Financialisation and assets price bubbles in an Euro Area economy

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<version 21-10-2019>

Abstract

Deregulation and globalisation, which took place in the late 1970s early 1980s, caused a boom in the current global financial cycle. In earlier papers we developed a model for an Euro Area economy to investigate various aspects of the impact of these developments. We analysed (1) the impact of the housing bubble on mortgage growth and house prices and the subsequent impact on lower leverage of the banking sector through the deposit financing gap; (2) the result of pension savings held abroad and the destabilising impact of low interest rates on pension claims; and (3) the consequence that firms more and more use their savings for share buy-backs and (speculative) investments abroad. (See Meijers, Muysken and Sleijpen 2015, 2014 and 2016, respectively). We also paid explicit attention to the influence of financial asset price bubbles and the role of the Central Bank with quantitative easing (Meijers and Muysken, 2016). In the present paper we bring all our earlier versions together in one stock-flow consistent model, which we estimate and calibrate for an Euro Area economy like the Netherlands. The model is based on a stock-flow consistent set of macroeconomic data, which we collected for the Netherlands.

From simulations with our model we show (a) why housing price bubbles occur (due to riskier bank behaviour); (b) why asset price bubbles occur (also due to speculation by firms); (c) why QE does not have a direct impact on the real sphere (because of leakages abroad); (d) how the vulnerability of the financial sector is aggravated by QE (larger foreign exposure). We also show how the economy reacts to various shocks, for instance in the interest rate, the wage rate and the risk appetite of banks and firms.

JEL Code: E44, B5, E6, F45, G21, G32

Key words: globalisation, financialisation, quantitative easing, stock-flow consistent modelling

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1. Introduction

The origins of the boom in the current global financial cycle can be traced to deregulation and globalisation, which took place in the late 1970s early 1980s. The deregulation facilitated amongst others the explosion of mortgage financing in developed economies, which caused the financial crisis in 2007, and the corresponding globalisation facilitated capital flows to shift net savings abroad. Because of both developments, the financialisation of the economy expanded dramatically (Bezemer, 2017).

The increased financialisation of the economy, together with deregulation and globalisation, has led to a strong decrease of productive investment and hence domestic economic growth through two channels. First, household savings were progressively absorbed by increased house prices and pension portfolios held abroad, while firm savings were diverted through share buy-backs and speculative investments abroad. Second, credit creation in the financial sector eased the re-routing of household and firm savings and created additional problems of increased volatility and higher risks to the financial system (Werner, 1997; Bezemer and Muysken, 2015).

In the present paper we capture these developments in a comprehensive framework. We integrate the results of previous versions of a model we developed for an Euro Area economy. We analysed (1) the impact of the housing bubble on mortgage growth and house prices and the subsequent impact on lower leverage of the banking sector through the deposit financing gap; (2) the result of pension savings held abroad and the destabilising impact of low interest rates on pension claims; and (3) the consequence that firms more and more use their savings for share buy-backs and (speculative) investments abroad. (See Meijers, Muysken and Sleijpen 2015, 2014 and 2016, respectively). We also paid explicit attention to the influence of financial asset price bubbles and the role of the Central Bank with quantitative easing (Meijers and Muysken, 2016). In the present paper we bring all our earlier versions together in one stock-flow consistent model, which we estimate and calibrate for an Euro Area economy like the Netherlands, based on data especially collected for this purpose.

For that reason, we start in section 2 with a brief overview of empirical stock-flow consistent macroeconomic models – these are few only, due to the complicated nature of finding appropriate data. We also discuss the problems in collecting a comprehensive set of stock flow consistent macroeconomic data. In particular, we point out that the presence of tax vehicles (so-called Special Financial Institutions) muddles the data on the financial sector considerably and that we have to rely on external sources to eliminate these from our data.

In section 3, we present the data we collected for the Netherlands for the various sectors of the economy in a stock-flow consistent way, together with a description of the main features of the model – for a detailed version of the model see the appendix. We point out that the financisalisation of the economy is pervasive in all sectors. The households accumulate large claims on the pension funds from which future benefits should be paid out (about 200 per cent of GDP). This is due to the funded nature of the pension system and the low interest rate. Next to that, the volatility of house prices accompanied by high mortgages, has affected consumption negatively. Firms use their retained earnings not to invest in physical capital but to buy foreign assets abroad (outward direct investments). Next to that, foreign countries buy a lot of domestic equity (inward direct investments). This process is accompanied by soaring equity prices. Foreign assets and equity, instead of physical

capital and loans, therefore dominate the balance sheet of firms (about 200 per cent of GDP for both foreign assets and liabilities).

In the financial sector, the fragility of the pension system leads to higher contributions and lower benefits, which has a negative impact on consumption. Moreover, pension funds use the majority of contributions by households to buy equity abroad (over 150 per cent of GDP). Banks also increased their foreign exposure considerably over time, with foreign assets currently around 120 per cent of GDP and foreign liabilities around 170 per cent – the gap between both constitutes the so-called deposit financing gap. Finally, the Dutch economy has a trade balance surplus, which increased from 6 per cent in 1996 to around 10 per cent in 2017. The current account surplus is lower, however, reflecting adverse valuation changes and rates of returns in foreign assets and liabilities. Nonetheless, net foreign debt increased over time until a level of 80 per cent of GDP in 2017.

Since our data cover a limited period, 1995 – 2017, and are on annual basis, it is hard to find reliable estimation results for the model. This is complicated by the adverse developments, which occurred during this period – the dot-com bubble, the financial crisis, the Euro-crisis and Quantitative Easing. We explain in section 4 how we used the available data to calibrate the model and discuss the calibration results. We also present a base run until 2030, which we will use for our simulation experiments.

We still have to perform simulations with our model. In section 5 we intend to show (a) why housing price bubbles occur (due to riskier bank behaviour); (b) why asset price bubbles occur (also due to speculation by firms); (c) why QE does not have a direct impact on the real sphere (because of leakages abroad); (d) how the vulnerability of the financial sector is aggravated by QE (larger foreign exposure). We will also show how the economy reacts to various shocks, for instance in the interest rate, the wage rate and the risk appetite of banks and firms.

2. Estimating stock flow consistent models and the nature of the data

It is not surprising that there a only few empirical stock flow consistent models, since it is very hard to construct a stock flow consistent set of macroeconomic data for a country which covers the economy reasonably well. Also, the scarcity of data makes it very difficult to capture the dynamics of the model in a reasonable way. In this section we survey the few empirical stock flow consistent models that we have found in the literature and discuss the problems we encountered when collecting a stock flow consistent set of macroeconomic data for the Netherlands.

2.1 Empirical stock flow consistent models

We are aware of only four recent publications where an effort is made to estimate or implement a stock flow consistent model to actual data of an economy.[1,2] All these analyses circulate as working papers.

The oldest model is Papadimitriou et al. (2013) which is estimated for the Greek economy – the LIMG model.[3] An important stylised fact that the model intends to analyse is the interaction between the government deficit, the external balance and private investment minus saving. However, as we elaborate in MBM (2017) the model is quite rudimentary. The same holds for the model estimated for the UK economy by Gudgin et al. (2015) – the UKMOD model. Here the authors ignore the financial sector and model the rest of the world only in a rudimentary way.

The analysis of Miess and Schmeltzer (2016) aims to implement a stock flow consistent model for Austria. The main contribution of the paper is a presentation of the data which are necessary for that purpose in a detailed way, consistent with the national account data (but they ignore data on the capital stock and the housing stock). These data also include the financial sector and allow for various assets. Interesting observations are that the financial assets of firms increased from 30 per cent of GDP in 1995 to 100 per cent in 2015 (the comparable figures for liabilities are 100 and 165 per cent, respectively); assets and liabilities of the financial sector were just over 300 per cent of GDP in 2015. While their treatment of the data is highly sophisticated, the model they use is very simple, using the data in a very elementary way, mainly relying on fixed coefficients and exogenous variables. Therefore, their analysis lacks a deeper insight in the determinants of the development of the Austrian economy.

The paper by Burgess et al. (2016) provides the most elaborate model, which is applied to the British economy. The authors point out that "the macroeconomic policy consensus at the time [of the financial crisis] did not provide clear answers as to how policymakers should respond to either financial imbalances or the rapid growth of potentially unsustainable debt burdens, at a time when

[1] An interesting early empirical stock-flow consistent model is presented in Davis (1987 a,b).

[2] For an overview see Nikiforos and Zezza (2017) and Zezza and Zezza (2019).

[3] The authors refer on several places to 'the Levy Institute US model', but don't provide any references for that model. On the website of the Levy institute for several years a strategic analysis for the US economy is provided, apparently based on this model "Underlying the main conclusions of this Strategic Analysis is an econometric model in which exports, imports, taxes, and public and private expenditures are functions of world trade, relative prices, tax rates, stocks of debt, and flows of net lending."(Papadimitriou et al., 2011, p. 12) but no reference to this model is provided.

the real economy appeared to be stable."(pp.1-2) The aim of their model is to analyse these phenomena in a coherent way. They distinguish between households, firms, government, a detailed financial sector and the rest of the world. Moreover, they distinguish between various assets and model the prices of these various assets – enabling them to include revaluation effects in their analysis. Since they do not provide detailed data for the UK economy, it is difficult to analyse to what extent they cover the relevant stylised facts. One omission which the authors identify themselves is that they assume that pension funds hold all of UK's equity claims against the rest of the world, while in reality "Many of those are held by NFCs, through foreign direct investment" (p. 15).[4] They also do not employ data on the capital stock, although they use a Cobb Douglas production function.[5] However, they employ data on the housing stock.

The model of Burgess et al. (2016) is described in a detailed way and several interesting simulations are performed.[6] These simulations show the importance of incorporating financial flows in the model. This is obvious for the two simulations which refer directly to the financial sphere: (1) a rise in bank's capital requirements of one percentage point (leading to a fall in GDP of 0.1 per cent) and (2) a 'sudden stop' on the current account by lowering the demand for UK bonds and equity by foreign investors by 20 per cent (leading to an increase in GDP, which the authors consider implausible). However, also for the other simulations the impact of including financial flows in the model is important: (3) an exogenous increase in investment of 10 per cent (leads to an increase in GDP of 2 per cent, but also to higher net lending by banks and an increase the current account deficit of 0.6 per cent point); (4) an increase in house prices by 10 per cent (leads to an increase of GDP of 0.6 per cent through increased consumption, but also to higher net lending by banks and an increase the current account deficit of 0.3 per cent point);[7] and (5) fiscal expansion through an increase in government spending of 10 per cent (leading to an overall increase in GDP of 2 per cent, a worsening of government debt of 1 per cent point and a higher current account deficit of 0.7 per cent point). In all these scenario's there is an important feedback of wealth effects on consumption and of net lending on the current account, which is moderated by the financial sector.

With respect to the estimation of the model, Burgess et al. use quarterly data, which enables them to capture the dynamics of the model better compared to annual data. However, the period remains relatively short and therefore the authors are restricted to perform simple OLS estimations per equation. We will follow the same procedure when estimating our model.

[4] A probably related issue is that the authors adjust the proportion of firm liabilities which consist of equity in their parameter set from 0.84 to 0.10 since the first value is considered to be "unrealistically high".(p. 19)

[5] Their calculated capital-output ratio varies between 400 and 440 per cent on an annual basis (Figure 8). The authors claim that this roughly matches the UK data (p. 19), referring to Oulton and Wallis (2015). However, the latter present a capital-output ratio which is about 200 per cent – see their Chart 10.

[6] Two points which are not clear in the model are (1) while the authors state that bank equity "is assumed to be privately held and not traded by investors in the rest of the world" (pp. 10-11), they allow for "dividend paid out by the banks to their foreign shareholders"(p.11). The corresponding equation (64) is the only place where bank equity shows up; it is not included in the portfolio of the rest of the world – equation (74). (2) the central bank "doesn't pay interest on reserves"(p. 12), although banks set the interest rate on deposits "as a mark down on the rate of interest the central bank pays them on their holdings of reserves."(p. 12) – see also equation (70).

[7] This is consistent with the analysis of the deposit financing gap in Meijers, Muysken and Sleijpen (2015).

2.2 The nature of the data used

We calibrate the model using data for the Netherlands. The data are provided by the Central Bureau of Statistics (CBS) in the Netherlands, unless indicated otherwise. The data are available from 1995 onwards on an annual basis till 2017. We present the data in section 3 below.

Our first attempt to collect data in a stock-flow consistent way for the Netherlands is presented in Muysken, Bonekamp and Meijers (2017) – MBM (2017) from hereon. We outlined three main problems. First, the national account data provide a consistent framework for flow data over all sectors of the economy, but the balance sheets presented for the economy are not reflecting this framework in two respects. The entries in the balance sheets for the financial assets and liabilities do not have clear counterparts in the national account data.[8] Also, the net capital accumulation in the balance sheets, excluding valuation changes, does not match net savings. In MBM (2017) we solved this problem by changing the stock data to match the savings data. We also observed that valuation changes can be an important source of changes in stock data, which are not reflected in the national accounts. A final observation when comparing national account data and balance sheet data is that while many national account data are available on a quarterly basis from 1995 onwards, stock data are hardly available on a quarterly basis.

The second problem was that in particular in relation to financial data there is a huge bias, following from special financial institutions (SFIs) in the Netherlands, which are created for tax reasons. These institutions appear in two or three sectors (banking, foreign and firms to some extent) - they create a huge inflow of financial assets in the Dutch economy which is matched by a corresponding outflow.[9] These special financial institutions are included in the data provided by the Central Bureau of Statistics, but they cannot be identified separately. However, the SFIs can be found in the statistics of the Dutch Central Bank (DNB). We solved the problem for firms in MBM (2017) by only using data on net-investment abroad and using corresponding stock data. We solved the problem for banks and the foreign sector by subtracting DNB data from CBS data, and using net data.

The third problem was that many items found in the national account data had no clear meaning in our model – for instance imputed interest payments and social security payments and capital transfers. We ignored these data in MBM (2017).

In the current analysis we have solved the problems mentioned above in a different way, staying as close as possible to the national account data and the balance sheet data provided by the Central Bureau of Statistics. We solved the third problem – data with no clear counterpart in the model – by adding a correction item in the national account data y_{corr}. This term should be added to the row in the social account matrix of each sector (Table 7A in the Appendix) to make total income consistent across rows and columns. The correction factor is presented in Figures 1 and 2 for the various sectors, relative to the income of that sector.

From Figure 1 one observes that for the real sectors – households, firms and government – the correction factor is relatively small, less than 10 per cent of sectoral income. However, for the financial

[8] The balance sheets for non-financial assets (physical capital and housing) do have clear counterparts, but these are separate statistics, with a lot of valuation problems – see MBM (2017) for a further discussion.
[9] The total assets (and liabilities) of the SFIs comprise between 500 and 600 per cent of GDP. See Bezemer and Muysken (2015) and CPB (2016) for concerns on the impact of these institutions on the financial system.

sectors – banks, pension funds and foreign – the factor is much larger as appears from Figure 2. This reflects the measurement problems in these sectors – see MBM (2017) for an elaboration.

Figure 1

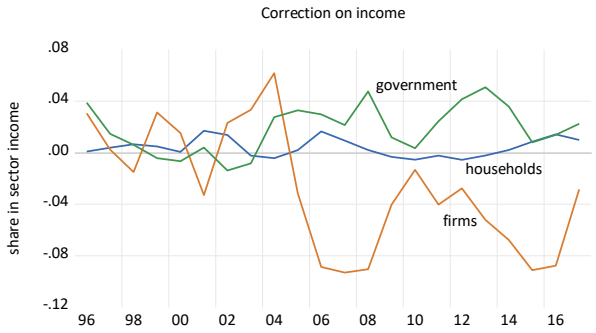
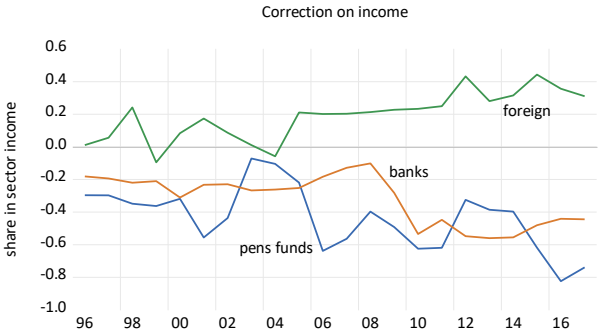


Figure 2



Similarly we solved the first problem – inconsistency between net savings taken from national account data and capital accumulation, net of valuation changes, taken from balance sheet data – by adding a correction item to the savings data s_{corr}. This item should be added to the column in the matrix of accumulation of savings and investment (Table 7C in the Appendix) after savings, to make total savings consistent with capital accumulation.

With respect to the second problem, the presence of tax vehicles, we consider these to be a significant problem in the banking sector and hence in the foreign sector, but not in the firm sector.[10] Therefore, when investment data in the firm sector are netted out as we did in MBM (2017), this ignores that a huge part of firm savings is used to buy financial assets. We identify the latter with direct investments abroad and have used the CBS data to reflect this phenomenon. However, with data on banks and the foreign sector, we have used DNB data to correct for the presence of SFIs – these data are net of SFIs. Nonetheless there is a significant capital inflow and outflow in the banking sector to other countries which we want to recognize – therefore we have not taken net flows. But these flows exclude the data on SFIs provided by DNB.

[10] The reason is that the full CBS data are consistent with firm net savings in the balance sheets and y_{corr} for firms is relatively low. However, the precise nature of the data is a question for further research.

3. Modelling developments in the Netherlands

It is important to look at the data carefully for two reasons as we explained in the introduction: observing relevant stylised facts and finding parameters to use in the model. The model then should be able to reproduce the relevant stylised facts.

