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A Quarterly Empirical Stock-Flow Consistent Model for the Danish Economy

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Abstract

In this paper, we present a quarterly model for the Danish economy while focusing on the main assumptions behind the model and the construction of the databank behind the model.

The purpose of the model is to build a platform for analysing the interdependencies between the real and financial sides of the economy, which is an important feature of the stock-flow consistent approach. The model parameters are estimated using quarterly Danish data over the period 2005–2020. We validate the model from both an empirical and theoretical perspective. From an empirical point of view, we numerically solve the model and compare the model results with the original data to ensure that the model is able to capture the dynamics of the economy. From a theoretical point of view, we introduce a standard shock to public spending and explore whether the response of the economy is in line with what is predicted by the theory. In both cases, we find that the model fulfils the intended objective.

KEYWORDS: Empirical Stock-Flow Consistent Models; Denmark; Open Economy

JEL CLASSIFICATIONS: E17; E12; F41

1 Introduction

The understanding of the interactions between the financial and real sectors has become essential for providing knowledge on minimizing risks in the economy and to ensure stability of the financial system. The balance sheet developments of the private sector in particular have been considered an important factor in the buildup of financial instability prior to the Global Financial Crisis.
Furthermore, the last couples of years have increased the need for understanding how different shocks not related directly related to economics might propagate through the economic system and call for intervention from either Governments or Central Banks.
In this regard, a good understanding of the interaction between the real and financial sectors can enable policymakers to react to early signs and take preventive measures to reduce the adverse effects of shocks, such as the ones experienced during COVID-19 pandemic.

The aim of this paper is to propose a framework that can coherently link the real and the financial sectors of a given economy, thereby highlighting the structural linkages through which the financial sector interacts with the real sector in a small open economy with a fixed exchange rate. The framework provided in this paper follows the well-known stock-flow consistent (SFC) approach, where the macroeconomic system as a whole is assessed from a sectoral perspective rather than through a microeconomic lens involving an individual agent as a representative of a given sector. From a theoretical perspective, the real and financial sectors are linked through standard accounting principles, and the dynamics of the data are explained through behavioral equations, which are built on a theoretical foundation predominantly inspired by Post-Keynesians theory. The structure of our model is greatly influenced by a number of studies within the Post-Keynesian empirical SFC tradition, including, amongst others, Godley and Zezza (1992), Godley (1999), Godley et al. (2007), Papadimitriou, Nikiforos, and Zezza (2013), Burgess et al. (2016), Valdecantos (2020), and Byrialsen and Raza (2019). Since the number of empirical SFC models is still very limited in the existing literature, our paper also contributes to the literature on empirical SFC models.

The rest of the paper is organized as follows. Section 2 provides a brief review of the current macro models used at various policy institutions in Denmark. Section 3 presents the main assumptions in the model. Section 4 explains the process of data construction to be used in our model. Section 5 presents the structure of the model. Section 6 explains the results of the model. Section 7 concludes this paper.

2 Tradition of Macro Modeling in Denmark

The tradition of macroeconomic modelling in Denmark started in the early 1970s where Ellen Andersen developed the first macroeconomic model for the Danish Economy (Kærgård 2020). A few years later Statistics Denmark took over the task of maintaining and the further development of the model under the new name ADAM (Annual Danish Aggregate Model). Concurrently, the Danish Economic Council (SMEC) developed other macroeconomic models for the Danish economy.

These models were built following the tradition of the work by Lawrence Klein relying on Keynesian theory (Grinderslev & Smidt 2020). The purpose of these models was to forecast the development of short run fluctuations in the Danish Economy, typically 1-2 years ahead, and to analyse the effect of different policy initiatives. The behavioural equations in the models were estimated individually using aggregated data, which at that time was not very detailed.

In the 1980s, several changes were made to ADAM, reflecting the international trends in the field of macroeconomic theory. The focus shifted away from explaining short run fluctuations within a structural econometric macroeconomic model (SEM) towards a higher emphasis on the long-term properties of the model (Grinderslev & Smidt 2020), which were normally grounded in the theoretical foundations of general equilibrium models (Kærgård 2020).

In 1997, the first dynamic general equilibriums model, DREAM, (Danish Rational Economic Agents Model) was developed with the purpose of analysing different long-run challenges for the Danish economy within the framework of an Overlapping generation model (OLG-model). (Knudsen et al. 1998)

Unlike other countries, empirical DSGE-models have not attracted the same attention in Denmark. However, in 2016 an estimated DSGE-model was published in a Central Bank working paper (Pedersen 2016), with the potential of analysing the effect of changes in fiscal policy variables and specific counter-factual changes in financial markets.

The shift from Keynesian models towards general equilibrium models initiated in the last half of the 1980s did not happen overnight. Both the SMEC and ADAM-models are still actively used for short to medium-term projections, while DREAM is used for long-term projections. In 2017, the work on a new macroeconomic model MAKRO was initiated. While both ADAM and DREAM are built and maintained by politically independent research groups, the newest macroeconomic model in Denmark, MAKRO is being built in collaboration with the ministry of finance. The model is intended to replace both ADAM and DREAM as the model used by the ministry of finance within the next couple of years.

The motivation to switch from the traditional Keynesian SEM-models to models based on forward-looking overlapping generations (OLG) setup as mentioned in Stephensen (2020), is to have a model that can be used to present a framework for evaluating the short-run effects of economic policy, create medium- and long-term projections and to evaluate the consequences of policy initiatives and exogenous shocks to the economy. The modelling team behind the model describes it as a hybrid between the short-run model and the long-run OLG model. On the short run, it is described to be a hybrid between a DSGE-model and a SEM-model. Stephensen et. al (2017).

Despite the fact that the shift towards equilibrium models was launched late in Denmark compared to other countries, the recent development with the DSGE-model from the Central Bank and MAKRO-model being implemented in the ministry of finance the next few years, seems to confirm this tendency. Kærgård (2020) points out, that the timing of this trend in macroeconomic model (both in Denmark and internationally) can seem a bit strange since 'economic front-line research' moves away from the foundation behind these models (Kærgård 2020).

While the trend in economic modelling as presented above moves towards equilibrium models, the model presented in this paper swims against the stream, since both the overall structure and the economic theory behind the model differentiate itself from MAKRO and DSGE-model in many aspects as being presented below. We believe, our model, based on what we can classify as non-mainstream theory, can bring many new insights regarding the economy and can potentially be used for interesting comparisons of policy implications suggested by other models for Denmark.

3 Assumptions

In this section, we present the main assumptions embedded in the model. First, we'll focus on the theoretical assumptions and later on, the assumptions regarding the data which will be presented in section 4.

Given the size and openness of the Danish economy, it is important to focus on building a model for a small open economy. We therefore assume that the dynamics of the Danish economy do not affect the rest of the world. Moreover, variables like economic activity of the rest of the world, import prices, foreign interest rates, returns of securities, and dividends on foreign assets are kept exogenous. The Danish currency (Danish Krona) is pegged to the euro, but is floating vis-a-vis other currencies of the world. In the figure below, the real effective exchange rate from 2005Q1 to 2020Q1 is illustrated. As can be seen in Figure 1, despite small fluctuations, the exchange rate seems to reverse towards a mean. We therefore take nominal exchange rate as exogenous in the model.

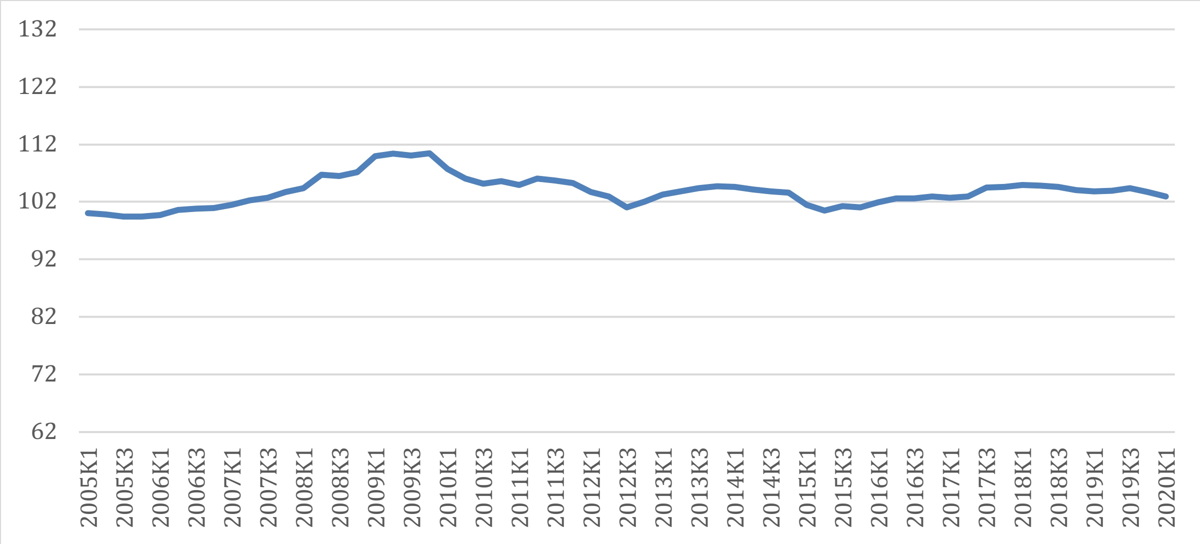

Figure 1: Real effective krone rate, source: Statistics Denmark DNVALQ

A common characteristic of empirical (and theoretical) PKSFC-models is the fact that the economic activity is determined by the level of aggregate demand in both short run, medium term, and long run. We adopt this approach, but with one significant difference: being a mature economy the Danish economy is very likely to face labour shortages in the labour market. The consequence of this is that the economy might be supply constraint in some situations.

Regarding the dimension of the model, we assume 5 institutional sectors: non-financial corporations, financial corporations, the general government, households, and the rest of the world. A common way of representing the multiple interactions of the institutional sectors within the model and, also, the holistic description of the economic system, is the so-called transaction flow matrix (Table 1). This matrix combines two important elements of the system of national accounts: the social accounting matrix and the flow-of-funds (also known as the financial account). The social accounting matrix registers all the transactions in the economy within a specific period. More specifically, it gathers all the transactions from the production account to the capital account of the system of national accounts, such as production, aggregate demand, wages, taxes, interests, transfers, etc. This registration is done on a whom-to-whom basis to obtain a complete description of the origin and destination of every flow, real or monetary, that takes place in the economy. Consequently, the model built on the basis of this watertight structure has no black holes, meaning that there are no transactions coming from or going nowhere. This accounting approach offers, thus, a general equilibrium framework based on the system of national accounts that consistently integrates the real and the financial spheres. The risk of omitting transactions or feedback effects that might end up being crucial for the dynamic behaviour of the economy is therefore minimized.

Table 1: Transaction Flow Matrix

	Households		Non-Financial Corporations		Financial Corporations		General Government		Rest of the World		Total
	Current	Capital	Current	Capital	Current	Capital	Current	Capital	Current	Capital	
Private Consumption	$-C_t$		C_t								0
Investment (Buildings and Dw.)		$-I^H_{BD_t}$	I_{BD_t}	$-I^{NFC}_{BD_t}$		$-I^{FC}_{BD_t}$		$-I^G_{BD_t}$			0
Investment (Equipment)		$-I^H_{E_t}$	I_{E_t}	$-I^{NFC}_{E_t}$		$-I^{FC}_{E_t}$		$-I^G_{E_t}$			0
Investment (Inventories)			$-I^H_{INV_t}$	$-I_{INV_t}$							0
Government Consumption	G^H_t		G^{NFC}_t				$-G_t$				0
Net Exports			NX_t						$-NX_t$		0
Wage Bill	WB^H_t		$-WB_t$						WB^{RW}_t		0
Gross Operating Surplus	GOS^H_t		GOS^{NFC}_t		GOS^{FC}_t		GOS^G_t				0
Net Indirect Taxes			$-NIT^{NFC}_t$				NIT^G_t		$-NIT^{RW}_t$		0
Net Interest on Assets	NIA^H_t		NIA^{NFC}_t		NIA^{FC}_t		NIA^G_t		NIA^{RW}_t		0
Net Income on Insurance	NII^H_t		NII^{NFC}_t		NII^{FC}_t		NII^G_t		NII^{RW}_t		0
Net Dividends	ND^H_t		ND^{NFC}_t		ND^{FC}_t		ND^G_t		ND^{RW}_t		0
Direct Taxes	$-DT^H_t$		$-DT^{NFC}_t$		$-DT^{FC}_t$		DT^G_t		$-DT^{RW}_t$		0
Social Contributions	$-SC^H_t$				SC^{FC}_t		SC^G_t		SC^{RW}_t		0
Social Benefits	SB^H_t				$-SB^{FC}_t$		$-SB^G_t$		SB^{RW}_t		0
Other Current Transfers	OCT^H_t		$-OCT^{NFC}_t$		OCT^{FC}_t		$-OCT^G_t$		OCT^{RW}_t		0
Saving/Current Account	$-S^H_t$	S^H_t	$-S^{NFC}_t$	S^{NFC}_t	$-S^{FC}_t$	S^{FC}_t	$-S^G_t$	S^G_t	CA_t	$-CA_t$	0
Capital Transfers		KT^H_t		KT^{NFC}_t		$-KT^{FC}_t$		$-KT^G_t$		$-KT^{RW}_t$	0
Others		$-NP^H_t$		$-NP^{NFC}_t$				NP^G_t		NP^{RW}_t	0
Net Lending		NL^H_t		NL^{NFC}_t		NL^{FC}_t		NL^G_t		NL^{RW}_t	0
Adjustment variable		Adj^H_t		Adj^{NFC}_t		Adj^{FC}_t		Adj^G_t		Adj^{RW}_t	0
Δ Interest Bearing Assets		$-\Delta NIBA^H_t$		$-\Delta NIBA^{NFC}_t$		$\Delta NIBA^{FC}_t$		$-\Delta NIBA^G_t$		$-\Delta NIBA^{RW}_t$	0
Δ Equities		$-\Delta EQ^H_t$		ΔEQ^{NFC}_t		$-\Delta EQ^{FC}_t$		$-\Delta EQ^G_t$		ΔEQ^{RW}_t	0
Δ Securities		$-\Delta SEC^H_t$		ΔSEC^{NFC}_t		$-\Delta SEC^{FC}_t$		ΔSEC^G_t		$-\Delta SEC^{RW}_t$	0
Δ Insurance		$-\Delta INS^H_t$		$-\Delta INS^{NFC}_t$		ΔINS^{FC}_t		$-\Delta INS^G_t$		$-\Delta INS^{RW}_t$	0
Δ Loans		ΔL^H_t		ΔL^{NFC}_t		$-\Delta L^{FC}_t$		$-\Delta L^G_t$		ΔL^{RW}_t	0
Rev. Interest Bearing Assets		$-Rev^H_{NIBA}$		$-Rev^{NFC}_{NIBA}$		Rev^{FC}_{NIBA}		$-Rev^G_{NIBA}$		$-Rev^{RW}_{NIBA}$	0
Rev. Equities		$-Rev^H_{EQ}$		Rev^{NFC}_{EQ}		$-Rev^{FC}_{EQ}$		$-Rev^G_{EQ}$		Rev^H_{EQ}	0
Rev. Securities		$-Rev^H_{SEC}$		Rev^{NFC}_{SEC}		$-Rev^{FC}_{SEC}$		Rev^G_{SEC}		$-Rev^{RW}_{SEC}$	0
Rev. Insurance		$-Rev^H_{INS}$		$-Rev^{NFC}_{INS}$		Rev^{FC}_{INS}		$-Rev^G_{INS}$		$-Rev^{RW}_{INS}$	0
Rev. Loans		Rev^H_L		Rev^{NFC}_L		$-Rev^{FC}_L$		$-Rev^G_L$		Rev^{RW}_L	0
Rev. Buildings and Dwellings		$-Rev^H_{BD}$		$-Rev^{NFC}_{BD}$		$-Rev^{FC}_{BD}$		$-Rev^G_{BD}$			0
Rev. Equipment		$-Rev^H_E$		$-Rev^{NFC}_E$		$-Rev^{FC}_E$		$-Rev^G_E$			0
Δ Net Worth		$-\Delta W^H_t$		$-\Delta W^{NFC}_t$		$-\Delta W^{FC}_t$		$-\Delta W^G_t$		$\Delta NIIP$	0

On the top of the transaction flow matrix the account for goods and services is presented. It is assumed that all domestic production takes place in the non-financial sector, which also gathers the totality of imports. It is further assumed that in the short run, production is demand-led. Thus, production is equal to the aggregate demand, which is given by the sum of both private and public consumption and investment, plus net exports. In order to account for the varying capital gains derived from the different existing physical assets, the model distinguishes between two types of investment goods: buildings and dwellings, normally subject to a low depreciation and a more volatile price, and equipment, which is often subject to a higher depreciation and a more stable price[1]. The sum of these two types of physical goods gives gross fixed capital formation, to which the change in inventories is added to obtain gross capital formation, which we can simply call investment.

