The impact of quantitative easing on a small open Euro Area economy: the case of the Netherlands

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Abstract

The Dutch economy is characterised by several stylised facts which constitute a highly interdependent framework: (1) households with positive savings, large pension claims and a huge mortgage debt; (2) firms with large positive savings and large financial claims abroad; (3) a large financial sector with assets mainly invested in mortgages and abroad; (4) a large balance of trade surplus; (5) a Central Bank buying Dutch government bonds abroad and aggravating the TARGET2 imbalances; and (6) a government with negative or even positive savings and a moderate debt.

The various interdependencies and imbalances are not sufficiently recognised in most debates on economic policy and also not in the analyses by the Dutch Central Bank and the Dutch Central Planning Bureau. This generally leads to an underestimation of the vulnerabilities of the Dutch economy.

In the present paper we elaborate the open economy stock-flow consistent model of Meijers, Muysken and Sleijpen (2015) by adding next to the banking sector a pension fund which invests to a large extent abroad, by introducing firms that invest a considerable part of their retained earnings abroad and by further endogenising prices of financial assets. The model recognises the balance sheets and portfolios of financial assets of the six sectors in the model, and analyses the financial flows leading to wealth changes. Amongst others the resulting model enables us to identify the impact of QE in detail. Both wealth effects and transmission channels for the impact of monetary policy play an important role.

We calibrate the model, using stock-flow consistent data for the Dutch economy. This enables us to reproduce the stylised facts presented above. From simulations with our model we show (a) why QE does not have a direct impact on the real sphere (because of leakages abroad); (b) how the vulnerability of the financial sector is aggravated by QE (larger foreign exposure).

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

Key words: stock-flow consistent modelling, quantitative easing, monetary transmission mechanism

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1 Introduction

The IMF's most recent Global Financial Stability Report is summarised as follows:

> Despite ongoing monetary policy normalization in some advanced economies and some signs of firming inflation, global financial conditions are still very accommodative relative to historical norms. Although supportive of near-term growth, easy financial conditions also continue to facilitate a build-up of financial fragilities, increasing risks to global financial stability and economic growth over the medium term. (IMF, 2018: 1)

Similar concerns are vented for the Dutch economy by two important institutions for macroeconomic policy, the Central Planningbureau (CPB) and the Dutch Central Bank (DNB) in their annual reports on risks from the financial sector for the Dutch economy. Their most recent reports, CPB (2017a) and DNB (2017a), both stress the strong impact of the low interest rate on Dutch economic performance, which is partly due to the accommodative monetary policy. For that reason both institutions are also very concerned about the impact of a reversal of the monetary policy by the ECB (and world-wide) on the Dutch economy and the impact of rising interest rates. The study of the CPB discussing this entitled "Back to normal monetary policy" has the subtitle "The return to normal: no plain sailing" (CPB, 2017b), and the DNB (2017b) concludes that "an abrupt international interest rate rise would cause the Dutch economy to slow down considerably" (p. 30).

A problem for both institutions – and a large part of the macroeconomic profession – is in our view that they do not employ macroeconomic models which enable them to analyse the impact of a low interest rate and reversals in monetary policy in a proper way. As we discuss below, these New Keynesian oriented models do not recognise the transmission channels of monetary shocks in a coherent framework and miss many interactions between the financial and the real sphere. In this paper we present the outline of a model which is much more appropriate, based on the stock-flow consistent modelling tradition initiated by Godley and Lavoie (2007). We use a simple version of this model to analyse the impact of quantitative easing and of an increase in interest rates on a small open economy.

The impact of monetary policy follows from three channels. The most important channel is widely recognised to be the portfolio rebalancing channel, where banks, other financial institutions and other holders of financial assets will rebalance their portfolios in response to changes in assets yields. For instance, when the Central Bank is buying government bonds, this will reduce the yields of other assets and the sellers of these bonds will rebalance their portfolios towards higher holdings of these other assets. Next to that the assets purchases of the Central Bank will also lead to a depreciation of the exchange rate following an increase demand for external assets by residents or repatriation of funds by non-residents (Gambetti and Musso, 2017). The portfolio rebalancing channel can also be triggered by easing banks' refinancing conditions at the Central Bank, allowing market based funding by Central Bank borrowing. However, the resulting encouragement of borrowing and expenditure for investment and consumption is usually identified with the direct pass-through channel (ECB, 2015). This channel is also operative according to Gambetti and Musso (2017), although to a lesser extent than the portfolio rebalancing channel. Finally, the signalling channel, which works through expectations, is thought to be ineffective by these authors.

The portfolio rebalancing channel is also an important mechanism to recognise the impact of low interest rates on the economy and to analyse the impact of an increase in interest rates. As we elaborate below, an application to the Dutch economy requires to extend the assets in the household portfolio to real estate and pension claims and to recognise that firms do not only invest in physical capital, but also in financial assets through direct investments abroad. Next to that, the banking sector plays an important role in providing mortgages to households, loans to firms and harbouring deposits and participations held by both households and non-residents. Also pension funds manage a portfolio of financial assets, held both domestically and abroad, to cover the pension claims of households. Finally, the Central Bank acts as lender of the last resort and holds Dutch government bonds – it can manipulate the interest rate and buy additional Dutch government bonds to stimulate the economy (quantitative easing). Moreover, the Central Bank accumulates foreign reserves, including the Target 2 balances. We present in section 2 some stylised facts for the Dutch economy to emphasise the importance of these various sectors and the portfolios indicated.

As we already indicated above, the widely used New Keynesian macroeconomic models do not recognise this variety of assets, which makes it hard to analyse the impact of the interest rate through the portfolio rebalancing channel in full. We illustrate this in section 3 for the model DELFI used by DNB to analyse the impact of a change in the interest rate as described in DNB (2017b) – this analysis attracted a lot of publicity in Dutch news.

In section 4 we then present our own model, based on the tradition of stock flow consistent modelling and building on our earlier models presented in Meyers, Muysken and Sleijpen (2015, 2016) and Meijers and Muysken (2016) – from hereon MMS (2015, 2016) and MM (2017). We use this model to simulate impact of quantitative easing and changes in the interest rate on the Dutch economy. The simulation results presented in section 5 illustrate the richness of the model. Concluding remarks are made in section 6.

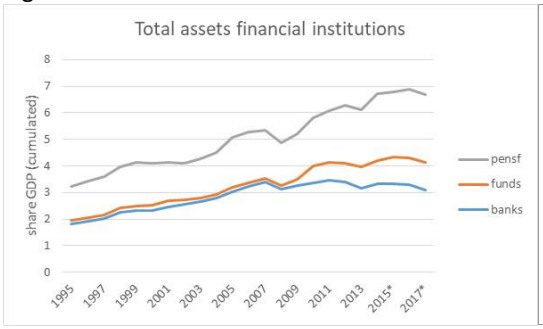
2 The Dutch economy and quantitative easing in the Netherlands, some stylised facts[1]

In this section we present stylised facts for the Netherlands which will influence the choice of the sectors in our model, the composition of the balance sheet of each sector and the flows between the sectors. We discuss the financial institutions in section 2.1, households, firms and government in section 2.2 and the foreign sector in section 2.3. We then conclude with a description of the role and the potential impact of quantitative easing in section 2.4.

2.1 Financial Institutions

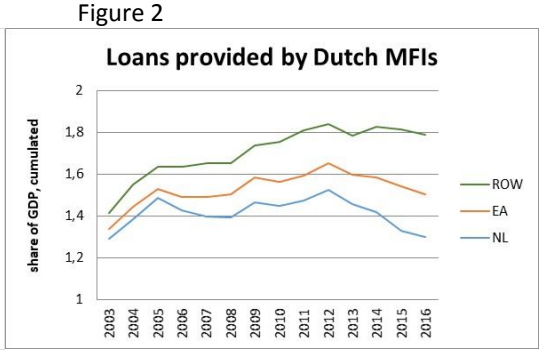
From Figure 1 one observes that the Netherlands has a very large financial sector compared to European standards: that is, the assets of the Dutch financial sector are almost 700 per cent of GDP whereas the average in the Euro Area is below 500 per cent.[2,3] As is elaborated in Bezemer and Muysken (2015) this is mainly due to the presence of large pension funds (and investment funds, as we elaborate below).

Figure 1



Source: CBS statistics

Figure 2



Source: DNB statistics

From the composition of the financial sector presented in Figure 1, one observes that the size of the banking sector (banks – MFIs in statistical terms) increased relative to GDP, from below 200 per cent in 1995 till above 300 per cent in 2006. However, after the financial crisis in 2008 it has stagnated around that level. Interestingly enough, this stagnation has initially been compensated by the increasing importance of investment funds (funds), which took over the role of banks in asset management for pension funds and to some extent for households too. Together total assets of banks and funds are at a level of over 400 per cent of GDP.

The remaining part of the financial sector consists of pension funds and insurance companies, which together have increased consistently relative to GDP, from 150 per cent of GDP in 1998 to about 250 per cent in 2015. Given their importance for the financial sector in the Netherlands, we discuss the banking sector (MFIs) and the pension funds in more detail below.

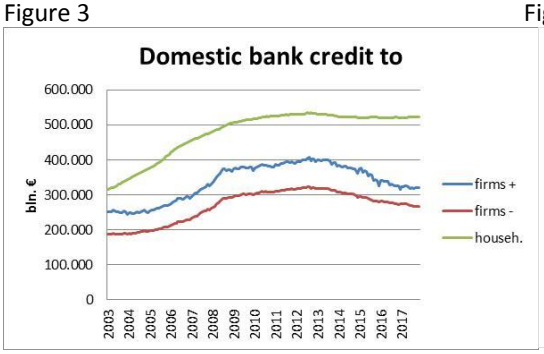
[1] Parts of this section also appeared in Meijers and Muysken (2016).
[2] Some fluctuations in the various statistics are due to definition changes.
[3] We ignore the so-called special financial institutions (SFI) which comprise both a large shadow banking sector and many companies ("brievenbus firma's") that are established in the Netherlands for tax reasons. The total assets (and liabilities) of these institutions vary in recent years 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.