In this section we present the main features of the model and illustrate these using our data, which we collected in a stock-flow consistent way for the Netherlands. A detailed description of the model is provided in the Appendix. We analyse each sector of the economy separately below. In the next section we then discuss the calibration results of the model and the base run.

3.1 Household behaviour

Two remarkable features of the financial situation of Dutch households are the funded pension system and the huge mortgage debt. Due to the funded pension system households have to pay each year a contribution to a pension fund until the retirement age is reached. Afterwards they receive each a benefit, related to the wage they earned in the past. Consequently, households accumulate large claims on the pension funds from which future benefits have to be paid out. This is illustrated in Figure 3. The sharp increase in pension claims follows from the low interest rate after the financial crisis – as we elaborate below, this low interest rate creates huge problems for the pension funds. Pension claims are around 220 per cent of GDP, whereas the financial assets of households, deposits plus participations,[11] together are less than 100 per cent of GDP.

The funded nature of the pension system also allows households to accumulate large mortgages relative to the value of their houses. For most households do not need the value of their houses to provide a buffer when they retire. One observes from Figure 4 that while in the late 1990s about 75 per cent of the value of houses was financed by mortgages, this share increased steadily to over 100 per cent in 2012. As we explain in MMS (2015), this is due to three factors, the initial sharp increase in house prices, the accommodating attitude of banks and the tax deduction of mortgages. The increase in house prices reflected the willingness of households to buy houses stimulated by the low interest rates. Moreover, banks were willing to provide ever more mortgages anticipating further house price increases. Finally, interest payments on mortgages were tax deductible.

Figure 3

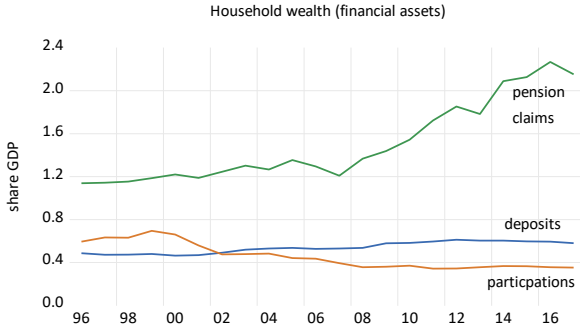
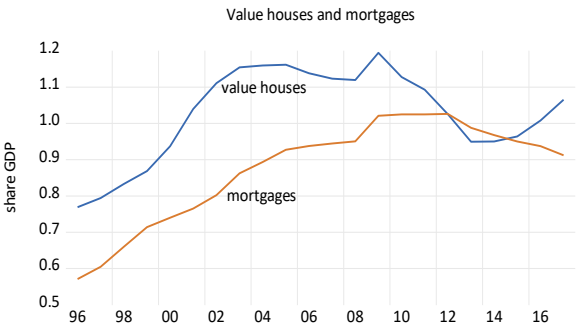


Figure 4



[11] The financial assets which households hold next to deposits consist to some extent of bonds and equity, but a large part is managed through "other financial institutions" (OFIs). Households hold claims on these OFIs – see MBM (2017) for a detailed discussion. We therefore denote the financial assets held by households next to deposits as "participations".

After the financial crisis, in particular after 2012, the housing market collapsed and house prices fell dramatically. Mortgages followed with some delay. But households suddenly realised their vulnerable debt position and started to pay back mortgage debt. Our model does reproduce these developments.

Using simple estimations for the Netherlands, we find that the growth rate in house prices depends positively on the disposable income of households, and negatively on the user cost of housing capital (including the (low) interest rate and tax deductions) and housing supply. The change in mortgages depends positively on the housing value and negatively on mortgage repayments.

We analyse the impact of these developments on consumption and savings. From Figure 5 one observes that consumption has dropped consistently relative to GDP since the dot com crisis in 2001, with a sharp fall prior to the financial crisis in 2008. Our simple estimation results for the Netherlands show that consumption depends positively on disposable income of households and on the value of houses net of mortgages. Disposable income declined sharply relative to GDP in the period prior to the financial crisis, from 73 per cent in 2000 to 67 per cent in 2007, mimicking the fall in the wage share during that period. While it stabilised after the financial crisis initially, the value of houses relative to mortgages started to fall, depressing consumption further.

Figure 5

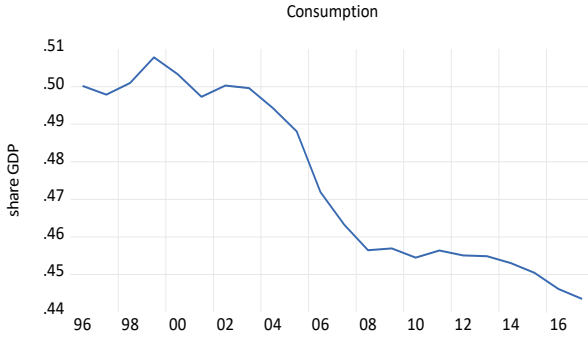
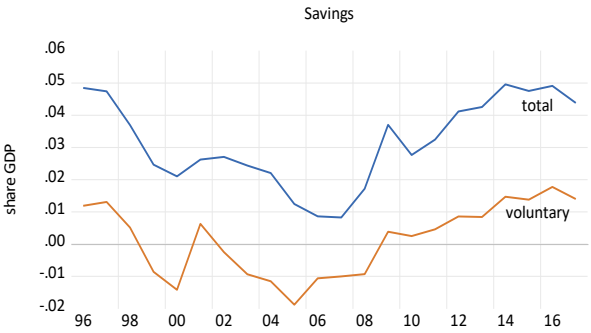


Figure 6



The impact of the developments on savings is also very interesting – see Figure 6. While total savings equal disposable income minus consumption, one should note that part of these savings are compulsory because of the net contributions by households to the pension fund. When one subtracts the latter from total savings, the voluntary savings result (Figure 6). It turns out that these were negative in the period 1999 – 2008 (except from the reaction to the dot com bubble). This illustrates that households were inclined to consume more than their disposable income net of contributions to the pension fund, because they enjoyed the booming housing market. It is only after the collapse of the housing market that households started to save voluntary in order to reduce their mortgages and to provide a buffer for future shocks.

We present the other aspects of household behaviour, like choice of financial assets in a portfolio, in detail in the model in the appendix.

3.2 Firm behaviour

A standard macroeconomic model using firms would suggest that firms finance their investments in physical capital by their retained earnings (savings) and issuing equity or borrowing from banks. However, the national account data show that firm savings exceed investment by a considerable

margin. Net investment of firms is very low, around 2 per cent of GDP, while net firm savings increased from 6 per cent of GDP in the late 1990s till 9 per cent in 2012 and dropped afterwards back till around 6 per cent – see Figure 7.

Figure 7

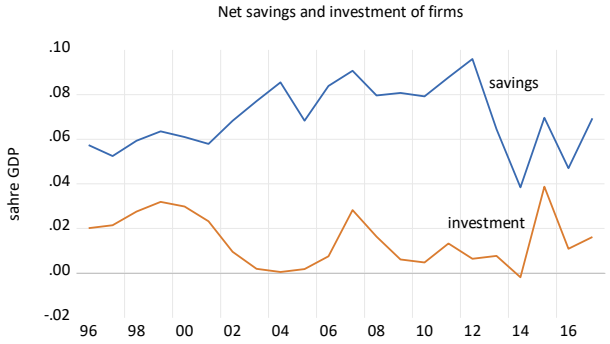
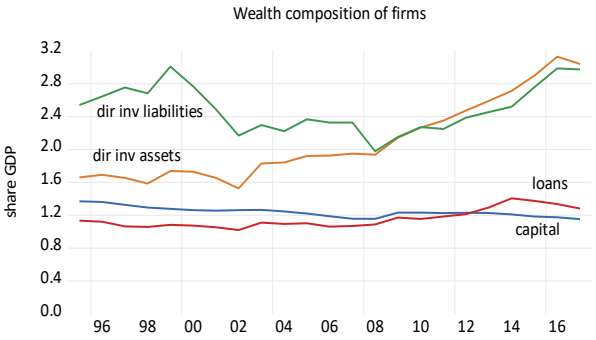


Figure 8



A related element which is not well recognised is that firms do not only invest in physical capital, but also buy financial assets. The latter is often identified with direct investment abroad and we model this as equity held by firms abroad. The impact on the wealth composition of firms is demonstrated in Figure 8. One observes that the capital stock on the assets side and loans on the liability side are quite close to each other, both about 120 per cent of GDP. Next to that the liabilities of firms consist of equity, decreasing from 300 per cent of GDP in 1999 till 200 per cent at the financial crisis in 2008 and gradually returning to 300 per cent of GDP in 2017 – this is often identified with foreign direct investment.[12] As noted above, firms also have a large amount of financial assets (equity in our model) on the asset side. These assets have increased from about 160 per cent of GDP in the early 2000's to 300 per cent in 2017. Since the financial crisis in 2008 direct investment abroad and foreign direct investment more or less balance each other on the assets and the liabilities side. Both have increased from 200 to 300 per cent of GDP and dominate the balance sheet of firms.[13]

Figure 9

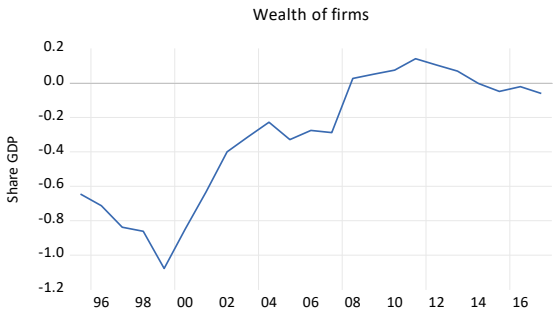
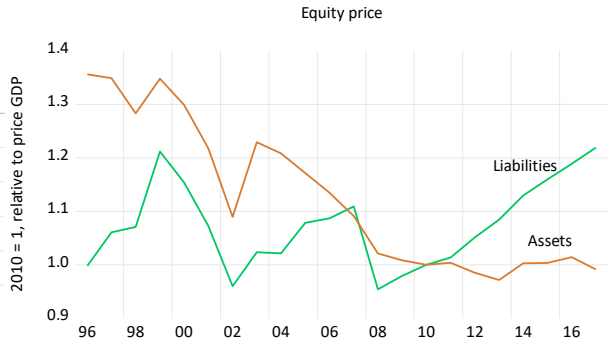


Figure 10



While net wealth of firms has been negative till the financial crisis, as appears from Figure 9, the strong increase in direct investment abroad since 2008 has turned net wealth of firms positive. Moreover, asset price developments have played an important role in the wealth development of firms. From Figure 10 one sees that the price of equities on the liabilities side of firms fluctuates sharply relative

[12] About 75 per cent of the shares of multinationals in the Netherlands is owned by non-residents – the comparable figures in Germany and France are less than half of the Dutch share (Eggelte et al., 2014).
[13] As we explain in section 2 part of this development may be related to tax vehicles. We leave this as a question for further research.

to the price of GDP, but the price has increased consistently since the financial crisis. The price of equities on the asset side of firms has decreased consistently relative to the price of GDP till the financial crisis and then flattened out.[14]

When evaluating these developments we distinguish between two realms which complement each other. One realm is that of the traditional view of firm behaviour where firms invest in physical capital and produce goods and services – the real firm behaviour. The other realm focuses on the financial behaviour of firms, where firms are mostly engaged in accommodating foreign direct investment and investing in foreign assets abroad – the financial firm behaviour. We discuss both in turn below.

From a simple estimation on Dutch data we find for real firm behaviour that net investment in physical capital by firms is positively influenced by aggregate demand, measured by the utilisation rate, and financial space, indicated by Tobin's q. It varies negatively with the costs of capital, represented by the interest on loans times relative to the capital stock.[15] Depreciation is a fixed proportion of the capital stock.

With respect to the financial behaviour of firms we assume that outgoing direct investment is exogenous, while incoming direct investment is determined in a portfolio model together with loans abroad. The (equity) price development of both types of investment is kept exogenous. A typical example of the exogenous nature of both incoming and outgoing direct investment is the lack of congruence between the asset price developments reported in Figure 10 and the composition of assets and liabilities reported in Figure 8. While asset equity prices decrease consistently over time, assets held in equity increase – but liability equity prices increased sharply since 2008 and equity liabilities increased too. These observations are hard to reconcile. Nonetheless, we will explore an endogenous equity price development in one simulation experiment – see section 5 below and section A.2 in the Appendix.

The retained profits are a fixed proportion of net profits. The remaining net profits flow to shareholders as dividends.

We present the other aspects of firm behaviour, like mark-up pricing, in detail in the model in the appendix.

3.3 Government behaviour

Government behaviour is modelled in a standard way. Taxes are fixed proportions of GDP as can be observed from Figure 11. The discrepancy between taxes levied on firms and on households is remarkable. One sees from Figure 12 that government expenditures consist mainly of government consumption. Government investment declined over time relative to GDP for political reasons. Interest payments declined too, due to the decrease in the interest rate.

[14] The worse relative performance of firms' direct investment abroad relative to foreign direct investment is well recognised in the Dutch literature (Eggelte et al., 2014).

[15] The investment function is taken from Hein (2012), only the cash flow rate which Hein uses is not significant for the Netherlands.

Figure 11

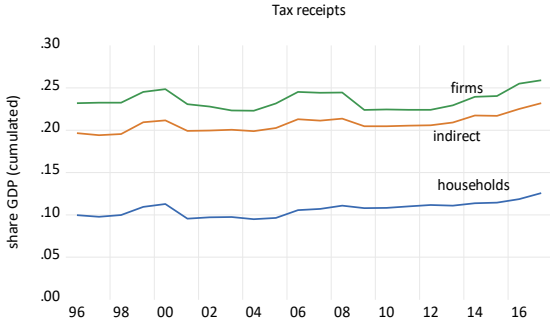
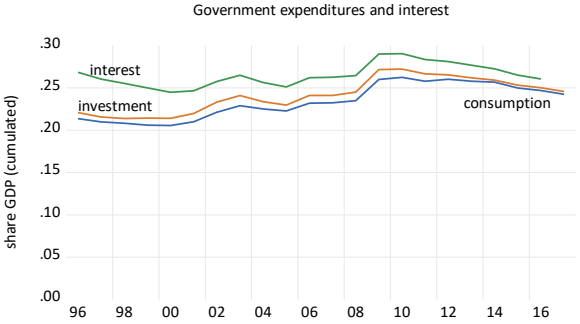


Figure 12



While tax rates are assumed to be constant in the model, simple estimation did show that government consumption fluctuates positively with GDP, while there is a negative impact of both government debt and the government deficit relative to GDP.

Figure 13

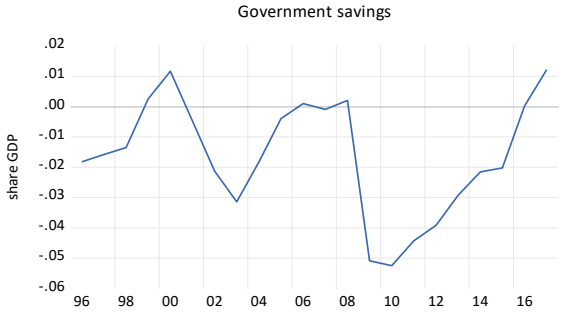
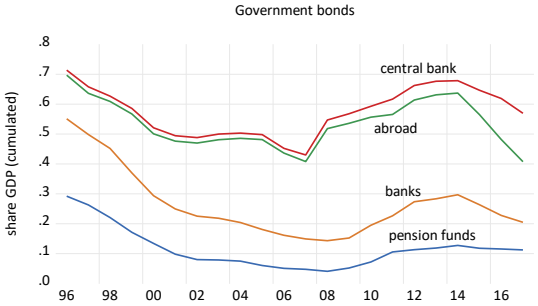


Figure 14



The government deficit fluctuated over time as can be seen from Figure 13. It decreased sharply in reaction to the dot com crisis in 2000 and to the financial crisis in 2008. However, in both cases it recovered relatively fast, resulting in a surplus since 2015. The corresponding fluctuations in government debt appear from Figure 14. The figure demonstrates how government bonds are distributed over the various sectors of the economy. A substantial part of the government bonds is held abroad. The quantitative easing operations of the central bank have mainly affected foreign debt holdings as we elaborate in section 5.

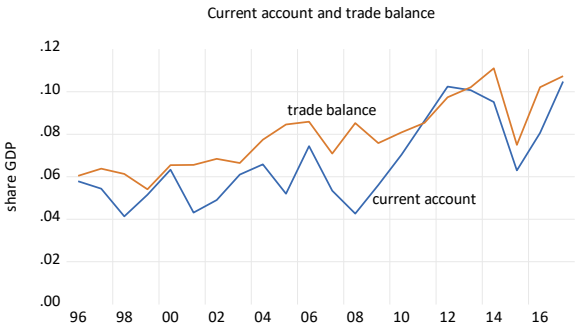
3.4 Foreign sector

The real side of the foreign sector is modelled in a standard way. As can be observed from Figure 15, both imports and exports increase relative to GDP – although the latter increases somewhat stronger. In our simulations, imports are a constant fraction of GDP, for simplicity, and exports are assumed exogenous. The result of these diverging trends is an increasing surplus on the balance of trade from 6 per cent of GDP in 1996 until around 10 per cent in 2016 – see Figure 16.

From Figure 16 one can observe that the current account behaves quite different compared to the trade balance. This reflects the strong interaction between the foreign sector and the financial sector as we discuss now.

Figure 15

Figure 16



The interaction with the financial sector

We saw already from section 3.2 that the foreign sector has a considerable amount of direct investments in domestic firms, while firms have a similar amount of direct investments abroad. This appears on the asset and liability side of the balance sheet of the foreign sector, respectively. We will discuss below that domestic pension funds also invest in foreign equity. Moreover, the banking sector has strong positions on both the asset and liability side of the foreign sector.