Gross production is, by definition, equal to gross income. The income generation account is presented below the goods and services account and shows how income is distributed between wages and profits. It is assumed that non-financial corporations generate the totality of income (since all the production process is concentrated in them) and, after having deducted the taxes (net of subsidies) on production, products and imports which are paid to the government, they pay wages to households and the rest of the world. The income remaining is gross profits or, in more technical terms, the gross operating surplus. Despite the assumption, that all production takes place in the sector for non-financial corporation, gross operating surplus is still distributed to the domestic sectors to establish the same income flows as reported in the national account. Since we do not model these flows, we treat them as exogenous shares of the total gross operating surplus in the model.

Institutional sectors, apart from receiving income as a result of their contribution to the production process, also earn property income and receive transfers. These transactions are registered in the primary and secondary distribution of income accounts, which give disposable income. The primary distribution of income account includes three types of property income: income on interest-bearing assets (like securities), income on insurance technical reserves and dividends (which is income on equities). Since there is no single payer and receiver of these income flows, we chose to write these transactions in net terms. This means that even if they all appear with a positive sign in the matrix, in some cases the variable will have a negative sign. For instance, non-financial corporations will always have a negative sign in the net dividends account because every period they pay dividends to the shareholders. However, this does not imply that non-financial corporations as a whole cannot earn dividends from their holdings of shares of both domestic and foreign companies, as within the aggregate NFC institutional sector there are all the companies of the economy, many of which purchase equities of other companies as part of their portfolio

[1] For details about how these variables are constructed see the Data section.

allocation decision. This being said, it must always be the case that the sum of all the components of these property income accounts add up to zero, meaning that all the interests and dividends paid are effectively being received by someone else.

The secondary distribution of income account includes all the sources of income that the institutional sectors have besides production and property. This is where direct taxes paid by all institutional sectors to the government are registered. Also, this account records the social contributions to the social security paid by households[2] to the different units administrating social security and pension fund systems. Since these units can belong to the government, the financial corporations or the rest of the world, the variables appear with a positive sign for these three institutional sectors. For their part, social benefits are paid by the government and financial corporations (which own pension funds) to households. The rest of the world is both a receiver and payer of social benefits, but in the case of Denmark the rest of the world has a net surplus of social benefits, we therefore write the corresponding variable with a positive sign.

As a result of all these sources of current income and outlays, the institutional sectors obtain a disposable income that is used to finance (part or all of) their current expenditure in the consumption of goods and services, which was already introduced in the goods and services account. When consumption and net exports are deducted from disposable income, gross savings is obtained. Savings is a measure that represents whether each sector is surplus or deficit. It should be noted that from the perspective of the rest of the world, foreign savings is simply equal to the inverse of the current account balance of Denmark.

Savings, in turn, is a flow of funds that together with (net) capital transfers finance gross fixed capital formation and the net acquisition of non-produced physical assets. The investment in the different types of capital goods was already defined in the goods and services account. Thus, the sum of all the components defined in the transaction flow matrix until the capital account gives net lending of each institutional sector, which represents whether each of them requires funding from another sector or, in case of

[2] The part of the contributions paid by non-financial corporations is already included in the labour compensation registered in the generation of income account. Therefore in the secondary income distribution account only the households pay these contributions.

exhibiting a net borrowing position, is able to provide funding to someone else. It is important to mention that in order for the accounting to be consistent, we had to create an "adjustment variable" that compensates for the differences between the net lending computed as a result of the sum of all the variables contained from the goods and services account to the capital account, and the net lending that is obtained from the sum of the net transactions of the financial assets presented in the financial account (see below). This is a standard procedure in the construction of empirical transaction flow matrices[3], the main cause of the problem being that the data sources used to construct the income accounts in some cases differ from the ones used to build the financial accounts. However, we take caution and ensure that these discrepancies are not very large and do not follow a tendency over time.

Once the financial position of each institutional sector has been obtained, the way this impacts their balance sheet is described in the financial account. In other words, the financial account represents how each institutional sector allocates its financial wealth and how it covers its financing needs. It should be noted that, as it happened in the transactions corresponding to the previous accounts, the sum of the components of each line has to equal zero, reflecting that every increase in the holding of a specific asset for a certain sector must entail an increase of the equivalent amount in the liabilities for another sector. This is a crucial feature of contemporary economies that is sometimes overlooked in macroeconomic models. Considering the strong links between the real and the financial spheres of the economy and that the channels of transmissions of different shocks and policy decisions combine these two dimensions, the stock-flow consistent approach puts great emphasis on its incorporation to the model building process.

In order to be consistent with the accounts presented so far, where uses (payments) are registered with a minus sign and resources (incomes) are recorded with a plus sign in the financial account, increases in assets (which is a use of funds) are registered with a minus sign and increases in liabilities (which is a source of funds) are recorded with a plus sign. As observed in the matrix, the wide variety of financial assets

[3] For more details see about this problem and the alternatives to deal with it see Zezza and Zezza (2019).

existing in the economy is simplified to include only five. However, this does not imply that some assets and liabilities are being left out of the analysis - all of them are being included in one of the five categories identified in the matrix[4]. As a result of this process of aggregation, it happens that for most assets, most sectors appear as both issuers and holders[5]. Phrased differently, it is not possible to claim that for sector X, financial asset Y is always only an asset or a liability. Thus, we chose to write the plus and minus signs depending on whether the change in the holdings of each asset is, on average, positive (negative sign) or negative (positive sign).

The last account incorporated in the transaction flow matrix is the revaluation account, which captures the changes in the holdings of financial assets and liabilities that instead of arising from transactions (as registered in the financial account) result from the variation in asset prices. In order to assign the sign of the variables, the same criterion used in the financial account is followed. It is worth mentioning that since the revaluation can also affect physical assets (in our model buildings and dwellings, and equipment), specific lines for this type of revaluation are included. The sum of the net transactions of financial assets and liabilities and their revaluation gives the change in each sector's net worth[6]. Therefore, the model is based on an accounting structure that provides a detailed description of uses and sources for each institutional sector both with the real and the financial spheres taken as part of a single inextricable entity.

4 Data and Estimation

In this section, we first discuss the information utilised in constructing the databank. We then discuss the strategy used in estimating the structural parameters of the model.

4.1 Data

[4] For details about the treatment of financial assets read the Data section.
[5] There are some exceptions, though. For instance, in the case of loans it is clear that both households and non-financial corporations take loans from the financial corporations or, eventually, from the rest of the world.
[6] The "other changes in assets" account is not explicitly included in the matrix, but the values of this account were summed to value reported in the revaluation account.

The data used in this databank is the sectoral national accounts provided by Statistics Denmark from 2005Q1 to 2020Q1. This time span was selected based on the availability of quarterly sectoral national accounts data. The data included in the databank is non-seasonally adjusted – the seasonal adjustment is only applied to the variables that will enter an estimation of a behavioural equation. In what follows, we discuss the dimensions of the databank (and assumptions related to the availability of data), including the balance sheet and the main transactions which are central to the model.

4.1.1 Assumptions on stock variables

One of the biggest challenges of building a model is to deal with data unavailability and inconsistency. In order to tackle these problems some assumptions have to be made. Following the structure of Post Keynesian SFC models and the aggregated way in which the data is provided by Statistics Denmark, we focus on explaining both the behaviour of the institutional sectors and the transactions of financial assets at an aggregated level.

4.1.2 Balance Sheet

At the most aggregated level the financial accounts published by Statistics Denmark report gross assets and liabilities for 8 asset classes and 6 institutional agents. A simple representation of how the balance sheet for a specific period looks like is shown in Table 2.

Table 2: Balance Sheet, 2019.Q4, billions of DKK

		Non-Financial Corporations		**Financial Corporations**		**General Government**		**Households**		**NFISH**		**Rest of the World**	
		Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
F1	**Monetary gold and SDR**	0	0	35	14	0	0	0	0	0	0	14	13
F2	**Currency and deposits**	352	0	1.283	2.876	106	16	1.102	0	32	0	809	793
F3	**Securities other than shares**	101	165	4.535	4.103	195	766	47	4	19	0	1.743	1.602
F4	**Loans**	1.000	2.331	6.066	1.565	328	286	1	2.575	0	16	640	1.263
F5	**Shares and other equity**	4.848	7.248	7.862	6.918	591	0	2.142	0	65	0	2.371	3.714
F6	**Insurance technical reserves**	7	0	4	3.950	1	0	3.857	0	0	0	81	0
F7	**Financial derivatives**	18	40	1.074	986	0	0	0	2	0	0	775	839
F8	**Trade credits and other accounts**	1.170	365	614	1.004	78	204	116	383	5	20	57	63

However, not all the assets and liabilities are relevant for all agents and for the research questions that the model is aimed to respond to. For instance, Gold and SDR is only relevant for the Central Bank (included in the Financial Corporations sector) and the rest of the world and will play a passive role in all the exercises that will be performed with the model. Similarly, financial derivatives represent a small share in all sectors' balance sheet, even in the case of financial corporations. Thus, following the principle that, to be useful, a map should not aim at being an exact representation of the territory, the balance sheet of the model will result from a series of simplifications to the balance sheet presented in Table 2. In order to narrow down the structure of the balance sheet two main steps were followed. First, we evaluated the relevance of this asset for each institutional agent along the entire sample (2005.Q1 - 2020.Q1), both as an asset and as a liability. In the cases where the value of the asset (liability) is zero or negligible, we opted for netting it out from the figure of the same asset as a liability (asset)[7]. Second, in the cases where the incumbent asset is relevant both as an asset and as a liability, we inspected the counterparty data to examine in what cases intra sector debtor-creditor relationships could be inferred[8]. In the cases where the greatest part of the transactions of the asset takes place within the sector, we opted to net the asset out.

The application of this criteria to each asset and liability for each institutional agent, added to the merging of households and NFISH into a single sector, left us with a much more simplified balance sheet which makes the modeling process easier without necessarily losing descriptive power. The final adjustment that we made to the balance sheet consisted of the merging of currency and deposits, financial derivatives and trade credits into a single interest-bearing asset. The reason for this simplifying assumption is that none of these three assets constitutes the main component of the balance sheet for any of the institutional agents. After all these adjustments we arrive at the final structure of the balance sheet that we use in the model (Table 3).

Table 3: Balance Sheet, average 2005.Q1 - 2020.Q1, billions of DKK

	Non-Financial Corporations		Financial Corporations		General Government		Households		Rest of the World	
	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
Interest-bearing assets	865			1906	50		809		182	
Securities	122	174	3624	3349	176	759	151	6	1446	1230
Loans		1163	3799		5			2340		300
Shares and other equity	2684	4323	4837	4405	413		1475		1389	2069
Insurance Technical Reserves	6			2559	1		2516		35	

[7] For instance, looking at the balance sheet on Table 3, this would imply that instead of households having loans as an asset for the value of 1 and as a liability for the value of 2575, we compute loans as a net liability for 2574.
[8] For instance, looking at the balance sheet on Table 3, the size of the figures for securities issued and held by financial corporations in comparison to the rest of the agents makes it clear that the bulk of the transactions occur within the financial sector. This information is confirmed by the counterparty data.

4.1.3 Stock of Capital

The stock of capital is composed of two main factors: fixed capital and inventories. In the capital account reported by Statistics Denmark, fixed capital can be broken down into the following categories: Dwellings (DW), Buildings other than dwellings (BU), Other structures and land improvements (OS), Transport equipment (TE), ICT equipment, other machinery and equipment and weapon systems (ICT), Cultivated biological resources, and Intellectual property products (IPP). All these seven categories of physical assets are reported for the four domestic institutional agents on an annual basis. Given the low share of Cultivated biological resources on total capital (0.13%) we do not include it in the model. The other six elements are merged into two composite assets: 1) buildings and dwellings (BD), which comprise the sum of Dwellings, Buildings other than dwellings, Other structures and land improvements; and 2) equipment (EQUIP), which include the sum of Transport equipment, ICT equipment, other machinery and equipment and weapon systems, and Intellectual property products. Since, we categorise investment into two types, from now on, the use of building and dwellings would refer to investments in *Dwellings (DW), Buildings other than dwellings (BU), Other structures and land improvements (OS)* where as investment in equipment would refer to investments in *Transport equipment, ICT equipment, other machinery and equipment and weapon systems, and Intellectual property products.*

The main criteria explaining this grouping is the different trajectories of their prices (which give rise to different capital gains on their holdings) and the different rates of depreciation (buildings and dwellings tend to have significantly lower depreciation rates compared to the different types of equipment used in production). In what follows, nominal variables are written in upper case letters, while real ones are expressed in lower case (for instance "DW" denotes the nominal stock of dwellings, while "dw" represents the real stock of the same asset).

Based on the aggregate net capital formation for each of the components of fixed assets computed at both current and chained prices, a price index was implicitly computed. In turn, a price index for the BD and EQUIP composite variables was constructed by computing the weighted averages of the price indices of their respective components.

$$P_t^{BD} = \eta_{1_t} p_t^{DW} + \eta_{2_t} P_t^{OS} + (1 - \eta_{1_t} - \eta_{2_t}) P_t^{BU}$$
$$P_t^{EQUIP} = \eta_{3_t} P_t^{TE.} + \eta_{4_t} P_t^{ICT} + (1 - \eta_{3_t} - \eta_{4_t}) P_t^{IPP}$$

where *P* represents prices and η represent the corresponding weights.

Since there are no quarterly series for sectoral investment in each of the subcategories of fixed assets, we build these variables by breaking down the stock of fixed assets into its sectors and types. We then compute the share of investment of each sector by considering its share in its total stock in the previous period. In simple words, we assume that if, for example, 30 percent of the total stock of a particular fixed asset belongs to the households, then we assume that 30 percent of the investment in that particular asset will from the households. A similar situation applies to net investment. For instance, households' gross investment on buildings and dwellings in 2005q1 is computed as the sum of the total economy's net investment in buildings and dwellings in 2005q1, weighted by households' share in the total economy's stock in the corresponding assets in 2004.

$$I_{BD,2005q1}^{H} = \omega_{BD,2004} * I_{BD,2005q1}^{T}$$

where $I_{BD,2005q1}^{H}$ represents households net investment in buildings and dwelling in 2005q1, $I_{BD,2005q1}^{T}$ represents total economy's net investment in building and dwellings, $\omega_{BD,2004}$ represents the annual weight of households share in the stock of building and dwelling in 2004. That is:

$$\omega_{BD,2004} = \frac{K_{BD,2004}^{H}}{K_{BD,2004}^{T}}$$

where $K_{BD,2004}^{H}$ represents households stock of building and dwellings and $K_{BD,2004}^{T}$ represents stock of building and building for the entire economy in 2004. Here, we assume that the weights observed at annual level are the same across the quarters. This way we recover quarterly data for investment across the sectors as well as across different types of fixed assets.