The banking sector

It has been suggested that when foreign partners sell their bonds to DNB after quantitative easing, these partners do not hold the resulting money abroad, but reinvest it in the Dutch financial system (ECB, 2017). In order to verify this we have used DNB data on credit issued by banks to the private sector. As is illustrated in Figure 2, this credit is mainly issued to Dutch counterparts. But the amount of credit issued to Dutch counterparts has decreased relative to GDP since 2013. This decrease is compensated by credit to the foreign sector. The foreign sector share has increased steadily from around 10 per cent of GDP in 2003 to over 50 per cent in 2016.

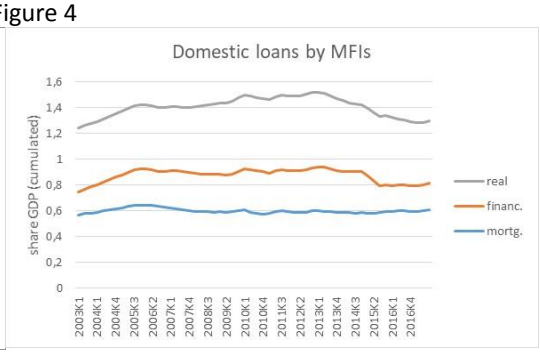
The decrease in domestic credit is further analysed in Figures 3 and 4. From Figure 3 one observes that bank credit to households in the form of mortgages increased in size till 2010 and stagnated afterwards. Credit provided to firms also increased initially, but altogether at a much lower level.[4] After 2013 credit provided by banks to firms started to decline.

Figure 3



Source: DNB statistics

Figure 4



Source: DNB statistics

Another way of analysing the domestic credit provision by banks is provided by Bezemer (2017). Following his analysis, total domestic credit provision by banks to the private sector is divided in to 'real credit provision', which consists of credit to private and public enterprises and households (excluding mortgages), and 'financial credit provision'. The latter includes next to mortgages to households, loans to pension funds and other financial institutions. Bezemer finds that banks have been providing systematically more credit to the domestic financial sector compared to the domestic real sector, which he attributes to speculation on asset price increases. The increasing financial fragility makes the economy increasingly vulnerable to shocks. Bezemers observations are consistent with Figure 4: From 2004 onwards banks have provided around 90 per cent of GDP to the domestic financial sector (including mortgages).[5,6] However, since 2012 the share of loans provided to firms has dropped from 58 per cent of GDP towards 48 per cent in 2017.

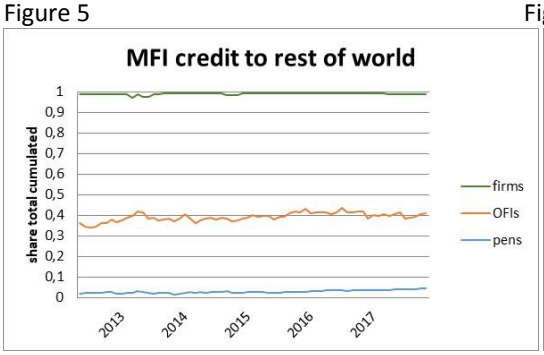
[4] The label 'frims +' is including cash-pooling, whereas the label 'firms –' is excluding cash pooling. The mortgage data are provided by DNB on a monthly basis, corrected for securitizations and breaks.

[5] A change of definition occurred in 2015:1, causing a drop in the share of the domestic financial sector and an increase in the share of the domestic real sector.

[6] The data on mortgages are taken from the balance sheet data, implying a lower share of mortgages provided. Whereas the data in Figure 7 lead to a declining share of mortgages provided by MFIs, we find here a stable share.

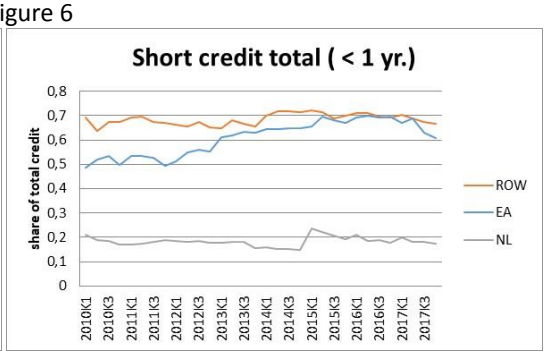
The DNB data also allow us to ascertain to which types of institutions the Dutch MFIs provide credit. One observes from Figures 5 that the credit provided to the rest of the world is almost entirely held by foreign OFIs and firms – a similar picture holds for credit provided to the Euro Area. It is remarkable that the credit is not provided to foreign pension funds. But as we have seen in Muysken, Bonekamp and Meyers (2017), OFIs are used extensively by pension funds to manage their assets. Hence part of the large share of loans held by foreign OFIs probably is implicitly held by foreign pension funds.[7]

Figure 5



Source: DNB statistics

Figure 6



Source: DNB statistics

One should realise that the credit provided by MFIs to the rest of the world and the Euro Area are predominantly short term loans, as is illustrated in Figure 6. While Dutch borrowing consists only for about 20 per cent of short-term credit, i.e. less than one year, the average share of short-term credit in total credit to the other countries of Euro Area increased from 50 percent in 2010 to 70 percent in 2017. The rest of the world consistently borrowed about 70 per cent of total credit provided short since 2010. This illustrates how volatile foreign held credit can be for the Netherlands. Within one year over 20 percent of the total outstanding credit provided by the Dutch financial sector can be withdrawn by foreign countries. This short-term position is certainly not only due to the foreign OFIs which hold domestic credit, but also due to the position of foreign firms. While Dutch firms hold about 25 – 30 per cent of their credit positions less than one year, foreign firms increased their short-term positions from around 60 per cent in 2010 to around 80 per cent in 2017. This illustrates the speculative nature of positions that foreign firms hold at Dutch banks. We return to this issue when we discuss the deposit financing gap problem of banks in section 2.2.

Pension funds

The Netherlands has a funded pension system according to which wage earners (and employers) are obliged to contribute to their pension fund by paying a premium based on their wage. When retiring, the pensioners receive a pension benefit. As a consequence the Netherlands has a very large pension sector.[8] For that reason we elaborate the structure and problems of the pension funds below.

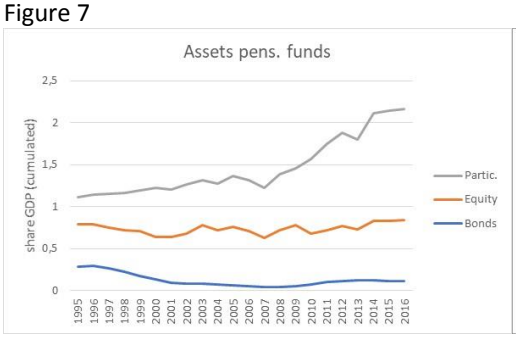
The composition of assets of pension funds is presented in Figures 7 and 8. As is illustrated in Figure 7 the share of equity in total assets of pension funds increased consistently over time – for a further

[7] The data on OFIs also include SPVs.

[8] Also the majority of the insurance sector consists of life insurances, which have a financing structure which is quite similar to that of pension funds.

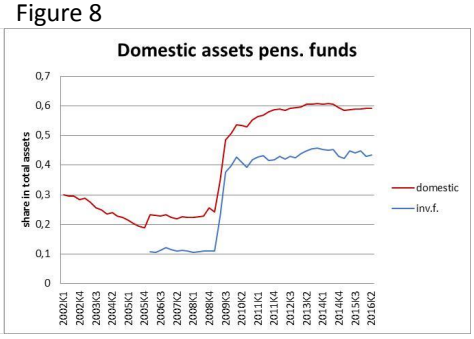
discussion of the historical development see Bezemer and Muysken (2015). As we already mentioned above, from 2009 onwards a substantial part of the portfolio of pension funds is handled by investment funds: the corresponding assets appear as participations on the balance sheet of pension funds. However, only 20 per cent of the portfolio of investment funds consists of bonds – hence implicitly equity remains dominant on the pension funds' balance sheet.

Figure 7



Source: DNB statistics

Figure 8

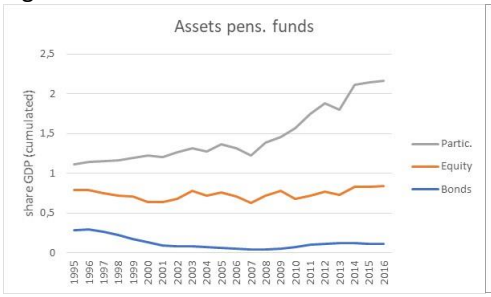


Source: DNB statistics

Another characteristic of the assets of pension funds is the foreign exposure, as appears from Figure 8. Till 2008 the share of domestic assets of pension funds decreased till below 25 per cent of total assets. The increase till 60 per cent after 2008 is due to the introduction of investment funds, which are registered domestically. However, investment funds only invest about 20 per cent of their assets domestically. As a consequence indirectly the share of foreign assets remains about 75 per cent of the total assets of pension funds.

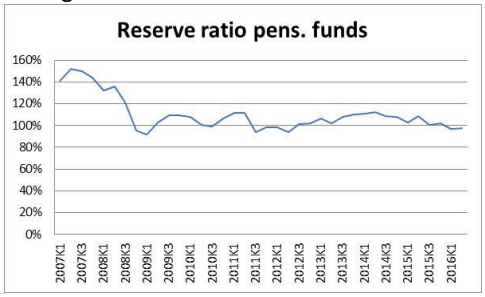
The returns on equity and participations are presented in Figure 9.

Figure 9



Source: CBS statistics

Figure 10



Source: DNB statistics

The liabilities of the pensions sector are predominantly liabilities to households. One should realise that future liabilities of pension funds are discounted at the market interest rate. This implies that a decrease in the interest rate then leads to higher liabilities on the balance sheet of the pension fund. Thus the low interest rate from 2008 onwards explains why the liabilities of the pension funds have increased dramatically after the financial crisis: from 120 per cent of GDP in 2007 to 180 per cent in 2015 – see Figure 11 below. As a consequence the reserve ratio of pension funds has fallen below the critical threshold of 110 per cent in recent years – see Figure 10. This forced pension funds to increase contributions and decrease benefits. It also initiated a debate about the desirability and the nature of the funded pension system.