Figure 17

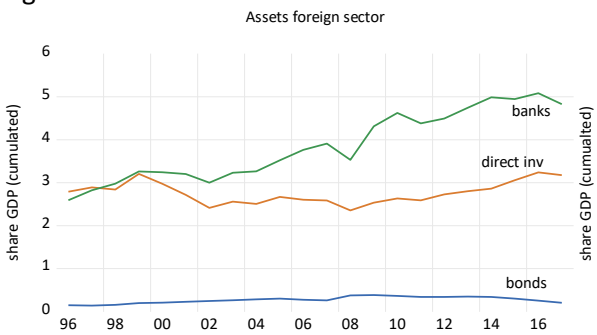
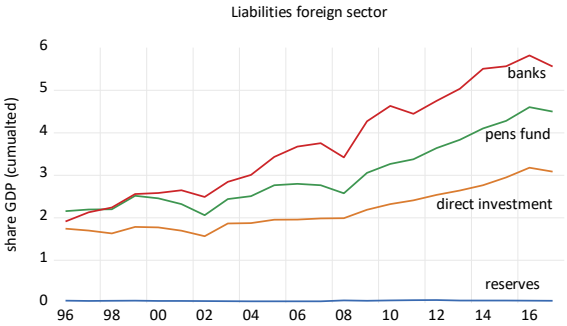


Figure 18



All these positions are presented in Figures 17 and 18, respectively. One observes that the foreign sector also holds government bonds (see also Figure 14) and borrows reserves from the central bank. Overall the domestic assets held by the foreign sector constitute about 500 per cent of GPD in recent years, whereas the liabilities are about 600 per cent. The net foreign debt in recent years is therefore about 100 per cent of GDP. This development is not surprising given the large surplus on the current account. This surplus corresponds to net savings of the foreign sector and adds to the net foreign debt, together with valuation changes. Net foreign debt increases consistently throughout the period under investigation till around 70 per cent of GDP in 2016 (Figure 19). Valuation changes almost net out over the period, but drop by around 300 per cent of net foreign savings around the dot com crisis in 2000 and the financial crisis in 2008 (Figure 20).

The equity positions on the liability side of the foreign sector follow from the decisions taken by firms and pension funds to buy foreign equity. We discuss bank behaviour below, and the reserves position follows from the foreign savings as we elaborate in section A.4 of the appendix.

We use a portfolio model to mimic the decisions of the foreign sector on the composition of assets as we elaborate in section A.4 of the appendix.

Figure 19

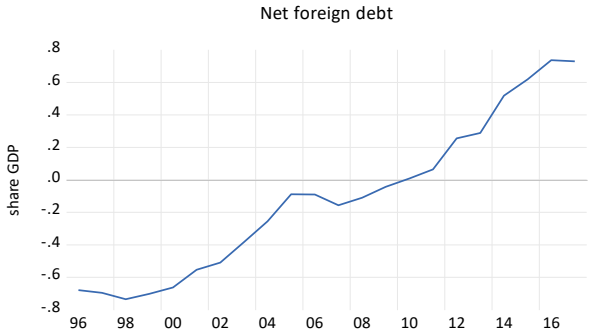
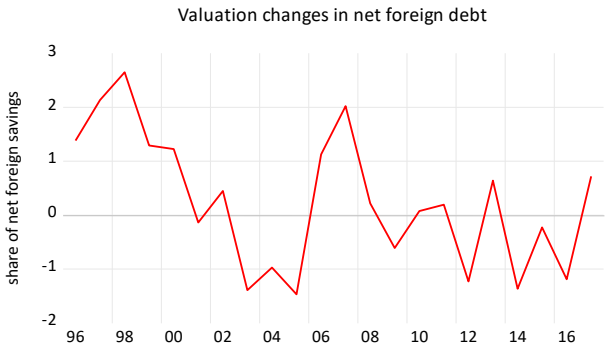


Figure 20



3.5 Pension Funds

We already discussed in section 3.1 that households hold large and increasing claims on pension finds – see Figure 3. The corresponding assets are presented in Figure 21. One observes that pension funds use the contributions of households to buy a small amount of government bonds, a moderate amount of participations and an increasing part of foreign equity. This investment behaviour can be explained from the development of asset prices presented in Figure 22. Simple estimation shows that the composition of assets can be explained by a portfolio model – see section A.5 in the appendix.

Figure 21

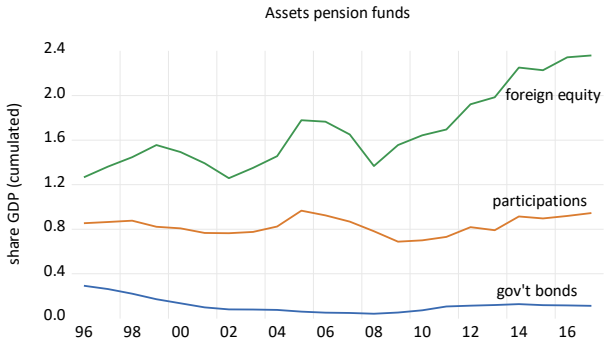
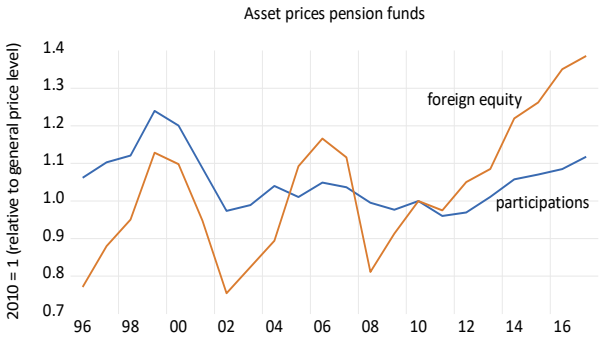


Figure 22



Pension claims increase due to ageing. But they also increase when the interest rate decreases, due to the discounted nature of claims – both aspects are elaborated in section A.5 of the appendix. A relevant observation is that while pension claims are financed by contributions provided by households, net of benefits, the claims have a tendency increase beyond these net contributions. We model this tendency by imputing a price on these claims, which reflects the extent to which claims are not supported by net contributions. As can be observed from Figure 23, this price has increased strongly over time, reflecting a systematic underestimation of both the ageing of the population and the decrease in the interest rate – see section A.5 of the appendix for details. The decrease of the interest rate on government bonds is presented in Figure 24 for illustration purposes.

Figure 23

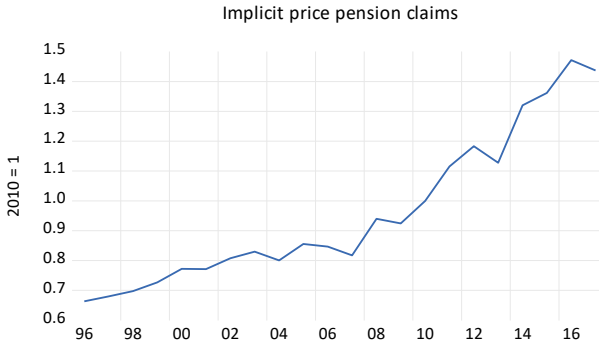
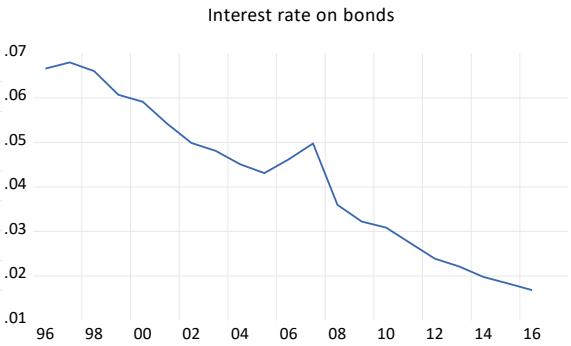


Figure 24



Because of these developments the reserve ratio of pension funds, presented in Figure 25, has fallen dramatically below its critical threshold of 120 per cent.[16] In that case pension funds must lower benefits and increase contributions in order to return to their target reserve ratio. This process explains the fluctuations in benefits and contributions shown in Figure 26. We model this process of adjustment of benefits and contributions – see section A.5 of the appendix. It is obvious that both lower benefits and higher contributions affect consumption negatively.

Figure 25

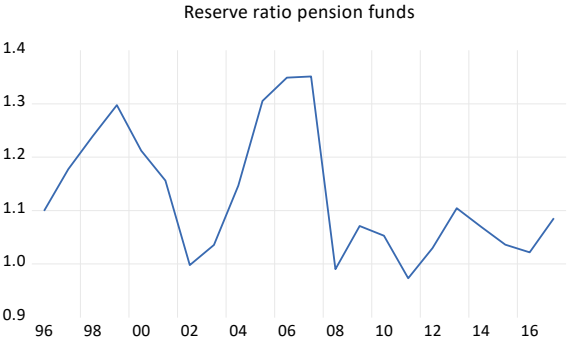
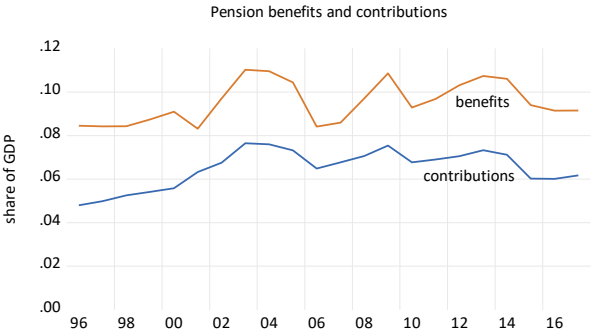


Figure 26



3.6 Banks and the Central Bank

As we discuss in MMS (2015) the presence of the ECB does not hinder the understanding of the Dutch situation by modelling a national central bank (DNB). We therefore start with a brief description of the Dutch Central Bank and then turn to the banks.

3.6.1 The Central Bank

Next to holding foreign reserves R, the Central Bank holds bills issued by the government B_{CB} and advances provided to banks A_{CB}, which include Target2 balances. Its liabilities are deposits held by banks M_{CB}. Since the revenues FC of the Central Bank are transferred to the government, the balance sheet of the Central Bank is closed without remaining net worth.

An important observation is that the Central Bank will always provide as much bills as demanded by the government, if other sectors do not buy these bills. Moreover, when it employs Quantitative

[16] The reserve ratio equals assets over liabilities of pension funds.

Easing operations, the central bank will buy additional bills from other sectors. We elaborate this in section 5 below and in section A6.2 of the appendix.

The Central Bank will also always accept as much deposits and provide as much advances as desired by domestic banks. It will try to influence this by setting the interest rates on advances and deposits. The success is mixed, as can be observed from Figures 27 and 28, respectively. We assume the interest rates to be exogenous in our model.

Figure 27

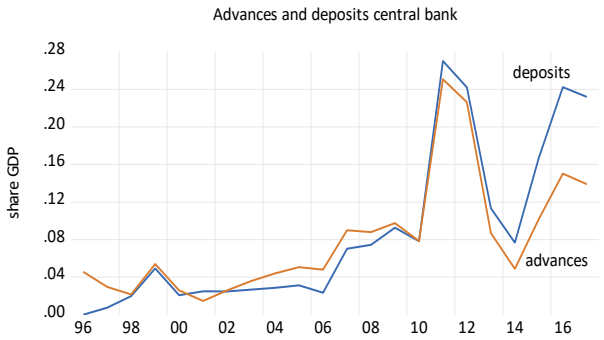
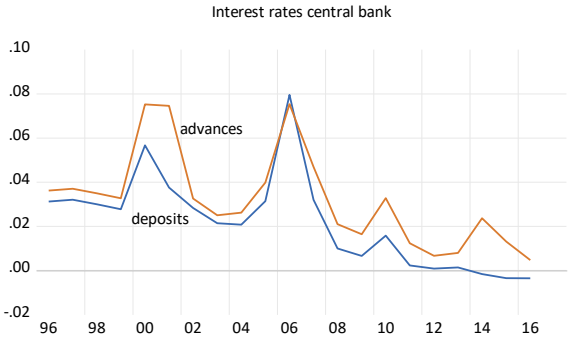


Figure 28



From Figure 27 we observe the huge increase in both advances (Target2 balances) and deposits in the Netherlands, following the Euro-crisis in 2011 – this is a result of the capital flight from the South to the North in the Euro Area as we discuss in MMS (2016). The next increase in deposits and less in advances (Target2 balances), follows the start of Quantitative easing in 2014 – see again MMS (2016) for a detailed discussion. The development of the deposit rate and rate on advances is presented in Figure 28. As is well known, the rate of deposits became negative in 2015.

3.6.2 Banks

We are still in the process of modelling the banking sector in a proper way. It is reasonable to assume that banks provide as many mortgages as demanded to households – and even actively encourage them to accept these mortgages (MMS, 2015).[17] We also assume that banks offer as many loans to firms as demanded.[18] For the moment being we assume the loans provided to the foreign sector to be exogenous. Bonds are assumed a fraction of outstanding domestic loans and deposits. Central bank deposits, net of advances, are a fraction of household deposits.

The development of the asset composition is presented in Figure 29. One observes that while loans to firms are a considerable part of total assets over time, the impact of mortgages did increase steadily till the collapse of the housing market – see also Figure 4. Moreover, the amount of loans to the foreign sector increased dramatically – we still must explain why this is the case.[19] Because of these developments the total assets of banks increased from 160 per cent of GDP in 1996 till 400 per cent of GDP in 2014 (Figure 30). This is a perfect example of the financialisation of the economy. Moreover,

[17] This is modelled by a special parameter in the mortgage equation of households – see equation (6) in the appendix and the discussion thereof.
[18] We therefore ignore the problem of credit rationing of small firms – see Bezemer and Muysken (2015) for a discussion.
[19] We used CBS data for banks, but used DNB data to exclude the SFIs (tax vehicles) which are present in the CBS data. Hence, the surge in foreign assets and liabilities is not due to the increased use of SFIs.

as Bezemer (2017) has forcefully argued, this tendency was accompanied by a strong relative decline in the "real" credit provision by banks as can be seen from Figure 31. The share of loans offered to in total bank assets declined from almost 70 per cent in 1996 to around 35 per cent in 2016.

Figure 29

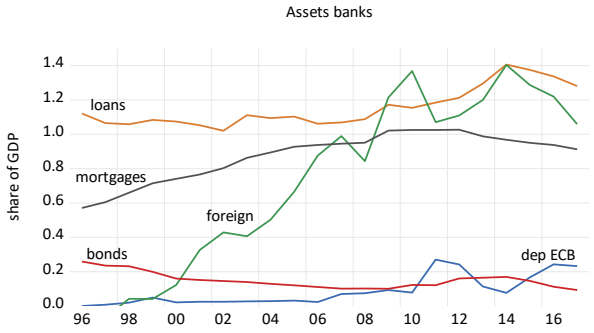
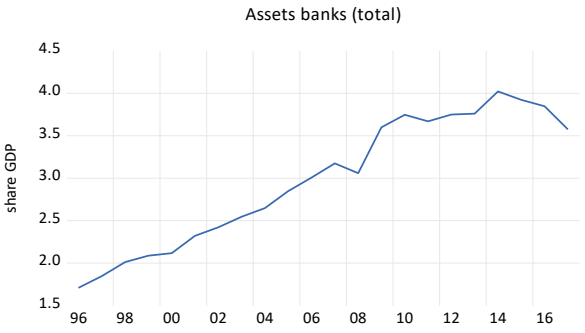


Figure 30



The liabilities of banks consist of deposits held by households, participations held by households pension funds – these are all stable over time relative to GDP. However, the liabilities of banks held by the foreign sector increased dramatically – from virtually no liabilities in the mid-1990s till over 200 per cent of GDP in 2014 (Figure 32). This resulted in an increase of the net foreign exposure of banks form zero in the mid-1990s till around 70 per cent of GDP in recent years (Figure 33).

Figure 31

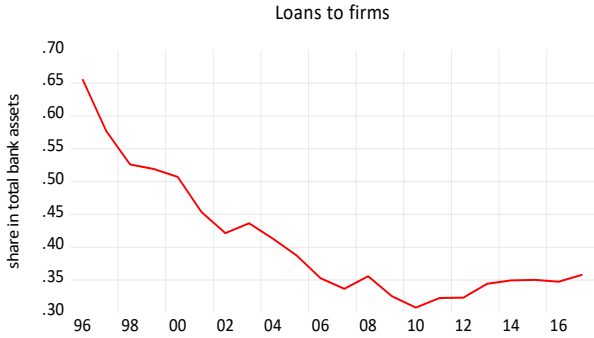
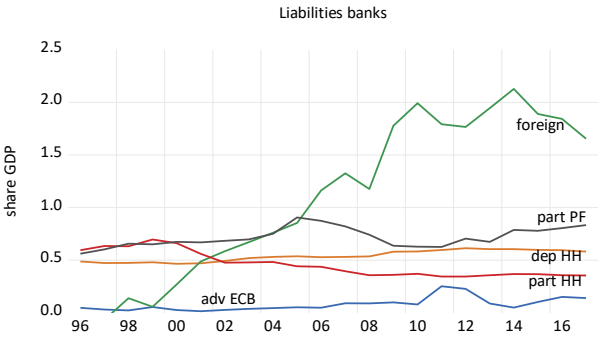


Figure 32



Around 2015 this was widely recognised as a serious problem in the Dutch debate, dubbed the 'deposit financing gap'. This referred to the phenomenon that deposits were considered as a secure way for banks to finance their outstanding loans and mortgages. Extending their sources beyond these positions, they would have to rely on highly volatile foreign liabilities which was considered very risky and therefore should be avoided (MMS, 2015). Surprisingly enough, this is no longer mentioned as problematic in the public debate, although the deposit financing gap hardly decreased (Figure 34).