Once the net fixed capital formation in each type of asset is obtained, the real net stock can be computed. For instance, the real net stock of buildings and dwellings for households is given by the stock in the previous period plus the sum of the net fixed capital investment by households in the three components of buildings and dwellings. The same procedure is made to compute the real net stock of the buildings and dwellings and equipment for the remaining sectors.

$$k_{BD,t}^{H} = k_{BD,t-1}^{H} + \frac{I_{BD,t}^{H}}{P_{t}^{BD}}$$

With the quarterly series for stocks and net flows of each fixed asset at the sectoral level, it is possible to implicitly compute the rates of depreciation. For instance, the rate of depreciation of households' stock of buildings and dwellings is given by:

$$\delta_{BD,t}^{H} = 1 - \frac{K_{BD,t}^{H} - I_{BD,t}^{H}}{K_{BD,t-1}^{H}}$$

The nominal net investment by each sector in each type of asset is given by real investment multiplied by the corresponding price index. Taking households' nominal net investment in buildings and dwellings, we get:

$$I_{BD,t}^{H} = \Delta k_{BD,t}^{H} P_{t}^{BD}$$

The capital gains (revaluation) on the net accumulated stock of each type of capital is given by:

$$RV_{t}^{BD,H} = K_{BD,t-1}^{H}(1 - \delta_{BD,t}^{H})\Delta P_{t}^{BD}$$

Finally, the nominal net stock of each asset for each sector is given by the stock in the previous period plus nominal net investment and the revaluation effect.

$$K_{BD,t}^{H} = K_{BD,t-1}^{H} + I_{BD,t}^{H} + REV_{BD_t}^{H}$$

Accounting consistency requires that the sum of all these disaggregated nominal investment flows both per type and sector, plus the change in inventories, is equal to aggregate gross capital formation. We also ensure that the data at sectoral level matches the aggregate statistics.

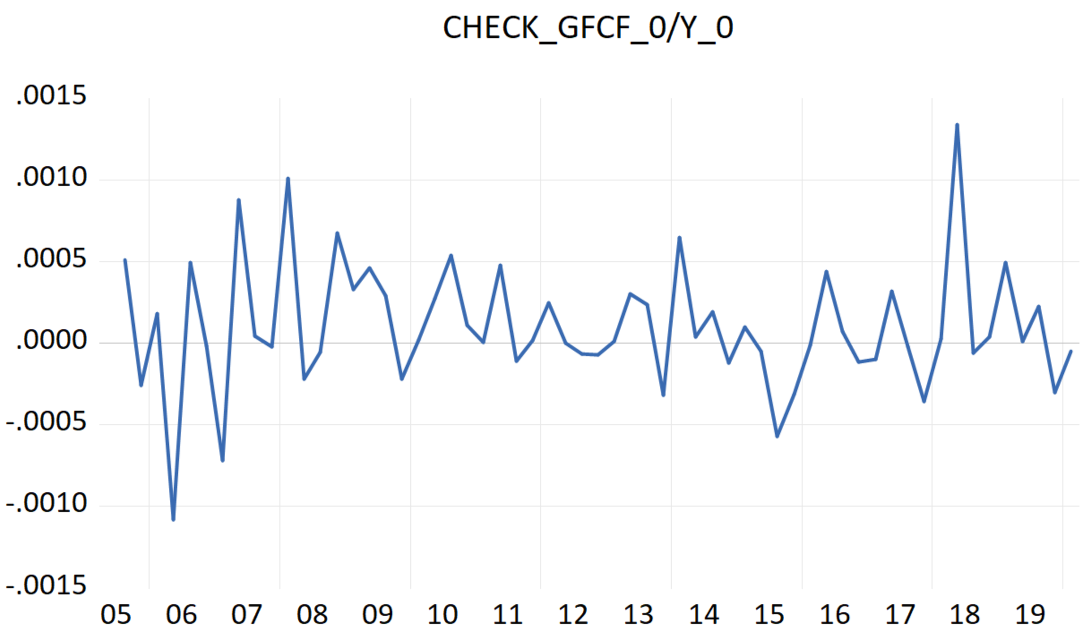

Figure 2: Descrepancies between the sum of investment and the aggregated numbers.

4.1.4 Assumptions on flow variables

An important element of the model is to be able to explain the transactions in each quarter. In this section, we discuss the relevant flows included in the databank. The presentation will be divided into real side flows and financial flows.

Property Income

The simplification of the Balance Sheet affects the property income attached to the different types of financial assets. In the national accounts, property incomes are classified in five groups, where three of the groups are of interest for this model:[9]

[9] The last two groups of property incomes are related to *reinvested earnings on foreign direct investment* and *Rent*. The former is equal to the operating surplus of the foreign direct investment

1. Interest received by owners of deposits, securities, loans, and other accounts.
2. Distributed income of corporations received by owners of shares.
3. Other investment income to insurance and pension holders.

Distribution of income from corporations can be associated with the group of financial assets characterised as *shares and other equities*, and other investment income can be attached to *Insurance Technical Reserves*. Since interest is related to more than one type of financial assets, a few criteria need to be defined in order to establish an accounting-consistent flow of interest between the sectors. The flow of interest received by sector *i* is modelled by the following identity:

$$interest\ received_t^i = r_{A_{t-1}} * IBA_{t-1}^{i,+} + r_{B_{t-1}} * Sec_{t-1}^{i,+} + r_{L_{t-1}} * L_{t-1}^{i,+}$$

Where the (+) indicates that this applies if the stock constitutes an (net) asset for sector *i*. The flow of interest paid by sector *i* is modelled using the same approach:

$$interest\ paid_t^i = r_{A_{t-1}} * IBA_{t-1}^{i,-} + r_{B_{t-1}} * Sec_{t-1}^{i,-} + r_{L_{t-1}} * L_{t-1}^{i,-}$$

Where the (-) indicates a (net) liability for sector *i.*

As seen from the two equations above, it is assumed that each group of financial assets is associated with a single interest rate. Even though in reality each group of financial assets consist of a large number of heterogeneous subgroups characterised by different maturities, risk profiles, etc, the underlying fluctuations in the interest rates of each of these subgroups can be expected to be correlated with each other. By using a single rate of interest for each group of financial assets, we are not aiming to explain the exact movement for each subgroup of financial assets, but to be able to capture the average movement across all the subgroups. This approach therefore secures that

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corporations, while the latter is defined as income received by the owner of a natural resource. Neither of these are therefore related to the financial assets in the balance sheet.

the model can reproduce the fluctuations in the flow of interest across the different sectors over time.[10]

We now explain the steps that we took to obtain these average rates of interest. The rate of interest is assumed to be the same for the domestic economy and rest of the world. When it comes to securities, the rate of interest differs between the domestic economy and rest of the world. The rate of interest on domestic securities is based on an average of all debt securities in Denmark published by Statistics Denmark. The rate of interest on debt securities issued by rest of the world is calculated as an average using OECD data for the US and EU interest rates.

The distributed income from the corporations is calculated as an average rate of dividends directly from the sectoral national account using the property income data (D.42) and the reported stock of shares (F5) as follows:

$$dividends_t^i = \mu_{t-1}^i * EQ_{t-1}^i$$

where μ_{t-1}^i represents the rate of dividends, and EQ_t^i represents the stock of equities held by a sector *i.*

The rate of return on equities issued by the domestic economy is calculated as an average of dividends paid by the domestic corporations (non-financial corporations and financial corporations):

$$\mu_{t-1}^{i,dom} = \frac{dividends\ paid_t^{NFC} + dividends\ paid_t^{FC}}{EQ_{t-1}^{NFC} + EQ_{t-1}^{FC}}$$

where $EQ_{t-1}^{NFC}\ and\ EQ_{t-1}^{FC}$ are outstanding stock of equities issued by NFC and FC respectively.

Regarding the rate of dividends of shares issued by the Rest of the World, it is calculated applying the same approach:

[10] Since this approach is capturing the fluctuations, adjustment terms are introduced in order to capture the levels for the individual sector. This approach can also be found in i.e., the ADAM-model.

$$\mu_{t-1}^{i,RoW} = \frac{dividends\ paid_t^{RoW}}{EQ_{t-1}^{Row}}$$

Since the rate of dividends is calculated as an average with the purpose of capturing the fluctuations in the rate of dividends. In order to capture the level effects, we add adjustment terms to the model.[11]

Finally, the incomes related to insurance and pensions are calculated using the same approach as the rate of dividends.

$$insurance\ received_t^i = \psi_{t-1}^i * INS_{t-1}^i$$

Where Ψ represents the rate of return on insurance and pensions, and INS_t^i represents the stock of insurance and pensions of sector i. The rate is calculated using property income in the household sector and the stock of insurance and pension held by the households:

$$\psi_{t-1}^i = \frac{insurance\ received_t^H}{INS_{t-1}^H}$$

The total property income of sector *i*, can therefore be written as

$$\begin{aligned} Property\ income_t^i \\ &= interest\ received_t^i - interest\ paid_t^i + dividends\ received_t^i \\ &- dividends\ paid_t^i + insurance\ received_t^i - insurance\ paid_t^i \\ &+ \text{adjustment term} \end{aligned}$$

We include an adjustment term due to ensure that the total capital income paid minus received sums to zero because there are some minor discrepancies in the original data.

[11] These adjustment terms are calculating by investigating the difference between the actual flow of dividends and the flow of dividends obtain using the average rate of dividends.

4.1.5 Data visualization

A way to present the important flows on the real side of the economy is to present these flows as a Sankey, which illustrates both the origin and the use of each transaction. All flows can be seen as an inflow in one sector and an outflow of another sector. The relative width of the flow illustrates the relative value of the transaction found in the national account for first quarter 2020 as shown in Figure 3.

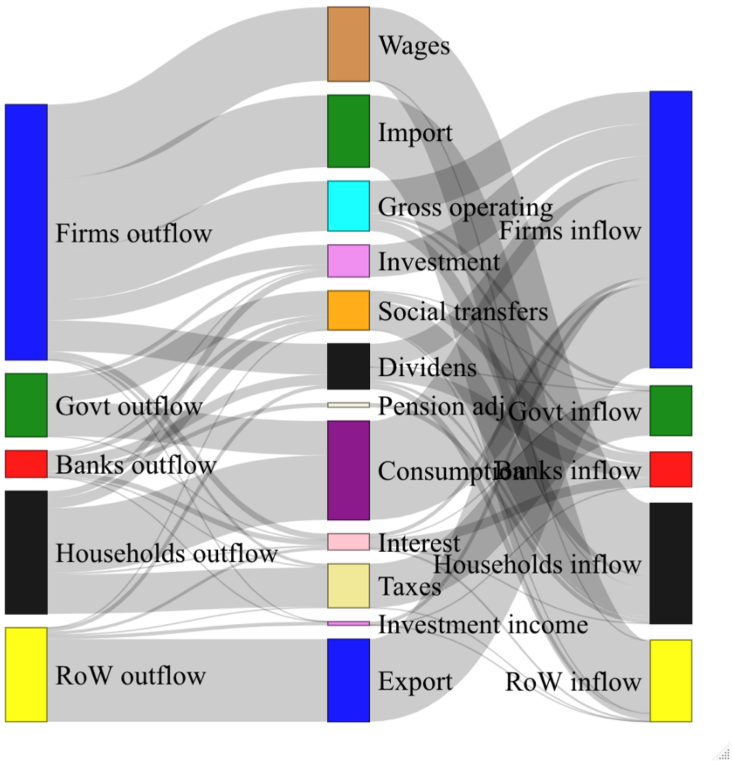

Figure 3: Sankey diagram of flows from 2020q1

The flows illustrated in this Sankey are the same as the transactions presented in the transaction flow matrix in Table 1.

We also visualise the balance sheets interaction through a Sankey as shown in Figure 4. The accumulation of financial assets follows the description of the balance sheet matrix and transaction flows matrix presented in previous sections.

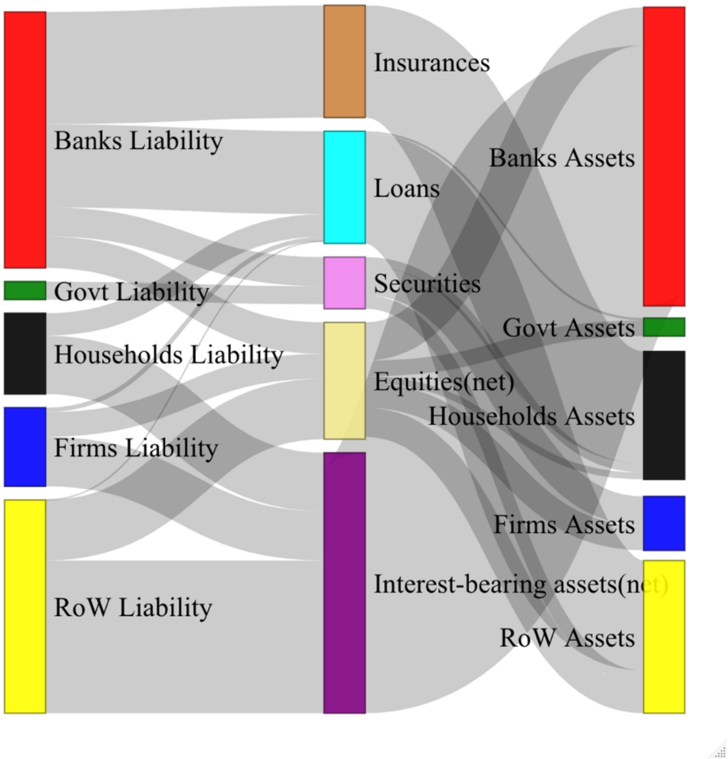

Figure 4: Sankey diagram of the balance sheets from 2020q1

4.2 Estimation strategy

After constructing the databank, we define accounting identities to identify certain key relationships. However, the equations involving structural parameters are estimated using linear regressions. We use single equation technique where the parameters of each behavioural equation are estimated as a single equation. While estimating the structural parameters, we also take the log of certain variables, if it is theoretically intuitive.

4.2.1 De-seasonalising the variables

Since, we have data with seasonal fluctuations, we remove seasonal fluctuation from our variables before estimating the behavioural equations. We do so by using the quarterly dummies as regressors. For example, a variable (X) is de-seasonalised using the following regression:

$$X_t = \beta_0 + \beta_1 Q_1 + \beta_2 Q_2 + \beta_3 Q_3 + \varepsilon_t$$

where *Q* represents quarterly dummies.

The residuals of the model give us the de-seasonalised series. We then add the mean value of the dependent variable to the residuals (which is our de-seasonalised series) to normalise the scale of the variable. For example, Figure 5 compares consumption containing seasonal fluctuation with the one that has been de-seasonalised.

