019). These share buy-backs have contributed to the increase in asset prices, which in turn have induced balance sheet expansions mostly via capital gains channel. Overall, the accumulation of liabilities exceeds the accumulation of assets most of the time, thus the financial net wealth is mostly negative.

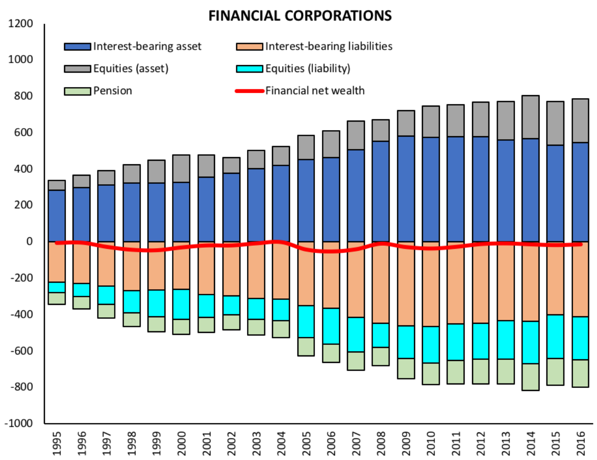


Figure 4: Financial Corporations

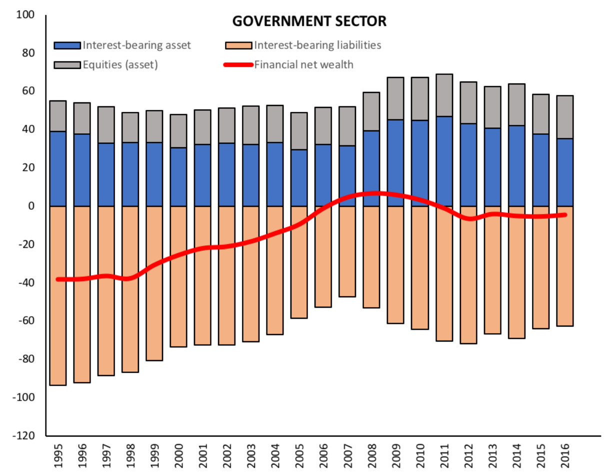


Figure 5: Public sector

Figure 4 shows the balance sheet structure of the financial corporations, where a general increase in the size of balance sheet relative to the economy can be observed. This persistent balance sheet expansion is consistent with the global trend of rising financial sector in most countries, referred to as the process of financialization. On the asset side, both interest bearing stocks as well as equities have increased. Regarding the composition of assets, it can be seen that there is a strong increase in the interest bearing asset during 2000-2009 which coincides with the increase in household debt. In the post crisis period, there is a shift in the asset composition where the asset side expansion of the balance sheet is driven by the stock of equities, while interest bearing stocks have remained relatively stable.

On the liability side, the expansion of the balance sheet roughly follows the same pattern as discussed above. That is, the stock of all liabilities relative to GDP expanded more aggressively until the crisis, and then slowed down in the post-crisis period. Regarding the composition of liabilities, the stock of liabilities – along with interest bearing assets and equities - also consist of pension stock which is an asset for the household sector. In the post crisis, one can observe a shift in the balance sheet composition, following a similar pattern that we observed in the case of assets composition. That is the liability side expansion of the balance sheet is driven by equities while interest bearing stocks have remained relatively stable.

Figure 5 shows the balance sheet development of the public sector. During the expansion of the public sector in the 1950s and 1960s, the public sector managed to balance their income and expenditures. In the 1970s, however, high level of unemployment put a pressure on both expenditures and tax revenues, leading to deficits and thereby accumulation of debt. The combination of public debt, high interest rates, and low economic activity deteriorated the balance of the public sector in the 1980s and in the first half of 1990s. Since automatic stabilizers are high in Denmark, business cycle fluctuations explain a major proportion of the movement in public balance. Against this background, the fall in unemployment in the middle of the 1990s improved the balance of the public sector, which enabled a fast repayment of the debt as can be seen by a fall in the stock of interest-bearing liabilities in Figure 5. The stock of debt fell until 2007 as a result of a positive balance. In the period 2007-2012, the stock of debt increased again due to deficits; these deficits were the result of expansionary policies during the first period of the crisis. Despite a small deficit since the crisis, the stock of interest-bearing liabilities has decreased, which can be explained by the fall in stock of interest-bearing assets (balance sheet contraction). Regarding the stock of equities, this seems to be relatively constant since 1995, which indicates that this stock is not being used as a financial tool for placing wealth or financing deficits.

The balance sheet for the rest of the world is presented in Figure 6. Note that the balance sheet is represented from the perspective of the rest of the world. Thus, assets (liabilities) in this case are liabilities (assets) for Denmark.

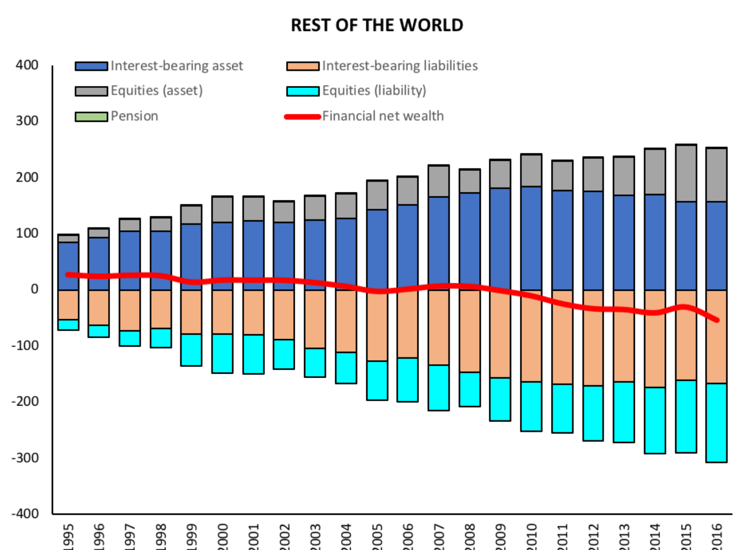


Figure 6: Financial balance sheets for Rest of the World

Being a small open economy, the interaction with the rest of the world plays a central role in the Danish economy. Denmark ran persistent current account deficits during the period 1950s to 1989, mainly due to wage increases, inflations, and high private and public borrowing. This resulted in the accumulation of a huge foreign debt. Since 1989, the economy started experiencing current account surpluses, due to increased competitiveness as well as the introduction of pension system, which induced household savings. The effect of current account surpluses can be seen in the development of the net financial wealth as Denmark became a net creditor to the rest of the world.

Overall, there is a general expansion in both the accumulation of assets and liabilities from 1995 to 2016. On the asset side, the period from 1995 to 2010 is characterized by a small steady increase in both the stock of interest-bearing assets and equities. From 2010 onwards, the stock of interest-bearing asset is falling, while the stock of equities is increasing. On the liability side, rest of the world has been accumulating both interest-bearing liabilities and also issuing equities to finance the negative net lending vis-à-vis Denmark.

3.2 Real and financial transactions in the economy

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 3. 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.

In order to simplify our dataset, some transactions are aggregated up to a certain extent. Regarding the flow of taxes, three flows namely taxes on wealth and income, taxes on production, and other taxes on production have been merged into an aggregated tax-variable. The transactions related to subsidies, other subsidies, other current transfers, social contributions and social benefits have been merged into one transaction called $Transfers$. It should be highlighted that the aim of the model is not to explain each and every transaction, but to focus on the most relevant flows.

Table 3: 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

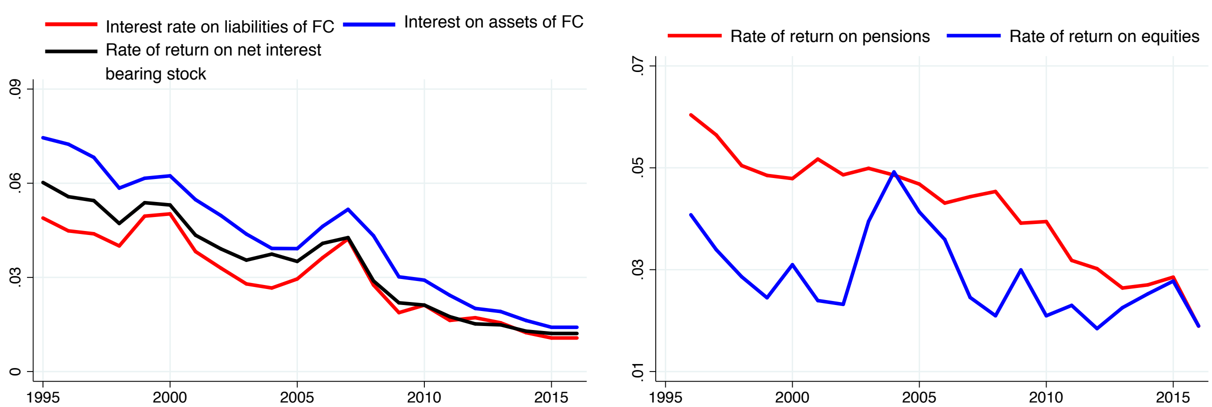
Turning to the capital income in our model, the income associated with assets originates from three financial assets namely, net interest-bearing assets, net equities, and pension, as discussed earlier. These income flows are determined in the following way:

$$\text{net capital income}_t = r_{t-1}(\text{net stock}_{t-1})$$

The above equation simply describes that capital income flow is equal to the previous value of stock times the rate of return on that stock. However, rates of return are not available in the data and need to be computed as well. For each financial asset, we calculate our own rate of returns, and take into account any discrepancy between the flows reported in the income account and the flows calculated using our computed rates of return. For example, the interest rate on interest-bearing assets for the household sector is computed as follows:

$$r^H_{A_{t-1}} = \frac{\text{interest recieved}_t}{IBA^H_{t-1}}$$

Following the above procedure, we calculate 3 interest rates, i.e., interest rates on household assets and liabilities, and interest rate on net interest bearing stocks. The same procedure is followed to calculate the rate of return on the stock of pension and equities. We consider one rate of return on equities, and one rate of return on pension stocks. Our computed rates of return are plotted in Figure 7. The discrepancies (or error terms) between the flows reported in the income account and the flows calculated using our rate of returns are plotted as a percentage of GDP in the appendix. Overall, these error terms are very small and not worthy of further discussion.