Figure 33

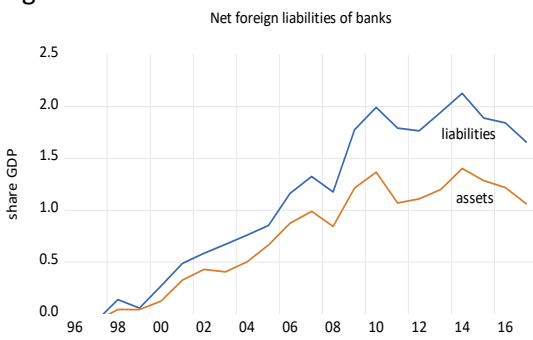
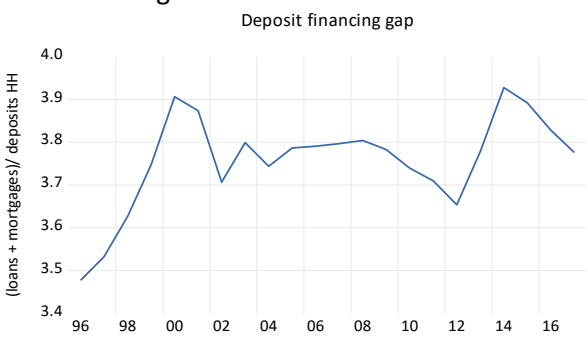


Figure 34



4. Calibration of the model and the base run

In this section, we present the calibration of the model, based on simple estimations, together with a base run.

4.1 Calibration of the model

Since our data cover a limited period, 1995 – 2017, and are on annual basis, it is hard to find reliable estimation results for the model. Moreover, the adverse developments, which occurred during this period – the dot-com bubble, the financial crisis, the Euro-crisis and Quantitative Easing complicate the estimation of the model.

The model is estimated using data from 1995 until (and including) 2017, the within-sample period. The estimated endogenous equations are described in the appendix, and in the calibration we employ the parameter values as estimated. The other parameters are based on actual data in the within-sample period. As initial values, we take actual data as starting values in 1995-1997, depending on the number of lags in the model. We present the results of the calibration together with the base run below.[20]

4.2 The base run

The base run simulation runs from 1998 until 2030. We present both a within-sample simulation (calibration) and an out-of-sample simulation.[21] As we mentioned above, the parameters that are not estimated are based on actual data in the within-sample period for the calibration. For out-of-sample simulations we set these parameters either to the last within-sample value or to the average value of the entire sample period. As initial values, we take actual data as starting values in 1995-1997, depending on the number of lags in the model.

For out-of-sample simulations, we employ an export growth rate of 1%, labour productivity growth of 0.5% and a similar growth of the wage rate. The latter implies that, given a constant mark up, prices are constant. Also growth rate of government expenditures is set to 1% for out-of-sample simulations. Growth of houses (roof count) is also set to 1%, as well as growth of consumption of fixed capital by government D_g ,government investment I_g and dividends paid by foreign sector (*Fapf*). The development of capital stock of the government follows directly from these numbers. All corrections made to balance sheets and incomes as explained above, i.e. y_{corr} and s_{corr} mentioned in section 2.2, are set to zero in the out-of-sample period.

For Advances *Av* and depreciation rates of fixed capital and of houses we take the sample average as value for the out-of-sample periods.

Prices of participations *pa*, foreign direct investment pe_{fa} and of equity abroad pe_{apf} and pe_{af} all follow the GDP price level. This implies that these price levels are constant in the base run.

Interest rates follow actual (calculated) data during the in-sample simulation and are set to their last observed value for out-of-sample simulations, except nominal returns of equity re_{fa} and re_{af}, which are

[20] The first three years are missing due to various lags in the model.
[21] The first three years are missing due to various lags in the model.

set to their sample averages. For all other parameters, we take the value they have at the last year within the data sample.

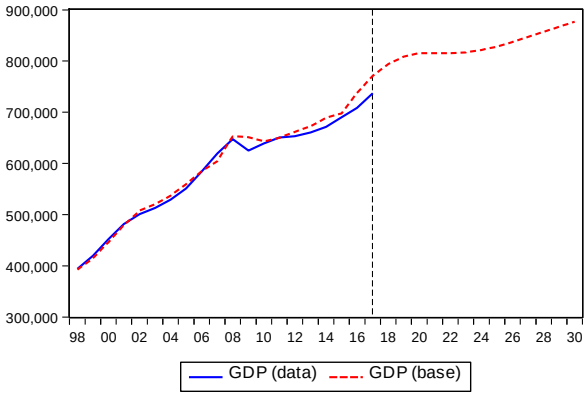
The adverse developments during the period for which we have data available do not only complicate the estimation of the model. They also have a strong impact on the base run. While in earlier versions we calibrated the model to mimic a steady state growth during a period of at least one 100 years, it is obvious that this is impossible using the estimated version of the model. The parameter values are characterised by a trade surplus and surplus on the current account of about 10 per cent, increasing foreign exposure of all sectors, a small government budget surplus and decreasing government debt. The corresponding path of the economy over time cannot persist very long. We therefore simulate the base run until 2030.

Nonetheless, we encountered one problem, which we solved ad hoc. Initial results showed that government deficit was decreasing rather fast in the out-of-sample period whereas firm's net wealth increased, and household wealth showed a decreasing trend. Therefore, we adjusted the exogenous direct tax rate and tax rate on profits in the out-of-sample simulations.[22]

4.3 The calibration results and the results for the base run

GDP as simulated follows actual GDP fairly well in the in-sample period. After the financial crisis, we see a slight overestimation of GDP. After some small initial adjustments, also due to changes in the taxes rates, the growth rate of GDP adjusts quickly to 1% in the out-of-sample period (Figure 1).

Fig 1, GDP



The various components of GDP are presented in Figures 2a and 2b. One observes that these follow the actual data rather well, though it should be noted that exports are exogenous and imports are based on an exogenous fraction of GDP.

[22] The rate of direct taxes is set 14% (the average in actual data is 17%) and the tax rate on profits is also set 14% (average is 9%).

Fig 2a, GDP components
(as % of GDP)

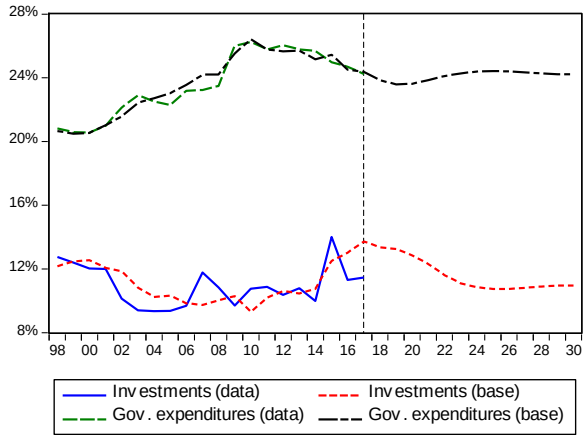
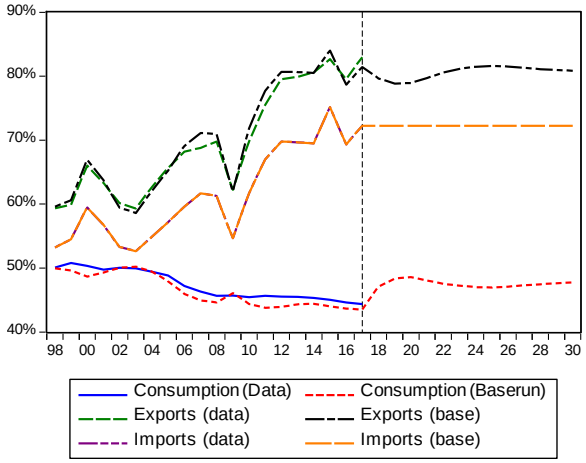


Fig 2b, GDP components
(as% of GDP)



The net household wealth to GDP ratio (Figure 3) is underestimated at the end of the in-sample simulation period and remains roughly constant afterwards. Deposits and bank participations of households (Figure 4) as result of portfolio decisions by households follow the actual data fairly well, whereas especially deposits seem to fluctuate anti-cyclical. We see a large drop in deposits and participations around 2020. This is due to an adjustment of the claims to the pension funds, which causes pension fund contribution and benefits rates to be adjusted over time. This needs further attention in the future.

Fig 3, Net Wealth Households
(to GDP ratio)

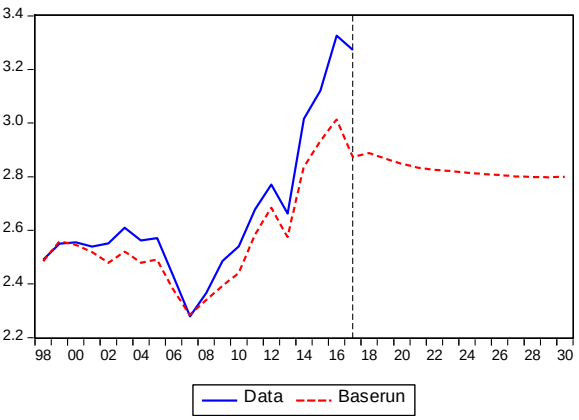
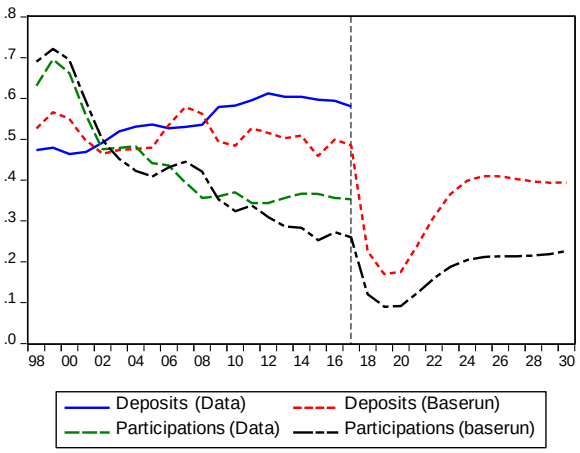


Fig 4, Deposits and Participations Households
(to GDP ratio)



Net wealth of firms (Figure 5) follows the actual data fairly well – note that the wage rate, tax rates and interest rates are exogenous and based on actual data. The out-of-sample simulation of firms' wealth shows a steady decrease. In line with that development, liabilities of firms decrease in the out-of-sample simulation (Figure 6).

Fig 5, Net Wealth Firms (to GDP ratio)

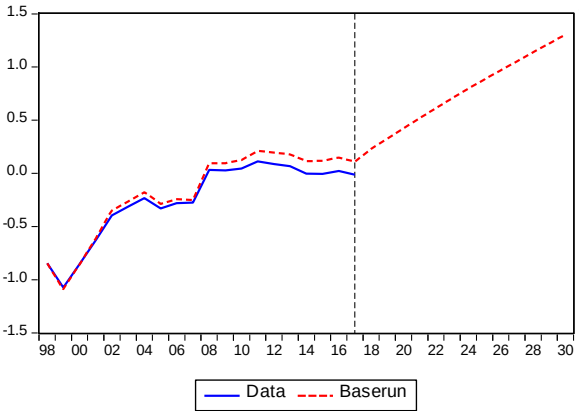
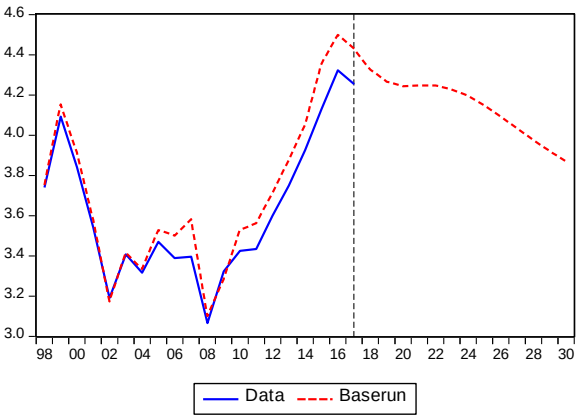


Fig 6, Total Liabilities Firms (to GDP ratio)



It is not surprising that since interest rates are determined exogenously, bank wealth (Figure 7) and pension fund net wealth (Figure 8) follow the actual data fairly well, whereas bank wealth shows an increase in the out-of-sample period. Nominal claims of households on pension funds (Figure 9) are slightly lower in the model compared to the actual data. As we mentioned above, the claims to pension funds by households need to be scrutinised more closely.

Fig 7, Net Wealth Commercial Banks (to GDP ratio)

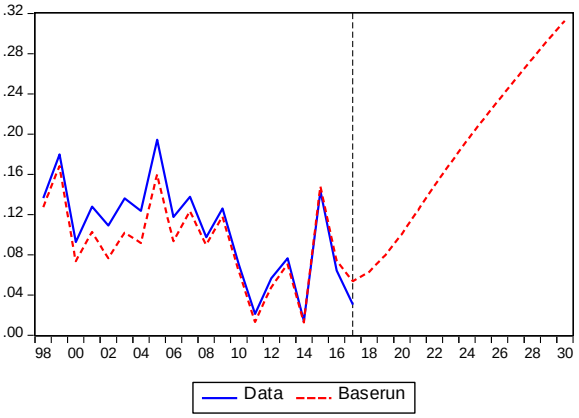


Fig 8, Net Wealth Pension funds (to GDP ratio)

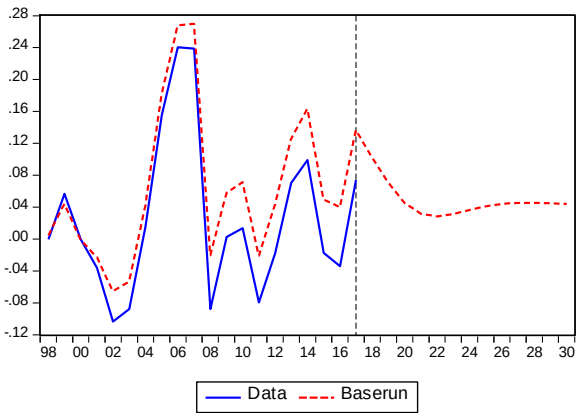
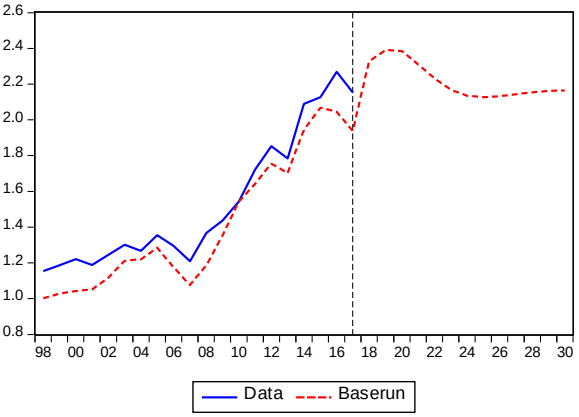


Fig 9, Nominal Claims Pension funds (to GDP ratio)



Government Deficit (Figure 11) increased sharply after the financial crisis and decreased toward a budget surplus in most recent years. Out-of-sample simulation shows an initial continuation of this situation and thus a further decrease in the government debt ratio, which is stabilizing rather quickly afterwards (Figure 12).

Fig 11, Government Deficit ratio

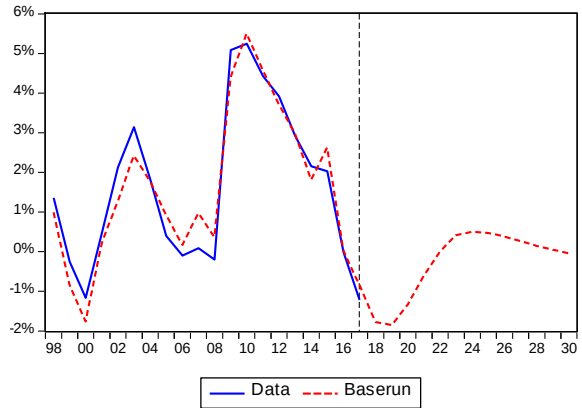
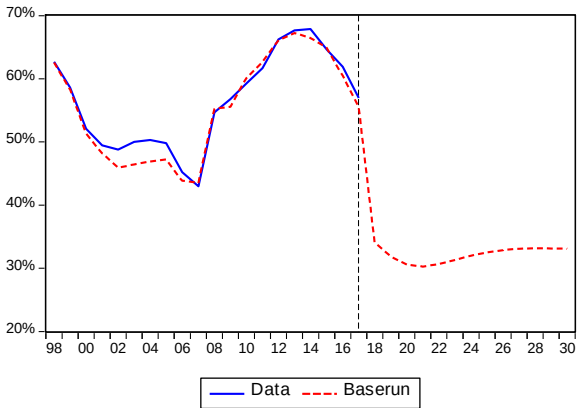
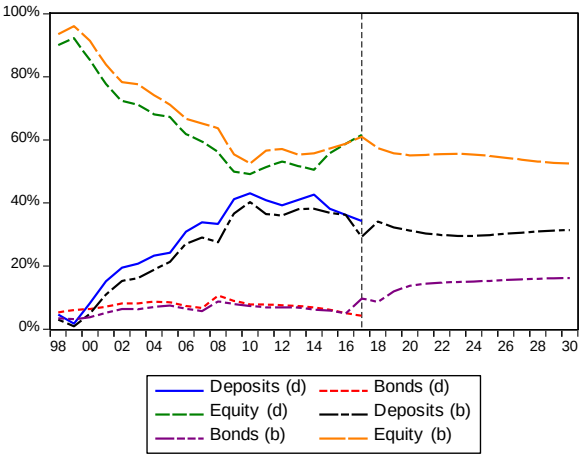


Fig 12, Government Debt ratio



Finally Figure 13 shows the portfolio distribution of the foreign sector. The out-of-sample distribution does not deviate strongly from the actual data, though the foreign sector invests more in bonds compared to the data.