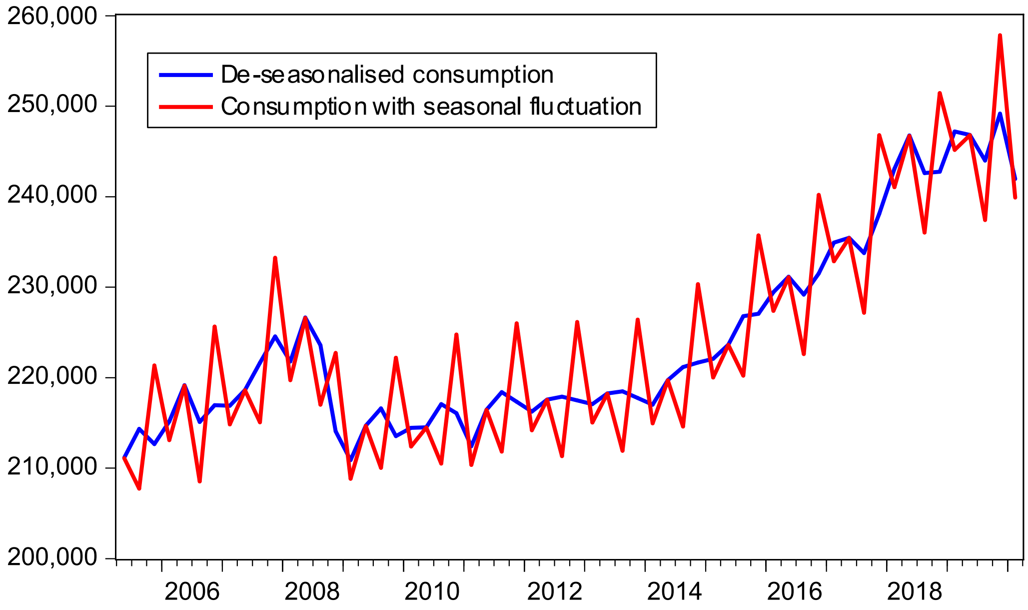

Figure 5: Private consumption

4.2.2 Parameters estimation

After de-seasonalising the data, we test the variables for stationarity and then explore the dynamic relationship between our variables of interest. In most cases, the structural parameters are estimated using Auto-regressive Dynamic Lag (ARDL), following the technique proposed in Pesaran et al (2001), which is also known as the ARDL bounds test. This estimation strategy is quite useful in exploring cointegrating relationships amongst variables that have different orders of integrations.[12] We follow

[12] This estimation technique is not very restrictive. The limitation of this approach is that it is not valid for variables that are I(2) – integrated of order 2. We did not find any variable to be I(2), hence, the estimation technique was useful and was employed in most cases.

general-to-specific methodology where we start with a large number of lags and then drop irrelevant lags to choose a parsimonious model. The exclusion of irrelevant lags in most cases is also justified through various statistical criteria. If we find evidence of cointegration, we estimate the so-called error-correction version of the model. If we do not find any cointegration, we simply estimate a dynamic regression using stationary data. Even though our estimation strategy attempts to choose a functional form that attempts to best describe the data for a given dependent variable, our choice of variables in every equation is purely based on theory. Our strong reliance on theory helps us avoiding model misspecifications. Moreover, we also ensure that neither the sign nor the magnitude of our estimated equations are at odds with theory. In short, we do not aim for a purely data driven solution to the model but attempt to choose a balance between empirics and theory.

5 Description of Model

5.1 Non-financial corporations

In this model it is assumed, that all production takes place in non-financial corporations. The total production is determined by the aggregate demand.
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 is given by:

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

GDP deflator is defined as:

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

The savings of the firms can be defined as the sum of the primary and secondary incomes:

$$S_t^N = Y_t - WB_t^N + \left(B_{2_t}^N - B_{2_t}\right) + Property\ income_t^N - T_t^N + STR_t^N + \epsilon^N$$

While the production creates an income for the firms, the major expenditures for the firms are wages (WB) paid to households in Denmark and abroad, net indirect taxes (including taxes and subsidies on products and production) (T_t^N) to the government sector and gross operating surplus paid to the other domestic sectors of the economy. The wage bill is a product of the wage rate ($Wage_t$) and the level of employment (N_t^N), where the wage rate is assumed to be the same for Denmark and the 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).

$$WB_t^N = W_t * N_t^N$$

Since the majority of taxes paid by the firms are taxes on production, it is further assumed that the tax rate in our model is fixed and the total amount of taxes paid by the NFC's changes accordingly with variations in total production.

$$T_t^N = \theta^N * Y_t$$

From an accounting perspective, the gross operating surplus (B_{2_t}) is the residual between GDP in factor prices (YF_t, which is given by $Y_t - T_t^N$) and compensation of employees. [13] Since all net taxes on production is assumed to be a proportion of total

[13] 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 provide an important income for all sectors, the distribution of this flow is kept exogenous for financial corporations, households, and the government sector, while the surplus for the NFC sector is a residual. For the government sector however, the gross operating surplus is equal to the consumption of fixed capital, so it is endogenous.

production, GDP at factor prices can be calculated as a share of GDP at market prices. It means, that gross operating surplus for the total economy is assumed to be described as follows:

$$B_{2,\mathrm{t}} = YF_t - WB_t^N$$

It means that the profit share of income can be measured as:

$$\phi_{\mathrm{t}} = \frac{B_{2,\mathrm{t}}}{YF_t}$$

The rest of the saving consists of property income on financial wealth and debt among the non-financial corporations.

$$Property\ income_t^N = interest\ received_t^N - interest\ paid_t^N - dividends\ paid_t^N$$

It was previously defined that the stock of capital could be decomposed into two types of assets: buildings and dwellings, and equipment. Since these two types of capital goods can be determined by different factors (or by the same ones, but with varying effects) we define a specific behavioural equation for each. The equation is written in terms of the rate of accumulation of each asset, i.e., $\frac{I_{BD,t}^{NFC}}{K_{BD,t-1}^{NFC}}$ and $\frac{I_{EQUIP,t}^{NFC}}{K_{equip,t-1}^{NFC}}$. In line with Kalecki (1971) we define the investment function as determined by an autonomous component (a proxy of the "animal spirits) and the profit rate, which can in turn be defined as the product of the profit share and the rate of capacity utilization. The rate of capacity utilization is constructed as the ratio of real GDP to the real stock of capital. We also extend this equation to include the cost of capital, which we measured by the interest rate on loans. Finally, in order to include an interaction between the real and the financial spheres of the economy, we add Tobin's "q" as an additional determinant (we construct Tobin's "q" as the ratio of the market value of the outstanding stock of equality liabilities to the nominal stock of capital).

In our estimations for the period 2005Q1 – 2020Q1, we do not find evidence of a relationship between the rate of accumulation of any of these two capital goods with the cost of capital, neither in the long-run nor in the short-run. In the case of the rate of accumulation of NFC on buildings and dwellings, we found capacity utilization to have both a short run and long run significant relationship. In the case of the profit share only the long run, relationship was found statistically significant. Overall, these results seem to support the Kaleckian investment function. Tobin's "q" was also found significant only in the long run, its effect being much smaller than those found for the profit share and capacity utilization.

$$\Delta ln\left(\frac{i_{BD,t}^{NFC}}{K_{BD,t-1}^{NFC}}\right) = 0.40 - 0.49 * \Delta ln\left(\frac{i_{BD_{t-1}}^{NFC}}{K_{BD,t-2}^{NFC}}\right) - 0.09 * \Delta ln(\phi_t) + 0.72 * \Delta \ln(u_t) + 0.01 * \Delta \ln(q_t) - 0.40 * ln\left(\frac{i_{BD_{t-1}}^{NFC}}{K_{BD,t-2}^{NFC}}\right) + 0.40 * \Delta ln(\phi_{t-1}) + 1.04 * \Delta \ln(u_{t-1}) + 0.09 * \Delta \ln(q_{t-1})$$

The long run coefficient defining the relationship between the profit share and the rate of accumulation of buildings and dwellings is 1.01, meaning that accumulation almost one-for-one with income distribution. As shown in the equation, the short run effect is much lower (-0.09) and with the "wrong" sign, though not statistically significant. Regarding the long run relationship between accumulation and capacity utilization, the coefficient is 2.6, signalling a high sensitivity of investment to the level of activity. The short run effect is relatively smaller (0.72). Finally, the long run relationship between investment and Tobin's "q" is estimated to be around 0.23, far below the impact of the other two determinants. The complete estimation output can be found in the appendix.

Similar results are found in the case of investment in equipment, where only significant long run relationship with the three explanatory variables is found. The estimated equation takes the following form:

$$\Delta ln\left(\frac{i_{equip,t}^{NFC}}{K_{equip,t-1}^{NFC}}\right)$$
$$= -0.01 - 0.17 * \Delta ln\left(\frac{i_{equip_{t-1}}^{NFC}}{K_{equip,t-2}^{NFC}}\right) + 0.01 * \Delta ln(\phi_t) + 0.32 * \Delta \ln(u_t)$$
$$- 0.24 * \Delta \ln(q_t) - 0.41 * ln\left(\frac{i_{equip_{t-1}}^{NFC}}{K_{equip,t-2}^{NFC}}\right) + 0.44 * ln(\phi_{t-1}) + 0.49$$
$$* \ln(u_{t-1}) + 0.06 * \ln(q_{t-1})$$

The equation also included a dummy variable to account for a few outliers that render the residuals non-normally distributed (see appendix for the full specification of the equation). The implicit long run coefficients are 1.07 for the profit share, 1.20 for the rate of capacity utilization, and 0.15 for Tobin's "q", also exhibiting a higher sensitivity of investment to "real" factors than financial ones. Not surprisingly, the short run coefficients are smaller (though not statistically significant).

Nominal investment in buildings and dwellings:

$$I_{BD,t}^{NFC} = i_{BD,t}^{NFC} * P_t^{BD}$$

Nominal investment in equipment:

$$I_{equip,t}^{NFC} = i_{equip,t}^{NFC} * P_t^{EQUIP}$$

Sum of real investment

$$i_t^N = i_{BD,t}^{NFC} + i_{equip,t}^{NFC}$$

Sum of nominal investment

$$I_t^N = I_{BD,t}^{NFC} + I_{equip,t}^{NFC}$$

The Nominal stock of capital of fixed capital in the NFC sector is determined by the following accounting identity:

$$K_{BD,t}^{NFC} = K_{BD,t-1}^{NFC} + I_{BD,t}^{NFC} - D_{BD}^{NFC} + REV_{BD_t}^{NFC}$$

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

$$D_{BD,t}^{NFC} = \delta_1 * K_{BD,t-1}^{NFC}$$

The Nominal stock of capital of equipment in the NFC sector is determined by the following accounting identity:

$$K_{equip,t}^{NFC} = K_{equip,t-1}^{NFC} + I_{equip,t}^{NFC} - D_{equip}^{NFC} + REV_{equip_t}^{NFC}$$

$$D_{equip}^{NFC} = \delta_2 * K_{equip,t-1}^{NFC}$$

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

Real stock of capital:

$$k_{equip,t}^{NFC} = \frac{K_{equip,t}^{NFC}}{P_t^{equip}} \text{ and } k_{BD,t}^{NFC} = \frac{K_{BD,t}^{NFC}}{P_t^{BD}}$$

The net lending of the firms is the difference between saving and investment adjusted for the exogenously determined capital transfers (KTR_t^N) and net acquisitions of non produced nonfinancial assets (NP_t^N).

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

On the financial side of the economy, the firms mainly finance their expenditures by issuing equities[14] or demanding loans. The stock of equities is modelled as a stock-flow ratio, where the stock of equities is determined by the need to finance investment:

The stock of equities:

$$NEQ_t^N = \rho * i_t^N$$

The demand for new loans is being exogenous in the current version of the model.

Stock of interest-bearing assets held by the firms:

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

The transaction of interest-bearing assets is described as the difference between total net lending and transaction for equities.

$$IBATR_t^N = NL_t^N + EQTR_t^N + LTR_t^N + SECTR_t^N - INSTR_t^N$$

The financial net wealth of the firms can be written as

$$FNW_t^N = IBA_t^N - EQ_t^N - SEC_t^N - L_t^N + INS_t^N$$

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

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

[14] The expenditures are also to a smaller degree financed by issuing securities by the firms. This however is kept exogenous in the current version of the model.

5.2 Household Sector

The household sector receives income mainly from four sources: wages from firms (WB^H), gross operating surplus from production ($B^H_{2_t}$), net social transfers (STR^H), and capital income ($Property\ income^H_t$).

The total income for households can be written as:

$$Y^H_t = WB^H_t + Property\ income^H_t + B^H_{2_t} + STR^H_t$$

The wage bill is determined by the wage rate and the level of employment.

$$WB^H_t = W_t * N^H_t$$

The capital income of the households originates from interest-bearing assets (IBA^H_{t-1}), securities (SEC^H_t), insurance and pensions (INS^H_{t-1}), and equities (EQ^H_{t-1}), while the outflow of capital income is determined by the stock of loans (L^H_{t-1}). The exogenous determined variables (r^H_A), (r^H_L) and ($r_{B_{t-1}}$) represent interest rates on assets, liabilities, and securities, respectively. (χ_t) and (ψ_t) represent returns on equities and insurance, respectively.

$$Property\ income^H_t = r^H_{A_{t-1}}(IBA^H_{t-1}) + \mu_{t-1}(EQ^H_{t-1}) + \psi_{t-1}(INS^H_{t-1}) + r_{B_{t-1}}(SEC^H_t) - r^H_{L_{t-1}}(L^H_{t-1})$$

Social transfers received by the household sector are the sum of social contributions ($NPEN^H$) paid by the households, net benefits ($NBEN^H_t$), and other transfers (OTR^H) received by the households.

The net social benefits ($NSBEN^H_t$) is determined by the difference between social benefits received and social contribution paid by the households:

$$NSBEN^H_t = NBEN^H_t - NPEN^H_t$$

$$STR^H = NSBEN^H_t + OTR^H_t$$

An important part of the net social benefits is the adjustment of pension entitlements. The net contributions to pension schemes are determined as a function of the wages received by the households and the ratio of people above 65 years old (Ret) to the total population. The change in pension entitlements due to social contributions is obtained as a function of the wage bill and share of retirees on total population, the first one having *a priori* a positive impact and the second one a negative effect. The cointegration tests suggest that there is a stable long run relationship between these variables. The short run relationship can therefore be expressed as follows, where $NPEN_t^H$ represents the change in pension entitlements due to social contributions:

$$\Delta \ln\left(NPEN_t^H\right) = 0.092 * \Delta \ln\left(NPEN_{t-1}^H\right) + 0.269 * \Delta \ln\left(WB_t^H\right) - 46.166 * \Delta ln\left(\frac{Ret_{t-1}}{Pop_{t-1}}\right) - 0.609 * \ln\left(NPEN_{t-1}^H\right) + 0.363 * \ln\left(WB_{t-1}^H\right) - 0.954 * \ln\left(\frac{Ret_{t-1}}{Pop_{t-1}}\right)$$

Before specifying the consumption function, it is required to define how benefits - an important component of the disposable income of lower income households - is determined. We assume that these transfers are mainly driven by amount of people that are outside the labour force ($Pop_t - LF_t$), and by those who belong to the labour force but are unemployed, UN_t (and therefore receive unemployment benefits). The effect of the amount of people that are outside of the labour force seems to dominate the dynamics of social benefits, which seems a reasonable result taking into account the nature of the Danish pension system.

$$\Delta \ln(NBEN_t^H) = -28.18 + 1.65 * \Delta \ln(Pop_t - LF_t) + 0.001 * \Delta(UN_t) + 0.0005 * \Delta(UN_{t-1}) - 0.77 * \ln(NBEN_{t-1}^H) + 0.0004 * (UN_{t-1}) + 2.48 * \ln(Pop_{t-1} - LF_{t-1})$$

Since households' behaviour can be subject to their income levels, we opted to break disposable income down into two components: one given by wage income plus current transfers from the government (such as social benefits) and the other one given by the gross operating surplus plus property income. Each of these two types of households are assumed to be subject to different tax rates, in line with the progressive tax system of the Danish economy.