Interest rates

return on pension and stocks

Figure 7: Rates of return Assets

The real economic transactions for the Danish economy in 2015 are visualised 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 a considerable part of the expenditures along with taxes, whereas the expenditures on investment and interest on debt are relatively small. For NFC, wages, imports, taxes, interest on liabilities and distribution of gross operating surplus are the main expenditures, while the primary source of income comes from selling goods domestically and abroad. For FC, inflows associated with financial assets (i.e., capital income) is the major source of income, while interest paid to the other sectors together with changes for adjustment of pension entitlements form the main flows on the expenditure side. For the Government sector, public consumption, social transfers (mostly towards the households) and investment are the main expenditures, whereas the interest expenditures are relatively small due to lower level of public debt. On the income side, the vast majority of income comes from taxes paid by other sectors. Finally, the rest of the world pays a higher capital income to Denmark than it receives, since Denmark is a net creditor and has a current account surplus.

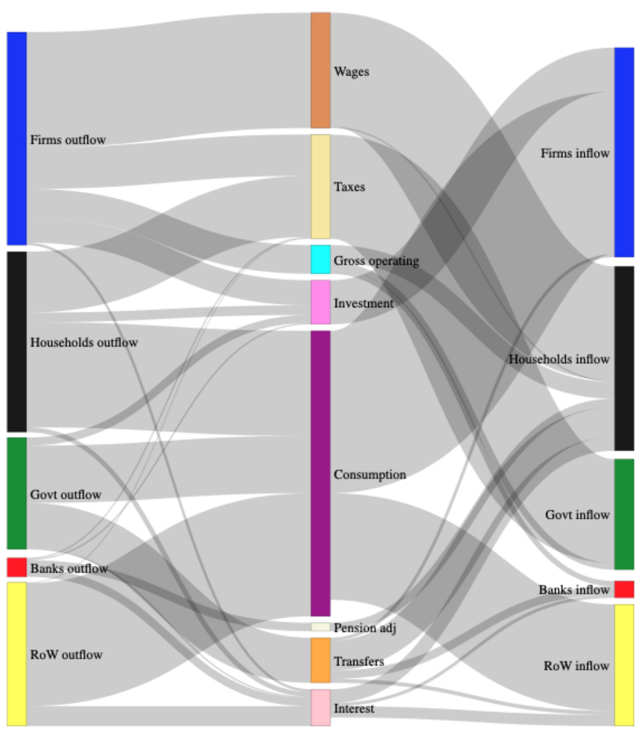


Figure 8: Transactions - real side of the economy, 2015

We also visualise the financial transactions for the Danish economy in 2015 as shown in Figure 9. These transactions need to be explained with caution. With the exception of the household sector, for all other sectors, the transactions are represented on net basis. Overall, most of these transactions are largely consistent with the way the balance sheet structures have evolved. For example, households outflows for the purpose of purchasing an asset includes pensions, interest bearing stocks and equities. Households inflows for the purpose of borrowing includes interest bearing loans. The only transaction which seems to be at odds with the balance sheet structure is the net equities in the NFC sector, i.e., in general NFC sector has net equities as a liability, but in 2015, this sector is purchasing more equities as assets than they issue as liabilities. Therefore, the net equity transaction appears on the asset side of NFC in the figure. This could be explained by the improved current account balance, where the surplus is invested in financial assets abroad. This is further evident by the net capital inflows received by the rest of the world originating from Denmark. In particular, rest of the world receives a relatively large net capital flow mostly in the form of net equities.

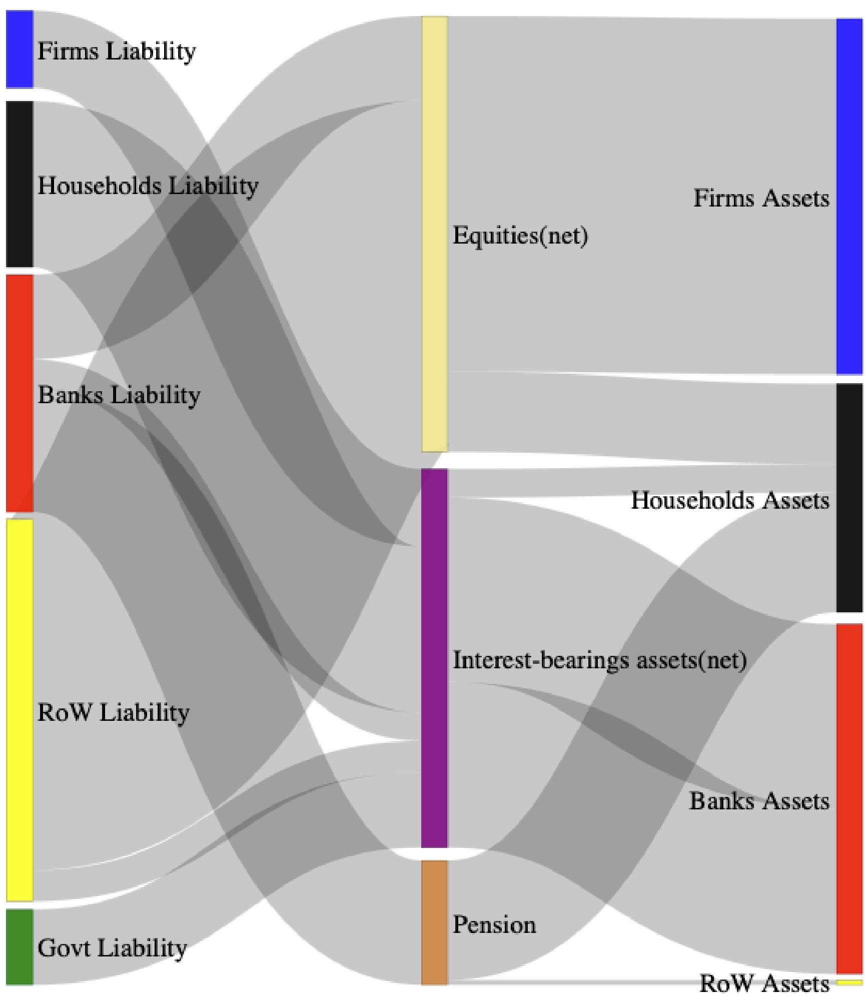


Figure 9: Financial transactions, 2015

4 Model structure

We now proceed to presenting the structure of the model.

4.1 Non-financial corporations (NFC)

We assume all production takes place in the sector for non-financial corporations.[8] The total production in nominal terms is determined in the standard way as follows:

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

This equation can be rewritten to express the total sales in domestic economy:

$$S_t = C_t + I_t + G_t + X_t$$

Value of real output:

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

GDP deflator:

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

Firms pay taxes (incl. production taxes) to the government sector, wages (WB) to households in Denmark and abroad, and gross operating surplus. The wage bill is defined as a product of the wage rate (W_t) and the level of employment (N_t^N), where the wage rate is assumed to be the same for Denmark and rest of the world. The level of employment is the sum of domestic employment and net foreign employment (foreign citizens employed in Denmark minus Danish citizens employed abroad).

Wage bill paid by NFC to its employees N^N:

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

Since, majority of taxes paid by the firms are taxes on production, it is further assumed that the level of taxes in our model changes accordingly with variations in the total production.

$$T_t^N = \beta_3(Y_t)$$

From an accounting perspective, the gross operating surplus is the residual between GDP, net taxes on production and compensation of employees. Since net taxes as described earlier are merged into the flows 'taxes' and 'transfers' (subsidies), the gross operating surplus for the total economy is assumed to be described by as a share of GDP as follows:

[8] Since all production is assumed to take place in the same sector, any distribution of the gross operating surplus cannot be determined within the model. Since the flows of this surplus provides an important income for all sectors, this flow is kept exogenous for the financial corporation, the households and the government sector, while the surplus for non-financial sector is a residual. For the Government sector however, the gross operating surplus is equal to the consumption on fixed capital, so this should be possible to make endogenous.

$$B_{2_t} = \beta Y_t$$

The stock of fixed capital is determined by the standard accounting identity as follows.

Nominal stock of capital of NFC:

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

where the level of depreciation (D) depends on the rate of depreciation and the stock of fixed capital in last period.

$$D_t^N = \delta(K_{t-1}^N)$$

The real stock of capital is determined by deflating the nominal stock with capital price deflator.

Real stock of capital:

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

We now focus on explaining the level of real investment in NFC. According to Godley and Lavoie (2012), empirical work seems to suggest that capacity utilization is an essential component that determines the decision to invest. The theoretical argument is that a high rate of capacity utilisation motivates the firms to raise their capital stock by increasing investment and vice versa. Thus, capacity utilisation in that sense also carries the accelerator effect. The level of real investment in our model is determined by the rate of capacity utilisation, which in turn is proxied by diving the level of economic activity (measured by real output) with the real stock of capital in NFC. Our investment function and measure of capacity utilisation is similar to the one used in SFC model for the UK by Burgess et al. (2016).

Real investment:

$$ln(i_t^N) = \beta_i + ln\beta_i.\left(\frac{y_{t-i}}{k_{t-i}^N}\right)$$

Theoretically, (β_i) in the above equation has also been interpreted by several authors as reflecting the ‘animal spirits’ (see, e.g., Fujita (2018); de Jesus et al. (2018)).

Nominal investment in fixed asset:

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

The savings of the firms can be computed from the primary and secondary incomes:

$$S_t^N = Y_t - WB_t^N + (B_{2_t}^N - B_{2_t}) + r_{N_{t-1}}(NIB_{t-1}^N) + \chi_t(NEQ_{t-1}^N) - T_t^N + STR_t^N + \epsilon^N$$

The net lending of the firms is the difference between saving and investment adjusted for the exogenous determined capital transfers and NP.

Net lending/borrowing:

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

On the financial side of the economy the firms finance their expenditures with two different financial assets: net interest-bearing assets and net equities. In the current version of the model, the transaction of net equities in the NFC sector plays a passive role, and accommodates the demand for new equities originating from other sectors. The transaction of net interest-bearing assets is described as the difference between total net lending and transaction for equities.

Net equities:

$$NEQ_t^N = NEQ_{t-1}^N + NEQTR_t^N + NEQ_{CG_t}^N$$

Net interest bearing stocks (assets - liabilities) held by the firms:

$$NIB_t^N = NIB_{t-1}^N + NIBTR_t^N + NIB_{CG_t}^N$$

Net interest bearing financial transactions:

$$NIBTR_t^N = NL_t^N - NEQTR_t^N$$

The financial net wealth of the firms can be written as the sum of the two assets explain above:

$$FNW_t^N = NIB_t^N + NEQ_t^N$$

The total net wealth of the firms can then be expressed as the sum of the financial net wealth and the stock of fixed capital:

$$NW_t^N = FNW_t^N + K_t^N$$

4.2 Household sector

We now turn to explaining the household sector which is the main endogenous sector of the economy in our model. The household sector receives income from mainly four sources: wages from the firms (WB^H), gross operating surplus from production ($B_{2_t}^H$), 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 for the households can be written as:

$$Y_t^H = WB_t^H + B_{2_t}^H + r_{A_{t-1}}^H(IBA_{t-1}^H) - r_{L_{t-1}}^H(IBL_{t-1}^H) + \chi_t(EQA_{t-1}^H) + \psi_t(PENA_{t-1}^H) + STR_t^H + \epsilon^H$$

where (r_A^H) and (r_L^H) represents interest rates on assets and liabilities, respectively. (χ_t) and (ψ_t) represents returns on equities and pensions, respectively.