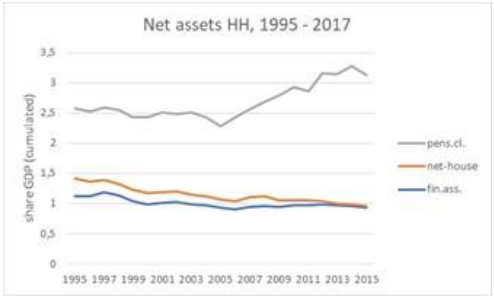
2.2 Households, firms and government

Next we present stylized facts on the balance sheets of households, firms and government.

Households: pension claims and the deposit financing gap

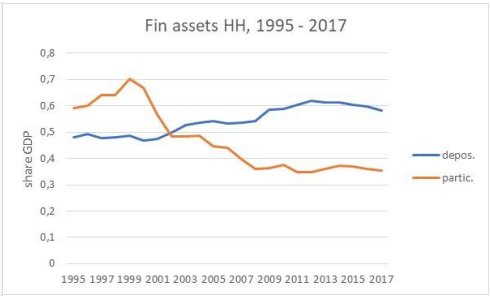
Including homeownership net of mortgages, the assets of households consist of deposits, financial assets and claims on pension funds, including life insurance – see Figure 11. The composition of financial assets is presented in Figure 12, which shows how participations systematically declined since the dot- com crisis in 2000.[9] This is consistent with the decrease in voluntary individual savings, which is related to the increase in housing prices and increased forced savings due to the funded pension system as explained in MMS (2015). The forced savings in the form of net pension contributions by households contributed to large pension claims – over 100 per cent of GDP prior to 2008. The sharp increase in these claims (including life insurances) after 2008 follows from the low interest rate as we discussed above.

Figure 11



Source: CBS statistics

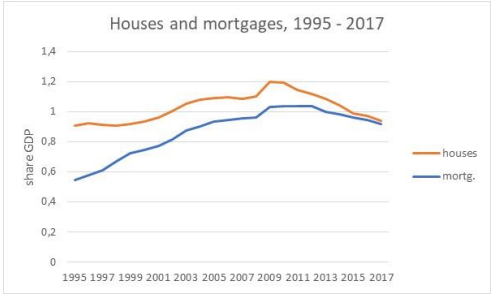
Figure 12



Source: CBS statistics

The liabilities of households consist predominantly of mortgages. Comparing Figures 13 and 14, one observes how the increase in the mortgage burden reflects increased house prices till 2009. Between 1995 and 2008 these prices increased by 250 per cent as can be seen from Figure 14. We explain in MMS (2015) how this reflects both the eagerness of banks and other financial institutions to provide mortgages and tax advantages which allow interest payments on mortgages to be deducted from pre-tax annual income. The house price bubble did burst after the financial crisis and

Figure 13



Source: CBS statistics

Figure 14

Source: CBS statistics

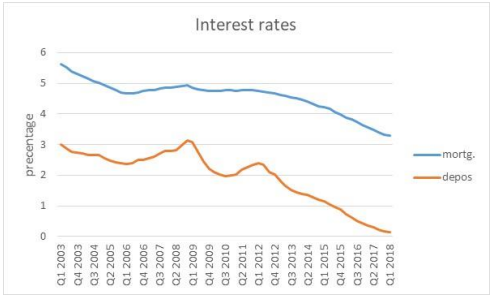
[9] Only 20 per cent of these assets are financed through investment funds – hence we ignore this for households.

house prices decreased after 2007. Mortgages stagnated and started to decline after 2012 because mortgage repayments increased sharply due to on the one hand the low interest rate and on the other hand due to tax incentives allowing gift tax deduction by rich family members to house owners.

House prices started to increase again in 2013 fuelled by the low interest rates (and stagnating supply of new houses). DNB is consistently warning against the potential dangers of low interest rates as we mentioned in section 1. This warning is also illustrated in Figure 13: the mortgage debt relative to the value of the house for house-owners with a mortgage has increased from 60 per cent in 1995 to over 95 per cent in 2017. In spite of the recent rebound of house prices, 32 per cent of all households in the Netherlands had a mortgage debt larger than the value of the house in 2016, compared to 13 percent in 2007.

A remarkable feature is that on the one hand households on average have a large mortgage debt, mainly held by banks, and on the other hand have a large claim on pension funds – compare Figures 11 and 13. An important issue in the discussion on the potential reforms of the funded pension system is to look for ways to net these assets and liabilities out, at least partially.

Figure 15



Source: CBS statistics

Finally, one observes from Figure 15 how both the interest rate for deposits and that for mortgages have decreased over time. Nonetheless deposits held by households remained relatively stable relative to GDP and increased even somewhat (Figure 11). This reflects the strong 'reliable' nature of household deposits as source of funding by banks. But comparing the share of deposits of 70 per cent of GDP with a provision of mortgages by banks, which increased from about 60 per cent of GDP to over 90 per cent of GDP, illustrates the deposit financing gap discussed extensively in MMS (2015). To finance the mortgages, banks have to rely increasingly on foreign borrowing. The latter is due to its speculative nature (Figure 6) a highly instable source of financing, which contributes to financial instability.

Firms: savings are invested in financial assets

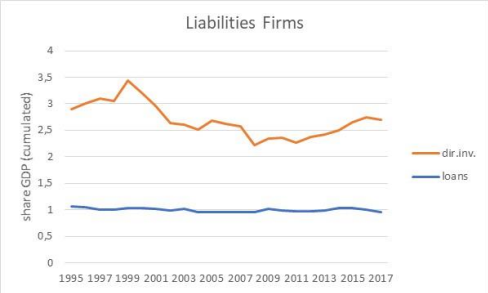
In a simple model of the economy the assets of firms consist of physical capital and deposits at banks and firm savings are invested in physical capital. However, from Figure 16 one observes that a considerable part of firm assets consist of financial assets, which we identify with direct investments abroad as is explained in Muysken, Bonekamp and Meijers (2017). The financial liabilities of firms consist mainly of loans and equity – see Figure 17.

The majority of firm financial assets are held by multinational corporations and not by the small and medium firm enterprises. Bezemer and Muysken (2015) point out in that context that a dichotomy exists between these two types of firms. For the multinationals holds for instance that non-financial assets covered around 175 per cent of their value added over the period 2000 -2014, while the financial assets increased from 450 per cent in 2000 to 800 per cent in 2012.

Figure 16

Source: CBS statistics

Figure 17



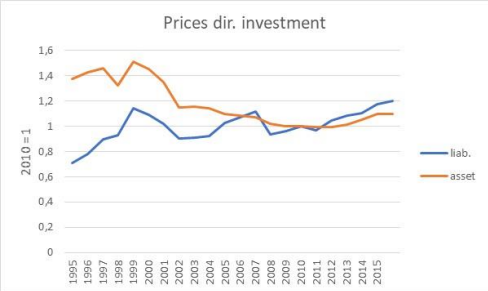
Source: CBS statistics

It is illustrated in Figure 18 that firms' savings, which consist of retained profits, are predominantly used to invest in direct investments abroad and not in physical capital ('invest.' in the figure). The other investments in physical capital in the domestic economy are made by government and households.

Figure 18

Source: CBS statistics

Figure 19



Source: CBS statistics

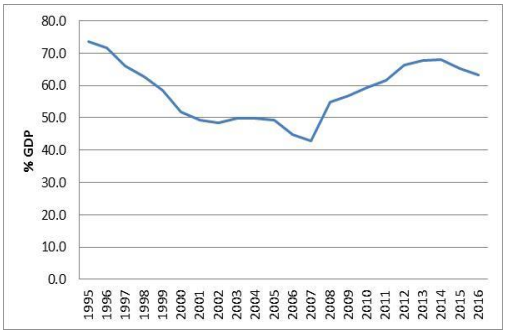
Finally, the implicit prices of direct investment are presented in Figure 19. The sharp drop in the price of direct investments on the asset side is consistent will a sharp fall in the price of assets held abroad after the dot-com crisis. Direct investment from abroad has performed consistently better.

Government: borrows mainly abroad

As in most countries government debt increased sharply after the financial crisis, partly due to the working of the automatic stabiliser and also to the bailing out of banks – see Figure 20. Government reacted by decreasing expenditures and increasing taxes – see Figure 21. Although one might argue that this exacerbated the recession and hence had an adverse effect on government debt,[10]

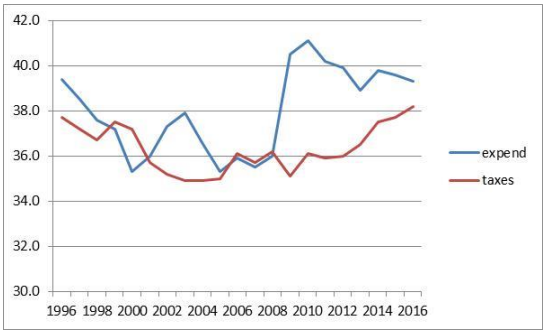
[10] See de Grauwe and Yi (2016) and Stiglitz (2016).

Figure 20 Government debt, 1995 – 2016



Source: CPB

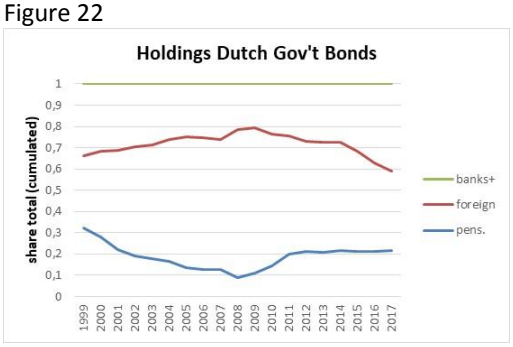
Figure 21 Expenditures and taxes, 1996 – 2016



Source: CPB

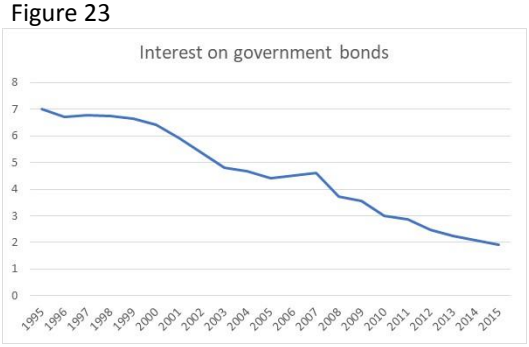
government debt started to decrease relative to GDP after 2014. Finally an important observation is that till 2015 the majority of government debt is held abroad – see Figure 22. The major domestic holders of bonds are banks (including DNB) and pension funds. We discuss the situation after 2015 below in the context of quantitative easing.