Fig 13, Asset distribution of Foreign Sector (data (d) versus baserun (b)



Although some questions remain, the base run is interesting enough to use as a back ground for simulation experiments. These will presented in the next section.

5. Simulation results <to be completed>

For all scenarios we keep the nominal values of exports exogenous and equal to the base run. We also keep the total wage sum that is used to calculate future commitments of the pension funds equal to the wage sum in the base run.

In all scenarios, we give an shock in 2019 and a reverse shock in 2029.

We discuss below three scenarios:

(a) decreasing the interest rates
(b) quantitative easing
(c) increasing government expenditures

We still have to develop scenarios for an increase in exports and firms buying their own equity.

5.1 Decreasing the interest rates

We analyse the impact of first a simultaneous decrease in interest rates on household deposits and on Central Bank deposits, next a decrease in the mortgage rate and finally a decrease in the rate of loans provided by banks to firms. Note that we do not change the discount rate of future pension claims, which would have strong effects through the pension funds portfolio.

Scenario a1: a decrease in both interest rates on household deposits (r_m) and on Central Bank deposits (r_{cb}) by 0.5%, i.e. 50 basis points.

Fig 5.1.a, GDP components

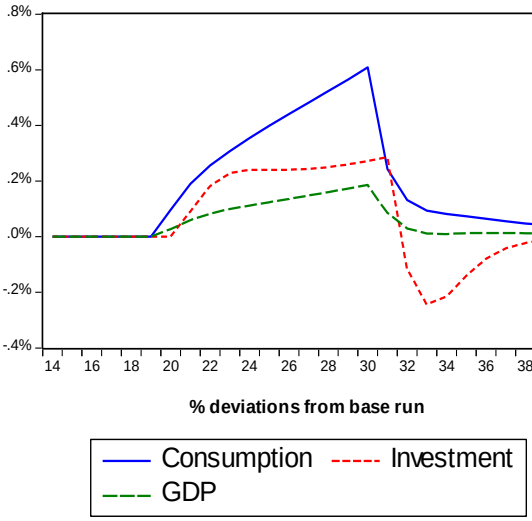
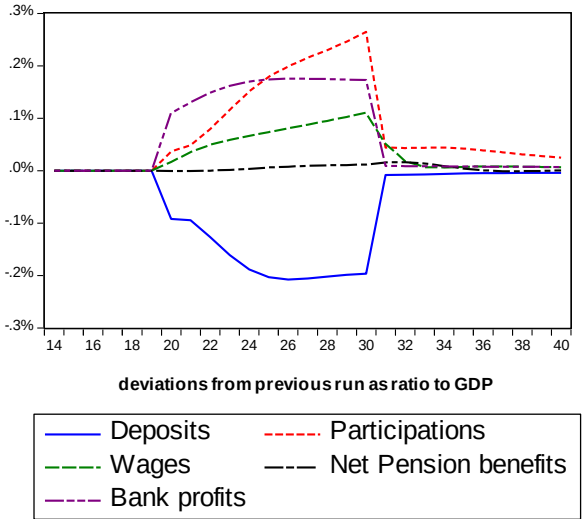


Fig 5.1.b, Income components households



Income from deposits obviously decrease. However, households also shift their portfolio to more participations instead of deposits. This decreases income from deposits even further, but income from participations increases (see Figure 5.1.b). Bank profits increase and are directly transferred to households. This all leads to a slight increase in consumption (Figure 5.1.a) and GDP, followed by a delayed increase in investment due to increase capacity utilisation.

Scenario a2: additionally, we also decrease the interest on mortgages (r_{mo}) by 50 basis points.

Following the discussion in section 3.1, a decrease the interest on mortgages has a positive effect on prices of houses (Figure 5.2.b). Since the nominal value of mortgages depends on the nominal value of houses, we also observe a (small) increase in mortgages. The resulting increase of housing value relative to mortgages has a positive impulse on consumption. As before, investments then increase one year delayed and GDP increases too (Figure 5.2.a).

However, we observe from Figure 5.2.a that after the initial positive impulse, consumption starts to decrease. The reason is that disposable income decreases because of declining bank profits. Since the total value of mortgages is about equal to GDP in the Netherlands, decreasing the mortgage rate by 50 basis points decreases income of banks by about 0.5% of GDP.

Fig 5.2.a, GDP components

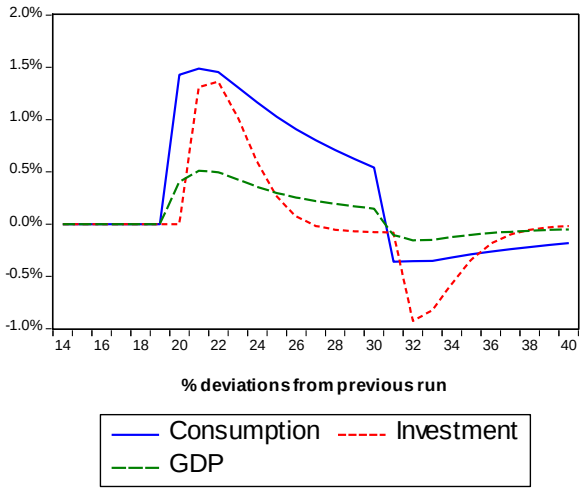


Fig 5.2.b, Households

Because the composition of wealth of households changes due to increased housing value, other assets have to be adjusted. From Figure 5.2d we observe a decrease in deposits and a decrease in household participations at banks. The decrease in participations is much stronger, since according to our estimation results the portfolio of households shows a much stronger adjustment in participations than in deposits – see also equation (2) in the Appendix. The bank do not adjust the composition of their assets strongly except for their position at the central bank, which is used to deposit remaining assets. (Figure 5.2.c)

Fig 5.2.c, Asset side of Bank Balance Sheet

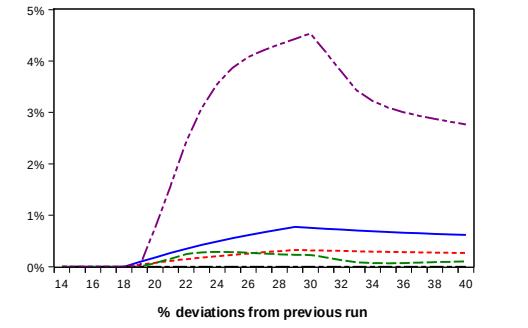
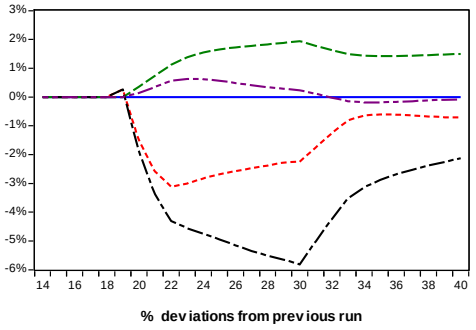


Fig 5.2.d, Liability side of Bank Balance Sheet



Scenario a3: Additionally, a decrease in the interest rate of bank loans by firms (r_l), also by 50 basis points.

Contrary to the impact of the mortgage rate, a decrease in the interest rate of bank loans to firms has almost no effect on GDP as can be seen in Figure 5.3.a. As expected, the decreased interest rate on loans has an immediate positive impact on investment by firms. One observes from Figure 5.3.c that profits increase and hence the dividends paid on equity issued abroad.

Fig 5.3.a, GDP components

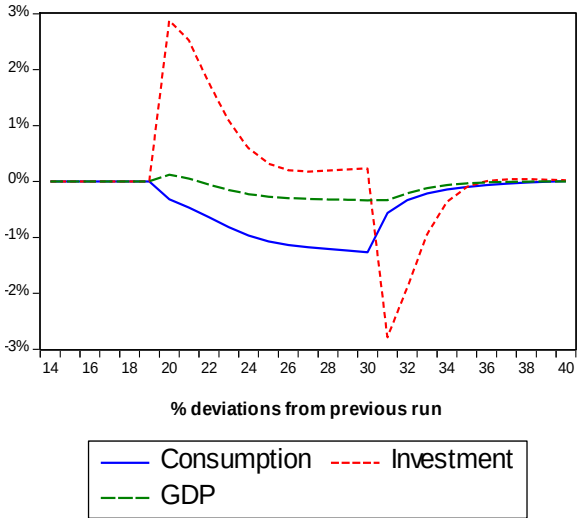
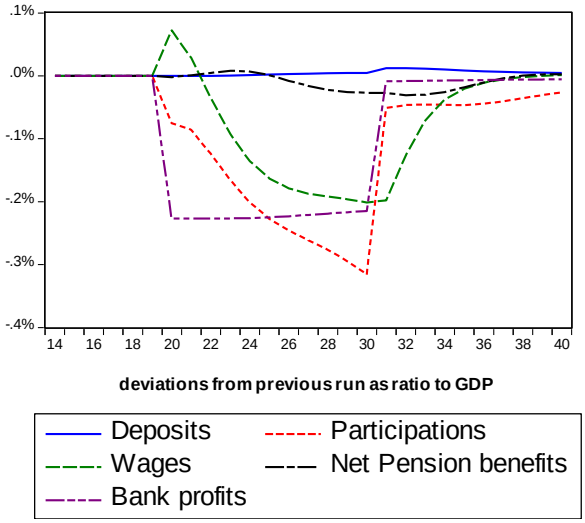
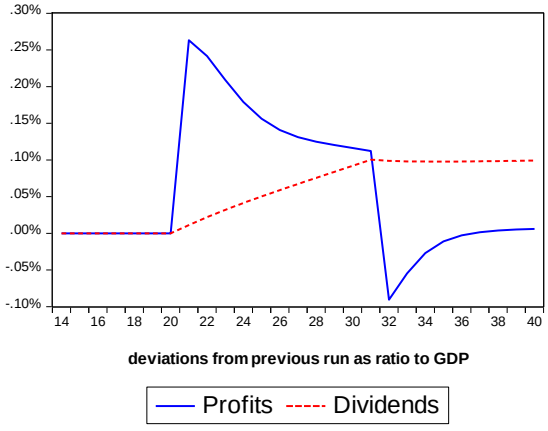


Fig 5.3.b, Income components households



However, the impact on consumption by households is negative because of decreased bank profits, which are (as noted before) directly transferred to households (Figure 5.3.b). Hence, an initial positive effect on GDP is cancelled out by decreased household incomes. This has a negative impact on investment and on firm's profits (Figures 5.3.b and 5.3.c, respectively).

Fig 5.3.c, Income components firms



Scenarios a1 – a3 taken together.

If we compare the outcomes of all three scenarios combined with the base run, we observe a strong initial increase in investment together with an increase in consumption (Figure 5.4a). GDP does not follow accordingly because exports are assumed to remain constant, while imports increase.

Fig 5.4.a, GDP components

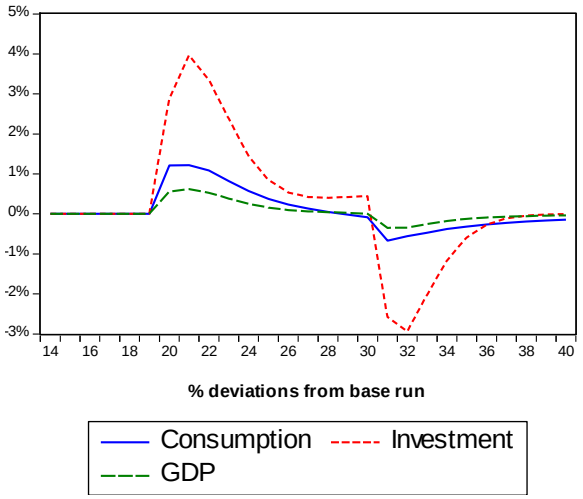
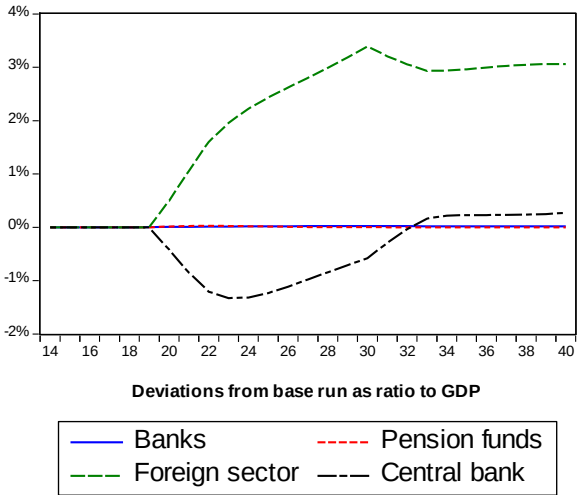


Fig 5.4.c, Changes in government bonds



Government debt increases somewhat, and the majority of additional bonds issued is bought by the foreign sector, which has a strong preference for Dutch government bonds. Initially the foreign sector reacts to the decreased deposit rate by buying bonds from the central bank to adjust its portfolio.

All in all the impact of a decrease in interest rates on the real sector is very moderate. The main adjustments are in the financial sphere, as can be observed form Figures 5.2.b – 5.2.d and Figure 5.4.c above.

5.2 Quantitative Easing

In this scenario we start from the base run and we give a shock by lowering the interest rate on government bonds by 50 basis points. Thereby we mimic the effects of QE as we explain in section A.6.2 of the Appendix.

Fig 5.5.c, Changes in government bonds

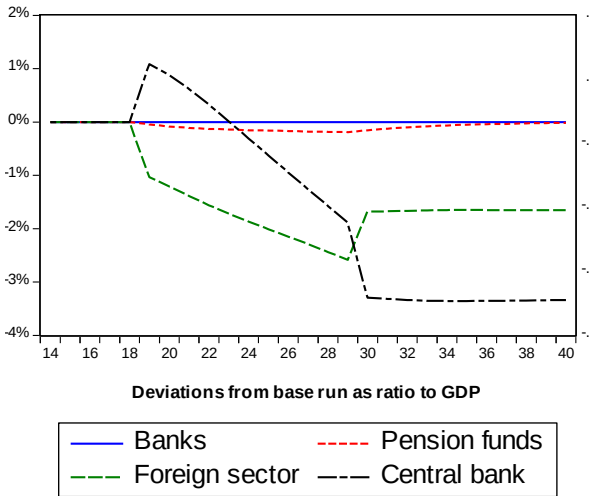
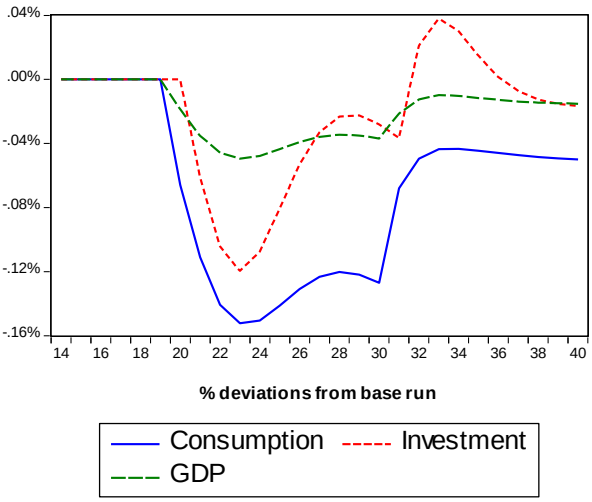


Fig 5.5.a, GDP components



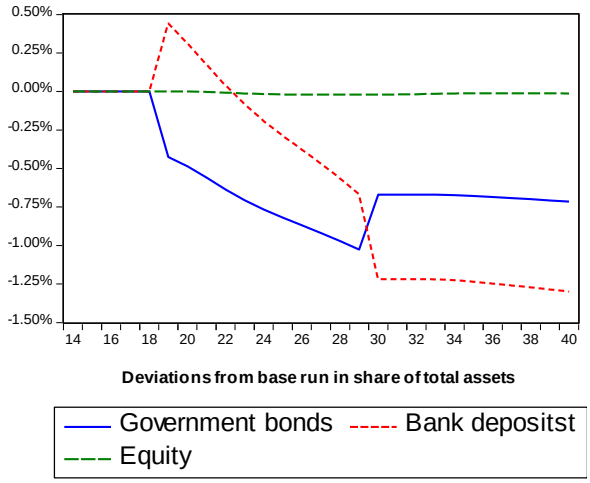
The changes in interest rate induce the central bank to buy government bonds as other parties want to get rid of these. This is the desired effect of QE. However, what we observe from our estimation

results and calibration of the model is that the decreased interest rate causes the foreign sector to invest less in bonds. We see that the foreign sector initially increases bank deposits and that their position in equity is not affected. Figure 5.5.c shows that government bonds indeed are bought by the central bank, as we have in QE. Hence, this scenario is in line with the development we observe from the actual data. Central bank increases its position in government bonds, the foreign sector sells these bonds and places the net worth as deposits at Dutch commercial banks

These transactions have a negative effect on consumption, a negative effect on GDP and therefore a negative effect on investment, cf. Figure 5.5.a (Note that this effect is very small). The negative effect on consumption is triggered by decreased disposable income, which is triggered by decreased profits of banks because income related to government bonds decreases. Note that banks hold government bonds in a fixed proportion to loans plus mortgages, so the portfolio of banks does not change due to a decreased interest on government bonds.

The foreign sector experiences two more effects. The first is that income related to their assets is reduced in the same way as the income of domestic banks on government bonds. This leads to a slow but steady decrease of total assets of foreign sector to about -1% in 2030 as compared to the base run. Secondly, the share of government bonds in total assets is about 15%, the share of deposits about 30% and the remaining 55% is held in equity. This implies that the changes in government bonds (relative to its own position in the portfolio) has only a small effect on the relative change in equity (Figure 5.5.b).

Fig 5.5.b, Assets held by foreign sector



5.3 Increased government expenditures

We now analyse the impact of an increase (exogenous) government expenditures by 0.5% points – for simplicity in addition to the QE scenario presented in the previous section. As expected, this increases GDP, consumption and investments as is displayed in Figure 5.6.a – although the effect is small.