Social transfers received by the households in the above equations is the sum of social contribution ($SCON^H$) paid by the households, social benefits ($SBEN_t^H$), and other transfers (OTR^H) received by the households:

Social transfers:

$$STR_t^H = SBEN_t^H + OTR_t^H - SCON_t^H$$

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_t^H) as follows:

$$YD_t^H = Y_t^H - T_t^H$$

The aggregate level of taxes paid by the households are determined as a fraction of their disposable income:

$$T_t^H = \beta_i(YD_t^H)$$

Social contributions paid by the households are assumed to be a time varying fraction of the previous disposable income of the households.[9]

Social contributions:

$$SCON_t^H = \beta_7(YD_{t-i}^H)$$

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:

$$ln(SBEN_t^H) = \beta_i + \beta_i ln(UN_t) + \beta_i ln(W_{t-i}^H)$$

The equation implies that a higher level of unemployment increases the level 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 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:

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

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), real net wealth (nw^H)

Real consumption by the households:

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

Nominal consumption:

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

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.

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

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

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 in fixed assets (housing):

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

The intuition behind the above equation is straight forward, i.e., an increase in the house prices motivates the households to invest more in the construction of new houses, while an increase in the construction costs 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.[10] 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).

Nominal investment in fixed asset 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:

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

The equation simply implies that a change in the stock of housing can occur due to new investment 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 occuring due to the change in house prices, i.e, we can express realised 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:

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

As demonstrated earlier, our measure of change in house prices is similar to the one provided by Statistics Denmark.

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

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 households savings S^H can be found 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 NP and capital transfers

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

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 stocks r_A^H as well as the credit available to the households.

Equities transactions:

$$EQAHTR_t = \beta_i + \beta_i(\chi_t) + \beta_i(r^H_{A_{t-1}}) + \beta_i(IBLTR^H_t)$$

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 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.

Pension transactions:

$$PENATR^H_t = \beta_i + \beta_i(\psi_t) + \beta_i WB^H_t$$

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

Interest bearing liability transactions:

$$IBLTR^H_t = \beta_i(I^H_{t-i}) + \beta_i(IBL^H_{t-i}) + \beta_i(FATR^H_t) + \beta_i(r^H_{L_{t-1}})$$

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 in increase in gross savings (implying an increase financial assets 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.[11] 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.

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 is the sum of the three financial assets

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

[11] 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.

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 financial wealth

$$fnw_t^H = \frac{FNW_t^H}{P_t^c}$$

Real wealth

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

4.3 Financial sector

The financial sector in this model is the main provider of credit in the economy, which means, that capital income plays a major role for the savings of the financial sector. The savings of FC is determined by the standard accounting identity, i.e., savings S^F can be expressed as the sum of the net capital income, gross operating surplus ($B_{2_t}^F$) (received), social transfers (STR^F) minus taxes paid to the government (T^F), and the changes in pension entitlements ($CPEN^F$) paid to the households:

$$S_t^F = B_{2_t}^F + r_{A_t-1}^F (IBA_{A_t-1}^{F\sim H}) - r_{L_t-1}^F (IBL_{L_t-1}^{F\sim H}) + r_{N_t-1}(NIB_{t-1}^F) + \chi_t (NEQ_{t-1}^F) - \psi_t (PENL_{t-1}^F) - T_t^F + STR_t^F - CPEN_t^F + \epsilon^F$$

The stock of fixed asset in the FC is determined in the standard way as explained for other sectors above.

$$K_t^F = K_{t-1}^F + I_t^F - D_t^F + K_{CG_{t-1}}^F$$

After taking (NP) and captital transfers into account (KTR^F), the net lending/borrowing of FC can be expressed as the difference between savings and investment as follows:

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

The financial balance (FNL^F) (which is equal to the net lending) is calculated as the difference between accumulation of financial assets and financial liabilities:

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

Interest-bearing inflows and outflows in the above equation are only linked to the balance sheets of the household sector. This is, interest-bearing transaction ($IBATR^{F\sim H}$) for the sake of acquiring an asset by the banks is equal to the new loans received by the households. Similarly, transactions for the sake of accumulating interest-bearing liabilities ($IBLTR^{F\sim H}$) by the bank are equal to the transaction of interest-bearing assets by the households. Thus, these transactions by construction are determined as follows:

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

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

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.

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.

We now turn to explaining the accounting identities involved in determining the development of interest bearing stocks. The change in the stock of interest-bearing asset in FC sector is determined by the corresponding transaction along with capital gains:

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

Similarly, the change in interest-bearing liabilities is expressed as follows:

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

The change in stock of net interest bearing stocks is equal to the transaction of net interest-bearing assets and net capital gains:

$$NIB_t^F = NIB_{t-1}^F + NIBTR_t^F + NIB_{CG_t}^F$$

Turning to the pensions, the transaction of pensions is the sum of pension transactions contributed by domestic households ($PENATR^H$) as well as the rest of the world ($NPENTR$). The overall development in $PENLTR^F$ is mainly explained by households contributions to pensions, as discussed earlier.[12]

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

[12] $NPENTR^W$ is exogenous in our model. It is a very small proportion of the total transaction.

We now turn to the last financial asset in FC. The transaction net equities is modelled as a residual between net lending and the transaction of the other financial assets:

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

This transaction leads to a change in the stock of net equities

$$NEQ_t^F = NEQ_{t-1}^F + NEQTR_t^F + NEQ_{CG_t}^F$$

The difference between the stock of total financial assets and total financial liabilities is equal to the financial net wealth:

$$FNW_t^F = NIB_t^F + NEQ_t^F + IBA_t^{F \sim H} - IBL_t^{F \sim H} - PENL_t^F$$

We can calculate the total net wealth by adding fixed assets to the financial wealth as follows:

$$NW_t^F = FNW_t^F + K_t^F$$

4.4 Government sector

The Government sector in Denmark is characterized as a welfare state with a high level of public expenditures, which are financed through taxes.

The total tax revenue received by the government is equal to the taxes paid by all 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. The social transfers paid by the government sector are equal to the sum of social transfers received by the other sectors:

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

The savings of the Government sector is an accounting identity, which also depends on the interest payment on the public debt and the government consumption (G_t), which is kept exogenous in this model. The savings S^G identity can be written as follows:[13]

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

The government sector can also affect the aggregated demand through public investment (I_t^G) in fixed assets, which is also treated as exogenous in this model. The stock of fixed capital is determined in the same way as discussed for other sectors:

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

After taking into account capital transfers and NP, the difference between savings and investment determines the net lending:

[13] Like for other sectors, the goverment sector also recieves a share of the gross operating surplus from the production sector.

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

On the financial side of the economy, the government is assumed to finance its deficit through net interest-bearing assets. The total transaction of this stock determines the financial net lending as follows:

$$FNL_t^G = NIBTR_t^G$$

Since changes in net interest-bearing assets is the only way to finance a deficit or to place a surplus, the net transaction of net interest-bearing assets is determined by the size of the net lending:

$$NIBTR_t^G = NL_t^G$$

The change in net stock of interest bearing asset is determined by its corresponding transactions along with capital gains:

$$NIB_t^G = NIB_{t-1}^G + NIBTR_t^G + NIB_{CG_t}$$

4.5 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. The development in the current account has greatly shifted in the last 50 years. 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.

We now proceed to explaining our model for trade flows in Denmark. The import equation in our model is pretty standard, that is, imports are affected by relative prices and private demand.

Real imports:

$$ln(m_t) = \beta_i + \beta_i ln\left(\frac{P_{t-1}^y}{P_{t-1}^m}\right) + \beta_i ln(c_{t-1} + i_{t-1} + x_{t-1})$$

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 $\frac{P_t^x}{P_t^m}$ indicates the relative prices of tradeables. m_t^W is an index representing the weighted import of the trading partners. Thus, $\frac{x_t}{m_t^W}$ represents the share of Danish exports in the market.

$$\frac{x_t}{m_t^W} = \left(\frac{P_t^x}{P_t^m}\right)^\beta$$

The link between relative prices $\left(\frac{P_t^x}{P_t^m}\right)$ and the share of Danish exports $\left(\frac{x_t}{m_t^W}\right)$ between 1995-2016 is presented below, where there is a clear pattern pointing to an inverse relationship, i.e., an increase in the relative prices is associated with a fall in the export market shares due to a loss of competitiveness.

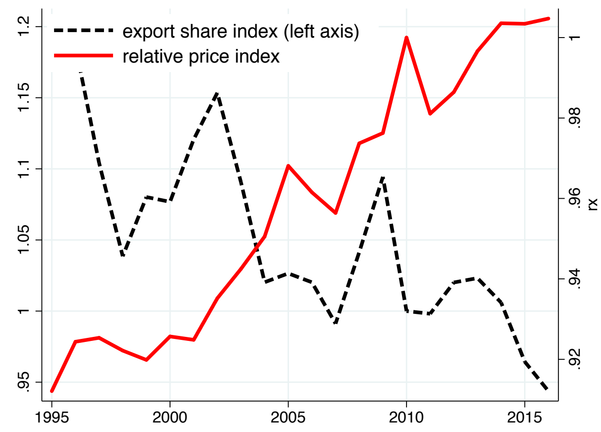


Figure 10: Exports and relative prices

The equation above can be transformed to express the real level of export as a function of relative prices and the export market index:

$$ln(x_t) = \beta_{35} + \beta_{36} ln\left(\frac{P^x_{t-1}}{P^m_{t-1}}\right) + \beta_{38} ln(m^W_t)$$

Nominal imports:

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

Nominal exports:

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

Import prices (P^m_t) are expressed in domestic currency assuming a fixed exchange rate of one. Export prices (P^x_t) are determined within the model as a function of unit labour cost and import prices. The inclusion of import prices in this equation is based on the fact that Denmark imports semi-manufactured goods and has a high degree of trade openness.

Price of exports:

$$ln(P^x_t) = \beta_{39} + \beta_{40} ln(P^m_t) + \beta_{41} ln(ULC_{t-1})$$

The sectoral balance for the foreign sector can be written as an identity containing exports, imports, capital income, net wages received from Denmark, net taxes paid to Denmark, and net social transfers:

Savings of the rest of the world:

$$S^W_t = M_t - X_t + \chi_t(NEQ^W_{t-1}) + \psi_t(NPEN^W_{t-1}) + r_{N_{t-1}}(NIB^W_{t-1}) + WB^W_t - T^W_t + STR^W_t + \epsilon^W$$

Finally, we express all the accounting identities for the rest of the world following the same principle as we did for the other sectors.