Figure 22



Source: CBS statistics

Figure 23



Source: CBS statistics

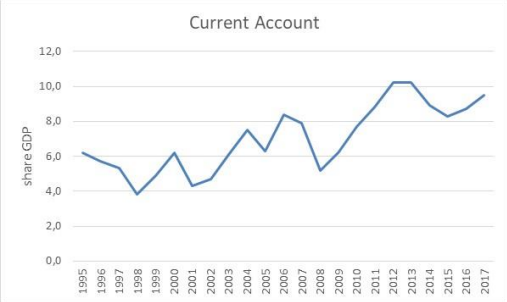
From Figure 23 one observes how the average interest on outstanding government debt has increased consistently over time.

2.3 *The foreign sector*

The Netherlands traditionally has a current account surplus. However, in recent years this has increased to unprecedented heights, almost 10 per cent of GDP – see Figure 24. The recent fall to 8 per cent is due to lower profitability of firms (non-financial institutions): they generated less return on their foreign assets and also distributed considerably less profit to their foreign companies (DNB, 2016c). This tendency reversed after 2015.

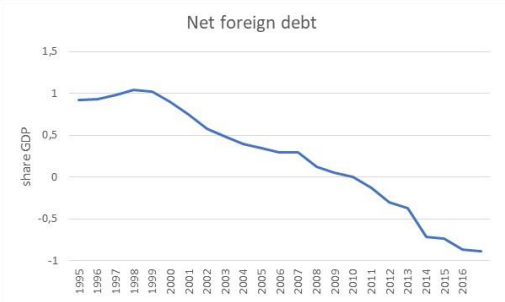
From Figure 25 one observes how net foreign debt has decreased over time, consistent with the persistent current account surplus. Currently net foreign assets are over 80 percent of GDP. Actually net external debt is reasonably close approximated by the net positions of securities plus direct investment as is observed in Muysken, Bonekamp and Meijers (2017). In the discussion above we have indicted how the various other sectors do hold positions abroad.

Figure 24



Source: CPB statistics

Figure 25



Source: DNB statistics

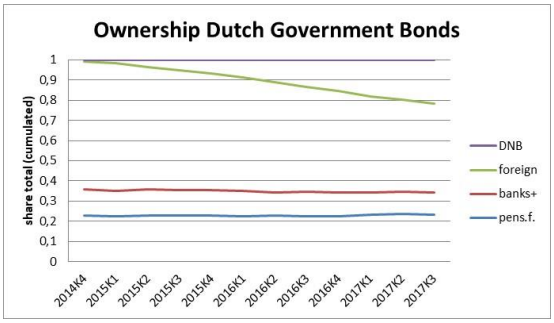
2.4 The impact of Quantitative Easing

As is well documented, the QE operations are mainly carried out under the responsibility of the National Central Banks. That is each NCB buys bonds issued by its own government on the secondary market, according to the share of the various countries in the ECB's capital. However, the related profits (and risks) are not borne according to capital share, but accrue to the National Central bank.

In that context DNB started to buy Dutch government bonds from the first quarter of 2015 onwards. This resulted in accumulating by DNB an amount of bonds around 10 per cent of GDP by the end of 2017. An interesting question then is how that affected the economy.

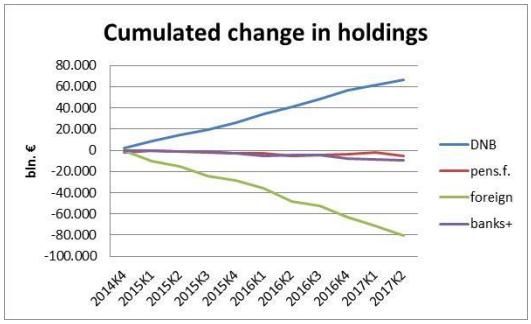
The conventional wisdom is that DNB buys these bonds from pension funds, through the banking system, which increases the quantity of money in the economy – i.e. pension fund deposits by banks. Then "It is expected that the institutional investors will use part of these increased deposits to purchase other financial assets, causing a wider fall in interest rates. This should improve the funding conditions for businesses and households, encouraging them to spend more."(DNB, 2015)

Figure 26



Source: DNB

Figure 27



Source: DNB

Recently the DNB has provided data which show how the holdings of government bonds by the various sectors in the economy are affected – see Figure 26. The quarterly data, which are only available from 2014:IV onwards, show that not only pension funds, but also banks hold a very stable

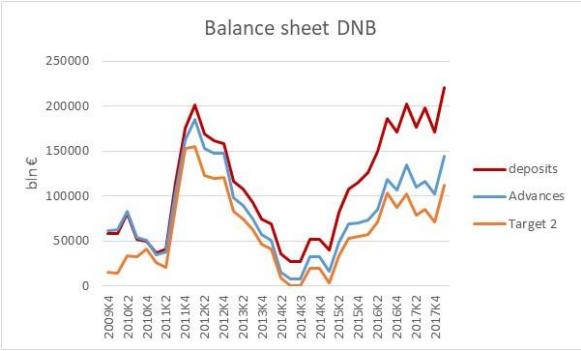
share of government bonds.[11] That is, the bonds bought by DNB are sold by foreign counterparties. This phenomenon is illustrated in a different way in Figure 27, which shows the cumulated change in bond holdings of the four agents. One observes that since 2014 both banks (excl. DNB) and pension funds have held on to their bonds and the acquisition by DNB was almost entirely facilitated by foreign partners. This has been recognised by DNB as we discuss below.

A relevant question then is whether the presumed mechanisms of QE still work when foreign investors sell Dutch bonds. Does it still result in "a wider fall in interest rates [which] should improve the funding conditions for businesses and households, encouraging them to spend more."(DNB, 2015)

The balance sheet of DNB

Taking a broader perspective, total assets of the DNB soared after the financial crisis. One observes from Figure 28 how after 2011 this was driven by the increase in Target2 balances – the main component of advances to banks issued by DNB. The increase in Target2 balances is a result from the capital flight from Southern Europe – see also DNB (2016a). Effectively the foreign sector transferred money to the domestic banks, increasing their positions in those banks, at the expense of increased liabilities towards DNB, which appear as increased reserves ("Target2") on the asset side of DNB's balance sheet. The domestic banks in turn increased their deposits at DNB (or paid back advances), which appears as liabilities ("depsosits") on the balance sheet of DNB. After the situation calmed down in 2014 we observe a new surge in Target2 balances coinciding with the QE programme from the first quarter in 2015 onwards.

Figure 28



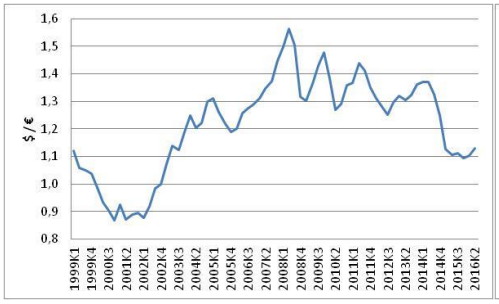
Source: DNB statistics

As can be seen from Figure 28 deposits of domestic banks ("dep banks"), liabilities at DNB, follow Target 2 closely till 2015 – this is consistent with the capital flight from Southern Europe. An interesting observation then is the growing gap between deposits of domestic banks from 2015 onwards. This gap is filled by government bonds acquired by the DNB – see also Figure 22 above. This is consistent with foreign selling of domestic bonds to DNB and replacing this by positions held at the domestic banks. In that case the deposits banks hold at DNB equal Target 2 balances plus government bonds held by DNB. Nonetheless, the increase in Target2 balances after 2015:1 can be

[11] The indication 'banks+' in the figures is because we included here the very small share of bonds held by households and firms.

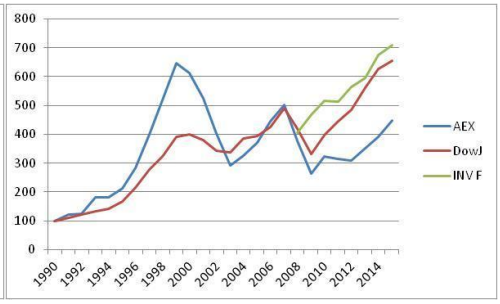
interpreted again as capital flight: the extra funds made available abroad through QE by foreign central banks is invested domestically.

Figure 29 The exchange rate ($/€) 1999:I – 2016:II



Source: DNB statistics

Figure 30 Stock indices 1990 – 2015



Source: DNB statistics

The indirect effects of QE appear through the various channels discussed in section 1.1, i.e. the mortgage burden for households and the development of house prices, the debt of firms and the decreased reserve ratio for pension funds. Two aspects which we have not presented yet are the depreciation of the Euro, which can be observed from Figure 29, and the increase in stock prices. The latter is presented in Figure 30 for the Dow-Jones index, the AEX index and from 2008 onwards returns on investment funds.

3 The DELFI model from a stock-flow consistent perspective

We evaluate in this section the DELFI model (DNB, 2011) from a stock-flow consistent perspective to illustrate the notion of stock flow consistent modelling. The DELFI model is presented here, because the DNB is a vocal participant in the debate on the impact of quantitative easing in the Dutch economy – which it considers to be negative. Its opinions are based on the DELFI model (DNB, 2017b). Our evaluation points out inconsistencies and gaps in the model, which we summarise at the end of this section. One should be aware that similar points of critique can be made when evaluating most other structural macroeconomic models used in economic policy advice.[12]

In the DELFI model five sectors are distinguished: households, firms, government, pension funds and the foreign sector. This is quite similar to many stock-flow consistent models, although we will argue that a banking sector should be added to complete the model.

In our discussion of the various sectors we focus on the way assets and liabilities of the sectors are modelled, as well as their accumulation – this is what constitutes the wealth of each sector. We concentrate in our discussion on the long run properties of the model.

Households

The assets and liabilities of the household sector are outlined clearly, distinguishing on the asset side between financial wealth and housing wealth. The amount available for investment in financial wealth follows from savings plus capital gains minus investment in housing.