Comparing the combined QE scenario and increased government expenditures with the base run, we see that the combined effect is still positive on consumption, GDP and investment.

Fig 5.6.a, GDP components

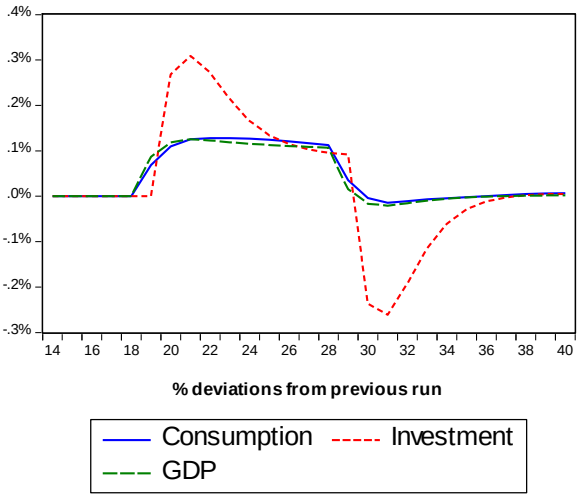


Fig 5.7.a, GDP components

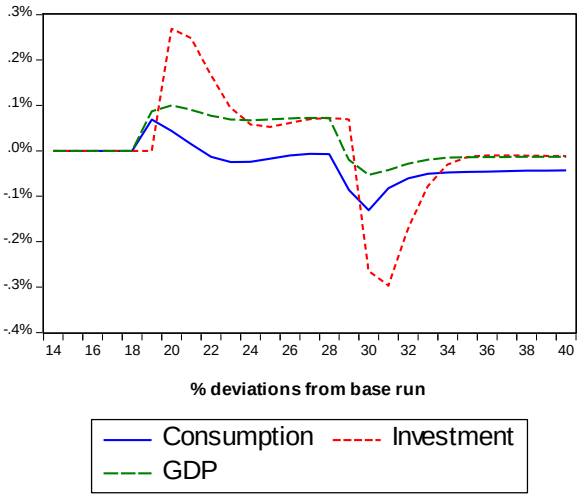
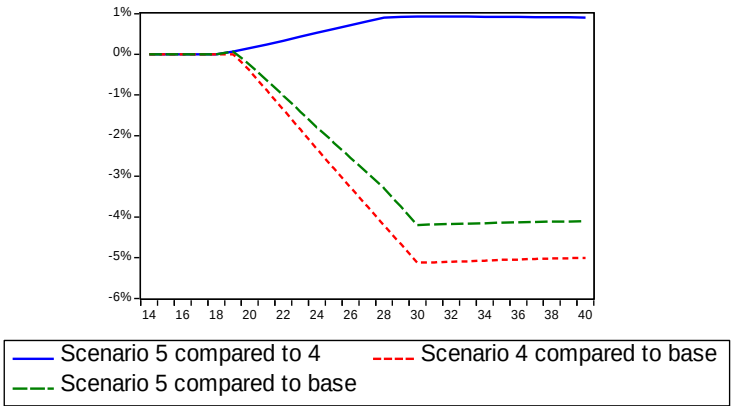


Figure 5.7.d shows that increased government expenditures lead to a modest increase of the government debt ratio when government expenditures are increased – scenario (c) against scenario (b).[23] In case of decreased interest rate on government bonds we see that also the debt ratio decreases (as compared to the base run). The combined overall effect shows indeed that the debt ratio decreases.

Fig 5.7.d, Changes in government debt ratio



[23] Scenario 4 in the Figure is our scenario (b) Quantitative Easing; scenario 5 is our scenario (c) increase in government expenditures.

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Appendix A detailed description of the model

In this appendix we present a detailed overview of the model used in our analysis. Many elements have already been presented in MMS (2015, 2016). However, new elements are the extension of the financial sector with a pension system with large foreign investments and the elaboration of the banking sector, including the operations of the Central Bank. Both elements contribute considerably to a proper understanding of the impact of globalisation and financialisation on the Dutch economy. We present the model subsequently for households, firms, government, the foreign sector, the pension funds and the banking sector, including the central bank. For each sector a balance sheet is presented and at the end of this appendix we present the overall balance sheet for the economy, the social accounting matrix and a table summarising the accumulation of savings and the way these are invested.

A.1 *Households*

The introduction of pension wealth as an extension to our earlier models has important consequences for consumption and savings behaviour of households, as we discuss below. Pension wealth of households consists of the claims on pension funds.

Each year the pension fund pays out benefits PF_b to households and receives contributions PF_c. However, in the analysis we focus on the net contributions by households only, i.e. $PF_c - PF_b$. These contributions constitute part of the claims by households on pension funds. The other part of the claims follows from discounted future obligations. As we elaborate in section 1.5 below, this inclusion of future obligations motivates us to distinguish between a real value of pension claims C_{pf}, and its implicit price p'_{pf}. That is, $p'_{pf}C_{pf}$ represents the nominal value of claims, valued at an implicit price p'_{pf}. These claims do not affect the wealth effect on consumption, although they affect savings behaviour as we discuss below.

A.1.1 *Wealth of households*

The composition of housing wealth is summarised in the balance sheet in Table 1. Household wealth consists of financial wealth, pension wealth and housing wealth, net of mortgages. Financial wealth consists of deposits M_h and participations at banks $p_a.A_h$. Pension wealth consists of the claims on pension funds $p'_{pf}C_{pf}$ and is discussed in section 4.5 below. Finally, we assume that with respect to the portfolio of wealth, housing wealth is determined separately from financial wealth.

Table 1 Balance sheet of the household sector

ASSETS		**LIABILITIES**	
Bank deposits	M_h	Mortgages	MO
Participations	$p_a.A_h$		
Pension claims	$p'_{cf}.C_{pf}$		
Houses	$p_h.HS$		
		Total (net worth)	V_h

The distribution of financial wealth over bank deposits and participations follow a Tobin type of model, implied by relative returns on assets. This implies that household financial wealth VN_h, net of housing minus mortgages and net of claims on pension funds:

$$VN_h = V_h - (p_h.HS - MO) - p'_{cf}.C_{pf} = M_h + p_a.A_h \quad (1)$$

is distributed over financial assets as follows:

$$M_h / VN_h = \lambda_{10} M_{h-1} / VN_{h-1} + \lambda_{11} + \lambda_{12} r^e_M - \lambda_{12}.r^e_{Ah} \quad (2)$$

$$p_a.A_h = VN_h - M_h \quad (3)$$

The variables r^e_{Ah} and r^e_M are the expected returns for participations and deposits, respectively. The return on deposits is the real interest rate, whereas the return on participations is the real interest rate including price changes of participations. The price of participations p_a is exogenous whereas the interest rate r_{Ah} isn't. Expected values of variables follow an adaptive expectations mechanism:

$$X^e = X_{-1} + \xi.(X_{-1}^e - X_{-1}) \quad (4)$$

A simple estimation for the Netherlands shows that the interest rate of deposits is not significant. We therefore left that out ($\lambda_{12} = 0$). Note that equation (2) also includes a trend term, an element that we clearly identify in the data. For out-of-sample simulations we set this trend term to zero.

In order to include housing and mortgages in the model, we assume that when banks and households decide on a loan for buying a house, the affordability of the household determines the maximum loan the bank is willing to provide, as modeled in Madsen (2012). As we argue in MMS (2015) this implies that the growth rate of the house price p_h follows from:

$$\Delta \ln p_{ht} = \alpha_0 + \alpha_1 \Delta \ln Y_t^h + (1-\alpha_1)\Delta \ln Y_t^e - \alpha_2 \Delta \ln[i_{MO}(1-\tau_h \tau_{MO}) + f_{MO}] - \alpha_3 \Delta \ln HS_t \quad (5)$$

where Y_t^h is disposable income (not net of mortgage payments) and Y_t^e is expected income for next year. The term between square brackets refers to the user cost of (housing) capital and includes the interest rate on mortgages i_{MO}, corrected for the fraction that is deductible for income tax, and the mortgage repayment rate f_{MO}. The fraction that is deductible from income tax is given by the income tax rate τ_h times the fraction of mortgage interest payments that is deductible τ_{MO}. The final term in the above equation refers to the number of houses on the market, *HS*. We assume housing supply *HS* to be given – growing at an exogenous rate – due to the highly regulated housing market in the Netherlands. As we explain in MMS (2015), the parameter in the equation α_0 represents the affordability of households, i.e. the total amount of housing costs that the household can spend (as perceived by banks), relative to its disposable income. The housing bubble was caused by an increase of α_0 and in reaction to overstretching their balances banks have decreased α_0.

In line with the affordability assumption above we assume with respect to the demand for mortgages *MO* by households that demand for mortgages is a fixed proportion φ of the housing value, while supply of mortgages by banks is accommodating. Hence:

$$\Delta MO = \varphi_1.p_h.\Delta HS - morc.MO_{-1} \quad (6)$$

where *morc* is the share of mortgage repayments.

Simple estimation of equations (5) and (6) yields significant results.

Finally, the increase in housing net of depreciation represents the net investment of households as presented in the national accounts. It should be included in the production of firms, which appears in the capital balance of the social accounting matrix – see Table 7B below.

A.1.2 *Consumption and savings*

Household income consists of wages *W*, bonuses received from banks F_b,[24] returns to financial assets, $i_M.M_h + i_a.p_a.A_h$, and net benefits, $PF_b - PF_c$, received from pension funds:

$$Y_h = W + F_b + PF_b - PF_c + i_{M,-1}.M_{h,-1} + i_a.\ p_{a,-1}.A_{h,-1} \quad (7)$$

Taxes are net of mortgage interest payments – this feature plays an important role in explaining the high incidence of mortgages in the Netherlands:

$$Td = \tau_h.(Y_h - \tau_{MO}.i_{MO,-1}.MO_{-1}) \quad (8)$$

where τ_h is the tax rate on income and τ_{MO} is the tax reduction on interest payments.

The disposable income of households is defined by deducting taxes paid by households *Td*, net contributions to the pension fund and interest payments on mortgages from household income Y_h:

$$Y_{hd} = Y_h - Td - i_{MO,-1}.MO_{-1} - [PF_c - PF_b] \quad (9)$$

We assume that households' real consumption depends on real disposable income, the opening stock of wealth V_h and on expected capital gains.[25] Moreover, we assume the stock of housing to have a different impact on consumption compared to financial wealth, due to its differences in liquidity. Simple estimation for the Netherlands revealed that expected capital gains did not affect consumption. Moreover, the wealth effect was mainly through housing. Therefore, the consumption function is:

$$C/p = \alpha_1.\ Y_{hd}/p + \alpha_2.(p_h.HS - MO)/p + \alpha_3. \quad (10)$$

Net household savings are defined as the disposable income of households *Yhd* minus consumption *C* and depreciation $\delta_h.HS_{-1}$:

$$S_h = Y_{hd} - C - \delta_h.\ p_{h,-1}HS_{-1} \quad (11)$$

or

$$S_h = W + F_b + i_{M,-1}.M_{h,-1} + i_a.\ p_{a,-1}.A_{h,-1} - p.C - \delta_h.\ p_{h,-1}HS_{-1} + [PF_b - PF_c] \quad (12)$$

The net savings in equation (12) follow by substituting equation (7) in (11). The resulting equation illustrates that savings consist of a voluntary part – the right-hand side of (12) without the term between brackets – and net contributions to the pension fund. The latter constitute the compulsory part of net savings, since pension contributions are mandatory and cannot be used for consumption.

[24] We assume that bank's profits F_b are distributed to households as bonuses.

[25] Here we exclude pension claims from household wealth, since they do not affect consumption – see also CPB (2010).

This is a relevant distinction since recently in the Netherlands aggregate savings were positive, while voluntary savings were negative as we discussed above.

Finally, the change in household wealth V_h follows from:

$$\Delta V_h = S_h + A_{h,-1}.\Delta pa + HS_{-1}.\Delta p_h + C_{pf,-1}.\Delta p'_{cf} \quad (13)$$

The second and third terms on the right-hand side follow from valuation changes in financial assets and houses, respectively. Moreover, since claims to pension funds are included in the household wealth, we should take their valuation changes also into account – see the last term on the right-hand side of equation (12).

A.2 *Firms*

We combine elements of MMS (2015) and (2016) in modelling both firm behaviour and wage and price setting – in MMS (2016) we allow firms to invest retained profits in foreign assets, which is also an important element in the present analysis.

A.2.1 *Wealth of firms*

The assets of firms consist of capital stock ($p_k.K$) and financial assets ($pe_{af}.E_{af}$) following from direct investments abroad. Liabilities consist of loans at banks (L) and equity issued abroad ($pe_{fa}.E_{fa}$), following from foreign direct investments in the Netherlands. This constitutes the balance sheet of firms presented in Table 2. The net worth of firms is V_f.

Table 2 Balance sheet of firms

ASSETS		**LIABILITIES**	
Capital	$p_k.K$	Loans	L
Equity acquired	$pe_{af}.E_{af}$	Equity issued	$pe_{fa}.E_{fa}$
		Total (net worth)	V_f

A.2.2 *Firm behaviour and wage and price formation*

Retained earnings follow from profits. Profits from production F_f result by deducting the wage bill W, indirect taxes $T_i = \tau_i.Y$ and other gross operating surpluses from nominal GDP (Y). The other surpluses are bank profits F_b, distributed to households as bonuses, and depreciation of government D_g, which constitutes the operating surplus of government for statistical reasons. Hence:

$$F_f = Y - W - T_i - F_b - D_g \quad (14)$$

Price p, net of indirect taxes τ_i, is set as a mark-up m on unit labour cost.[26] Unit labour cost are defined as nominal wages w times the exogenous labour-output ratio a. Hence:

$$p.(1 - \tau_i) = [1 + m].w.a \quad (15)$$

Given the labour-output ratio, employment N follows from $N = a.(Y/p)$, where (Y/p) represents real output. The wage bill then follows from:

$$W = w.N \quad (16)$$

Nominal wages are exogenous.[27]

When calculating total income of firms Y_f, we should include the returns on foreign assets $pe_{af}.E_{af}$, next to profits from production F_f. The rate of return on foreign assets re_{af} is exogenous. Hence:

$$Y_f = F_f + re_{af,-1}.\ pe_{af,-1}.E_{af,-1} \quad (17)$$

Direct taxes on firms are proportional to its total income (gross profits):

$$Td_f = \tau_f.Y_f \quad (18)$$

Net profits F_{fn} then are defined as total income of firms minus taxes Td_f, interest payments on loans $i_L.L$ and depreciation $p_k.\delta_k.K$:

$$F_{fn} = Y_f - Td_f - i_{L,-1}.L_{-1} - p_{k,-1}.\delta_k.K_{-1} \quad (19)$$

A fixed proportion $(1 - \phi_1)$ of the net profits is kept as retained earnings, FU, and the remaining part is paid out as dividend payments. Hence:

$$re_{fa,-1}.\ pe_{fa,-1}.E_{fa,-1} = \phi_1.\ F_{fn} \quad (20)$$

and retained earnings are given by:

$$F_{f,ret} = F_{fn} - re_{fa,-1}.\ pe_{fa,-1}.E_{fa,-1} \quad (21)$$

The retained earnings $F_{f,ret}$ also constitute firm's savings S_f. They are invested in both the capital stock and used to buy foreign assets, which we define here as equity abroad bought by firms $pe_{af}.E_{af}$.

The amount of foreign assets bought is a fixed proportion ϕ_2 of these savings:

$$\Delta(E_{af}) = \phi_2.S_f\ /\ pe_{af} \quad (21a)$$

Where the price of these assets pe_{af} is exogenous.

[26] Hein (2012) assumes a positive impact of the rate of return on equity ρ on the mark-up, i.e. $m'(\rho) > 0$ – we leave this out for simplicity.

[27] We ignore in this version of the model the determination of unemployment and its potential interaction with wage determination and social security expenditures. That is left for further research.

A.2.3 *Investment behaviour*

From simple estimation on Dutch data, we find that investment is determined by three variables – see also Hein (2012). First by the utilization rate, *u*, with normal utilization defined at *u**:

$$u = (Y/p)/(\kappa.K) \tag{22}$$

The second determinant is Tobin's q:

$$q = (L + pe_{fa}.E_{fa}) /(p_{k,-1}.K_{-1}) \tag{23}$$

The third determinant of investment is the interest payments on the leverage ratio, *lev*:

$$lev = L/(p_{k,-1}.K_{-1}) \tag{24}$$

We then find for the growth of the capital stock:

$$g_K = \gamma_0 + \gamma_1. (u_{-1} – u^*) + \gamma_2.q_{-1} – \gamma_3.r_{L-1}lev_{-1}. \tag{25}$$

Equation (25) then constitutes the investment equation.

A.2.4 *Closing the model*

Financial needs by firms Fin_f is determined by investments in physical capital plus investments in equity abroad minus retained profits. Hence:

$$Fin_f = pe_{af}.\Delta E_{af} + p_k.\Delta K – F_{f,ret} \tag{26}$$

These needs are financed by loans and by issuing equity abroad, where firms employ a portfolio approach to decide on the distribution of both. Therefore the fraction financed by increasing loans is given by:

$$\Delta L/Fin_f = \lambda_{20} \Delta L_{-1}/ Fin_{f,-1} + \lambda_{21} + \lambda_{22} r^r_l – \lambda_{23}.r^r_{efa}– \lambda_{24}.gr_{pefa} \tag{26a}$$

where r^r_l denotes the real interest rate on loans, r^r_{efa} the real return on equity and gr_{pefa} the growth rate of equity prices. The remaining fraction of Fin_f is financed by issuing equity $pe_{fa}.\Delta E_{fa}$ against an exogenous price pe_{fa}. The foreign sector is assumed to absorb this demand for equity.