Net lending of the rest of the world

$$NL^W_t = S^W_t - NP^W_t + KTR^W_t$$

Current account balance

$$CAB_t = -NL_t^W$$

Financial account balance

$$FNL_t^W = NIBTR_t^W + NEQTR_t^W + NPENTR_t^W$$

Net interest bearing stocks

$$NIB_t^W = NIB_{t-1}^W + NIBTR_t^W + NIB_{CG_t}^W$$

Net equity stocks

$$NEQ_t^W = NEQ_{t-1}^W + NEQTR_t^W + NEQ_{CG_t}^W$$

Net pension stocks

$$NPEN_t^W = NPEN_{t-1}^W + NPENTR_t^W + NPEN_{CG_t}^W$$

Net interest bearing transactions

$$NIBTR_t^W = NL_t^W - NEQTR_t^W - NPENTR_t^W$$

Net financial wealth of the rest of the world

$$FNW_t^W = NIB_t^W + NEQ_t^W + NPEN_t^W$$

4.6 Labour market

We now turn to explaining the labour market, which determines wages and employment in the model. First, we determine GDP at factor cost to determine adjusted wage shares. Then we derive a measure for the ULC, as a ratio of the wage share and GDP at factor costs.

GDP at factor cost:

$$Y_t^F = WB_t^N + B_{2_t}$$

Wage share:

$$WS_t = \frac{WB_t^N}{Y_t^F}$$

Unit labour cost:

$$ULC_t = \frac{WS_t(Y_t)}{Y_t^F}$$

The number of unemployed individuals is defined as the difference between the total labour force and the number of employed individuals. The number of individuals employed domestically is explained by the level of economic activity as well as the participation in the labour force, which is exogenous in the model.

Number of unemployed individuals

$$UN_t = LF_t - N_t$$

The ratio between the number of unemployed and the labour force measures the rate of unemployment

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

The number of employed individuals in the domestic economy is assumed to be determined by real economic activity, and the actual size of the labour force.

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

The number of total employed individuals by the firms is the sum of domestic labour and foreign labour employed in Denmark:

$$N_t^N = N_t + N_t^W$$

Domestic wage bill received by the household sector is simply the product of wage rate and the number of employed individuals domestically. Wage rate is determined by unemployment rate, i.e., a rise in unemployment rate would reduce the wage rate and vice versa.

Wage bill of the household sector

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

The wage rate is modelled through a Phillips-curve relation, i.e., it is a function of the change in the rate of unemployment. 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.

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

Finally, the number of individuals hired from abroad can be deducted from the ratio between the total wage bill paid abroad and the wage share, which is assumed to be the same for all employed.

$$N_t^W = \frac{WB_t^W}{W_t}$$

5 Confronting the model with the data

Our model has a number of structural parameters which are estimated using annual Danish data from 1995-2016, following an auto-regressive distributive lag (ARDL) model. Before estimating the regression equations, we test our variables for a unit root using ADF and

Phillip-Perron test. If we suspect a strong structural break in the data, we supplement our analysis with a unit root structural break test of Zivot and Andrews. If a variable is found to be non-stationary, we estimate the equation in first-differences, and test for cointegration, given that the pre-requisites for establishing cointegrating relationships are fulfilled.

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 account for any significant structural breaks in our estimations. While our estimation technique is entirely econometric in nature aimed at obtaining statistically valid estimators, our choice of variables in every equation is purely theoretical as discussed earlier. The number of variables in our econometric equations are to some extend limited by data availability. Overall, we did not encounter any contradictions between our theoretical and empirical relationships, that are worthy of consideration. In some cases, the variables of interest revealed an insignificant relationship, however, the estimators in all cases had the right signs. All econometric results are reported in the appendix.

After estimating the structural parameters, we simulate the model and compare the overall performance of our model with the actual data. The use of simulation is essential to characterize the dynamic properties of any given model. Here we only focus on our key variables. Overall, the estimated behavioural equations are able to explain the dynamics of the data to some extent.