Financial wealth consists of equities and other financial assets. The composition of financial wealth over its two components is determined by a Tobin portfolio model. It is not clear which parties have issued the equities and other financial assets held by the households. In the portfolio allocation only share prices and the long term interest rate play a role. However, the interest rate on the other financial assets "is a weighted average of the long term interest rate and the short term interest rate, but it also depends on the cyclical stance of the economy" (p.64) – this is inconsistent with the portfolio model which only uses the long term interest rate. Both long term and short term interest rates as well as stock prices are exogenous.

Housing wealth is determined by an income effect and a price effect: the ratio of housing investment to private consumption is negatively influenced by the house price relative to the consumption price. Surprisingly the house price is fully determined by the amount of mortgage credit, reflecting the financing restrictions of households (p. 82). "This rather unconventional way to model house price dynamics captures the Dutch data remarkably well."(p. 20)

On the liabilities side households have mortgage debt and other debt – since the latter is very small, we ignore that in our discussion. Mortgage debt is modeled in such a way that mortgage payments are an exogenous share of disposable income of households – this exogenous share shows an upward-sloping logistic trend over time. Next to that, mortgage payments also depend on the mortgage interest rate net of taxes. The mark-up of the mortgage interest rate over the long term

[12] An exception is Burgess et al. (2016) who developed a tock-flow consistent version of the Bank of England model.

interest rate depends positively on the utilization rate, to reflect pro-cyclical pricing behavior of banks. However, there is also a negative trend in the mark-up, "possibly reflecting increased competition in the market for mortgages."(p. 83)

It is not clear from the description of the model how the ratio of mortgages to housing wealth develops over time and what the constraints are to mortgage provision by banks and other parties. It is also not clear which parties, domestic and foreign, have issued these mortgages and other debt to the households.

Firms

The production side of firms and the corresponding demand for factors of production is modeled in an elaborate way. However, with respect to the wealth formation and its composition the model is very poor. Of course there is an elaborate investment function, which determines the demand for capital. Although this is not spelled out, our impression is that physical capital determined by the investment function is the only item on the asset side of the firms' balance sheet. Firms do not hold financial assets in the model, although in the Dutch economy they do hold a considerable amount of financial assets, as is discussed in MMS (2016). In the verbal description of the model we find that "firms finance investment with 25 per cent equity and 75 per cent debt." (p. 14) – this statement is repeated on p. 56 when defining the price of capital. However, in the equation part we find only references to loans. The statement "Following the pecking-order theory of corporate finance, the demand for loans in decreases as internal funds become more abundant."(p. 59) is used to motivate why profitability enters negatively in the demand function for loans. We interpret this statement as the use of retained profits to finance investment. However, we could not find any description of the financing of the capital stock apart from the quotes above.[13] Neither could we find information on equities issued by firms, nor on the role of retained profits in financing firms. Our impression is that the only liability of firms is loans, as defined in equation (23) on p. 59. It is not clear to us why the loans are included in the model, since the amount of loans does not affect other variables. Nor is it clear which parties issue these loans. The mark-up of the loans interest rate over the long term interest rate depends on the credit spread which equals the exogenous credit spread in the US minus a factor related to the profit share of firms in national income.

Government

For government the accumulation of government debt is described as the sum of government deficit and an exogenous deficit debt adjustment. However it is not indicated in which financial assets the debt is issued, nor by whom the debt is held. The only indication follows from the statement that the change in interest paid by government follows for 90 per cent the long term interest rate and for 10 per cent the short term interest rate.

Foreign sector

The accumulation of foreign assets follows from exports, factor income received and capital gains. There is no specification of the composition of these assets. But capital gains depend on the world

[13] We ignore for brevity sake the interesting discussion of credit rationing of investment during times of financial stress (DNB, 2011, p 61 – 62).

stock price and the German long term interest rate, while received factor income depends on the German long term interest rate and both the US and the German short term interest rates.

Similarly, the accumulation of foreign liabilities follows from imports, factor income paid and capital gains. Also there is no specification of the composition of these liabilities. Factor income paid to the rest of the world depends on “the Dutch short and long term interest rates" while foreign “capital gains or losses are captured by the change in Dutch stock prices and the long term interest rate”.(p. 88)

Pension funds

The assets side of the portfolio of pension funds is specified. It consists of bonds, loans and shares. However, these assets are not distributed in a portfolio model – as in the case of households, described above – but their shares are fixed. Bonds constitute 20 per cent of assets and loans and shares 40 per cent each. This is not further motivated. It is also not clear which parties issued the assets held by pension funds, although the shares follow the world share price index (of which 80 per cent is hedged against exchange rate risk) and the loans follow the domestic long term interest rate.

Surprisingly there is also no discussion of the forced savings for households implied by the obligatory participation in pension funds and its impact on consumption – see MMS (2015) for an elaboration of this point.

Conclusion

It is interesting to observe that in some sectors assets and liabilities are carefully identified, for instance households and pension funds, whereas in others they are not, such as firms and the foreign sector. Only households have an asset portfolio which is determined endogenously. In no cases it is clear how the connection is between the assets of one sector and the liabilities of another sector. For instance it is not clear which sector has provided the mortgages held by households (the banking sector is not modelled and the pension sector does not identify mortgages as an asset). Nor is it clear who has provided the loans taken by firms (the banking sector is not modelled and nor the pension sector nor the foreign sector do identify loans to firms as an asset).

As a consequence the returns on assets held by the various sectors and the interest paid out to other sectors are also not identified, except in a very ad hoc way, as indicated above. Next to that most interest rates and all stock prices are exogenous. The only endogenous interest rates are those on mortgages and loans to firms. Moreover, the house price is endogenous, albeit modelled in an ‘unconventional’ way.

4 A detailed description of the model

In this section 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 development of the Dutch foreign net assets position and the small impact of QE on the Dutch economy. We present subsequently the model for the pension funds, households, firms, government, the foreign sector and the banking sector, including the central bank. For each sector the balance sheet is presented and at the end of this section 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.

4.1 *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.[14] 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.

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 $p_{pf}.WB$, and the pensioners receive each year $b_{pf}.\ WB.\ N^O/\ N^Y$. or, from the view of the pension fund: Each year the pension fund pays out $PF_b = b_{pf}.\ WB.\ N^O/\ N^Y$ and receives $PF_c = p_{pf}.\ WB$ 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 $i_{ass,pf}.Ass_{pf}$:[15]

$$Y_{pf} = i_{ass,pf}.Ass_{pf} \qquad (1)$$

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

$$S_{pf} = Y_{pf} - (PF_b - PF_c) = (PF_c - PF_b) + i_{ass,pf}.Ass_{pf} \qquad (2)$$

As a consequence 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}.

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

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;[16] 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:[17]

$$p'_{pf}C_{pf} = b_{pf}WB.\frac{N^o}{N^y}\sum_{t=0}^{T^o}\frac{1}{(1+r^o)^t} \tag{3}$$

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:

$$\Delta p'_{pf}C_{pf} = (PF_c - PF_b) + C_{pf,-1}\Delta p'_{pf} \tag{4}$$

and the change in the implicit price is equal to:

$$\frac{\Delta p\prime_{pf}}{p\prime_{pf,-1}} = \frac{\Delta p\prime_{pf}C_{pf} - (P_{fc} - P_{fb})}{p\prime_{pf,-1}C_{pf,-1}} \tag{5}$$

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 (3).

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 f_{pf}^{min} of liabilities in excess of their assets.[18] That is, the required nominal assets are:

$$Ass_{pf}^{min} = (1 + f_{pf}^{min}).p'_{pf}C_{pf} \tag{6}$$

We assume that if the required assets are below their target level, the pension fund has to adjust its contribution rate upwards and its benefit rate downwards, such that the target level is reached

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

[17] 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 L_{pf} will not change in an extended specification of equation (1).

[18] 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%.

within three years.[19] Also we assume that when the assets are relatively large, say a fraction f_{pf}^{max}, a downward adjustment of the contribution rate and an increase of pension benefits of the same magnitude are initiated.

The composition of assets and liabilities

Savings minus net contributions by households are used for asset accumulation. From equation (3) then follows:

$$\Delta B_{pf} + pa.\Delta A_{pf} + pe_a.\Delta E_{apf} = i_b.B_{pf} + i_a.p_a.A_{pf} + ie_{apf}.pe_a.E_{apf} \quad (7)$$

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_a, and the corresponding returns are i_b, i_a and ie_{apf}. The right-hand side of equation (7) constitutes the returns on assets of pension funds in equation (1).

As a consequence the balance sheet of the pension fund has the structure as presented in Table 1. The change in net-worth V_{pf} is given by:[20]

$$\Delta V_{pf} = S_{pf} - C_{pf,-1}.\Delta p'_{pf} + A_{pf,-1}.\Delta p_a + E_{apf,-1}.\Delta pe_a \quad (8)$$

Where the last two elements of equation (8) 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 1 Balance sheet of the pension funds

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

The composition of financial assets follows from a Tobin type portfolio model. This implies that wealth net of liabilities:[21]

$$VN_{pf} = V_{pf} - p'_{pf}.C_{pf} = B_{pf} + p_a.A_{pf} + pe_a.E_{apf} \quad (9)$$

is distributed over financial assets as follows:

$$B_{pf}/VN^e = \lambda_{00} - \lambda_{01}.r^e_A - \lambda_{02}.r^e_E + \lambda_{03}.r^e_B \quad (10)$$

$$pa.A_{pf}/VN^e = \lambda_{10} + \lambda_{11}.r^e_A - \lambda_{12}.r^e_E - \lambda_{13}.r^e_B \quad (11)$$

[19] 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.

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

[21] The subtraction of claims on pension funds is new compared to MMS (2015).

$pe_a.E_{apf} = VN_{pf} - B_{pf} - p_a.A_{pf}$ (12)

The variables r^e_A and r^e_B are the expected real interest rates for participations and bonds, respectively, and r^e_E is the expected return on equity. The expected values of variables are based on an adaptive expectations mechanism:

$X^e = X_{-1} + \xi.(X_{-1}^e - X_{-1})$ (13)

The above items constitute the balance sheet of the households, presented in Table A5. One should realise that when presenting the balance sheet this way, claims to pension funds L_{PF} are included in the household wealth V_h.

4.2 *Households*

Important components of household wealth in the Netherlands are housing wealth net of mortgages and pension wealth. We therefore discuss these two components first.