Disposable income related to property income and gross operating surplus can be written as,

$$YD_t^{H,1} = (1 - \theta^{H,1})[Property\ income_t^H + B_{2_t}^H]$$

Where θ^1 expresses the fixed tax-rate of this type of income. The disposable income from wages and current transfers can be found the same way, where θ^2 expresses the tax-rate of this type of income

$$YD_t^{H,2} = (1 - \theta^{H,2})[WB_t^H + STR_t^H]$$

Real disposable income can be calculated from the disposable income and the consumption prices:

$$yd_t^1 = \frac{YD_t^1}{P_t^c} \text{ and } yd_t^2 = \frac{YD_t^2}{P_t^c}$$

where P_t^c represents the price index for consumption.

Households' consumption is defined along the lines of the standard equations used in the SFC literature, where consumption is determined by disposable income and a wealth effect. There can eventually be an autonomous component reflecting the exogenous determinants of private consumption.

In line with the underlying economic theory, there seems to be evidence of cointegration between real consumption and both real disposable income (of upper and lower classes) and real financial wealth. The consumption function is therefore estimated using an error correction model, which takes the following form.

$$\Delta \ln(c_t) = 1.60 - 0.33 * ln(c_{t-1}) + 0.11 * ln(yd1_{t-1}) + 0.06 * \ln(yd2_{t-1}) + 0.03 * ln(fnw_{t-1}) + 0.06 * \Delta \ln(yd1_t) + 0.06 * \Delta \ln(yd1_{t-2}) + 0.09 * \Delta \ln(yd2_t)$$

The long run coefficients are 0.33, 0.18 and 0.09 for disposable income of upper classes, lower classes, and real net financial wealth, respectively. The short run dynamics of consumption seem to be driven similarly by the fluctuations of the disposable income of both types of households. Financial wealth was found to be insignificant in the estimation of short run dynamics.

Nominal consumption:

$$C_t = c_t \cdot P_t^c$$

This model treats income distribution as an endogenous process determined by the evolution of wages and prices, and their relationship with productivity. This does not imply, however, that income distribution cannot be affected by structural or institutional aspects – the impact of these aspects should be captured by the coefficients of the behavioural equations.

It is assumed that real wages are set based on the evolution of productivity and the rate of unemployment. As productivity rises, workers aim at a higher real wage such that their share on income is not affected. As the unemployment rate decreases, their bargaining power goes up, thereby increasing their capacity to negotiate higher real wages. The equation determining the real wage (w) takes the following form:

$$\Delta \ln(w_t) = 0.13 - 0.31 * \Delta \ln(ur_{t-4}) + 0.55 * \Delta \ln(a_t) - 0.10 * \ln(w_{t-1}) - 0.15 * (ur_{t-2}) + 0.07 * \ln(a_{t-1})$$

where the rate of unemployment (ur) seems to affect the real wage with some delay while the effect of real productivity (a) seems to be immediate. The long run effect of the unemployment rate and productivity are -1.52 and 0.6, respectively, but only the former being statistically significant (see appendix). In the short run, on the other hand, it is the unemployment rate (with a four-period lag) that has a statistically significant effect on the real wage.

Non-financial corporations set prices following a mark-up pricing setting, where nominal unit labour costs, given by the ratio of the nominal wage and labour productivity $\left(\frac{W}{A}\right)$, and import prices (P_t^c) are the main elements determining production costs. Both the long and short run relationships between prices and total costs are significant and economically relevant, the coefficients being 0.72 and 0.14, respectively.

$$\Delta P_t^c + = -0.18 * \Delta P_{t-1}^c + \; -0.19 * \Delta P_{t-2}^c + \; +0.45 * \Delta P_{t-4}^c + \; +0.14 * \Delta\left(\frac{W_t}{A_t} + P_t^m\right) - 0.03 * P_{t-1}^c + \; 0.02 * \Delta\left(\frac{W_{t-1}}{A_{t-1}} + P_{t-1}^m\right)$$

With the prices and wages being given by independent equations, and given labour productivity and import prices, the markup rate is determined endogenously as:

$$\sigma_t = \frac{P_t^c}{\left(\frac{W_t}{A_t}\right) + P_t^m}$$

The household savings, S^H, can be found as the difference between disposable income and consumption plus the adjustment for the change in pension entitlements, $NPEN_t^H$:

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

Besides consuming goods and services, households also demand capital goods, which in this model are given by buildings and dwellings on the one hand, and equipment on the other. As it was done previously in the estimation of non-financial corporations' investment decision, the dependent variable we work with is the rate of accumulation $\left(\frac{i_{BD_t}^H}{K_{BD,t-1}^H}\right)$. Its determinants are, *a priori*, aggregate disposable income, the relative price of dwellings with respect to construction prices $\frac{P^{BD}}{P^I}$ (to introduce a speculative determinant of this type of investment) and leverage defined as the ratio of households' debt to the value of their fixed assets ($\frac{L_t^H}{K_{BD,t}^H}$). The interest rate on loans was also included in a first specification of the equation, but results were not found to be significant. A significant long run relationship is found between investment in buildings and dwellings, and disposable income, relative prices and households' debt, the coefficients being 3.39, -4.09, and -2.04, respectively. The short run effects exhibit signs which are in line with economic theory, although the coefficients of prices and disposable income are not highly statistically significant (see appendix).

$$\Delta \ln\left(\frac{i^H_{BD_t}}{K^H_{BD,t-1}}\right) = 0.45 - 0.39 * \Delta \ln\left(\frac{i^H_{BD_{t-1}}}{K^H_{BD,t-2}}\right) - 0.43 * \Delta \ln\left(\frac{i^H_{BD_{t-3}}}{K^H_{BD,t-2}}\right) + 0.62 * \Delta \ln\left(\frac{P^{BD}_{t-1}}{P^I_{t-1}}\right) + 0.65 * \Delta \ln\left(\frac{P^{BD}_{t-2}}{P^I_{t-2}}\right) + 0.21 * \Delta \ln\left(\frac{yd^H_{t-2}}{K^H_{BD,t-3}}\right) - 0.68 * \Delta \ln\left(\frac{L^H_{t-1}}{K^H_{BD,t-2}}\right) - 0.16 * \ln\left(\frac{i^H_{BD_{t-1}}}{K^H_{BD,t-2}}\right) + 0.53 * \left(\frac{yd^H_{t-1}}{K^H_{BD,t-2}}\right) - 0.64 * \left(\frac{P^{BD}_{t-1}}{P^I_{t-1}}\right) - 0.32 * \left(\frac{L^H_{t-1}}{K^H_{BD,t-2}}\right)$$

In the case of households' investment in equipment, no significant long run relationship was found. As a result, it was estimated as an auto-regressive process with an "exogenous" component given by disposable income, the underlying intuition being that a higher disposable income will lead to an increase in the purchase of the durable goods comprised in the equipment category.

$$\Delta \ln\left(\frac{i^H_{EQUIP}}{K^H_{equip,t-1}}\right) = -0.62 * \Delta \ln\left(\frac{i^H_{EQUIP_{-1}}}{K^H_{equip,t-2}}\right) - 0.25 * \left(\frac{i^H_{EQUIP_{-2}}}{K^H_{equip,t-3}}\right) + 0.19 * \left(\frac{yd^H_{-1}}{K^H_{equip,t-2}}\right)$$

Nominal investment in buildings and dwellings:

$$I^H_{BD,t} = i^H_{BD,t} * P^{BD}_t$$

Nominal investment in equipment:

$$I^H_{equip,t} = i^H_{equip,t} * P^{EQUIP}_t$$

Sum of real investment

$$i_t^H = i_{BD,t}^H + i_{equip,t}^H$$

Sum of nominal investment

$$I_t^H = I_{BD,t}^H + I_{equip,t}^H$$

The change in the nominal stock of equipment (K_{equip}^{NFC}) follows the basic accounting identity:

$$K_{equip,t}^H = K_{equip,t-1}^H + I_{equip,t}^H - D_{equip}^H + REV_{equip_t}^H$$

$$D_{equip}^H = \delta_3 * K_{equip,t-1}^H$$

The Nominal stock of building and dwellings in the Household sector is determined by the following accounting identity:

$$K_{BD,t}^H = K_{BD,t-1}^H + I_{BD,t}^H - D_{BD}^H + REV_{BD_t}^H$$

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

$$D_{BD}^H = \delta_4 * K_{BD,t-1}^H$$

As the case with the other sectors, net lending of households is measured as the difference between savings and investment, adjusted for the exogenous determined net acquisitions of non-produced non-financial assets (NP_t^H) and capital transfers (KTR_t^H)[15]

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

[15] net acquisitions of non-produced non-financial assets (NP_t^H) and capital transfers (KTR_t^H) are both determined exogenous in the model.

We now turn to explaining the households' allocation of wealth in the financial markets.. 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 overall development of the financial markets in our model is primarily driven by household demand for credit (loans) and assets (interest-bearing assets, equities, insurances, and securities). In our behavioral equations for the demand for equities and securities, we attempt to explain the demand for a particular stock, and then let these stocks (along with capital gains) determine the transactions of each financial asset in the model. Regarding the demand for insurance and interest-bearing asset, we explain the transactions and then determine the stock by using accounting identities. In case of insurances, the net transaction is closely related to the income of the household and the change of pension entitlements, which is the main reason for modelling the transaction instead of the stock. In case of interest-bearing asset, this transaction secures the link between net lending and financial net lending and is therefore required to be a flow. It should be highlighted that capital gains on financial assets in the model are exogenous.

The total transaction of financial assets, $FATR^H$, is the sum of four financial transactions: interest-bearing asset transactions, $IBATR^H$, equities transactions, $EQATR^H$, transaction of securities $SECTR^H$, and transactions of insurance, $INSTR^H$.

$$FATR_t^H = IBATR_t^H + EQTR_t^H + SECTR_t^H + INSTR_t^H$$

The demand for insurances is captured by an endogenously determined element related to changes in pension entitlements and an exogenously determined element related to insurances:

$$INSTR_t^H = NPEN_t^H + INSXTR_t^H$$

Stock of insurances can be written as:

$$INS_t^H = INS_{t-1}^H + INSTR_t^H + REV_{INS_t}^H$$

Households portfolio is composed of equities, securities and interest-bearing assets.

The demand for interest-bearing assets is used as the balancing item that ensures the fulfilment of households' budget constraint.

$$IBATR_t^H = NL^H + LTR_t^H - EQTR_t^H - INSTR_t^H - SECTR_t^H$$

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:*

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

Thus, we are left to define the choice between equities and securities. Considering that equities represent on average 90% of the portfolio of these two assets, we keep the demand for securities as an exogenous variable and focus on the demand for equities. The demand for equities is written as a proportion of financial assets net of insurance. When carrying out the estimation, we also net out the demand for equities (taken as a stock) from the revaluation effects, as these are not part of households' demand at the moment of making their portfolio decision (in a model in discrete time revaluation effects take place at the end of each period). The main determinants of the demand for equities are given by the interest rate on securities (r_{B_t}) and the rate of profitability of equities, this later being computed as the ratio of the sum of dividends received by households and revaluation effects to the previous stock of equities. In order to avoid problems of collinearity (given by the inclusion of revaluation effects as a component of profitability), the rate of profitability is included with a lag. The cointegration tests suggest that there is a long run relationship between these variables, which allows us to express the demand for equities as an error correction model.

$$\Delta\left(\frac{EQ_t^H - EQ_{rv,t}^H}{EQ_{t-1}^H + SEC_{t-1}^H + IBA_{t-1}^H}\right) = 0.07 + 6.85 * \Delta r_{B_{t-1}} + 0.16 * \Delta\left(\frac{DIV_{t-1}^H + EQ_{rv_{t-1}}^H}{EQ_{t-2}^H}\right) - 0.10 * \left(\frac{EQ_{t-1}^H - EQ_{rv,t-1}^H}{EQ_{t-2}^H + SEC_{t-2}^H + IBA_{t-2}^H}\right) - 2.14 * r_{B_{t-1}} + 0.16 * \left(\frac{DIV_{t-2}^H + EQ_{rv_{t-2}}^H}{EQ_{t-3}^H}\right)$$

Although in the short run, there seems to be a positive relationship between the interest rate and the relative demand for equities, this effect is smaller compared to the one registered for the long run (which is -22.06). The convergence towards the long run equilibrium therefore offsets the positive effect that interest rates have on the relative demand for equities in the short run. Regarding the impact of profitability, although it is almost negligible in the short run, it is positive in the long run (1.64).

Regarding households' liabilities, their demand for loans is expressed as loan transaction to disposable income. The main determinants for households' loan transactions are the interest rate on loans, the ratio of households' investment to disposable income, and the stock of outstanding debt to income ratio - considering that most of the credit is taken to purchase dwellings. These relationships can also be expressed by means of an error correction model, which takes the following form:

$$\Delta\left(\frac{L_{tr,t}^H}{YD_t^H}\right) = 1.27 + 0.13 * \Delta\left(\frac{L_{tr_{t-2}}^H}{YD_{t-2}^H}\right) - 26.26 * \Delta r_{L_t} + 0.26 * \Delta ln\left(\frac{i_{BD_{t-3}}^H}{yd_{t-3}^H}\right) - 0.72 * \left(\frac{L_{tr_{t-1}}^H}{YD_{t-1}^H}\right) - 0.49 * \left(\frac{L_{t-2}^H}{YD_{t-2}^H}\right)$$

The only relevant long run relationship that we found is the one linking the demand for loans and the debt-to-income ratio, the coefficient being -0.68. The short run coefficients were all found significant and with the correct sign.

Interest-bearing liabilities can be written as:

$$L_t^H = L_{t-1}^H + LTR_t^H + REV_{L_t}^H$$

Total financial assets in this model is the sum of the four financial assets given by the following identity:

$$FA_t^H = IBA_t^H + EQ_t^H + INS_t^H + SEC_t^H$$

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

$$FL_t^H = L_t^H$$

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 housing to financial net wealth:

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

Real financial wealth is defined as:

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

Real wealth can be written as:

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

5.3 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 FC's savings are 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 ($B^F_{2_t}$) (received), social transfers (STR^F) minus taxes paid to the government (T^F), and the changes in pension entitlements ($NPEN^F$) paid to the households:

$$S^F_t = B^F_{2,t} + Property\ income^F_t - T^F_t + STR^F_t - NPEN^F_t$$

The property income of the financial corporations can be found from their financial assets:

$$\begin{aligned} &Property\ income^F_t \\ &\quad = interest\ received^F_t - interest\ paid^F_t + dividends\ received^F_t \\ &\quad - dividends\ paid^F_t + insurance\ received^F_t - insurance\ paid^F_t \end{aligned}$$

Gross Investment for the financial The FC's stock of fixed assets is determined in the standard way, as explained for other sectors above:

$$K^F_t = K^F_{t-1} + I^F_t - D^F_t + REV^F_{K_t}$$

After taking net acquisitions of non-produced nonfinancial assets (NP) and capital transfers into account (KTR^F), the net lending of FC can be expressed as the difference between savings and investment as follows:

$$NL^F_t = S^F_t - I^F_t - NP^F_t + KTR^F_t$$

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

$$FNL^F_t = -IBATR^F_t + SECTR^F_t + EQTR^F_t + LTR^F_t - INSTR^F_t$$

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

$$IBATR_t^F = -(IBATR_t^N + IBATR_t^G + IBATR_t^H + IBATR_t^W)$$

where $IBATR^N$, $IBATR^G$, $IBATR^H$ and $IBATR^W$ represent the transactions of interest-bearing assets of the NFCs, the government sector, the households and the rest of the world, respectively.