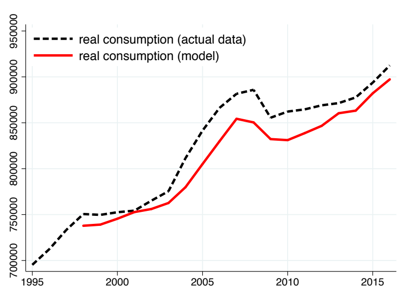


Figure 11: Real consumption

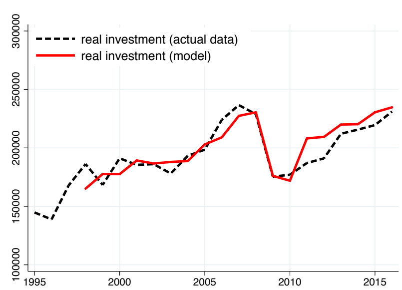


Figure 12: NFC investment

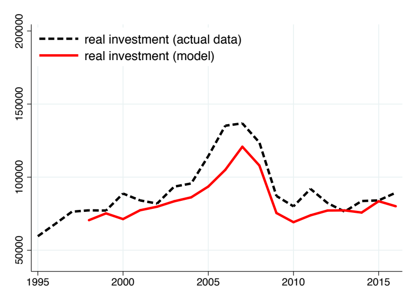


Figure 13: Household investment

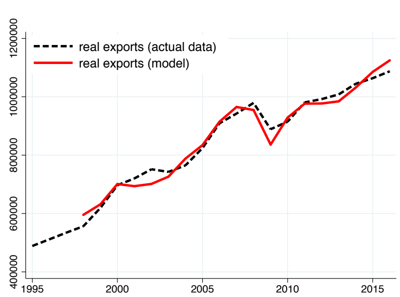


Figure 14: Real exports

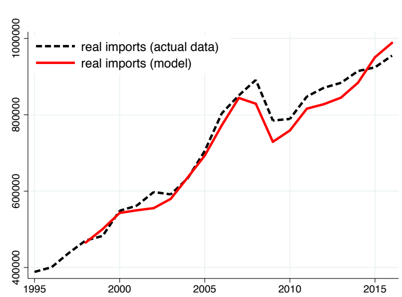


Figure 15: Real imports

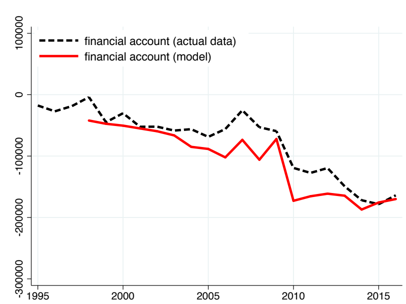


Figure 16: Financial account balance

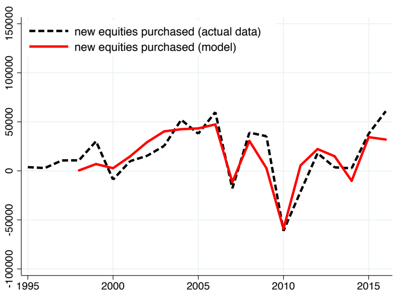


Figure 17: HH demand for equities

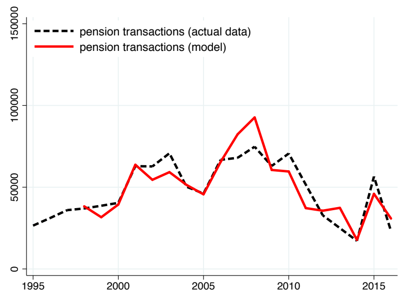


Figure 18: HH contribution to pension

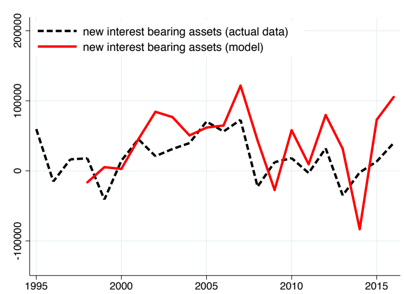


Figure 19: HH demand for interest bearing assets

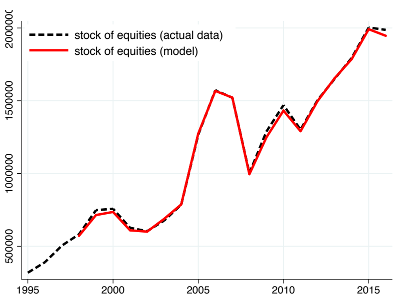


Figure 20: HH stock of equities

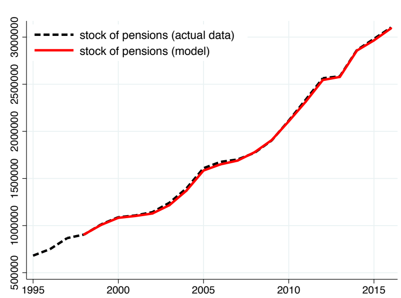


Figure 21: HH stock of pension

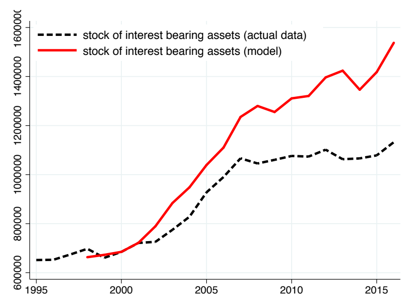


Figure 22: HH stock of interest bearing assets

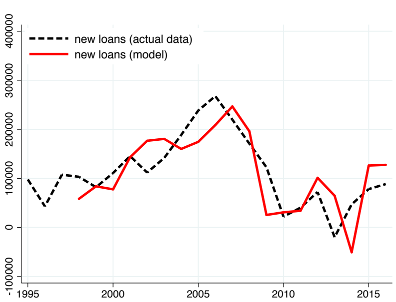


Figure 23: HH demand for loans

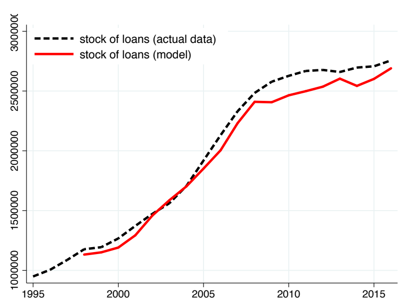


Figure 24: HH stock of debt

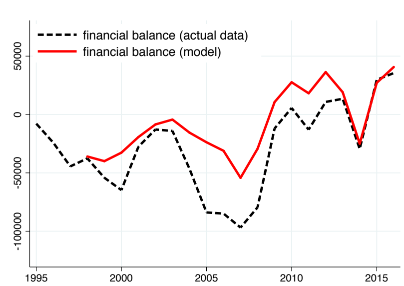


Figure 25: HH balance

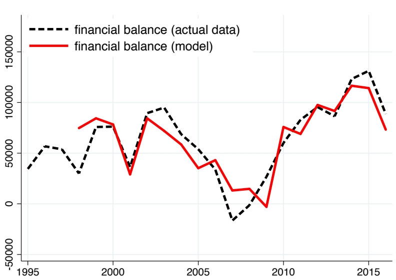


Figure 26: NFC balance

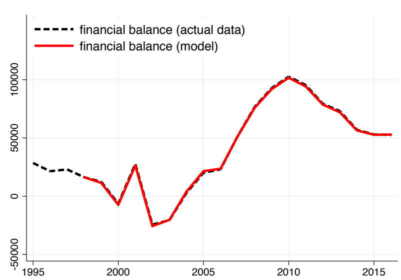


Figure 27: FC balance

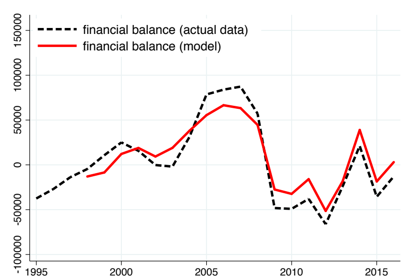


Figure 28: Govt. balance

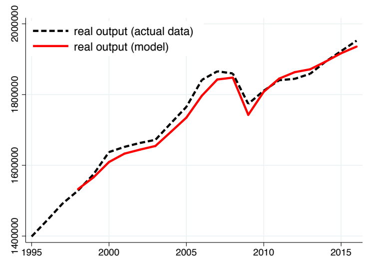


Figure 29: Real output

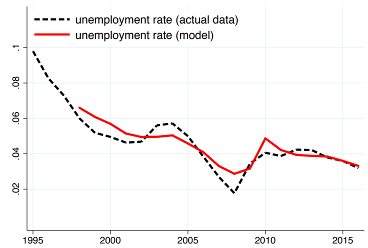


Figure 30: Unemployment rate

5.1 Baseline

We now proceed to performing simulations on the model for several periods ahead. It is important to make it clear, that our primary objective of the simulations is not to provide a forecast of the growth rates, but to explore how the economy that is based on the structure presented earlier might unfold. The result from this simulation is used as our baseline result against which different scenarios are compared in order to analyse the effects of different shocks to the economy.

In order to perform simulations and create sensible outcomes, we follow a simple approach and forecast some key exogenous variables while keeping the estimated parameters constant. It should be highlighted that a combination of exogenous variables can be crucial for determining the growth rate of the economy in the simulations. In particular, we find that choosing a combination of prices is critical, as it determines both inflation and competitiveness in the economy. It is nonsensical to project all the exogenous variables with the same growth rate, and choosing a particular forecasted-combination of exogenous variables becomes extremely difficult. The task becomes even more complicated when it comes to projecting capital gains due to their fragile nature. Thus, we refrain from forecasting capital gains and prefer to analyse their effects in the form of shocks in the future.

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. However, the depreciation of capital stock is determined on the basis of its ratio to the stock of capital (instead of GDP) in the projections. We allow the prices to grow at an average growth rate of the last 12 years. 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. 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. Finally, we do not allow for capital gains on stocks in the baseline simulations for the reasons discussed earlier. We randomly choose to solve the model up to 50 periods, which gives us a baseline solution, without any nonsensical explosions in any variable. Here, we will only focus on our results until 2030.

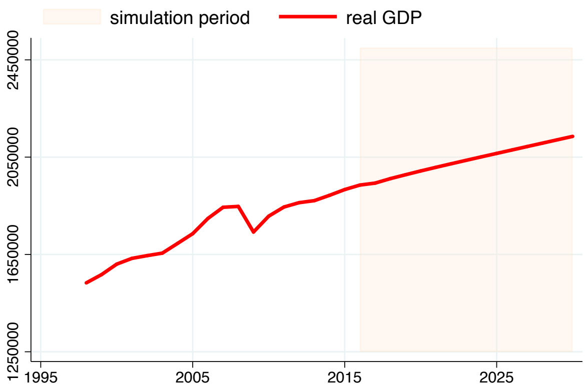


Figure 31: Real GDP

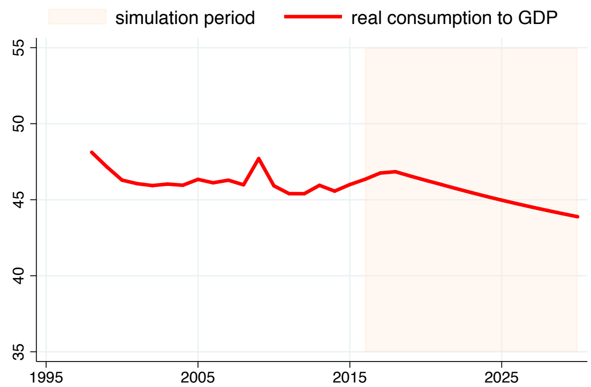


Figure 32: Consumption

Figure 31 shows the baseline scenario for real GDP, which has a growth rate of 0.7% - 0.95% whereas the nominal growth rate is around 2% - 2.2%. The growth rate in our model is lower as compared to the baseline growth in other models, e.g., the nominal growth rate in Burgess et al. (2016) is around 5%.[14] We now present other components of real GDP as a ratio of GDP.

Focusing on consumption, Figure 32 shows real consumption to GDP which follows a slight downward trend, implying that the growth rate of real consumption is slightly lower than that of real GDP. As discussed earlier, the slow growth in consumption is primarily due to slow demographic changes projected for Denmark, higher pension contributions by employed individuals, and zero capital gains on households assets assumed in the simulation period.

[14]The lower growth rate is primarily because of lower household and government consumptions. Focusing on household consumption, the growth rate is slightly lower because of slow demographic changes projected for Denmark (i.e., low labour force), higher pension contributions by employed individuals, and zero capital gains on households assets. Focusing on the government sector, we let the real government consumption to grow by 1.18% which is consistent with the lower growth rates of the previous governments, and also close to the growth rate expected by the Danish Central Bank in the next few years. Note that the sample average growth rate for real government expenditure is 1.6% and for nominal government expenditure, it is 3.63%. In contrast, Burgess et al. (2016) project this variable using its long-term average.

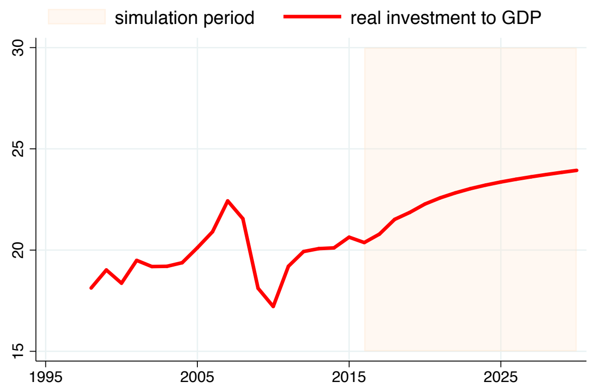


Figure 33: Real investment

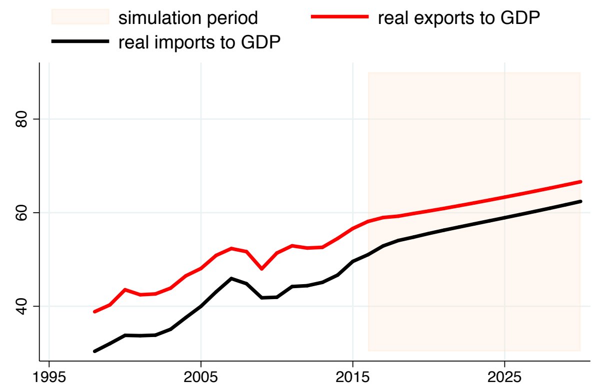


Figure 34: Trade

Figure 33 shows real investment to GDP, where the post-crisis upward trend continues to drive economic growth. The same is the case of trade openness, i.e., both real exports and imports as ratios of real GDP follow an upward trend as shown in Figure 34. The growth in imports seems to be slightly higher than that of exports. However, the overall trade balance continues to be positive and Denmark experiences a current account surplus in the simulation period.

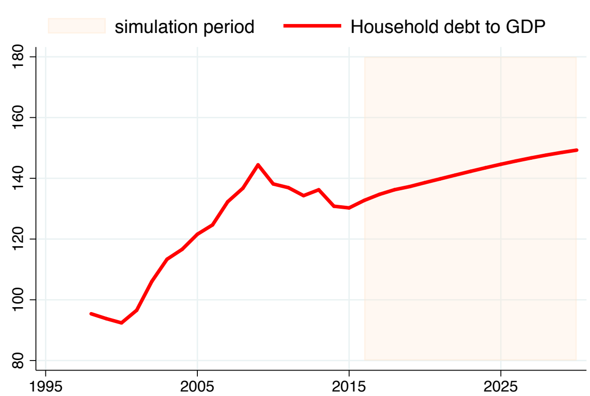


Figure 35: Household debt

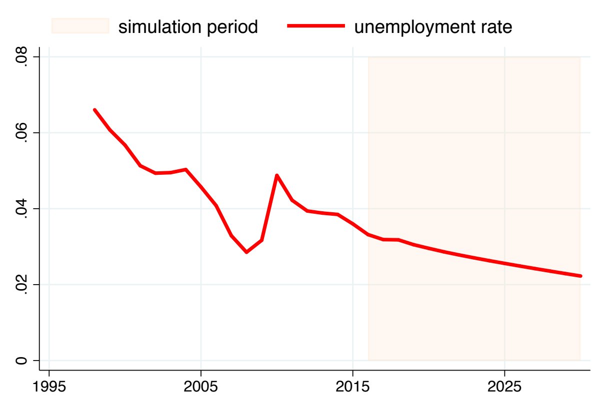


Figure 36: Unemployment rate

Figure 35 shows household debt to GDP, where we can see a slightly upward trend indicating that debt is growing faster than GDP. The accumulation of debt in our simulation is not as sharp as it was in the pre-crisis period. Focusing on the labour market, Figure 36 shows that unemployment rate continues to fall in Denmark despite low economic growth. This result can be explained by the fact that the growth rate of labour force in our simulation is very small.