The housing market and mortgages

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:

$$\Delta \ln p_{ht} = \psi_t + \alpha \Delta \ln Y_t^h + (1-\alpha)\Delta \ln Y_t^e - \Delta \ln[i_{MO}(1-\tau_h \tau_{MO}) + f_{MO}] - \Delta \ln HS_t \quad (14)$$

where Y_t^h is disposable income (not net of mortgage payments) and Y_t^e is expected income for next year. The one but last term 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[22] – due to the highly regulated housing market in the Netherlands. The crucial parameter in the equation, however, is the affordability Ψ, which is the total amount of housing costs that the household is able to spend (as perceived by banks), relative to its disposable income. The housing bubble was caused by an increase of Ψ and in reaction to overstretching their balances banks have decreased Ψ.

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:

$\Delta MO = \varphi.p_h.\Delta HS + \varphi.\Delta p_h.HS - morc.MO_{-1}$ (15)

where *morc* is the share of mortgage repayments.

[22] Equal to the 10-years moving average of past GDP growth.

Wealth of households

Household wealth consists of housing wealth, net of mortgages and depreciation, pension wealth and financial wealth. Housing wealth is discussed above.

We discussed the pension wealth of households already in section 4.1, it consists of the claims on pension funds $p'_{pf}C_{pf}$. However, these claims do not affect the wealth effect on consumption, although they affect savings behaviour as we discuss below. Finally we assume with respect to financial wealth that household hold deposits M_h and invest in participations at financial institutions $pa.A_h$. The above items constitute the balance sheet of the households, presented in Table 2.

Table 2 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

With respect to the portfolio of wealth, we assume that housing wealth is determined separately from financial wealth, as discussed above. Pension claims are also determined separately as discussed in section 4.1. 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 wealth VN_h net of housing minus mortgages and net of claims on pension funds:[23]

$$VN_h = V_h - (p_h.HS - MO) - p'_{cf}.C_{pf} = M_h + p_a.A_h \quad (16)$$

Is distributed over financial assets as follows:

$$pa.A_{pf}/VN^e = \lambda_{10} + \lambda_{11}.r^e_A - \lambda_{12}.r^e_M \quad (17)$$

$$M_h = VN_h - p_a.A_h \quad (18)$$

The variables r^e_A and r^e_M are the expected real interest rates for participations and deposits, respectively.

The change in household wealth V_h then follows from:

$$\Delta V_h = S_h + C_{pf,-1}.\Delta p'_{cf} + A_{h,-1}.\Delta pa + HS_{-1}.\Delta p_h \quad (19)$$

where one should realise that since claims to pension funds are included in the household wealth, we should take these changes into account. Household savings S_h are discussed below.

Finally, the increase in housing net of depreciation should be included in the production of firms, which appears in the capital balance of the social accounting matrix – see Table 7B below.

[23] The subtraction of claims on pension funds is new compared to MMS (2015).

Consumption and savings

Household income consists of wages *WB* and returns on financial assets, $i_M.M_h + ia_h.pa.A_h$, and net benefits, $PF_b - PF_c$, received from pension funds:

$$Y_h = WB + PF_b - PF_c + i_{M,-1}.M_{h,-1} + i_{a,-1}.\ p_{a,-1}.A_{h,-1} \quad (20)$$

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

$$Td = \tau_h.(Y_h - \tau_{MO}.i_{MO,-1}.MO_{-1}) \quad (21)$$

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:

$$Y_{hd} = Y_h - Td - i_{MO,-1}.MO_{-1} \quad (22)$$

We assume that households' real consumption depends on real disposable income, the opening stock of wealth V_h and on real capital gains. Capital gains can be obtained on participations, the only financial asset with a market price, on housing and on pension claims. Moreover, we assume the stock of housing to have a different impact on consumption compared to financial wealth, due to its differences in liquidity. However, capital gains on housing are assumed to have the same impact as those on participations. As a consequence the consumption function is given by:

$$C = \alpha_1.yhd + \alpha_2.v_{-1} + \alpha_3.(p_h.HS - MO)/p + \alpha_4.(cga^e + cgh^e + cgc^e - [g^e{}_p/(1 - g^e{}_p)].v_{h,-1}) \quad (23)$$

where small letters for variables indicate real values, f.i. $yhd = Y_{hd}/p$.

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

$$S_h = Y_{hd} - p.C - \delta_h.HS_{-1} \quad (24)$$

4.3 *Firms*

Firm behaviour and wage and price formation

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.

As we elaborate below, the capital stock ($p_k.K$) is financed by firms using domestically accumulated retained earnings, equity issued abroad ($pe.E_{fa}$), and loans at banks (*L*). Moreover, firms hold part of their retained earnings in foreign assets ($pe_a.E_{af}$). This constitutes the balance sheet of firms presented in Table 3. The net worth of firms is V_f.

Table 3 Balance sheet of firms

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

Retained earnings follow from profits. Profits from production *FP* result by deducting the wage bill *WB* and indirect taxes $T_i = \tau_i.p.Y$ from nominal GDP *p.Y*. Hence:

$$FP = p.Y - WB - T_i \quad (25)$$

Price *p*, net of indirect taxes τ_i, is set as a mark-up *m* on unit labour cost.[24] Unit labour cost are defined as nominal wages *w* times the exogenous labour-output ratio *a*. Hence:

$$p.(1 - \tau_i) = [1 + m].w.a \quad (26)$$

Given the labour-output ratio, employment *N* follows from *N = a.Y*, where *Y* represents real output. The wage bill then follows from:

$$WB = w.N \quad (27)$$

Nominal wages are exogenous.[25]

When calculating total income of firms Y_f, we should include the returns on foreign assets $pea.E_{af}$, next to profits from production *FP*. The rate of return on foreign assets re_a is an exogenous mark-up on domestic return *re*. Hence:

$$Y_f = FP + re_{a,-1}.\ pe_{a,-1}.E_{af,-1} \quad (28)$$

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

$$Td_f = \tau_f.Y_f \quad (29)$$

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

$$FN = Y_f - Td_f - i_{L,-1}.L_{-1} - p_{k,-1}.\delta_k.K_{-1} \quad (30)$$

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

[24] Hein 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. However, we include indirect taxes, which are ignored by Hein, since he does not include government in his analysis.

[25] 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.

$$re_{-1}.\ pe_{-1}.E_{fa,-1} = \phi.FN \quad (31)$$

and retained earnings are given by:

$$FU = FN - re_{-1}.\ pe_{-1}.E_{fa,-1} \quad (32)$$

The retained earnings *FU* also constitute firm's savings S_f. They are used to invest in both the capital stock and in foreign assets. Whereas in MMS (2016) we model the distribution of retained earnings according to a portfolio model, we use here an exogenous distribution. That is, foreign assets are bought according to:[26]

$$pe_a.\Delta(E_{af}) = inv_f.FU \quad (33)$$

And the remaining part of retained profits is used to finance investment.

Investment behaviour

Investment is determined by four variables. First the cash-flow rate, *rfc*, which is a source of self-financing of investment:

$$rfc = FU/(p.K_{-1}) \quad (34)$$

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

$$lev = L/(p.K_{-1}) \quad (35)$$

The third determinant is Tobin's q:

$$q = (L + p_eE)\ /(p.K_{-1}) \quad (36)$$

and the fourth determinant is the utilization rate, *u*, with normal utilization defined at *u**:

$$u = Y/(\kappa.K_{-1}) \quad (37)$$

As a consequence we find for the growth of the capital stock:

$$g_K = \gamma_0 + \gamma_1.rfc_{-1} - \gamma_2.r_{L-1}lev_{-1} + \gamma_3.q_{-1} + \gamma_4.(u_{-1} - u^*) \quad (38)$$

Net investment is financed by domestically retained earnings $(1\text{-}inv_f).FU$, equity issued abroad $pe.\Delta E_{fa}$ and loans from banks ΔL. With respect to equity we assume that new equities are issued as in a portfolio model, related to the amount of external funds required to finance investment:

$$pe.\Delta E_{fa} = €.[p_k.\Delta K - (1- inv_f).FU] \quad \text{with} \quad € = \mu_{02} - \mu_{12}.re + \mu_{22}.i_L \quad (39)$$

Bank loans then are used to close the remaining financing gap:

$$\Delta L = (1 - €).[p_k.\Delta K - (1- inv_f).FU] \quad (40)$$

Remember that retained earnings *FU* constitute firm's savings S_f, which contribute to the wealth of firms. Next valuation changes should be taken into account. Hence holds:

[26] With an endogenous share we use $invf = \mu_{01} + \mu_{11}.re_a - \mu_{21}.r$, where $r = (FN + i_L.L)/p.K$ represents the return on capital.

$$\Delta V_f = S_f + (\Delta pe).E_{fa} - (\Delta pe_a).E_{af} + (\Delta p_k).K \quad (41)$$

4.4 *Government*

Since we assume government expenditures *G* proportional to output, growth in government expenditures is equal to output growth:

$$g_G = g_{y,-1} \quad (42)$$

Value added taxes, profit taxes and income taxes are proportional to the relevant tax base. The budget balance, together with profits from the Central Bank *FC* minus interest paid on government bonds i_B. *B*, constitute government savings S_g:

$$S_g = Ti + Td + Tf + FC - p.G - i_B.\ B \quad (43)$$

These savings, which usually are negative, are financed by supplying bills to the various sectors of the economy:

$$\Delta\ B = -\ S_g \quad (44)$$

Accumulated government debt therefore equals $B = B_{CB} + B_{PF} + B_B + B_a$, which is also the financial net worth of government. The corresponding balance sheet is presented below.

Table 4 Balance sheet of the government sector

ASSETS	**LIABILITIES**	
	Government bonds	+ B_{CB}
		+ B_B
		+ B_{PF}
		+ B_a
	Total (net worth)	+ V_g

We assume that the government adjusts its tax rate to keep government debt under control. When the deficit exceeds its target, government increases the tax rates on household income and firm profits such that one third of the difference between actual and target deficit is removed. If the actual deficit is below its target level, the tax rates are decreased in a similar fashion.

4.5 *The foreign sector*

The foreign sector is 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 assumed to be exogenous.[27] Hence the trade balance is given by:

$$TB = X - IM = X - i_m.p.Y \tag{45}$$

Since foreigners hold bills issued by the government (B_a), bank deposits (M_{ab}) and equity ($p_{ea}.E_{fa}$) 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, $p_e.E_{af}$ and $p_e.E_{aPF}$, respectively, and by foreign reserves (R) held by the Central Bank. The balance sheet of the foreign sector is given in Table 5.