The change in the FCs' stock of interest-bearing assets is determined by the corresponding transaction along with capital gains:

$$IBA_t^F = IBA_{t-1}^F + IBATR_t^F + REV_{IBA_t}^F$$

Regarding the transaction of securities for the FCs, the sector engages in transactions with both the domestic market and well as the RoW.

$$SECTR_t^{F\sim W} = SECTR_t^W$$

In this version of the model, it is assumed that all international trade in securities involves the financial corporations, where the foreign demand for securities is being met by the domestic financial sector.

For the domestic transactions of securities, the FCs use this asset as a residual for all other transactions to ensure the fulfilment of the budget constraint of the financial sectors.

$$SECTR_t^{F\sim dom} = SECTR_t^{F\sim W} + NL_t^F + IBATR_t^F + INSTR_t^F - LTR_t^F - EQTR_t^F$$

The total transaction of securities can be found as,

$$SECTR_t^F = SECTR_t^{F \sim dom} + SECTR_t^{F \sim W}$$

The stock of securities can be found using the standard accounting identity,

$$SEC_t^F = SEC_{t-1}^F + SECTR_t^F + REV_{SEC_t}^F$$

The stock of loans is determined by the demand for credit from the rest of the economy:

$$L_t^F = -(L_t^N + L_t^G + L_t^H + L_t^W)$$

Where the supply of new loans can be described as an accounting identity:

$$LTR_t^F = L_t^F - L_{t-1}^F - REV_{L_t}^F$$

We now turn to the stock of equities ($EQTR_t^F$), which is modeled as a residual of the demand for equities from the other sectors:

$$EQ_t^F = EQ_t^N + EQ_t^G + EQ_t^H + EQ_t^W$$

This transaction of equities can be expressed as:

$$EQTR_t^F = EQ_t^F - EQ_{t-1}^F - REV_{EQ_t}^F$$

Finally, the overall development in $INSTR^F$ is mainly explained by household contributions to pensions, as discussed earlier.[16]

$$INSTR_t^F = INSTR_t^H + INSTR^W$$

The stock of insurance can be found by following the same procedure as the rest of the financial assets,

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

$$INS_t^F = INS_{t-1}^F + INSTR_t^F + REV_{INS,t}^F$$

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

$$FNW_t^F = -IBA_t^F + EQ_t^F + SEC_t^{F\sim H} + L_t^F - INS_t^F$$

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

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

5.4 Government Sector

The Danish economy is characterized by having a welfare state with a very active government. The public expenditures are mostly 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 is social transfers. Net social transfers paid by the government sector are equal to the sum of net 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 government consumption (G_t) and the interest payment on public debt. The savings S^G identity can be written as follows:[17]

[17] Like for other sectors, the government sector also receives a share of the gross operating surplus from the production sector.

$$S_t^G = B_{2_t}^G + Property\ income_t^G + T_t^G + STR_t^G - G_t$$

The property income of the government sector depends on their stock of financial assets and can be expressed as:

$$\begin{aligned} Property\ income_t^G \\ &= r_{A_{t-1}}^F (IBA_{t-1}^G) - r_{L_{t-1}}^F (L_{t-1}^G) + \mu_{t-1}(EQA_{t-1}^G) + \psi_{t-1}(INS_{t-1}^F) \\ &- r_{B_{t-1}}(SEC_t^G) \end{aligned}$$

The government sector can also affect the aggregate 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 the other sectors:

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

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

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

On the financial side of the economy, the government is assumed to finance its deficit through issuing securities as well as a reduction in the stock of interest-bearing assets. The issuing of securities for the government depends on the demand for securities among the other domestic sectors:

$$SECTR_t^G = NL_t^G - LTR_t^G - IBATR_t^G - EQTR_t^G - INSTR_t^G$$

The stock of securities can be defined as the standard accounting identity,

$$SEC_t^G = SEC_{t-1}^G + SECTR_t^G + REV_{SEC_t}^G$$

5.5 Rest of the World

In 1982 Denmark decided to peg the Danish Krones to the D-mark, which later was replaced by a peg to the euro. For this reason, the exchange rate is assumed to be fixed in this model. Denmark is characterized as a small open economy, which a high degree of interaction with the rest of the world. From the 1950s to the late 1980s, the Danish economy experienced persistent current account deficits and therefore accumulated a large stock of foreign debt. Since 1989, on the contrary, the economy has been running persistent surpluses on the current account resulting in a reduction of its external debt. The persistent surpluses on the current account eventually resulted in Denmark holding external wealth towards the rest of the world.

The positive foreign net wealth results in a positive property income to the Danish economy each year, which together with a positive trade balance improves the overall position of the current account.

Focusing on the trade balance, exports are modelled following a traditional Armington model, where the quantity of exported goods is a function of both the level of activity of trading partners and the real exchange rate. In order to estimate exports, we constructed a variable containing the weighted average of the GDP of Denmark's ten main trading partners[18]. A similar process was followed to build the real exchange rate[19]. Supply effects are simply included by adding real GDP as an additional independent variable. In order to avoid simultaneity problems, this real GDP will enter regressions with a lag. In the case of exports, the evidence seems to show that the real exchange rate is not significant in the long run. The relation takes the following form:

$$\Delta \ln(x_t) = 0.60 + 1.43 * \Delta \ln(y_{t-4}^{TP}) - 0.49 * \Delta \ln(rer_t) - 0.49 * \ln(x_{t-1}) + 0.37 * \ln(y_{t-1}^{TP})$$

[18] Each country's real GDP was converted into USD and weighted by its share on Danish export basket.

[19] The real exchange rate index was built as the weighted average of the bilateral real exchange rate, which was in turn computed using consumer price indices and nominal exchange rates.

Besides showing a strong effect of trading partners' activity on Danish exports in the short run, this estimation suggests that there is also a significant long run relationship, the coefficient being 0.76. An increase in the real exchange rate (i.e., an appreciation) has a negative impact on exports, but this effect is only found to be significant in the short run.

The estimation of imports is based on the standard Post-Keynesian import function. Cointegration tests suggest that there is a long run relationship between Danish imports and real GDP, the long run coefficient being around 1.84. The estimated equation takes the following functional form:

$$\Delta \ln(m_t) = -3.79 - 0.12 * \Delta \ln(m_{t-2}) + 0.30 * \Delta \ln(rer_{t-1}) + 0.41 * \Delta \ln(rer_{t-3}) + 1.30 * \Delta \ln(y_t) - 0.32 * \ln(m_{t-1}) + 0.59 * \ln(y_{t-1})$$

The sign of the coefficients suggests that in the short run imports are quite responsive to changes in domestic demand, and much less sensitive to movements in the real exchange rate. The speed of convergence towards the long run equilibrium is slightly lower (32%) than observed in the case of exports (49%).

Nominal imports:

$$M_t = m_t * P_t^m$$

Nominal exports:

$$X_t = x_t * P_t^x$$

Import prices (P_t^m) are expressed in domestic currency assuming a fixed exchange rate of one. Export prices (P_t^x) are kept exogenous in the current version of the model.

Savings of the rest of the world can be written as an identity containing exports, imports, net property income, net wages received from Denmark, net taxes paid to Denmark, and net social transfers:

$$S_t^W = M_t - X_t + Property\ income_t^W + WB_t^W - T_t^W + STR_t^W$$

Net property income can be written as:

$$Property\ income_t^W$$
$$= \mu_{t-1}(EQ_{t-1}^W) + \psi_{t-1}(INS_{t-1}^W) + r_{A_{t-1}}(IBA_{t-1}^W) - r_{L_{t-1}}(L_{t-1}^W)$$
$$+ r_{B_{t-1}}(SEC_t^W)$$

Finally, we express the net lending of rest of the world:

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

The current account balance from a Danish perspective can be seen as the mirror of the net lending for rest of the world:

$$CAB_t = -NL_t^W$$

Financial account balance:

$$FNL_t^W = IBATR_t^W + EQTR_t^W + INSTR_t^W + SECTR_t^W - LTR_t^W$$

Net interest-bearing stocks:

$$IBA_t^W = IBA_{t-1}^W + IBATR_t^W + REV_{IBA_t}^W$$

Net equity stocks:

$$EQ_t^W = EQ_{t-1}^W + EQTR_t^W + REV_{EQ_t}^W$$

Net pension stocks:

$$INS_t^W = INS_{t-1}^W + INSTR_t^W + REV_{INS_t}^W$$

Net interest-bearing transactions:

$$IBATR_t^W = NL_t^W - EQTR_t^W - INSTR_t^W + L_t^W - SEC_t^W$$

The rest of the world's net financial wealth:

$$FNW_t^W = IBA_t^W + EQ_t^W + INS_t^W + SEC_t^W - L_t^W$$

5.6 Labor Market

Wages and employment are determined in the labor market and market for goods and services in combination. First, we determine GDP at factor cost to determine wage shares and therefore the functional distribution of income.

Wage share:

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

Employment (N) is simply given as the ratio of real output to productivity.

$$N_t = \frac{y_t}{a}$$

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

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

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 persons:

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

The number of unemployed individuals is defined as the difference between the total labor force and the number of employed individuals.

$$UN_t = LF_t - N_t$$

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

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

In this model the supply of labor is determined by both the participation rate and demographic factors.
The labor force is being calculation as

$$LF_t = part * Pop_t$$

Finally, the fraction of the population on retirement are calculated as the ratio of the population being older than 64 years. This ratio plays an important role for the net contribution to pension schemes:

$$Ret_t = \frac{Pop_{(65+),t}}{Pop_t}$$

5.7 Model Closure

Once all the sectors the behavioural equations and accounting identities of the institutional agents have been defined, it is required to ensure that the model-specification is stock-flow consistent. This requires that all the transactions flows incorporated in the social accounting matrix and all the financial assets described in the flow-of-funds are such that ex post supply (resources) is equal to demand (uses).

Stock-flow consistency also requires that ex post the budget constraints of all the institutional agents are being fulfilled.

In the description made in the subsection describing households, it was assumed that interest-bearing assets adjust for any discrepancies between net lending and the transactions of the rest of the financial assets (equities, securities and insurance) and liabilities (loans). The same procedure was followed for non-financial corporations and the rest of the world, in both cases interest-bearing assets closing their budget constraints. We assume that the market of interest-bearing assets is entirely demand determined, implying that the financial sector supplies as many assets as the other sectors demand. The same assumption is made in the case of loans and insurance. In the case of the equity market, it is non-financial corporations that issue as many equities as is required to meet the demand of the other sectors.

Having defined how the markets of interest-bearing assets, loans, equities and insurance are closed, and how the budget constraint of households, non-financial corporations, and the rest of the world are closed, it is left to define the closure of the market of securities and the budget constraint of the government and financial corporations. As mentioned above, there are two types of securities in the model: domestically issued securities and securities issued to the rest of the world. The issuers of securities can be the financial corporations and the government. We assume that financial corporations issue securities to the rest of the world on demand. Having already defined all the other transactions of financial assets and liabilities and given net lending, domestically issued securities closes the budget constraint of financial corporations.

Finally, the government's budget constraint is closed through the net issuance of domestically issued securities. Given that the rest of the world's demand for domestic securities is exogenously determined and that the supply of these assets by financial corporations and the government are such that their respective budget constraints are fulfilled, there is (in principle) nothing that explicitly ensures that ex post the supply of domestic securities will match demand. However, the stock-flow consistency of the model is such that this accounting identity is fulfilled even if not written explicitly. In the following figure, we plot this identity (as a ratio of GDP) as generated by the baseline model. As can be seen in Figure 6, the identity is fulfilled, as it is zero (meaning that supply equals demand), the small discrepancies are the ones observed in the original database.

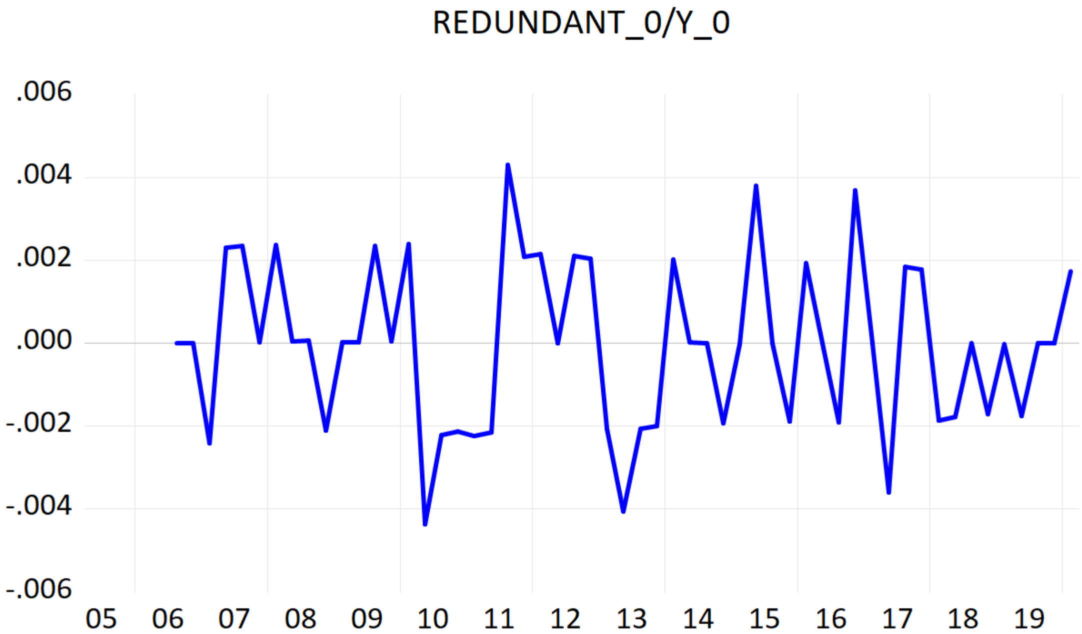

Figure 6: Discrepancies between supply and demand of securities

6 Validation of the Model

In this section, we will look at the performance of the model by both comparing the results from the simulations with actual data for the period under observation and by running a standard shock and investigating how the model responds to this shock.

In the figures below, we compare the results from the simulation with the actual data for real GDP, real household consumption, total real investment and level of employment.

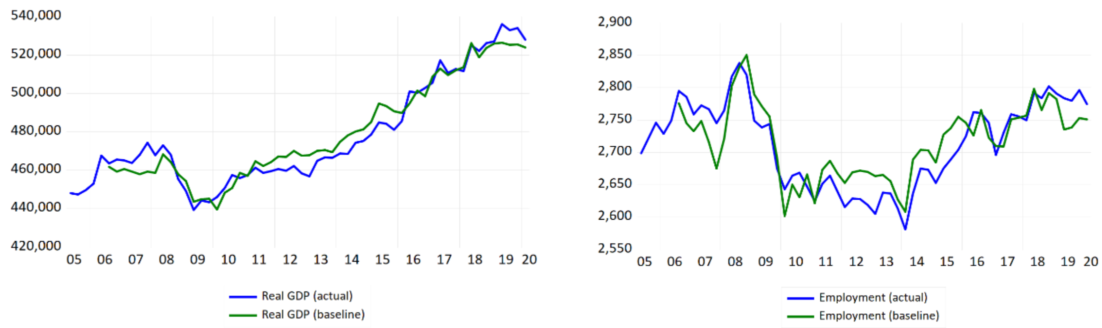

Figure 7: Real GDP and Employment, actual vs baseline model

As can be seen in the left part of figure 7, the model seems to be able to capture the dynamics of real economic activity quite well. In particular, the model does explain the medium to long-run tendency of the data pretty well even though there are some divergences in some quarters. The model, however, seems to overshoot the economic activity in the period from 2011 to 2016. This overshooting can be explained by the fact that the model simulates both the level of investment (green line in the left panel of figure 8) and consumption (green line in the right panel) too high compared to the actual data in 2011-2016. Having this overshooting in mind, the model is still able to explain the overall trajectory of the level of employment from 2005 to 2020.