Finally, retained earnings $F_{f,ret}$, which constitute firms' savings S_f, contribute to the wealth of firms. Next valuation changes should also be considered. Hence holds:

$$\Delta V_f = S_f + (\Delta pe_{fa}).E_{fa} – (\Delta pe_{af}).E_{af} + (\Delta p_k).K \tag{27}$$

A.3 *Government*

Traditionally government is treated in a very simple way in SFC models. We follow that tradition but as a new feature, we introduce the government capital stock and allow for government investment in our analysis.[28] We first discuss the wealth composition of government and then turn to government behaviour.

A.3.1 *Wealth of government*

Government supplies bills to the various sectors of the economy Accumulated government debt therefore equals $B = B_{CB} + B_{PF} + B_B + B_a$, which constitutes also the financial liabilities of government. Next to that, government capital $p_k.K_g$ appears as an asset. The corresponding balance sheet is presented in Table 3.

Table 3 Balance sheet of the government sector

ASSETS		**LIABILITIES**	
Government capital	$p_k.K_g$	Government bonds	B_{CB}
			B_B
			B_{PF}
			B_a
		Total (net worth)	V_g

A.3.2 *Government behaviour*

Income of government, Y_g, consists of taxes T, profits from the Central Bank F_C and its gross operating surplus D_g. Taxes consist of Value added taxes T_i, profit taxes T_f and income taxes T_d, with $T = T_i + T_d + T_f$. The taxes are proportional to the relevant tax base with fixed rates. We discuss profits from the Central Bank below in section 1.6.1. The depreciation of the government capital stock is a fixed proportion of the government capital stock – following national account conventions it is included as gross operating surplus of government. Government income therefore is:

$$Y_g = T + F_c + D_g \tag{28}$$

Government outlays consist of government expenditures G and the interest paid on governmen8t bonds $i_B.B$.

From our data we see that the government expenditures as ratio to GDP is not constant (but increasing over time). We therefore also include both deficit (GD) and debt (B) rates in determining the growth of government expenditures. We use the follow equation:

$$g_G = \eta_0 + \eta_1.\overline{g_{y_{-1}}} + \eta_2 \frac{GD}{Y} + \eta_3 \frac{B}{Y} \tag{29}$$

[28] Allowing for a productive use of this investment is left for further research.

where the growth rate of output is averaged over two years. The first two parameters are positive whereas the latter two are negative, as expected. This equation works very well for within-sample simulations but shows to be very high for out-of-sample simulations. For the latter we simply employ an exogenous growth rate of government expenditures. The interest rate paid on government bonds i_B is exogenous.

The budget balance, together with profits from the Central Bank F_C minus interest paid on government bonds $i_B.B$, and minus consumption of fixed capital (D_g) constitute net government savings S_g:

$$S_g = T - p.G + F_C - i_B.B - D_g \quad (30)$$

These savings, which usually are negative, correspond to the change in the amount of bills supplied to the various sectors of the economy minus government investment:

$$\Delta B + pk.\Delta Kg = - S_g \quad (31)$$

A.4 *The foreign sector*

The foreign sector is very important for the Dutch economy. Imports and exports are important components of GDP – this implies that economic growth and fluctuations are highly dependent on the development of world trade. Moreover, the financialisation of the Dutch economy is strongly interwoven with globalisation and the openness of the Dutch economy. We elaborate both points below. First, we present foreign wealth. Then we discuss the trade balance. Finally, we discuss the accumulation of net foreign wealth and its composition.

A.4.1 *Foreign wealth*

Since foreigners hold bills issued by the government (B_a), bank deposits (M_{ab}) and equity ($pe_{fa}.E_{fa}$) issued by firms, these appear as assets in the balance sheet of the foreign sector. The liabilities of the foreign sector consist of foreign equity held by domestic firms and pension funds, $pe_{af}.E_{af}$ and $pe_{aPF}.E_{aPF}$, respectively, loans provided by banks L_a, and foreign reserves held by the Central Bank R. The balance sheet of the foreign sector is given in Table 4.

Table 4 Balance sheet of the foreign sector

ASSETS		**LIABILITIES**	
Equity	$pe_{fa}.E_{fa}$	Equity	$pe_{af}.E_{af}$
Bills	B_a	Equity	$pe_{aPF}.E_{aPF}$
Deposits	M_a	Loans	L_a
		Foreign Reserves	R
		Total (net worth)	V_a

1.4.2 *Imports, exports and the trade balance*

The real side of the foreign sector introduced in a simple way. Next to consumption, investment and government goods, firms also produce net-exports ($X - IM$). This does not affect their balance sheet,

however, nor does it affect their flow of funds. We assume imports *IM* to be proportional to GDP with a fraction *im*. Exports *X* are exogenous. Hence the trade balance is given by:

$$TB = X - IM = X - im.p.Y \tag{32}$$

Below we discuss foreign wealth and its composition.

A.4.3 *The accumulation of net foreign debt abroad*

The trade balance is part of the current account *CA* together with net primary income and net secondary income. We ignore the latter in our model and net primary income consists of interest received on loans from domestic banks, $i_{La}.L_a$, and as well as dividends paid to domestic firms and pension funds on their foreign investment, $\rho_a.pe_a.E_{af}$ and $\rho_a.pe_a.E_{aPF}$ respectively,[29] minus interest paid for deposits held at domestic banks and government bonds, $i_a.M_a$ and $i_b.B_a$ respectively, and dividend paid by domestic firms $\rho_{fa}.pe_{fa}.E_{fa}$. Therefore we find:

$$CA = TB + i_{La,-1}.L_{a,-1} + \rho_{af}.\ pe_{af,-1}.E_{af,-1} + \rho_a.\ pe_{aPF,-1}.E_{aPF,-1} - i_{b,-1}.B_{a,-1} - i_{a,-1}.M_{a,-1} - \rho_{fa}.pe_{fa,-1}.E_{fa,-1} \tag{33}$$

The current account equals minus foreign savings, since income of the foreign sector Y_a equals:

$$Y_a = i_{b,-1}.B_{a,-1} + i_{a,-1}.M_{a,-1} + \rho_{fa,-1}.pe_{fa}.E_{fa,-1} \tag{34}$$

Savings then follow from:

$$S_a = Y_a - TB - i_{La,-1}.L_{a,-1} - \rho_{af}.\ pe_{af,-1}.E_{af,-1} - \rho_a.\ pe_{aPF,-1}.E_{aPF,-1} = -CA \tag{35}$$

These savings deplete the desired foreign reserves *R'* held by the domestic Central Bank:

$$\Delta R' = \Delta B_a + \Delta M_a + pe_{fa}.\Delta E_{fa} - \Delta L_a - pe_{af}.\Delta E_{af} - pe_a.\Delta E_{aPF} - S_a \tag{36}$$

As Godley and Lavoie (2007b) emphasize, there is no inherent mechanism for a country with a trade surplus to converge to a balanced current account, as long as it is willing to accumulate ever more foreign debt. This situation is quite relevant for the Netherlands as appears from the stylised facts.

Actual foreign reserves held by the Central Bank follow from a pragmatic rule that these are proportional to GDP plus a correction factor from the difference between actual and desired reserves in previous period:[30]

$$R = \omega.S + (R''_{-1} - R_{-1}) \qquad \text{where} \quad R''_{-1} = R_{-2} + \Delta R'_{-1} \tag{37}$$

Considering the liabilities of the foreign sector, equity held by pension funds $pe_a.E_{aPF}$ follows from the portfolio choice by pension funds – see eq. (57) in section 1.5 below. On the other hand, foreign equity held by domestic firms $pe_{af}.E_{af}$ follows from firm behaviour as discussed in section 1.2 above. The formation of foreign reserves is presented above in equation (37).

On the assets side the foreign sector absorbs all equity that is demanded by domestic firms as to finance their investments and we assume that the remaining assets, B_a and M_a, are distributed

[29] We ignore interest payments on reserves held by the central bank.

[30] The introduction of desired reserves is needed to handle simultaneity in the model. The error introduced by doing so is very limited and far less then 0.1% of GDP in the simulations.

according to a portfolio model. That is, bonds issued by government B_a are a fraction of the remaining assets, where *TA* represents total assets:

$$B_a = \Omega.(TA - pe_{fa}.E_{fa}) \quad \text{with} \quad \Omega = \lambda_{40} - \lambda_{41}.r^e_M + \lambda_{42}.r^e_B \tag{38}$$

In line with portfolio analysis, this fraction depends negatively on the interest rate of deposits and positively on the interest rate of bonds. Then M_a follows from:

$$M_a = TA - pe_{fa}.E_{fa} - B_a \tag{39}$$

Equation (37) determines the demand amount for domestic government bonds B_a held by the foreign sector. As we discuss in section A.6.1 below, under QE operations by the domestic National Central Bank the amount for domestic government bonds held by the foreign sector B_a decreases due a decrease in the real interest rate for bonds. This is compensated by an increase in bank deposits M_a held by the foreign sector.

Finally, foreign savings S_a contribute to the net foreign wealth. Next to that, valuation changes should be taken into account. Hence:

$$\Delta V_a = S_a + (\Delta pe_{fa}).E_{fa} - (\Delta pe_{af}).(E_{af} + E_{aPF}) \tag{40}$$

With respect to asset prices and asset returns we explicitly allow for different developments of prices pe_{fa} and returns ρ_{fa} on equity held by foreign parties in the domestic country, compared to the prices pe_{af} and returns on ρ_a equity held by domestic parties abroad. However, these are all exogenous.

A.5 *Pension Funds*

The Netherlands has a funded pension system according to which wage earners are obliged to contribute to their pension fund by paying a premium, p_{pf}, based on their wage.[31] When retiring, the pensioners receive a pension benefit. Till recently we used to have a traditional defined benefit system, which implied that pensioners receive a benefit which is a fraction, b_{pf}, of their (mean) wage with pension benefits and accruals being increased based on price or wage developments. However, this defined benefit system has been under discussion recently and the fraction has been decreased, as we explain below.

A.5.1 *Background*

To understand the pension system, we distinguish between the working age population, N^Y, and the retired population, N^O. The working age population contributes each year $p_{pf}.W$, and the pensioners receive each year $b_{pf}.\ W.\ N^O/\ N^Y$. or, from the view of the pension fund: Each year the pension fund pays out $PF_b = b_{pf}.\ W.\ N^O/\ N^Y$ and receives $PF_c = p_{pf}.\ W$ from the workers. However, since contributions and benefits are transfer payments, they do not constitute part of income of pension funds in the national accounting system. The income Y_{pf} of the pension funds equals the return on its assets $i_{ass,pf}.Ass_{pf}$.[32]

[31] We ignore here for simplicity that employers are in practice paying (a substantial) part of the premium.
[32] We elaborate on these returns below – cf. equation (6).

$Y_{pf} = i_{ass,pf}.Ass_{pf}$ (41)

This income then is spent on net benefits, $PF_b - PF_c$, and savings S_{pf} remain. Hence pension fund savings are given by:

$S_{pf} = Y_{pf} - (PF_b - PF_c) = (PF_c - PF_b) + i_{ass,pf}.Ass_{pf}$ (42)

Therefore, in the national accounting system only the net contributions by households are included, i.e. $PF_c - PF_b$. These contributions constitute part of the claims by households on pension funds. The other part of the claims follows from discounted future obligations. This distinction of claim components motivates us to distinguish between a real value of pension claims, C_{pf}, and its implicit price, p'_{pf}. That is, $p'_{pf}C_{pf}$ represents the nominal value of claims, valued at an implicit price p'_{pf}.

A.5.2 *The value of claims on the pension fund*

The discounted future obligations follow from the notion that in a funded pension system the contributions by the workers increase their claims on the pension fund. If the number of working years is T^y, each young worker accumulates on average an amount $\sum_{t=0}^{T^y}(1+r^y)^t.p_{pf}W$ which is available to pay out for the pension at the beginning of his or her retirement;[33] r^y represents the real interest rate during the period of accumulating the pension. The liabilities of the pension fund with respect to this person then are on average $\sum_{t=0}^{T^o} b_{pf}W/(1+r^o)^t$ at the beginning of retirement; T^o is the average number of retirement years and r^o represents the real interest rate which should be used to discount the future claims of the worker and retired person. However, the future is uncertain, for instance due to longevity T^o, which has increased beyond expectations, and the interest rate has decreased beyond expectations, which affects r^o. Thus, the nominal value of claims can be represented by:[34]

$$p'_{pf}C_{pf} = b_{pf}WB.\frac{N^o}{N^y}\sum_{t=0}^{T^o}\frac{1}{(1+r^o)^t} \quad (43)$$

Changes in claims of households $\Delta p'_{pf}C_{pf}$ are equal to the net transfer from household to pension funds $(PF_c - PF_b)$, plus the change in discounted future obligations reflected in a change in the implicit price. We then find:

$$\Delta p'_{pf}C_{pf} = (PF_c - PF_b) + C_{pf,-1}\Delta p'_{pf} \quad (44)$$

and the change in the implicit price is equal to:

[33] The use of the word "average" refers to the notion of risk-sharing between plan members.

[34] This is a very rough approximation, since the claim of the existing old pensioners is about half of the liabilities indicated here (remember T^o is the average number of years of retirement). The other part of the liabilities consists of future claims built up by the young till now – for simplicity we assume that to equal the other half of the liabilities here. This short cut is taken because we want to focus on the impact of a decrease in the interest rate r^o and an increase in the ratio N^O/N^Y. The qualitative impact of these variables on $p'_{pf}C_{pf}$ will not change in an extended specification of equation (43). For the moment we multiply the right-hand side of equation (43) by a factor 1.5.

$$\frac{\Delta p'_{pf}}{p'_{pf,-1}} = \frac{\Delta p'_{pf} C_{pf} - (P_{fc} - P_{fb})}{p'_{pf,-1} C_{pf,-1}} \quad (45)$$

It is important to notice that an (unexpected) increase in longevity and/or a decrease in the interest rate, without changes in net contributions, will lead to an increase implicit price since future claims will increase – see equation (43).

The claims of households, $p'_{pf} C_{pf}$, constitute the liabilities of the pension funds. To ensure future payments, the pension funds are required to hold a fraction of liabilities in excess of their assets, the coverage rate, Cov.[35] That is, the coverage rate of pension funds is:

$$Cov = \frac{V_{pf}}{p'_{pf} . C_{pf}} \quad (46)$$

Which must be within boundaries such that the targeted coverage ratio remains within a lower and an upper bound: $\underline{cov} \leq Cov^* \leq \overline{cov}$ where Cov^*denotes the targeted coverage ratio.

Combining the above implies that the targeted wealth position of pension funds is equal to:

$$V_{pf}{}^* = Cov^* . p'_{pf} . C_{pf} \quad (47)$$

where we assume the latter term to be given and thus independent of the future benefits.[36] The targeted change of net wealth is thus given by:

$$\Delta V^*_{pf} = Cov^* . p'_{pf} . C_{pf} - V_{pf_{-1}} \quad (48)$$

Given the wealth position of pension funds in previous year the pension fund contributions and benefits are to be adjusted such that the targeted coverage ratio is achieved. As mentioned above, we assume that current capital gains and current returns on various types of assets is independent of this adjustment process. This implies that targeted contributions and benefits are given by:

$$\begin{aligned} &P^*_{pf} - P_{pf}{}^* = \Delta V^*_{pf} - Y_{pf}{}' \\ &p^*_{pf} W - b_{pf}{}^* . p_{NoNy} . \overline{W} = \Delta V^*_{pf} - Y_{pf}{}' \end{aligned} \quad (49)$$

Assume that the change in the benefits rate is a fraction of the change in contribution rate as:

$$\Delta b_{pf} = -\rho . \Delta p_{pf} \quad (50)$$

Combining the above, using $\Delta p^*_{pf} = p^*_{pf} - p_{pf_{-1}}$, and rearranging gives the targeted change in the contribution rate:

$$\Delta p^*_{pf} = \frac{\frac{\Delta V^*_{pf} - Y_{pf}{}'}{W} - p_{pf_{-1}} + \frac{\overline{W}}{W} . b_{pf_{-1}} . p_{NoNy}}{1 + \frac{\overline{W}}{W} . \rho . p_{NoNy}} \quad (51)$$

And the targeted change in the benefits rate:

[35] In the Netherlands, for instance, solvency rules require pension funds to have on average a funding ratio (i.e. assets divided by liabilities) of at least 120%.

[36] In a later stage the future benefits may also be influenced by the current coverage ratio.

$$\Delta b_{pf}{}^{*} = -\rho.\Delta p_{pf}{}^{*} \quad (52)$$

We further use a smooth adjustment of these targeted benefits and contribution rates using a weighted moving average, currently over two years. [37]

A.5.3 *The composition of assets and liabilities*

Savings minus net contributions by households are used for asset accumulation. From equation (42) then follows:

$$\Delta B_{pf} + pa.\Delta A_{pf} + pe_{apf}.\Delta E_{apf} = i_{b,-1}.B_{pf,-1} + i_{apf}.p_{a,-1}.A_{pf,-1} + i_{eapf}.pe_{apf,-1}.E_{apf,-1} \quad (53)$$

when we recognize that pension funds invest in government bonds B_{pf}, participations in investment banks A_{pf}, and equity abroad E_{apf}. The respective prices are *pa* and pe_{apf}, and the corresponding returns are i_b, i_a and ie_{apf}. The right-hand side of equation (53) constitutes the returns on assets of pension funds in equation (42).

Therefore, the balance sheet of the pension fund has the structure as presented in Table 5. The change in net-worth V_{pf} is given by:[38]

$$\Delta V_{pf} = S_{pf} - C_{pf,-1}.\Delta p'_{pf} + A_{pf,-1}.\Delta p_a + E_{apf,-1}.\Delta pe_{apf} \quad (54)$$

The last two elements of equation (54) follow from valuation changes of financial assets. Since the pension funds adjust benefits and contributions to obtain balance between assets and liabilities, the net-worth of pension funds is very small.