Table 5 Balance sheet of the foreign sector

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

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. (12). On the other hand, foreign equity held by domestic firms $pe_a.E_{af}$ is determined by firms' savings as follows from eq. (33). The formation of foreign reserves is discussed below in relation to foreign savings.

On the assets side we use a portfolio model to determine the distribution of total assets, *TA*, over financial assets, similar to the case of pension funds. *TA* is distributed over financial assets as follows:

$$M_a / TA^e = \lambda_{30} + \lambda_{31}.r^e_M - \lambda_{32}.r^e_B - \lambda_{33}.re^e_A \tag{46}$$

$$B_a / TA^e = \lambda_{40} - \lambda_{41}.r^e_M + \lambda_{42}.r^e_B - \lambda_{43}.re^e_A \tag{47}$$

$$pe.E_{fa} = TA - B_a - M_a \tag{48}$$

The variables r^e_M and r^e_B are the expected real interest rates for deposits and bonds, respectively, and re^e_A is the expected return on equity.

An important assumption is that domestic bills and deposits held by foreigners are perfect substitutes. This implies:

$$\lambda_{31} = \lambda_{41}\ ;\ \lambda_{32} = \lambda_{42}\ ;\ \lambda_{33} = \lambda_{43} \tag{49}$$

[27] We assume that they adjust such that the trade balance reaches a target level. An alternative is to assume that exports grow at a rate which is the ten year moving average of past GPD growth

Equation (47) determines the demand amount for domestic government bonds B_a held by the foreign sector. As we discuss in section 2.4 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.

The trade balance is part of foreign savings S_a, together with 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, as well as dividend received from firms $\rho_{fa}.pe.E_{fa}$, and interest received on deposits held at domestic banks and government bonds, $i_{ab}.M_a$ and $i_b.B_a$ respectively:

$$S_a = i_{b,-1}.B_{a,-1} + i_{ab,-1}.M_{a,-1} + \rho_{fa,-1}.\ pe.E_{fa,-1} - TB - \rho_{a,-1}.\ Pe_a.E_{af,-1} - \rho_{a,-1}.\ Pe_a.E_{aPF,-1} \quad (50)$$

These savings deplete the foreign reserves held by the domestic Central Bank, taking into account acquired domestic financial assets, net of equity issued to domestic firms and pension funds:

$$\Delta R = \Delta B_a + \Delta M_a + pe.\Delta E_{fa} - pe_a.\Delta E_{af} - pe_a.\Delta E_{aPF} - S_a \quad (51)$$

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.

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

$$\Delta V_a = S_a + (\Delta pe).E_{fa} - (\Delta pe_a).(E_{af} + E_{aPF}) \quad (52)$$

With respect to asset prices and asset returns we explicitly allow for different developments of prices pe and returns ρ_{fa} on equity held by foreign parties in the domestic country, compared to the prices pe_a and returns on ρ_a equity held by domestic parties abroad.

4.6 *The banking sector and the Central Bank*

We describe both sectors, starting with the central bank.

The Central Bank

Next to holding foreign reserves R, which include Target2 balances, the Central Bank holds bills issued by the government, B_{CB} and provides deposits M_{CB} to banks. 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.

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:

$$B_{CB} = B - B_{PF} - B_B - B_a \quad (53)$$

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

The amount of deposits to banks is provided to satisfy the banks' need.[28] We discussed the foreign reserves in equation (51) above and explain why these also close the balance sheet of the Central Bank.

Table 6A Balance sheet of the Central Bank

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

The revenues of the Central Bank are given by:

$$FC = i_{R,-1}.R_{-1} + i_{B,-1}.\ B_{CB,-1} - i_{M,-1}.M_{CB,-1} \qquad (54)$$

Here i_B is the rate on government bills set by the Central Bank and i_M is the interest rate on deposits. Both interest rates are set exogenous in real terms, r_B 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.

Quantitative Easing operations

As we discussed above, in normal times the Central Bank provides as much bills as demanded by the government – see equation (53). To understand the situation better we should realise that the interest rate is found endogenously at a rate r_B. Hence does hold:

$$B_{CB} = B - B_{PF}(r_B) - B_B(r_B) - B_a(r_B) \qquad (53')$$

where *B* is the amount of bonds issued by government

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:

$$B'_{CB} = B_{CB} + B_{QE} = B - B_{PF}(r'_B) - B_B(r'_B) - B_a(r'_B) \qquad (53'')$$

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.

[28] For simplicity, deposits by banks held at the central bank are taken net of advances.

The Banking Sector (MFIs)

In our analysis banks finance their assets not only by holding deposits and participations from households, M_h and $pa.A_h$ respectively, but also to a considerable extent by borrowing from the foreign sector. The latter is done by providing deposits M_a to foreign holders and by issuing participations $pa.A_{pf}$ to pension funds, who mainly invest abroad.[29] The main assets held by the bank are loans *L* issued to firms and mortgages *MO* issued to households. 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 return on advances, i.e. implicitly as bonuses to households, the net worth of the banking sector is zero.[30]

Table 6B Balance sheet of the banking sector

ASSETS		**LIABILITIES**	
Central bank deposits	+ M_{CB}	Bank deposits	+ M_h
Bonds	+ B_B	Bank deposits	+ M_a
Loans	+ L	Participations	+ $pa.A_{pf}$
Mortgages	+ MO	Participations	+ $pa.A_h$
		Total (net worth)	0

On the asset side we assume a constant loans-deposit ratio *ldr*:

$$ldr = \frac{M_h}{L+MO} \tag{55}$$

That is, since household deposits are assumed to be a certain source of funding, banks do want to provide no more loans and mortgages than a given fraction of these deposits (Van den End, 2016). And for simplicity bonds are assumed to be held as a constant fraction of outstanding loans and mortgages too. Banks set the mark-up on the interest rate to achieve the targeted value of *ldr*.is constant ratio.[31]

Turning to the liabilities side we assume that the demand for deposits *M* 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.[32]

[29] See section 2.1.

[30] This includes valuation gains and losses equal to $-(\Delta p_a).A_{pf} - (\Delta pa_h).A_h$.

[31] From equation (39) we know: $\Delta L = (1 - \mu_{02} + \mu_{12}.re - \mu_{22}.i_L).[p.\Delta K - (1- inv_f).FU]$
From equation (15) we know: $\Delta MO = \varphi.p_h.\Delta HS + \varphi.\Delta p_h.HS - morc.MO_{-1}$ With:
$\Delta \ln p_{ht} = \psi_t + \alpha \Delta \ln Y_t^h + (1-\alpha)\Delta \ln Y_t^e - \Delta \ln[i_{MO}(1-\tau_h\tau_{MO}) + f_{MO}] - \Delta \ln HS_t$ from (14).
If we for simplicity assume that the mortgage rate and rate on loans are equal and both are a mark-up on the deposit rate, this mark-up can be calculated to ensure that the target value of *ldr* does hold.

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

4.7 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.

Table 7A Balance sheet

		Households	Firms	Banks	Pension funds	Central bank	Government	Foreign	Total
Central bank deposits				Mcb		-Mcb			
Bank deposits	domestic	Mh		-Mh					
	abroad			-Mab				Mab	
Loans			-L	L					
Bills	domestic			Bb	Bpf	Bcb	-Bb-Bpf-Bcb		
	abroad						-Ba	Ba	
Capital			pk.K						pk.K
Participations	domestic	pa.Ah		-pa.Ah-pa.Apf	pa.Apf				
Equities	firms		-pe.Efa					pe.Efa	
	abroad		pea.Eaf		pea.Eapf			-pea.Eaf – pea.Eapf	
Mortgages		-MO		MO					
Houses		ph.HS							ph.HS
Claims/Liabilities		pcpf.Cpf			-pcpf.Cpf				
Foreign Reserves						R		-R	
Total net worth		Vh	Vf	0	Vpf	0	Vg	Va	Vt

Table 7B Social Accounting Matrix

	Prod.	Households	Firms	Commercial Banks	Pension Funds	Central Bank	Government	Capital Account	Foreign	Total
1. Production		+ p·C					p·G	I + IH	X - IM	+p·Y
2. Households	+ WB			+ $i_m M_h$ + $i_a.p_a.A_h$	+PfB-PfC					+ Yh
3. Firms	+ FT								+Faf	+ Yf
4. Commercial Banks		+ i_{mo}MO	+ i_lL			+ $i_{cb}M_{cb}$	+ $i_b B_b$			+ Yb
5. Pension Funds				+ $i_a.p_a.A_{PF}$			+ $i_b B_{pf}$		+ Fapf	+ Ypf
6. Central Bank							+ $i_b B_{cb}$			+ Yc
7. Government	+ Ti	+ Td	+ Tf			+ Fc				+ Yg
8. Consumption of fixed capital		+Dh	+Df							+ D
9. Capital Account		+ Sh	+ Sf =FU	Sb (=0)	+Spf	Scb (=0)	+ Sg		+ Sa	+ S
10. Foreign			+ Ffa	$i_m M_{ab}$			+ $i_b B_a$			+ Ya
TOTAL	+ p·Y	+ Yh	+ Yf	+ Yb	+Ypf	+ Yc	+ Yg	I + IH	+ Ya	