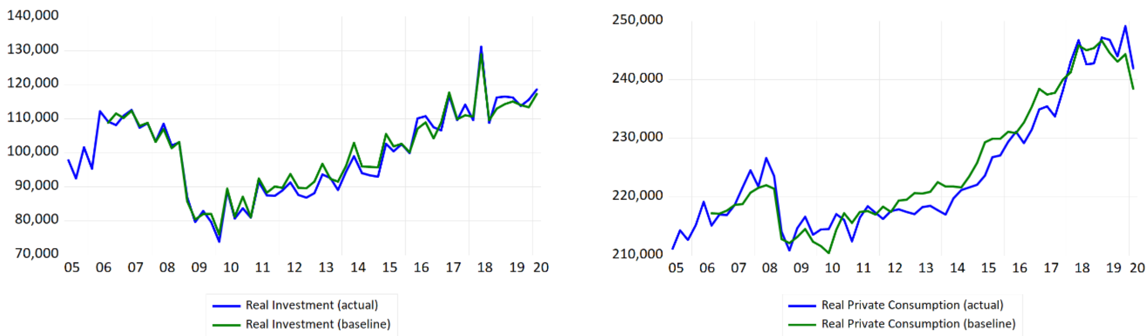

Figure 8: Real investment (left) and real consumption (right)

We now proceed to testing the performance of the model from a more theoretical perspective where we analyse how the model responds to particular shocks. Of course, this exercise can also have important empirical relevance. In order to analyze the behavior of the model, we propose a simple shock consisting of a 2% permanent increase in public expenditure from 2010. From the left panel of Figure 9 below, it can seen that the shock produces a positive effect on real income (the green line is slightly above the blue one), which is reasonable considering that public expenditure is one of the components of aggregate demand. As can be seen in the right panel of Figure 9, real private consumption increases as well.

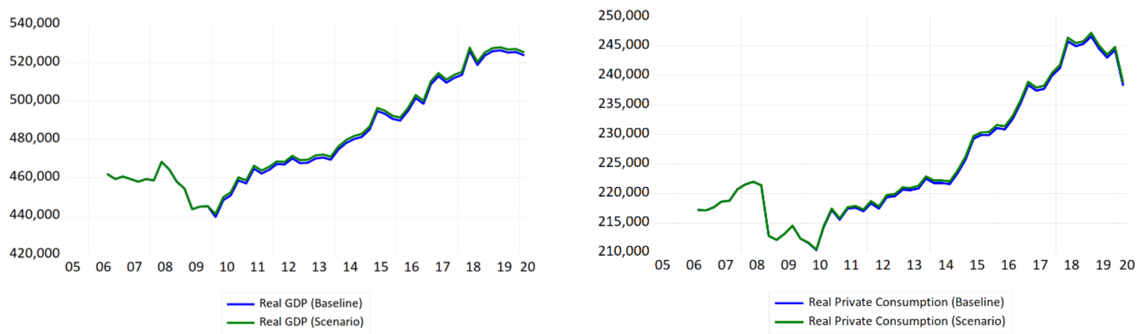

Figure 9: Real GDP (left) and Real Private Consumption (right)

The positive effect that the shock has on aggregate demand implies that, given labour productivity, the level of employment increases. Since the size of the labour force is exogenous, the shock produces an immediate drop in the rate of unemployment (see the left panel of Figure 10). The lower rate of unemployment, in turn, induces upward pressures on wages (right panel of Figure 10), which according to the equation specified in the previous section are assumed to react automatically.

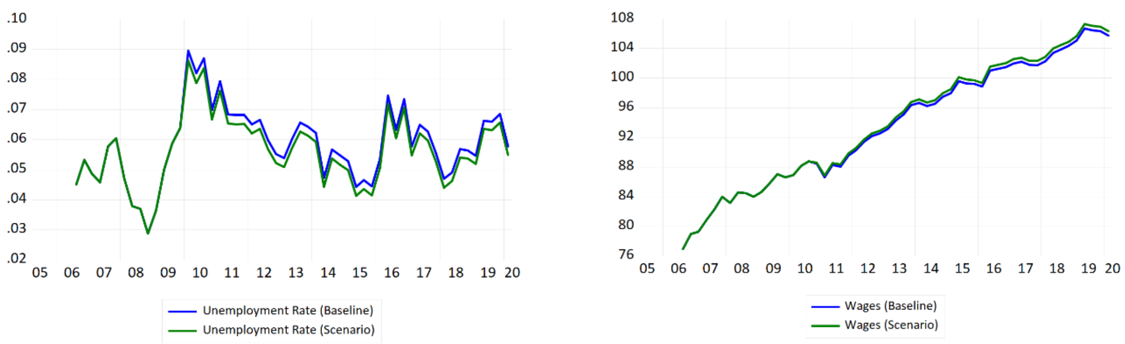

Figure 10: Unemployment Rate (left) and Nominal Wages (right)

Since prices are determined following a markup pricing equation, where the mark-up is assumed exogenous, the increase in unit labour costs (wages are higher while productivity has not changed) results in an increase in prices, as shown in the left panel of Figure 11. The fact that wages increase more than prices, leads to an increase the real wage, which explains why private consumption is higher in the context of an expansionary fiscal policy.

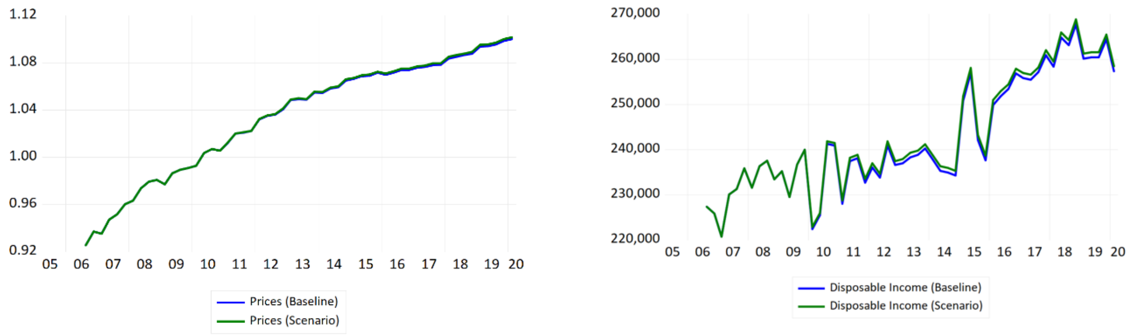

Figure 11: Price level (left) and Real Disposable Income (right)

7 Conclusion and future research

In this paper we presented our preliminary results of our work on the quarterly model for the Danish economy. This first version of the model seems to be able to reproduce the actual dynamics of the key variable of the Danish economy in a fairly accurate way. The simulations carried out so far also showed that the model behaves in line with the underlying economic theory. However, as every structural macroeconometric model, the work presented in this paper is always in progress. With this benchmark model already producing reliable results, we expect to undertake a series of studies of the Danish economy that will help us to fine-tune each of its building blocks (mainly the behavioural equations).

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Annex 1: Assumptions made in the construction of the balance sheet

In the main text we broadly described the criteria used to go from the financial accounts as they are informed by the Central Bank of Denmark to the simplified balance sheet used in the model. In this appendix we explicitly report the decisions made in the procedure of netting out assets and liabilities for each institutional agent.

1. Currency and deposits were netted out for all institutional agents. The only cases where they were significant both as an asset and as a liability were financial corporations and the rest of the world. In the former, deposits as an asset represent deposits held within the financial corporation sector. Thus, it seemed reasonable to net them out leaving deposits as a net liability. In the latter, considering that deposits constitute a net asset (foreigners holding deposits in Danish banks) and they are not as relevant as the main components of the balance sheet, they were also netted out. This leaves domestic financial corporations as the sole issuer of currency and deposits.
2. Securities were kept as gross stocks, i.e., they were kept both as an asset and as a liability for all the institutional agents, as informed by the financial account statistics. It was also assumed that all domestic agents but financial

corporations purchase domestically issued securities (mainly from the government), while financial corporations acquire securities issued by the rest of the world.

3. Loans were netted out for all institutional agents, leaving them as a net asset only for the financial corporations and the government (in this latter case of a very small amount, very close to zero, mostly comprising intra public sector transactions).
4. Equities were netted out for households and the government, as they only hold stocks as an asset. For non-financial corporations, financial corporations and the rest of the world, equities were kept as gross stocks since for the entities comprised in each of these institutional agents they can be both a source of funding and a component of their portfolio. As the figures in the balance sheet show, however, equities naturally constitute a net liability only for non-financial corporations.
5. Insurance technical reserves only take significant values for financial corporations as a liability and for households as an asset. We therefore chose to net the figures out for all the institutional agents.
6. Trade credits, mostly composed of short-term credit associated with commercial transactions, is netted out for all institutional agents thereby rendering it a net asset for non-financial corporations and a net liability for the rest.

Annex 2: Estimation of Behavioural Equations

Wages

Dependent Variable: D(LOG(RW_DS))
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 05/30/22 Time: 13:00
Sample (adjusted): 2006Q3 2020Q1
Included observations: 55 after adjustments
D(LOG(RW_DS)) = P(520) + P(521)*D(UR(-4)) + P(522)
*D(LOG(PRODK_DS)) + P(523)*LOG(RW_DS(-1)) + P(524)
*UR_DS(-2) + P(525)*LOG(PRODK_DS(-2)) + P(526)*D_2009Q4
+ P(527)*D_2011Q1

	Coefficient	Std. Error	t-Statistic	Prob.
P(520)	0.126429	0.113408	1.114809	0.2706
P(521)	-0.306399	0.182799	-1.676150	0.1003
P(522)	0.551023	0.087966	6.264020	0.0000
P(523)	-0.100306	0.053624	-1.870537	0.0676
P(524)	-0.152915	0.073282	-2.086660	0.0424
P(525)	0.065181	0.045946	1.418633	0.1626
P(526)	-0.020795	0.007935	-2.620528	0.0118
P(527)	-0.018751	0.007405	-2.532095	0.0147

R-squared	0.586263	Mean dependent var	0.002833
Adjusted R-squared	0.524642	S.D. dependent var	0.010129
S.E. of regression	0.006984	Akaike info criterion	-6.956737
Sum squared resid	0.002292	Schwarz criterion	-6.664761
Log likelihood	199.3103	Hannan-Quinn criter.	-6.843827
F-statistic	9.514097	Durbin-Watson stat	1.954218
Prob(F-statistic)	0.000000		

Prices

Dependent Variable: D(PC_DS)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 05/30/22 Time: 13:00
Sample (adjusted): 2006Q3 2020Q1
Included observations: 55 after adjustments
D(PC_DS) = C(21)*D(PC_DS(-1)) + C(22)*D(PC_DS(-2)) + C(23)
*D(PC_DS(-4)) + C(24)*D(WAGE_DS/PROD_DS+PM_DS) + C(25)
PC_DS(-1) + C(26)(WAGE_DS(-1)/PROD_DS(-1)+PM_DS(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(21)	-0.178351	0.102659	-1.737308	0.0886
C(22)	-0.192208	0.101302	-1.897367	0.0637
C(23)	0.446135	0.103457	4.312279	0.0001
C(24)	0.136355	0.041869	3.256735	0.0020
C(25)	-0.029245	0.017149	-1.705359	0.0945
C(26)	0.021289	0.011715	1.817351	0.0753

R-squared	0.570991	Mean dependent var	0.003099
Adjusted R-squared	0.527214	S.D. dependent var	0.007639
S.E. of regression	0.005253	Akaike info criterion	-7.557476
Sum squared resid	0.001352	Schwarz criterion	-7.338495
Log likelihood	213.8306	Hannan-Quinn criter.	-7.472794
Durbin-Watson stat	2.309287		

Real Private Consumption

Dependent Variable: D(LOG(PCONK_DS))
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 06/01/22 Time: 17:15
Sample (adjusted): 2006Q1 2020Q1
Included observations: 57 after adjustments
D(LOG(PCONK_DS)) = C(1) + C(2)*LOG(PCONK_DS(-1)) + C(3)
*LOG(YD1_HK_DS(-1)) + C(4)*LOG(YD2A_HK_DS(-1)) + C(5)
*LOG(FNW_HK(-2)) + C(6)*DLOG(YD1_HK_DS) + C(7)
*D(LOG(YD1_HK_DS(-2))) + C(8)*D(LOG(YD2A_HK_DS)) + C(10)
*D_2008Q4 + C(11)*D_2018Q2 + C(12)*D_2020Q1

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1.587713	0.590569	2.688448	0.0100
C(2)	-0.331284	0.090341	-3.667029	0.0006
C(3)	0.117414	0.047778	2.457506	0.0178
C(4)	0.060414	0.025419	2.376777	0.0217
C(5)	0.028064	0.009288	3.021632	0.0041
C(6)	0.061398	0.038694	1.586761	0.1194
C(7)	0.061843	0.031019	1.993708	0.0521
C(8)	0.090805	0.019010	4.776672	0.0000
C(10)	-0.036097	0.009689	-3.725377	0.0005
C(11)	0.021656	0.009370	2.311248	0.0254
C(12)	-0.026748	0.009497	-2.816490	0.0071

R-squared	0.635285	Mean dependent var	0.002265
Adjusted R-squared	0.555999	S.D. dependent var	0.013178
S.E. of regression	0.008781	Akaike info criterion	-6.460932
Sum squared resid	0.003547	Schwarz criterion	-6.066659
Log likelihood	195.1366	Hannan-Quinn criter.	-6.307704
F-statistic	8.012588	Durbin-Watson stat	2.184965
Prob(F-statistic)	0.000000		

Exports

Dependent Variable: DLOG(XK_DS)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 05/31/22 Time: 10:47
Sample (adjusted): 2006Q3 2020Q1
Included observations: 55 after adjustments
DLOG(XK_DS) = P(651) + P(652)*DLOG(GDP_TP(-4)) + P(653)
*DLOG(RER) + P(654)*LOG(XK_DS(-1)) + P(655)*LOG(GDP_TP(
-1)) + P(657)*D_2008Q2

	Coefficient	Std. Error	t-Statistic	Prob.
P(651)	0.599442	0.329621	1.818581	0.0751
P(652)	1.426091	0.455354	3.131832	0.0029
P(653)	-0.494797	0.262204	-1.887070	0.0651
P(654)	-0.487067	0.102481	-4.752768	0.0000
P(655)	0.377061	0.078055	4.830700	0.0000
P(657)	0.057398	0.020549	2.793175	0.0074

R-squared	0.404258	Mean dependent var	0.005666
Adjusted R-squared	0.343468	S.D. dependent var	0.024440
S.E. of regression	0.019803	Akaike info criterion	-4.903302
Sum squared resid	0.019216	Schwarz criterion	-4.684321
Log likelihood	140.8408	Hannan-Quinn criter.	-4.818620
F-statistic	6.650086	Durbin-Watson stat	1.941515
Prob(F-statistic)	0.000085		

Imports

Dependent Variable: DLOG(MK_DS)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 05/31/22 Time: 09:37
Sample (adjusted): 2006Q2 2020Q1
Included observations: 56 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)
DLOG(MK_DS) = P(661) + P(662)*DLOG(MK_DS(-2)) + P(663)*DLOG(RER(-1)) + P(664)*DLOG(RER(-3)) + P(665)*DLOG(YK_DS) + P(666)*LOG(MK_DS(-1)) + P(667)*LOG(YK_DS(-1)) + P(668)*D_20091 + P(669)*D_2009Q4