Table 5 Balance sheet of the pension funds

ASSETS		**LIABILITIES**	
Bills	B_{pf}	Outstanding claims	$p'_{pf}C_{pf}$
Participations	$p_a.A_{pf}$		
Equities	$pe_{apf}.E_{apf}$		
		Total (net worth)	V_{pf}

The composition of financial assets follows from a Tobin type portfolio model. This implies that wealth net of liabilities:

$$VN_{pf} = V_{pf} + p'_{pf}.C_{pf} = B_{pf} + p_a.A_{pf} + pe_{apf}.E_{apf} \quad (55)$$

is distributed over financial assets. Since pension funds have to hold a minimum amount of bonds, pension funds seem to decide first to invest in government bonds and afterwards decide to invest the

[37] This is roughly what happened in the Netherlands when the liabilities of the pension funds increased due to the fall in the interest rate after the financial crisis.

[38] This follows from $\Delta V_{pf} = S_{pf} - (PF_b - PF_c) + A_{pf,-1}.\Delta pa_{pf} + E_{apf,-1}.\Delta pea + p'_{pf}\,\Delta C_{pf}$

remaining part in either participations or equity abroad. Assuming for the moment that $AE_{pf} = p_a.A_{pf} + pe_{apf}.E_{apf}$ we find:

$$B_{pf}/VN_{pf} = \lambda_{10} . B_{pf,-1}/VN_{pf,-1} + \lambda_{11} + \lambda_{12}.r_B \quad (56)$$

$$AE_{pf}/VN_{pf} = 1 - B_{pf}/VN_{pf}$$

From simple estimation we observed that any combination of (weighted) real returns on equity and participations did not give any significant results in equation (56). In the second round pension funds distribute the remaining net wealth over participations and equity:

$$pa.A_{pf}/AE_{pf} = \lambda_{20} . pa_{-1}.A_{pf,-1}/AE_{pf,-1} + \lambda_{21}.r_A - \lambda_{22}.r_E \quad (57)$$

$$pe_{apf}.E_{apf}/AE_{pf} = 1 - pa.A_{pf}/AE_{pf}$$

Using equations (56) and (57) we find that the final distribution over all assets is given by:

$$pa.A_{pf}/VN_{pf} = pa.A_{pf}/AE_{pf}*(1 - B_{pf}/VN_{pf})$$

$$pe_{apf}.E_{apf}/VN_{pf} = (1 - pa.A_{pf}/AE_{pf})*(1 - B_{pf}/VN_{pf}) = 1 - B_{pf}/VN_{pf} - p_a.A_{pf}/VN_{pf} \quad (58)$$

The variables r_A and r_E are the returns on participations and equity, respectively, and both include price changes of assets. r_B is the real interest rates for bonds.

The above items constitute the balance sheet of the households, presented in Table 5. One should realise that when presenting the balance sheet this way, claims to pension funds $p'_{pf}.C_{pf}$ are included in the household wealth V_h.

A.6 *The banking sector and the Central Bank*

We describe both sectors, starting with the central bank.

A.6.1 *The Central Bank*

Next to holding foreign reserves R, the Central Bank holds bills issued by the government B_{CB} and advances provided to banks A_{CB}, which include Target2 balances. Its liabilities are deposits held by banks M_{CB}. Since the revenues FC of the Central Bank are transferred to the government, the balance sheet of the Central Bank is closed without remaining net worth. The resulting balance sheet is presented in Table 6A.

Table 6A Balance sheet of the Central Bank

ASSETS		**LIABILITIES**	
Advances	A_{CB}	Central bank deposits	M_{CB}
Bills	B_{CB}		
Foreign reserves	R		
		Total (net worth)	0

The Central Bank provides as much bills as demanded by the government. That is B_{CB} bonds are held by the Central Bank, such that holds:

$$B_{CB} = B - B_{PF} - B_B - B_a \quad (59)$$

Where B is the amount of bonds issued by government. However, the situation is different under QE operations, as we discuss below.

Deposits to banks are provided to satisfy the banks' need, while advances are exogenous. Hence:

$$M_{CB} - A_{CB} = \varphi.M_h \quad (60)$$

We discussed the foreign reserves in equation (36a) above.

The revenues of the Central Bank are given by:

$$FC = i_{R,-1}.R_{-1} + i_{B,-1}.\ B_{CB,-1} + i_{A,-1}.\ A_{CB,-1} - i_{M,-1}.M_{CB,-1} \quad (61)$$

Here i_B is the rate on government bills set by the Central Bank, i_A is the interest rate on advances and i_M is the interest rate on deposits. These interest rates are set exogenous in real terms, r_B, r_A and r_M, respectively. The nominal rates then take expected inflation into account, which in the current version of the model is zero. The interest rate on reserves, i_R, is zero as well in the current version of the model.

A.6.2 *Quantitative Easing operations*

As we discussed above, in normal times the Central Bank provides as much bills as demanded by government – see equation (59). To understand the situation better we should realise that the interest rate is found endogenously at a rate r_B. Hence does hold:

$$B_{CB} = B - B_{PF}(r_B) - B_B - B_a(r_B) \quad (59')$$

where B is the amount of bonds issued by government and bank bonds are determined independent of the interest rate – see equation (67) below.

When Quantitative Easing takes place, the Central Bank wants to obtain an additional amount of B_{QE} bonds. Compared to the initial situation then should hold:

$$B'_{CB} = B_{CB} + B_{QE} = B - B_{PF}(r'_B) - B_B - B_a(r'_B) \quad (59'')$$

and r'_B is the new interest rate in equilibrium. We will find that almost all bonds obtained through QE, B_{QE}, will be held abroad. The reason is that the foreign sector sells all bonds demanded by the Central Bank – the banks and pension funds do not want to sell their bonds, as we discussed under the stylised facts. The latter implies that domestic demand for bonds is interest inelastic, while foreign demand – where deposits are perfect substitutes for bonds – is interest elastic.

A.6.3 *The Banking Sector (MFIs)*

In our analysis banks finance their assets not only by holding deposits and participations from households, M_h and $p_a.A_h$ respectively, but also to a considerable extent by borrowing from the foreign sector. The latter is done by providing deposits M_{ab} to foreign holders and by issuing participations $p_a.A_{pf}$ to pension funds, who mainly invest abroad. Finally banks also borrow advances A_{CB} from the

Table 6B Balance sheet of the banking sector

ASSETS		**LIABILITIES**	
Central bank deposits	M_{CB}	Advances	A_{CB}
Bonds	B_B	Bank deposits	M_h
Loans to firms	L	Bank deposits	M_{ab}
Mortgages	MO	Participations	$p_a.A_{pf}$
Loans abroad	L_a	Participations	$p_a.A_h$
		Total (net worth)	V_b

Central Bank. The main assets held by the bank are loans *L* provided to firms, mortgages *MO* issued to households and loans L_a provided abroad. Next to that banks also hold government bonds B_B and deposits M_{CB} held at the Central bank. The corresponding balance sheet is presented in Table 6B. Since we assume that all profits are distributed as bonuses to households, the net worth of the banking sector consists only of valuation gains and losses.

An interesting observation is that since we assume that all profits are distributed as bonuses to households, savings by the banking sector are zero. That is, income of banks is:

$$Yb = i_{M,-1}.M_{CB,-1} + i_{B,-1}.B_{B,-1} + i_{L,-1}.L_{a,-1} + i_{L,-1}.L_{a,-1} + i_{MO,-1}.MO_{-1} + F_b \quad (62)$$

Where F_b represents bank profits. Bank savings S_b then are given by:

$$S_b = 0 = Y_b - i_{A,-1}.A_{CB,-1} - i_{h,-1}.M_{h,-1} - i_{ab,-1}.M_{ab,-1} - i_a.p_{a,-1}.A_{h,-1} - i_a.p_{a,-1}.A_{PF,-1} - F_b \quad (63)$$

Since bank savings are zero, this implies

$$i_{A,-1}.A_{CB,-1} + i_{h,-1}.M_{h,-1} + i_{ab,-1}.M_{ab,-1} + i_a.p_{a,-1}.A_{h,-1} + i_a.p_{a,-1}.A_{PF,-1} =$$

$$i_{M,-1}.M_{CB,-1} + i_{B,-1}.B_{B,-1} + i_{L,-1}.L_{a,-1} + i_{L,-1}.L_{a,-1} + i_{MO,-1}.MO_{-1} \quad (64)$$

The interest rate on participations, then is set by banks consistent with equation (63). Hence[39]:

$$i_a = [(Y_b - F_b) - (i_{A,-1}.A_{CB,-1} + i_{h,-1}.M_{h,-1} + i_{ab,-1}.M_{ab,-1})]/[p_{a,-1}.A_{h,-1} + p_{a,-1}.A_{PF,-1}] \quad (65)$$

Profits are set in proportion to the return on participations, i.e.

$$Fb = fracp.[i_a.p_{a,-1}.A_{h,-1} + i_a.p_{a,-1}.A_{PF,-1}] \quad (66)$$

Finally, for simplicity bonds are assumed to be held as a constant fraction of outstanding loans and mortgages:

$$Bb = \Psi.(L + MO) \quad (67)$$

[39] Note that these gains on participations depend on *current* income and *current* profits. Therefore, the implied "interest" rate is not lagged in expenditures of banks (e.g. equation (62)) and incomes by households (e.g. equation (7)) and pension funds (e.g. equation (53))

Turning to the liabilities side we assume that the demand for deposits M_h by households and from abroad is fully accommodated by banks. With respect to participations we also assume that the demand by households and pension funds is fully accommodated by banks.[40]

For the moment being both bank loans to the foreign sector L_a and deposits held t banks by the foreign sector *Mab* are assumed to be exogenous.

[40] A further refinement of the model is to introduce here also endogenous prices for participations. We leave this for later.

Table 7A Balance sheet

		Households	*Firms*	*Banks*	*Pension funds*	*Central bank*	*Government*	*Foreign*	*Total*
Central bank deposits (net)				M_{cb}		$-M_{cb}$			
Bank deposits	*Domestic*	M_h		$-M_h$					
	Abroad			$-M_{ab}$				M_{ab}	
Loans			-L	$L + L_a$				$- L_a$	
Bills	*Domestic*			$p_b.B_b$	$p_b.B_{pf}$	$p_b.B_{cb}$	$-p_b.(B_b+B_{pf}+B_{cb})$		
	Abroad						$-p_b.B_a$	$p_b.B_a$	
Capital			pk.K				pk.K_g		pk.$(K+K_g)$
Participations	*domestic*	pa.A_h		$-pa.A_h-pa.A_{pf}$	pa.A_{pf}				
Equities	*firms*		$-pe_{fa}.E_{fa}$					$pe_{fa}.E_{fa}$	
	abroad		$pe_{af}.E_{af}$		$pe_{apf}.E_{apf}$			$-pe_{af}.E_{af}$ $-pe_{apf}.E_{apf}$	
Mortgages		-MO		MO					
Houses		ph.HS							ph.HS
Claims/Liabilities		p_{cpf}.Cpf			$-p_{cfp}$.Cpf				
Foreign Reserves						R		-R	
Miscellaneous		Xa_h		$-Xa_h-Xa_g+Xl_{pf}+Xl_{cb}$	$-Xl_{pf}$	$-Xl_{cb}$	Xa_g		
Total net worth		Vh	Vf	Vb	Vpf	0	Vg	Va	Vt

Table 7B. Social Accounting Matrix

	Production	*Households*	*Firms*	*Banks*	*Pension funds*	*Central Bank*	*Government*	*Capital Account*	*Foreign*	*Correction*	*Total*
Production		C					G	I+IH+IG+Δinv	X-Im		Y
Households	W			$r_m.M_h$+ $r_{ah}.pa.A_h$+ F_b	Pfb-Pfc					$Ycorr_h$	Yh
Firms	F_f								Faf	$Ycorr_f$	Yf
Banks	F_b	$r_{mo}.MO$	$r_l.L$			$r_{cb}.Mcb$	$r_b.B_b$		$r_{la}.L_a$	$Ycorr_b$	Yb
Pension funds				$r_{apf}.pa.A_{pf}$			$r_b.B_{pf}$		Fapf	$Ycorr_{pf}$	Ypf
Central Bank							$r_b.B_{cb}$			$Ycorr_{cb}$	Ycb
Government	$Ti+D_g$	T_d	T_f			Fc				$Ycorr_g$	Yg
Consumption of fixed capital		D_h	D_f				D_g				D_{tot}
Capital account		S_h	S_f	0	S_{pf}	0	S_g		S_a	0	S_{tot}
Foreign sector			Ffa	$r_{mab}.M_{ab}$			$r_b.B_a$			$Ycorr_a$	Ya
Total	Y	Yh	Yf	Yb	Ypf	Ycb	Yg	I+IH+IG+Δinv	Ya	0	

Wealth accumulation: $\Delta Vh = Sh + \Delta ph.HS(-1);\ \Delta Vf = Sf + \Delta pea.Eaf(-1) - \Delta pe.Efa(-1) + \Delta p.K(-1);\ \Delta Vpf = Spf + \Delta pea.Eapf(-1)$

$\Delta Va = Sa + \Delta pe.Efa(-1) - \Delta pea.Eaf(-1) - \Delta pea.Eapf(-1);\ \Delta Vb = 0\ ;\ \Delta Vg = Sg\ ;\ \Delta V = S + \Delta p.K(-1) + \Delta ph.HS(-1)$

$Faf = \rho_{ea}p_{ea}.E_{af}\ ;\ Ffa = \rho_e p_e.E_{fa};\ Fab = \rho_{ea}p_{ea}.E_{ab};\ Fapf = \rho_{ea}p_{ea}.E_{apf}$

Table 7C Accumulation and investment of savings

	Households	*Firms*	*Banks*	*Pension funds*	*Central Bank*	*Gov.*	*Foreign*	*Total*
Consumption	- C	C+G				-G		0
Gross Investment		I+IH+IG+Δinv						I+IH+IG+Δinv
Net exports		(X – IM)					-(X – IM)	0
Wages	$W+F_b$	-W	$-F_b$					0
GOS		$-F_b-D_g$	F_b			D_g		0
Taxes	$-T_d$	$-T_f -T_i$				T		0
P. Contributions/Benefits	Pfb-Pfc			-Pfb+Pfc				0
Interest Deposits	r_mM_h		$r_{cb}.M_{cb} - r_m.M_h - r_{mab}.M_{ab}$		$- r_{cb}M_{cb}$		$r_{mab}M_{ab}$	0
Interest Loans/Advances		$-r_l.L$	$r_l.L+ r_{la}.L_a$				$-r_{la}.L_a$	0
Interest Bills			$r_b.B_b$	$r_b.B_{pf}$	$r_b.B_{cb}$	$-r_b.B$	$r_b.B_a$	0
Interest Participations	$r_{ah.}pa.A_h$		$-pa.(r_{ah}.A_h+r_{apf}.A_{pf})$	$r_{apf}.pa.A_{pf}$				0
Interest Mortgages	$-r_{mo}.MO$		$r_{mo}.MO$					0
Dividends		Faf -Ffa		Fapf	-Fc	Fc	Ffa-Faf-Fapf	0
Cons of fixed capital	$-D_h$	$-D_f$				$-D_g$		$-D_{tot}$
Correction	$Ycorr_h$	$Ycorr_f$	$Ycorr_b$	$Ycorr_{pf}$	$Ycorr_{cb}$	$Ycorr_g$	$Ycorr_a$	0
Net Savings	S_h	S_f	0	S_{pf}	0	S_g	S_a	S_{tot}
Savings, correction	$Scorr_h+Scorr_{ph}$	$Scorr_f$	$Scorr_b$	$Scorr_{pf}$	$Scorr_{cb}$	$Scorr_g$	$Scorr_a$	$Scorr_{ph}$
ΔDeposits	ΔM_h		ΔM_{cb} - ΔM		$- \Delta M_{cb}$		$+ \Delta M_{ab}$	0
ΔLoans		-ΔL	ΔL					0
ΔBills			ΔB_b	ΔB_{pf}	ΔB_{cb}	-ΔB	ΔB_a	0
ΔParticipations	$pa\Delta A_h$		$-pa\Delta A_h -pa\Delta A_{pf}$	$pa\Delta A_{pf}$				0
ΔMortgages	-ΔMO		ΔMO					0
ΔEquity		$p_{eaf}\Delta E_{af} - p_{efa}\Delta E_{fa}$		$p_{eapf}\Delta E_{apf}$			$p_{efa}\Delta E_{fa}-p_{eaf}\Delta E_{af}-p_{eapf}\Delta E_{apf}$	0
ΔClaims	$p_{cpf}\Delta Cpf$			$- p_{cpf} \Delta Cpf$				0
ΔReserves					+ΔR		-ΔR	0
ΔCapital	phΔHS	pkΔK				$pk\Delta K_g$		$pk\Delta K+ph\Delta HS+pk\Delta K_g$
ΔMiscellaneous	ΔXa_h		ΔXa_b	$-\Delta Xl_{pf}$	$-\Delta Xl_{cb}$	ΔXa_g		0

A.7 Summary tables

The stocks and flows of the model are summarised in Tables 7A – 7C. In Table 7A the balance sheet of each sector is presented, showing how all financial assets of one sector correspond to the financial liabilities of another sector. The physical assets, houses and capital constitute total wealth.

The social accounting matrix is presented in Table 7B, indicating the financial flows in the model and the interactions between the various sectors. Below the table it is summarised how valuation changes contribute to wealth accumulation.

Finally, Table 7C summarises how for each sector savings are formed in each sector and how these savings are invested in either financial or physical assets.