Finally, we present the financial balances of all the sectors in Figure 37. It can be seen that, all domestic sectors with the exception of financial corporations, have a surplus. The Rest of the World shows an increasing deficit vis-a-vis Denmark, which is in line with the persistent current account surpluses experienced by the Danish economy since 1990s. In our model, the household sector despite experiencing an increase in debt to GDP, manages to achieve a surplus which indicates that there is also strong growth in the accumulation of financial assets. This is in line with the feature of the Danish households balance sheet presented in section 3.

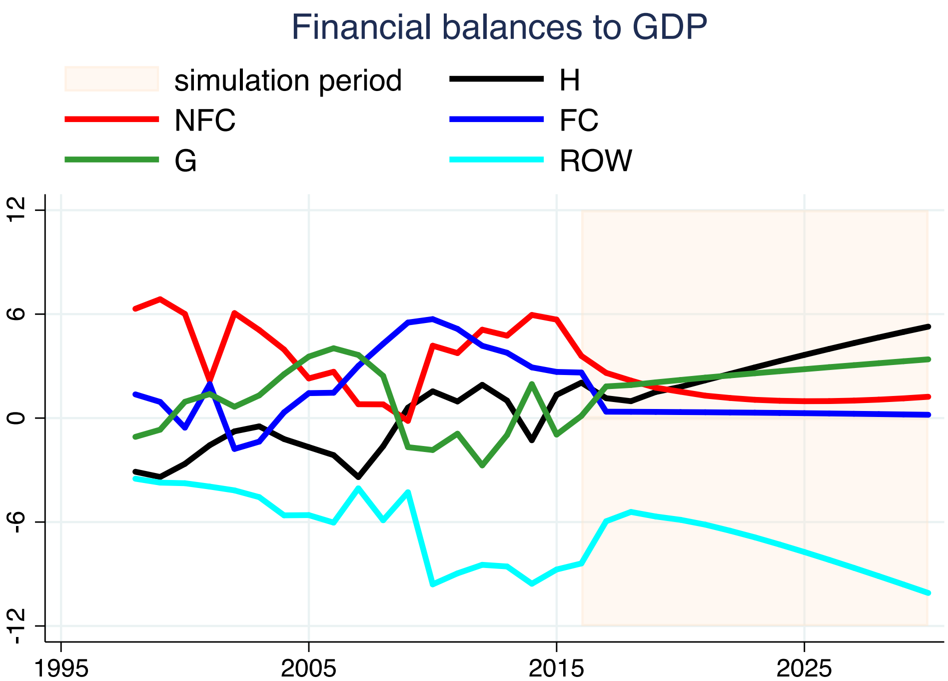


Figure 37: Financial balances of sectors

We now proceed to analysing the effect of two standard shocks (fiscal shocks and interest rate shocks) in our model in order to explore whether our model is able to explain some of the stylized facts.

5.2 Fiscal shocks

We analyse the effects of a fiscal shock in our model by increasing real public consumption with 1 percentage point in 2017 (i.e., the growth rate of real government consumption in 2017 increases to 2.18 as compared to the baseline of 1.18 percent).[15] While focusing on our key variables, the effects of the shock are analysed as percentage deviations from the baseline scenario.

Figure 38 shows the response of real output to a fiscal shock; a permanent increase in government expenditures positively affects real economic activity. The multiplier effect is around 0.3%. We now turn to explaining the effects of the shock on individual components of

[15] This leads to a permanent increase in the level of public consumption in the simulation sample.

GDP. Figure 39 shows the response of households consumption to a fiscal shock, indicating a positive response, however, the magnitude of this response is very small. The increase in consumption in this case can be explained by both an increase in the wage rate and employment. The effect is weaker because a fall in unemployment rate also affects real consumption due to an increase in prices of consumption.

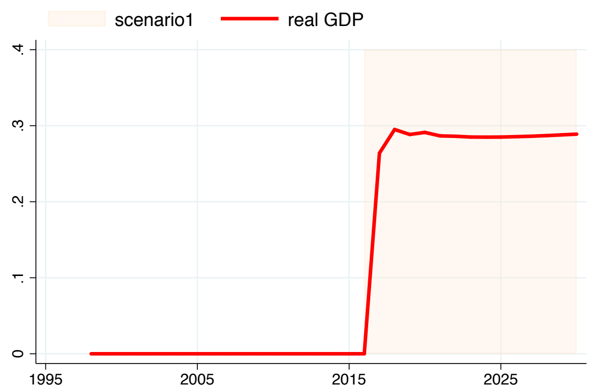


Figure 38: Real GDP

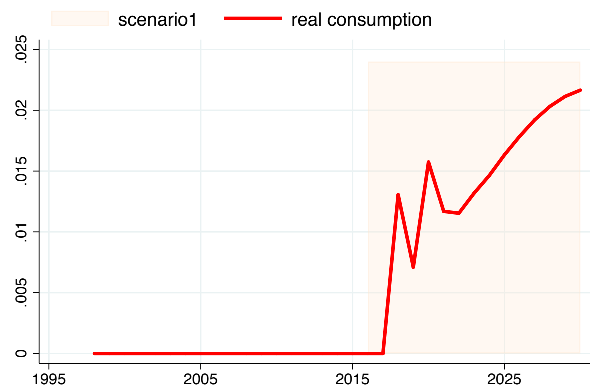


Figure 39: Consumption

Figure 40 shows the effect of the shock on real investment. The level of real investment increases in 2018 mainly due to the accelerator mechanism in the investment function as presented earlier. The effect of the shock is stronger in the short-run but it then slowly fades away. However, the overall level of investment stabilises at a level slightly above the baseline in the long run.

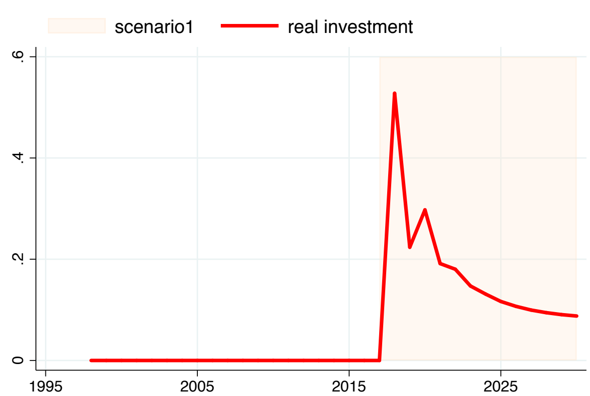


Figure 40: Real investment

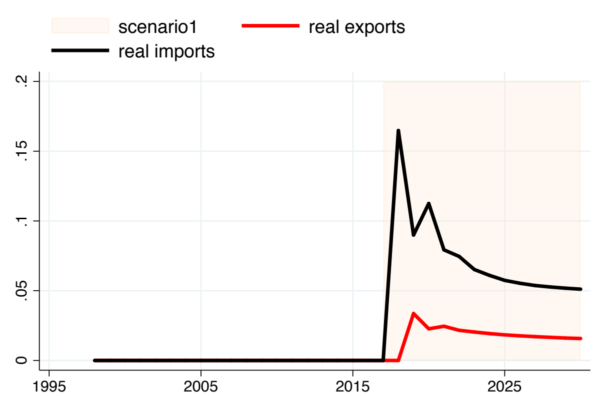


Figure 41: Trade

Turning to the trade balance, following a fiscal shock the economy experiences a trade deficit, which in turn leads to a current account deficit. In particular, the level of import increases strongly in response to a fiscal shock, which can be explained by two main channels in our model: i) an increase in the level of economic activity affects the demand for imported goods as seen in the import function, ii) since import prices are assumed to be fixed, an increase in domestic prices in response to a fiscal shock adversely affects the real exchange rate, which in turn increases the demand for imports. This effect is very strong in the short run, but then it slowly reduces and stabilises slightly above the baseline scenario.

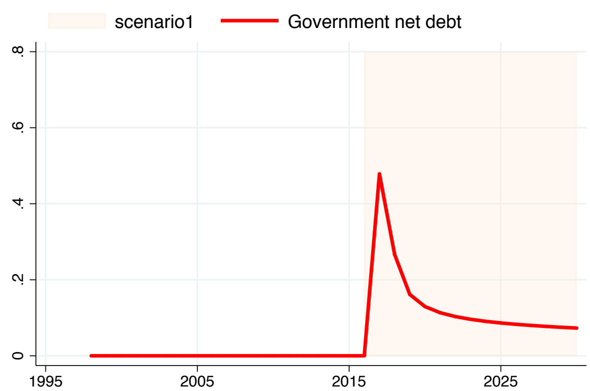


Figure 42: Government debt

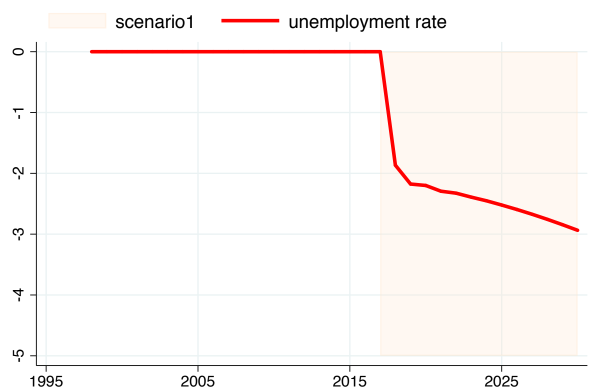


Figure 43: Unemployment rate

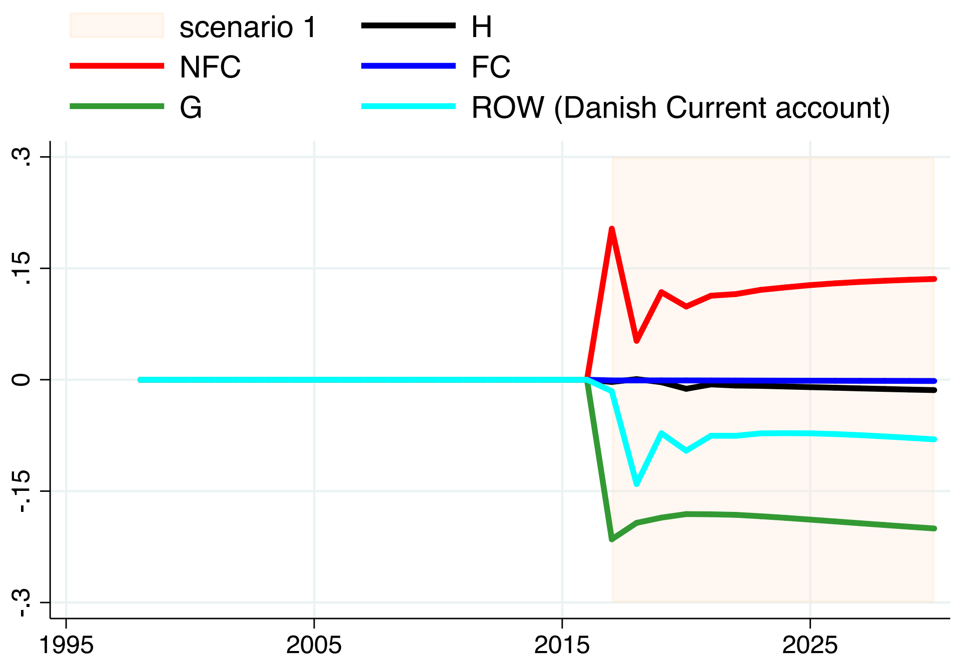


Figure 44: Financial balances of sectors

On the financial side, an increase in the public consumption leads to fall in the financial balance of the public sector as seen in Figure 44. An increase in public consumption directly increases the sales of goods & services for NFC, leading to an increase the financial balance of NFC. The effect of a fiscal shock on financial account balance of the Rest of the World is explained earlier. Finally, the effects on the household sector and financial sector are negligible.