	Coefficient	Std. Error	t-Statistic	Prob.
P(661)	-3.798025	0.730446	-5.199594	0.0000
P(662)	-0.125433	0.063756	-1.967384	0.0551
P(663)	0.298491	0.227577	1.311606	0.1960
P(664)	0.406530	0.209667	1.938933	0.0585
P(665)	1.297138	0.204759	6.334957	0.0000
P(666)	-0.317032	0.056579	-5.603327	0.0000
P(667)	0.590128	0.104653	5.638925	0.0000
P(668)	-0.078005	0.004651	-16.77269	0.0000
P(669)	-0.071022	0.005777	-12.29438	0.0000

R-squared	0.683320	Mean dependent var	0.006830
Adjusted R-squared	0.629417	S.D. dependent var	0.030491
S.E. of regression	0.018561	Akaike info criterion	-4.989246
Sum squared resid	0.016193	Schwarz criterion	-4.663743
Log likelihood	148.6989	Hannan-Quinn criter.	-4.863049
F-statistic	12.67687	Durbin-Watson stat	2.512723
Prob(F-statistic)	0.000000		

Households' investment in buildings and dwellings

Dependent Variable: DLOG(I_BD_H_K_DS/BD_H_K(-1))
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 05/31/22 Time: 09:37
Sample (adjusted): 2006Q3 2020Q1
Included observations: 55 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)
DLOG(I_BD_H_K_DS/BD_H_K(-1)) = P(620) + P(621)*DLOG(I_BD_H_K_DS(-1)/BD_H_K(-2)) + P(622)*DLOG(I_BD_H_K_DS(-3)/BD_H_K(-4)) + P(623)*DLOG(P_BD(-1)/PI(-1)) + P(624)*DLOG(P_BD(-2)/PI(-2)) + P(625)*DLOG(YD_HK_DS(-2)/BD_H_K(-3)) + P(626)*DLOG(-L_H(-1)/BD_H(-2)) + P(627)*LOG(I_BD_H_K_DS(-1)/BD_H_K(-2)) + P(628)*LOG(YD_HK_DS(-1)/BD_H_K(-2)) + P(629)*LOG(P_BD(-1)/PI(-1)) + P(630)*LOG(-L_H(-1)/BD_H(-2)) + P(631)*D_2006Q4 + P(632)*D_2014Q4

	Coefficient	Std. Error	t-Statistic	Prob.
P(620)	0.454193	0.355606	1.277235	0.2085
P(621)	-0.389618	0.119782	-3.252733	0.0023
P(622)	-0.428082	0.107446	-3.984173	0.0003
P(623)	0.623658	0.350623	1.778715	0.0825
P(624)	0.652399	0.399479	1.633124	0.1099
P(625)	0.205805	0.129286	1.591856	0.1189
P(626)	-0.682466	0.190783	-3.577181	0.0009
P(627)	-0.155232	0.042641	-3.640441	0.0007
P(628)	0.526918	0.132545	3.975382	0.0003
P(629)	-0.635644	0.331642	-1.916657	0.0621
P(630)	-0.317241	0.101717	-3.118848	0.0033
P(631)	-0.059486	0.028000	-2.124486	0.0396
P(632)	0.098915	0.009764	10.13016	0.0000

R-squared	0.730172	Mean dependent var	-0.006495
Adjusted R-squared	0.653079	S.D. dependent var	0.050140
S.E. of regression	0.029533	Akaike info criterion	-4.003576
Sum squared resid	0.036631	Schwarz criterion	-3.529115
Log likelihood	123.0983	Hannan-Quinn criter.	-3.820098
F-statistic	9.471240	Durbin-Watson stat	2.260117
Prob(F-statistic)	0.000000		

Households' investment in equipment

Dependent Variable: DLOG(I_EQUIP_H_K_DS/EQUIP_H_K(-1))
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 06/01/22 Time: 16:47
Sample (adjusted): 2006Q2 2020Q1
Included observations: 56 after adjustments
DLOG(I_EQUIP_H_K_DS/EQUIP_H_K(-1)) = P(636) + P(637) *
DLOG(I_EQUIP_H_K_DS(-1)/EQUIP_H_K(-2)) + P(638) *
DLOG(I_EQUIP_H_K_DS(-2)/EQUIP_H_K(-3)) + P(639)
*DLOG(YD_HK_DS/EQUIP_H_K(-1)) + P(640)*DUMMY4

	Coefficient	Std. Error	t-Statistic	Prob.
P(636)	0.006986	0.006055	1.153814	0.2540
P(637)	-0.619173	0.097291	-6.364125	0.0000
P(638)	-0.246440	0.096155	-2.562929	0.0134
P(639)	0.192310	0.150914	1.274295	0.2083
P(640)	-0.144175	0.022627	-6.371723	0.0000

R-squared	0.605536	Mean dependent var	-0.001263
Adjusted R-squared	0.574598	S.D. dependent var	0.065602
S.E. of regression	0.042787	Akaike info criterion	-3.380109
Sum squared resid	0.093368	Schwarz criterion	-3.199274
Log likelihood	99.64305	Hannan-Quinn criter.	-3.309999
F-statistic	19.57234	Durbin-Watson stat	1.859806
Prob(F-statistic)	0.000000		

Non-financial Corporations' investment in buildings and dwellings

Dependent Variable: DLOG(I_BD_NFC_K_DS/BD_NFC_K(-1))
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 06/21/22 Time: 19:32
Sample (adjusted): 2006Q1 2020Q1
Included observations: 57 after adjustments
DLOG(I_BD_NFC_K_DS/BD_NFC_K(-1)) = P(800) + P(801)
*DLOG(I_BD_NFC_K_DS(-1)/BD_NFC_K(-2)) + P(802)
*DLOG(PS_DS) + P(803) * DLOG(U_DS) + P(804)*
LOG(I_BD_NFC_K_DS(-1)/BD_NFC_K(-2)) + P(805) *
LOG(PS_DS(-1)) + P(806) * LOG(U_DS(-1))+P(892)
*DLOG(TOBINQ)+P(893)*LOG(TOBINQ(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
P(800)	0.397106	0.238655	1.663931	0.1026
P(801)	-0.485097	0.101002	-4.802834	0.0000
P(802)	-0.090710	0.242614	-0.373888	0.7101
P(803)	0.720729	0.404068	1.783680	0.0808
P(804)	-0.396795	0.097098	-4.086535	0.0002
P(805)	0.402187	0.203555	1.975814	0.0539
P(806)	1.043789	0.279083	3.740066	0.0005
P(892)	0.008666	0.071092	0.121900	0.9035
P(893)	0.086964	0.034904	2.491496	0.0162

R-squared	0.643092	Mean dependent var	-0.005002
Adjusted R-squared	0.583608	S.D. dependent var	0.048768
S.E. of regression	0.031470	Akaike info criterion	-3.935655
Sum squared resid	0.047536	Schwarz criterion	-3.613068
Log likelihood	121.1662	Hannan-Quinn criter.	-3.810287
F-statistic	10.81107	Durbin-Watson stat	2.020163
Prob(F-statistic)	0.000000		

Non-financial Corporations' investment in equipment

Dependent Variable: DLOG(I_EQUIP_NFC_K_DS/EQUIP_NFC_K(-1))
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 06/21/22 Time: 19:32
Sample (adjusted): 2006Q1 2020Q1
Included observations: 57 after adjustments
DLOG(I_EQUIP_NFC_K_DS/EQUIP_NFC_K(-1)) = P(807) + P(808) * DLOG(I_EQUIP_NFC_K_DS(-1)/EQUIP_NFC_K(-2)) + P(809) * DLOG(PS_DS) + P(810) * DLOG(U_DS) + P(811) * LOG(I_EQUIP_NFC_K_DS(-1)/EQUIP_NFC_K(-2)) + P(812) * LOG(PS_DS(-1)) + P(813) * LOG(U_DS(-1)) + P(814) * DUMMY10 + P(815) * DUMMY11 + P(890)*DLOG(TOBINQ) + P(891) *LOG(TOBINQ(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
P(807)	-0.007702	0.320692	-0.024017	0.9809
P(808)	-0.172228	0.100883	-1.707199	0.0945
P(809)	0.005661	0.280151	0.020207	0.9840
P(810)	0.317621	0.470105	0.675637	0.5027
P(811)	-0.410045	0.096222	-4.261453	0.0001
P(812)	0.440581	0.214514	2.053856	0.0457
P(813)	0.488587	0.152082	3.212653	0.0024
P(814)	0.179397	0.029401	6.101706	0.0000
P(815)	-0.132821	0.022862	-5.809745	0.0000
P(890)	-0.239325	0.081730	-2.928253	0.0053
P(891)	0.064286	0.033594	1.913628	0.0619

R-squared	0.763999	Mean dependent var	-0.001262
Adjusted R-squared	0.712694	S.D. dependent var	0.066459
S.E. of regression	0.035623	Akaike info criterion	-3.660117
Sum squared resid	0.058373	Schwarz criterion	-3.265844
Log likelihood	115.3133	Hannan-Quinn criter.	-3.506889
F-statistic	14.89144	Durbin-Watson stat	2.112399
Prob(F-statistic)	0.000000		

Households' contributions to the pension system

Dependent Variable: DLOG(D8_H)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 05/30/22 Time: 13:00
Sample (adjusted): 2005Q4 2020Q1
Included observations: 58 after adjustments
DLOG(D8_H) = P(701)*DLOG(D8_H(-1)) + P(702)*DLOG(W_H_R) + P(703)*DLOG(OLD_AGE_RATIO(-1)) + P(704)*LOG(D8_H(-1)) + P(705)*LOG(W_H_R(-1)) + P(706)*LOG(OLD_AGE_RATIO(-1)) + P(707)*D_2014Q3

	Coefficient	Std. Error	t-Statistic	Prob.
P(701)	0.092838	0.119086	0.779591	0.4392
P(702)	0.269194	0.900522	0.298931	0.7662
P(703)	-46.16681	22.08243	-2.090658	0.0416
P(704)	-0.609349	0.116019	-5.252142	0.0000
P(705)	0.363869	0.090146	4.036461	0.0002
P(706)	-0.954255	0.387350	-2.463546	0.0172
P(707)	-0.957432	0.279314	-3.427795	0.0012

R-squared	0.430822	Mean dependent var	0.009375
Adjusted R-squared	0.363860	S.D. dependent var	0.322814
S.E. of regression	0.257471	Akaike info criterion	0.236943
Sum squared resid	3.380858	Schwarz criterion	0.485617
Log likelihood	0.128653	Hannan-Quinn criter.	0.333807
Durbin-Watson stat	2.398285		

Social benefits paid by the government

Dependent Variable: DLOG(NBEN_H)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 05/30/22 Time: 13:00
Sample (adjusted): 2005Q4 2020Q1
Included observations: 58 after adjustments
DLOG(NBEN_H) = P(671) + P(672)*DLOG(ZALAND_JESPER) +
P(673)*D(UNEMP) + P(674)*D(UNEMP(-1)) + P(675)
*LOG(NBEN_H(-1)) + P(676)*UNEMP(-1) + P(677)
*LOG(ZALAND_JESPER(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
P(671)	-28.18008	4.307949	-6.541415	0.0000
P(672)	1.652034	0.403811	4.091110	0.0002
P(673)	0.001782	0.000217	8.204793	0.0000
P(674)	0.000505	0.000241	2.097979	0.0409
P(675)	-0.771564	0.119319	-6.466408	0.0000
P(676)	0.000427	0.000122	3.499584	0.0010
P(677)	2.479639	0.376669	6.583079	0.0000

R-squared	0.750755	Mean dependent var	0.008585
Adjusted R-squared	0.721432	S.D. dependent var	0.046925
S.E. of regression	0.024767	Akaike info criterion	-4.445882
Sum squared resid	0.031283	Schwarz criterion	-4.197208
Log likelihood	135.9306	Hannan-Quinn criter.	-4.349018
F-statistic	25.60302	Durbin-Watson stat	1.775083
Prob(F-statistic)	0.000000		

Households' demand for loans

Dependent Variable: D(-L_H_TR/(YD_HK_DS*PC))
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 05/31/22 Time: 09:37
Sample (adjusted): 2006Q2 2020Q1
Included observations: 56 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed
bandwidth = 4.0000)
D(-L_H_TR/(YD_HK_DS*PC)) = P(641)*D(-L_H_TR(-2)/(YD_HK_DS(-2)
*PC(-2))) + P(642)*D(ILOAN) + P(643)*DLOG(I_BD_H_K_DS(-3)
/(YD_HK_DS(-3))) + P(644)*-L_H_TR(-1)/(YD_HK_DS(-1)*PC(-1))
+ P(645)*LOG(-L_H(-2)/(YD_HK_DS(-2)*PC(-2))) + P(646) +
P(647)*D_2007Q34 + P(648)*@TREND

	Coefficient	Std. Error	t-Statistic	Prob.
P(641)	0.127344	0.117151	1.087007	0.2825
P(642)	-26.26315	11.69886	-2.244933	0.0294
P(643)	0.261147	0.082518	3.164717	0.0027
P(644)	-0.720430	0.080304	-8.971314	0.0000
P(645)	-0.488317	0.106854	-4.569961	0.0000
P(646)	1.268992	0.260811	4.865555	0.0000
P(647)	0.176276	0.032207	5.473253	0.0000
P(648)	-0.003043	0.000494	-6.161984	0.0000

R-squared	0.624534	Mean dependent var	-0.006331
Adjusted R-squared	0.569779	S.D. dependent var	0.080650
S.E. of regression	0.052899	Akaike info criterion	-2.909285
Sum squared resid	0.134321	Schwarz criterion	-2.619949
Log likelihood	89.45997	Hannan-Quinn criter.	-2.797110
F-statistic	11.40588	Durbin-Watson stat	2.205272
Prob(F-statistic)	0.000000	Wald F-statistic	36.78385
Prob(Wald F-statistic)	0.000000		

Households' demand for equities

Dependent Variable: D((EQ_H-EQ_H_RVX)/(EQ_H(-1)+SEC_H(-1)
+IBA_H(-1)))
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 05/31/22 Time: 09:37
Sample (adjusted): 2006Q1 2020Q1
Included observations: 57 after adjustments
D((EQ_H-EQ_H_RVX)/(EQ_H(-1)+SEC_H(-1)+IBA_H(-1))) = P(770) +
P(771)*D(IBD(-1)) + P(772)*D((DIV_R_H(-1)+EQ_H_RVX(-1))
/EQ_H(-2)) + P(773) * ((EQ_H(-1)-EQ_H_RVX(-1))/(EQ_H(-2)
+SEC_H(-2)+IBA_H(-2))) + P(774) * IBD(-1) + P(775) * ((DIV_R_H(
-2)+EQ_H_RVX(-2))/EQ_H(-3))

	Coefficient	Std. Error	t-Statistic	Prob.
P(770)	0.070730	0.018440	3.835776	0.0003
P(771)	6.847554	2.147688	3.188338	0.0024
P(772)	0.163228	0.019919	8.194419	0.0000
P(773)	-0.097716	0.026077	-3.747154	0.0005
P(774)	-2.143093	0.548228	-3.909130	0.0003
P(775)	0.159301	0.026086	6.106703	0.0000

R-squared	0.742552	Mean dependent var	0.003354
Adjusted R-squared	0.717311	S.D. dependent var	0.015968
S.E. of regression	0.008490	Akaike info criterion	-6.600511
Sum squared resid	0.003676	Schwarz criterion	-6.385453
Log likelihood	194.1146	Hannan-Quinn criter.	-6.516932
F-statistic	29.41958	Durbin-Watson stat	2.195081
Prob(F-statistic)	0.000000		