Focusing on the debt, a fall in the financial balance of the public sector results in an increase in the stock of debt as shown in Figure 42. The effect is very sharp in the short run, but then it slowly reduces as more tax revenues flow into the public sector, and recipients of social benefits fall. These tax revenues originate mostly from NFC as they experience an increase in sales. Overall, we can conclude that the effects of a fiscal shock in our model are consistent with the theory.

5.3 Interest rate shocks

We now analyse the effect of interest rate shocks in our model. Since we have more than one interest rate in the model, we introduce an interest rate shock by increasing the interest rate with 1 percentage point on all interest bearing stocks. Here, we retain the assumption of a fixed exchange rate, and assume that the increase in interest rate is a response to the rise in the foreign interest rates. Figure 45 shows the overall effect of an increase in interest rate on real GDP and its components. The effect of an interest rate shock on the real economy is contractionary in nature, however, the overall effect on output is not so strong, as will be explained. The negative effect on GDP is clearly driven by a strong fall in both consumption and investment. Specifically, the fall in consumption in the short run is due to a fall in disposable income as shown in Figure 46. The decline in investment is due to the accelerator mechanism built into the investment function as well as due to rising cost of investment (i.e., higher interest rate).

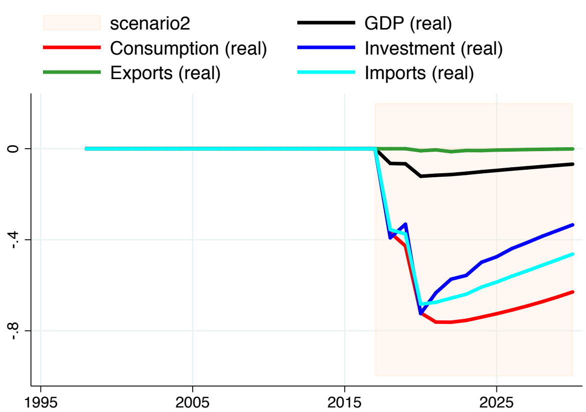


Figure 45: Real Economic activity

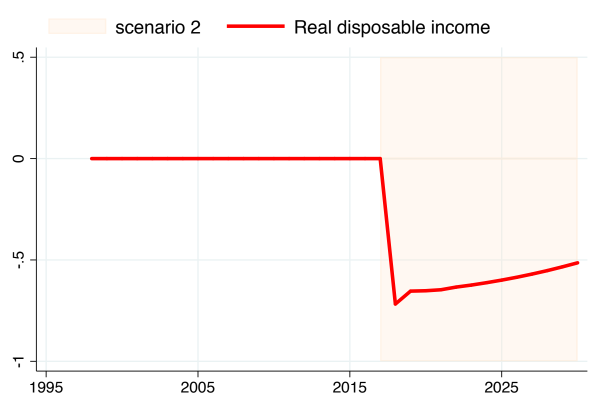


Figure 46: Real Disposable income

Focusing on the trade balance, interest rate shocks do not have a strong effect on real exports, since we still assume a fixed exchange rate. Real imports on the other hand decline in response to the shock mainly due to a fall in domestic activity as well as due to a fall in domestic prices. The overall contraction in real economic activity also affects unemployment rate, which increases with almost 1% from 2017 to 2021.

Focusing on the financial balances, Figure 48 shows that amongst the domestic sectors, FC experiences a considerable improvement in its financial balance, following an interest rate shock. The financial balance of NFC falls due to aggregate demand contraction and increased interest payments. The government balance also falls due to falling tax revenues and increased interest payments. Overall, positive interest rate shocks will adversely affect the financial balances of the sectors (i.e., NFC, government, and RoW) with negative stock of interest bearing assets and positively affect the financial balances of sectors (Financial Corporations) with positive net interest bearing stock.

We now focus on the household sector which holds both interest bearing assets and liabilities. The real disposable income of households drop as a result of the fact, that the stock of interest-bearing liabilities exceeds the stock of interest-bearing assets. Moreover, the adverse effect on disposable income is further induced by a fall in aggregate demand and an increase in the rate of unemployment as shown in Figure 47.

Figure 47: Unemployment rate

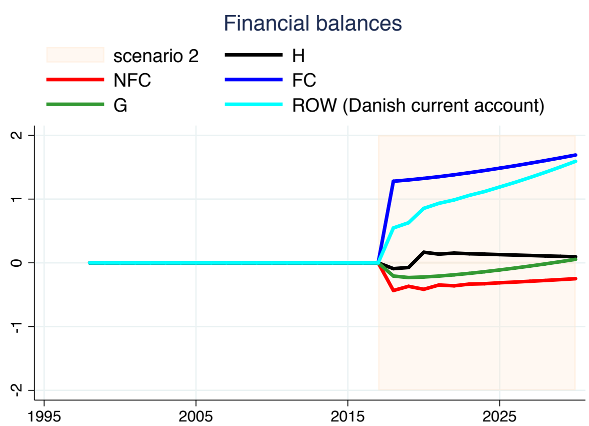


Figure 48: Financial balances

In the short term, financial balance is negative because the fall in disposable income exceeds the fall in households consumption and investment. However, the effect of the shock on net lending turns positive after a year mainly due to a fall in households investment, i.e., the improvement in net lending is due to the deleveraging.

6 Conclusion

This paper emphasises the need for understanding the interdependencies between the real and financial side of the economy in macroeconomic models. While the real side of the economy is generally well-explained in macroeconomic models, the financial side of the economy and its interaction with the real economy remains poorly-understood. This is partly due to the complexity of financial system, but more importantly due to methodological neglect of an active financial system in macroeconomic tradition. This paper makes an attempt to model the interdependencies between the real and financial side of the economy in Denmark while adopting a stock-flow-consistent approach. The model is estimated using Danish data for the period 1995-2016.

The model is simulated to create a baseline scenario for the period 2017-2030, against which the effects of two standard shocks (fiscal shocks and interest rate shocks) are analysed. An increase public consumption affects the economy through different channels. Specifically, a fiscal shock increases domestic demand, and adversely affects the current account balance. It also deteriorates the public balance, resulting in a higher level of debt in the public sector, which in turn improves the financial net wealth in the production sector and the foreign sector. An increase in the interest rate has the effect of contracting aggregate demand, however, the overall effect on output is not so strong. Overall, positive interest rate shocks adversely affect the financial balances of sectors (i.e., NFC, government, and RoW) with negative stock of interest bearing assets and positively affect the financial balances of sectors (Financial Corporations) with positive net interest bearing stock. The results of these two shocks are in line with the theoretical arguments.

While the model structure is fairly simple due to different constraints, the use of stock-flow approach makes it possible to explain the development of accumulation of different individual financial assets and liability in a meaningful way. The financial and real side of the economy are tied together via the net lending (or financial balances), where a surplus on the real side of the economy requires a net accumulation of financial assets, just like a deficit on the real side of the economy requires a net accumulation of financial liabilities. Hence, the real economy has a direct effect on the balance sheets, and these balance sheets have a feedback effect on the real side of the economy.

Finally, in common with all studies, our analyses are subject to several limitations. In particular, the supply of credit needs to be explained since credit creation in our model is demand driven. Moreover, there are no policy reactions in the economy. Hence, the results drawn from this model needs to be interpreted with great caution.

Appendix

Consumption equation

$$\begin{aligned} ln(c_t) = &-0.007^{**} + ln(c_{t-1}) + 0.23^{*}\Delta ln(c_{t-1}) + 0.51^{***}\Delta ln(yd_t^H) \\ &+ 0.38^{**}\Delta ln(yd_{t-2}^H) + 0.09^{**}\Delta ln(nw_{t-1}^H) \end{aligned}$$

Investment by NFC sector:

$$ln(i_t^N) = 0.03^{***} + ln(i_{t-1}^N) - 0.41^{**}\Delta ln(i_{t-1}^N) + 3.23^{***}\Delta ln\left(\frac{y_{t-1}}{k_{t-1}^N}\right) - 0.25^{***}D_{2009}$$

The level of investment by the household sectors is estimated as follows:

$$ln(i^H_t) = -0.11^{**} + ln(i^H_{t-1}) - 0.3^{*}\Delta ln i^H_{t-1} + 2.54^{**}\left(\frac{P^H_t}{P^i_t}\right)$$
$$+ 1.91^{**}\left(\frac{P^H_{t-1}}{P^i_{t-1}}\right) + 2.6^{**}ln(yd^H_t) + 3.19^{**}ln(yd^H_{t-2})$$

The level of exports and imports:

$$ln(x_t) = 13.73^{***} - 0.47ln\left(\frac{P^x_{t-1}}{P^m_{t-1}}\right) + 0.87^{***}ln(y^w)$$

$$ln(m_t) = -12.16^{***} + 0.09^{**}ln\left(\frac{P^y_{t-1}}{P^m_{t-1}}\right) + 1.76^{***}ln(c_t + i_t + x_t) + 0.05^{***}D_{2009}$$

The demand for new equities is determined by the return on equities and the return on interest bearing assets:

$$EQATR^H_t = 427062^{*}\chi_t - 581223^{**}r^H_{A_{t-1}} + 0.23^{***}IBLTR^H_t - 59072^{***}D_{2007} - 64431^{***}D_{2010}$$

The transaction for pensions is determined by:

$$PENATR^H_t = 0.24^{**}PENATR^H_{t-1} - 212033.2 + 2714501.5^{***}(\psi_t) + 0.16^{**}WB^H_t$$

The demand for new interest bearing liabilities is determined by:

$$IBLTR^H_t = 1.99^{***}I^H_t - 0.05^{***}(IBL^H_{t-1}) + 0.67^{***}(FATR^H_t) - 270042^{*}r^H_{L_{t-1}}$$

Total gross operating surplus:

$$B_{2_t} = 175119.1^{**} + 0.189^{**}Y_t + 6362.97^{**}t - 53422.90^{**}D_{2009}$$

Social benefits:

$$ln(SBEH_t) = 0.59^{**}ln(SBEH_{t-1}) + 0.06^{**}ln(UN) + 0.88^{**}ln(W_{t-1}) - 0.01^{**}t$$

Price of consumption goods:

$$lnP^c_t = -0.0006^{**} + lnP^c_{t-1} + 0.462^{**}ln\Delta(P^c_{t-1}) + 0.462^{**}ln\Delta(W_{t-2}) + 0.10^{**}\Delta ln(P^m_y) + 0.008^{**}D_{2008}$$

Price of export goods:

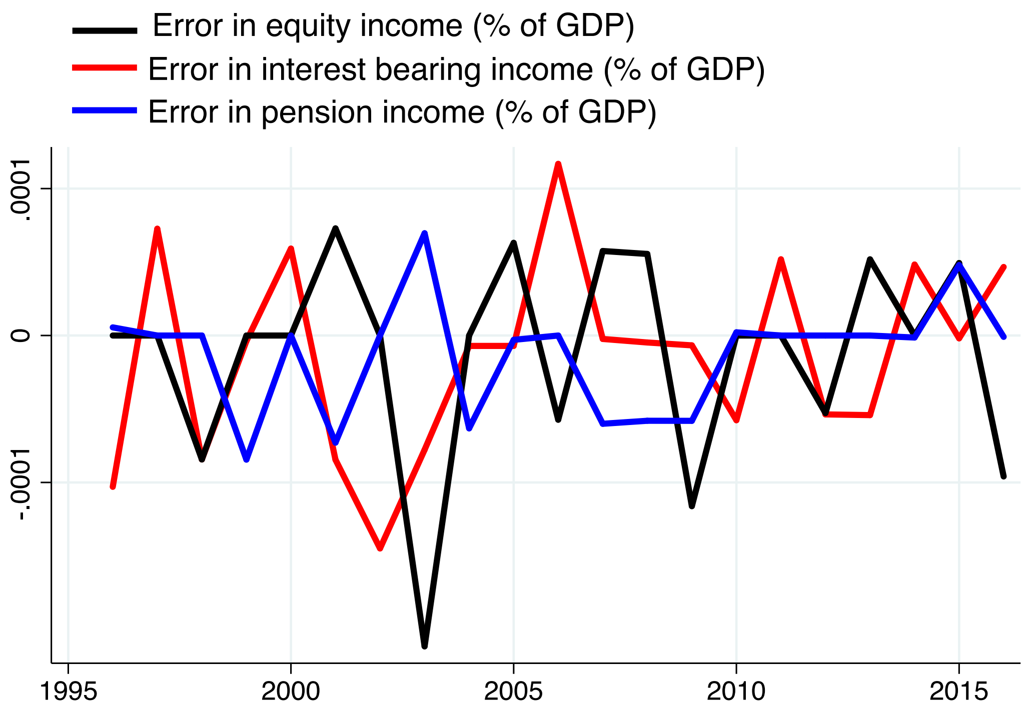
$$lnP^x_t = 0.0028^{**} + lnP^x_{t-1} + 0.040^{**}ln\Delta(P^x_{t-2}) + 1.05^{**}ln\Delta(P^m_t) + 0.269^{**}\Delta ln(ULC_{t-1})$$

Number of employed individuals:

$$ln(N) = -4.54^{**} + 0.232^{**}ln(y_{t-1}) + 1.148^{**}ln(LF) - 0.0016^{**}t$$

Wage rate:

$$W_t = 0.822^{**} + W_{t-1} + 0.426^{**}\Delta(W_{t-1}) + 0.453^{**}\Delta(W_{t-2}) - 101.47^{**}\Delta(UR) + 88.98^{**}\Delta(UR_{t-1}) - 126.26^{**}\Delta(UR_{t-2}) - 4.691D_{2011}$$



Error terms

Table 4: 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

Table 4: List of variables *(continued)*

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
K_{CG}^N	Capital gains on capital stock of NFC
K_{CG}^H	Capital gains on capital stock of households
K_{CG}^F	Capital gains on capital stock of FC
K_{CG}^G	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

Table 4: List of variables *(continued)*

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
$NIBTR^G$	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

Table 4: List of variables *(continued)*

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
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^H_A	Interest rate on household interest bearing assets

Table 4: List of variables *(continued)*

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

References

ADAM (2012). Adam-a model of the danish economy. *Statistics Denmark, Copenhagen, Denmark.*

Armington, P. S. (1969). A theory of demand for products distinguished by place of production. *Staff Papers*, 16(1):159–178.

BIS (2011). The transmission channels between the financial and real sectors: a critical survey of the literature.

Blanchard, O. (2018). On the future of macroeconomic models. *Oxford Review of Economic Policy*, 34(1-2):43–54.

Borio, C. (2014). The financial cycle and macroeconomics: What have we learnt? *Journal of Banking & Finance*, 45:182–198.

Bovari, E., Giraud, G., and Mc Isaac, F. (2018). Coping with collapse: a stock-flow consistent monetary macrodynamics of global warming. *Ecological economics*, 147:383–398.

Brown, S., Garino, G., and Taylor, K. (2013). Household debt and attitudes toward risk. *Review of Income and Wealth*, 59(2):283–304.

Brown, S. and Taylor, K. (2008). Household debt and financial assets: evidence from germany, great britain and the usa. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 171(3):615–643.

Burgess, S., Burrows, O., Godin, A., Kinsella, S., and Millard, S. (2016). A dynamic model of financial balances for the united kingdom.

Byrialsen, M. R. (2018). Post-keynesianske stock-flow-konsistente makroøkonomiske modeller: en introduktion. *Nationaløkonomisk Tidsskrift*.

Byrialsen, M. R. and Raza, H. (2018). Macroeconomic effects of unemployment benefits in small open economies: a stock–flow consistent approach. *European Journal of Economics and Economic Policies: Intervention*, 15(3):335–363.

Caldera, A. and Johansson, Å. (2013). The price responsiveness of housing supply in oecd countries. *Journal of Housing Economics*, 22(3):231–249.

Caverzasi, E. and Godin, A. (2014). Post-keynesian stock-flow-consistent modelling: a survey. *Cambridge Journal of Economics*, 39(1):157–187.

Christiano, L. J., Eichenbaum, M., and Evans, C. L. (2005). Nominal rigidities and the dynamic effects of a shock to monetary policy. *Journal of political Economy*, 113(1):1–45.

Christiano, L. J., Eichenbaum, M. S., and Trabandt, M. (2018). On dsge models. *Journal of Economic Perspectives*, 32(3):113–40.

Dafermos, Y., Nikolaidi, M., and Galanis, G. (2017). A stock-flow-fund ecological macroeconomic model. *Ecological Economics*, 131:191–207.

de Jesus, C. S., Araujo, R. A., and Drumond, C. E. (2018). An empirical test of the post-keynesian growth model applied to functional income distribution and the growth regime in brazil. *International Review of Applied Economics*, 32(4):428–449.

DREAM (2008). Documentation.

DREAM (2016). Finanspolitisk holdbarhed, skattelettelser og det saakaldte raaaderum. *Working Document*.

Friedrichsen, O. (2019). Kvartalskapitalismen hersker i danmark – eller gØr den?

Fujita, S. (2018). Mark-up pricing, sectoral dynamics, and the traverse process in a two-sector kaleckian economy. *Cambridge Journal of Economics*, 43(2):465–479.

Gattini, L. and Ganoulis, I. (2012). House price responsiveness of housing investments across major european economies.

Godley, W. (1999). Seven unsustainable processes. *Special report*.

Godley, W. and Lavoie, M. (2012). *Monetary economics: an integrated approach to credit, money, income, production and wealth*. Palgrave.

Godley, W., Papadimitriou, D. B., Hannsgen, G., and Zezza, G. (2007). The us economy is there a way out of the woods? *Available at SSRN 1055521*.

Godley, W. and Zezza, G. (1992). A simple stock flow model of the danish economy. In *Themes in Modern Macroeconomics*, pages 140–179. Springer.

Hendry, D. F. and Mizon, G. E. (2014). Why dsges crash during crises. *VOX CEPR Policy Portal*.

Hendry, D. F. and Muellbauer, J. N. (2018). The future of macroeconomics: macro theory and models at the bank of england. *Oxford Review of Economic Policy*, 34(1-2):287–328.

IMF (2017). Global financial stability report: Is growth at risk?

Jakab, Z. and Kumhof, M. (2019). Banks are not intermediaries of loanable funds - facts, theory and evidence.

Kohlscheen, E., Mehrotra, A. N., and Mihaljek, D. (2018). Residential investment and economic activity: evidence from the past five decades.

Lindé, J. (2018). Dsge models: still useful in policy analysis? *Oxford Review of Economic Policy*, 34(1-2):269–286.

Naqvi, A. and Stockhammer, E. (2018). Directed technological change in a post-keynesian ecological macromodel. *Ecological Economics*, 154:168–188.

Nationalbanken (2016). Finansiel stabilitet, 1. halvaar 2016.

Nikiforos, M. and Zezza, G. (2017). Stock-flow consistent macroeconomic models: A survey. *Journal of Economic Surveys*, 31(5):1204–1239.

Papadimitriou, D. B., Nikiforos, M., and Zezza, G. (2013). A levy institute model for greece. *Technical paper, Levy Institute*.

Ponta, L., Raberto, M., Teglio, A., and Cincotti, S. (2018). An agent-based stock-flow consistent model of the sustainable transition in the energy sector. *Ecological economics*, 145:274–300.

Raza, H., Zoega, G., and Kinsella, S. (2018). Asymmetries exist in the feldstein–horioka relationship. *The Journal of International Trade & Economic Development*, 27(6):667–684.

Romer, P. (2016). The trouble with macroeconomics. *The American Economist*, 20:1–20.

Smets, F. and Wouters, R. (2007). Shocks and frictions in us business cycles: A bayesian dsge approach. *American economic review*, 97(3):586–606.

Smidova, Z. (2016). Betting the house in denmark.

Stephensen, P., Ejarque, J., Høegh, G., Kronborg, A., and Bonde, M. (2017). The new danish macroeconomic model makro. *Working Paper*.

Stiglitz, J. E. (2018). Where modern macroeconomics went wrong. *Oxford Review of Economic Policy*, 34(1-2):70–106.

Wren-Lewis, S. (2018). Ending the microfoundations hegemony. *Oxford Review of Economic Policy*, 34(1-2):55–69.

Zezza, G. (2008). Us growth, the housing market, and the distribution of income. *Journal of Post Keynesian Economics*, 30(3):375–401.