Wealth accumulation

$$\Delta Vh = Sh + \Delta ph.HS(-1)$$

$$\Delta Vf = Sf + \Delta pea.Eaf(-1) - \Delta pe.Efa(-1) + \Delta p.K(-1)$$

$$\Delta Va = Sa + \Delta pe.Efa(-1) - \Delta pea.Eaf(-1) - \Delta pea.Eapf(-1)$$

$$\Delta Vb = 0$$

$$\Delta Vpf = Spf + \Delta pea.Eapf(-1)$$

$$\Delta Vg = Sg$$

$$\Delta V = S + \Delta p.K(-1) + \Delta ph.HS(-1)$$

$$Faf = \rho_{ea} p_{ea}.E_{af}$$

$$Ffa = \rho_e p_e.E_{fa}$$

$$Fab = \rho_{ea} p_{ea}.E_{ab}$$

$$Fapf = \rho_{ea} p_{ea}.E_{apf}$$

Table 7C Accumulation and investment of savings

	Households	Firms	Banks	Pension funds	Central Bank	Government	Foreign	Total
Consumption	- p·C	+p.C+p.G				-p·G		0
Gross Investment		+I+IH						I+IH
Net exports		+X - IM					-(X – IM)	0
Wages	+WB	-WB						0
Taxes	-Td	-Tf -Ti				+T		0
P. Contributions/Benefits	+PfB-PfC			-PfB+PfC				0
Interest Deposits	$+ i_m M_h$		$+i_{cb}M_{cb} - i_m M$		$- i_{cb}M_{cb}$		$+ i_m M_{ab}$	0
Interest Loans		$-i_l L$	$+ i_l L$					0
Interest Bills			$+i_b.B_b$	$+i_b.B_{pf}$	$+ i_b.B_{cb}$	$-i_b.B$	$+i_b.B_a$	0
Interest Participations	$+ i_a.p_a.A_h$		$-i_a.p_a.A$	$+ i_a.p_a.A_{pf}$				0
Interest Mortgages	$-i_{mo}.MO$		$+i_{mo}.MO$					0
Dividends		+Faf -Ffa		+ Fapf	-FC	+FC	+ Ffa-Fa	0
Cons of fixed capital	-Dh	-Df						-D
Net Savings	S_h	S_f (FU)	0	Spf	0	S_g	S_a	S
ΔDeposits	$+\Delta M_h$		$+\Delta M_{cb} - \Delta M$		$- \Delta M_{cb}$		$+ \Delta M_{ab}$	0
ΔLoans		-ΔL	+ΔL					0
ΔBills			$+\Delta B_b$	$+\Delta B_{pf}$	$+\Delta B_{cb}$	-ΔB	$+\Delta B_a$	0
ΔParticipations	$+p_a\Delta A_h$		$-p_a\Delta A_{ah}-p_a\Delta A_{apf}$	$+p_a\Delta A_{apf}$				0
ΔMortgages	-ΔMO		+ΔMO					0
ΔEquity		$+p_{ea}\Delta E_{af} - p_e\Delta E_{fa}$		$+p_{ea}\Delta E_{apf}$			$+p_e\Delta E_{fa}-p_{ea}\Delta E_{af}-p_{ea}\Delta E_{apf}$	0
ΔClaims	$+p_{cpf}\Delta Cpf$			$-p_{cpf}\Delta Cpf$				0
ΔReserves					+ΔR		-ΔR	0
ΔCapital	phΔHS	+ pΔK						pΔK+phΔHS

5 The simulation results

We calibrated the model to obtain a base run which is consistent with a steady state. That is, over a run of 2000 periods the economy grows at a constant rate of 2 per cent and all variables have a plausible value (relative to GDP). We present the base run below in section 5.1. Next we analyse in section 5.2 the impact of changes in each interest rate of the model separately, as well as changes in equity prices and exports – the aim is to understand in detail the transmission channels of monetary policy. We simulate for each interest rate a decrease of 50 basis points, assuming that in the end all interest rates move together. We also simulate separately the impact of equity prices and exports, consistent with DNB (2017B). Finally we analyse in section 5.3 the overall impact of a decrease of 50 basis points in all interest rates and the corresponding changes in equity prices and exports. The results are compared to the simulations provided by DNB.

5.1 The base run

The results for assets and liabilities are presented in Table 8.

Table 8 Balance sheet in the steady state (items relative to GDP)

	House holds	Firms	Banks	Pension funds	Central bank	Govern ment	Foreign	Total
Central bank deposits			0.21		-0.21			
Bank deposits, domestic	0.64		-0.64					
Bank deposits, abroad			-0.02				0.02	
Loans		-0.67	0.67					
Bills, domestic			0.06	0.11	0.30	-0.47		
Bills, abroad						-0.01	0.01	
Capital		2.02						2.02
Participations	0.21		-1.17	0.96				
Equities, firms		-0.29					0.29	
Equities, abroad		0.26		0.99			-1.25	
Mortgages	-0.89		0.89					
Houses	1.11							1.11
Claims/Liabilities	2.06			-2.06				
Foreign Reserves					-0.09		0.09	
Total net worth	3.13	1.32	0.00	0.00	0.00	-0.49	-0.84	3.13

The shares in GDP of financial assets of firms and households presented in Table 8 are quite consistent with the data presented in Figures 11 and 12 for households and Figures 16 and 17 for firms. Also the data on government are in a reasonable range with the Dutch data presented in Figure 20. However the debt is somewhat lower at 49 per cent of GDP and the share of bills held abroad is far too low at 3 per cent of total debt instead of the 40 per cent presented in Figure 22. Finally the assets and liabilities of the pension funds are quite consistent with the data presented in Figure 7.

A problem when running a steady state for 2000 periods is that deficits and surpluses cannot mimic the actual Dutch situation in all respects. While a government deficit of 1.4 per cent is still consistent with a steady state – this is what we find in our model, a surplus on the trade balance of 10 per cent certainly is not sustainable. For that reason we generate a surplus on the trade balance of 1 per cent in our steady state, but then it turns out that the foreign reserves we generate are far too low, and even of the wrong sign. Also the deposits and bills held by the foreign sector are far too low compared to the actual Dutch situation. But that is a consequence of the unsustainability of a trade balance surplus of 10 per cent.

We use this base run to simulate the effect of shocks in the model by introducing the shock in period 10 for a period of 15 years. During all these shocks we assume that all exogenous variables, such as exports, tax rates and growth rate of government expenditures, remain equal to the base run unless stated otherwise.[33] The results are presented in the next section.

5.2 The transmission channels of monetary policy

In the discussion below, we present the simulation results of changes in each interest rate of the model separately, as well as changes in equity prices and exports. We simulate for each interest rate a decrease of 50 basis points, assuming that in the end all interest rates move together. We also simulate separately the impact of equity prices and of exports, consistent with DNB (2017B).

We compare step by step the deviations of the simulation results with the results that are obtained in the previous step. The figures therefore do not display the (total) deviation from the base run. The latter will be discussed in section 5.3. We first discuss subsequently the impact of a decrease of 50 basis points in the interest rates on government bonds, mortgages, deposits and loans. Next we also look subsequently at the impact of changes in the prices of equity and participations and of the change in exports.

Impact of the interest rate on bonds

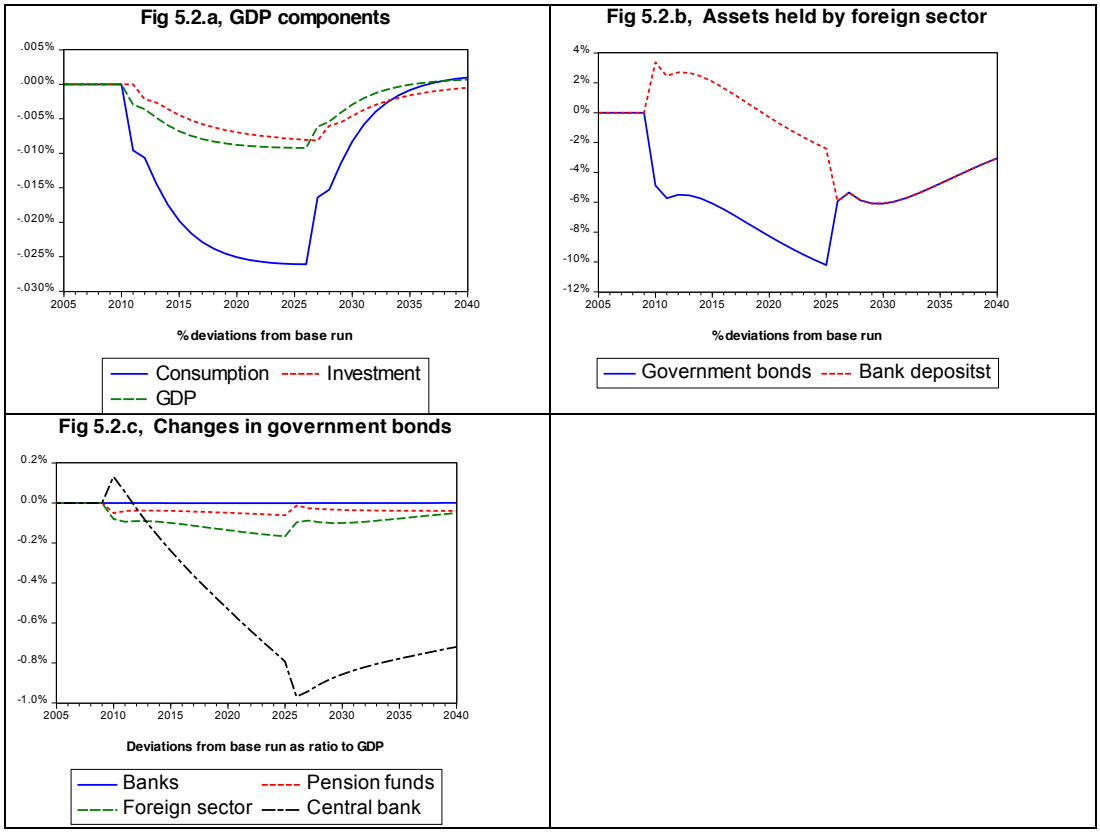
Our first simulation experiment is to decrease the interest rate of government bonds by 50 base points, i.e. from 1 percent to 0.5 percent.

It is illustrated in Figure 5.2, panel A that as a consequence consumption decreases slightly and therefore also investment and GDP decrease somewhat. The reason that consumption declines is that income from government bonds by banks decreases because of the decreased interest rate. This leads to decreased bank profits, which leads to a decreased income of households since bank profits are transferred to the household sector via participations.

The foreign sector adjusts its portfolio by selling domestic government bonds and depositing the proceeds at domestic banks. Because of the decreased interest payments on government bonds, income of foreign sector decreases which leads, after the first year, to a decrease in both assets held by the foreign sector as can be seen in panel B. So we see a shift in the portfolio of the foreign sector

[33] For the moment being we also kept the rate of pension contributions and benefits constant at their base-run values.

from government bonds to bank deposits and we observe an overall decrease in total assets held by the foreign sector.



Panel C displays the changes in the distribution of government bonds among all sectors. Here we use the absolute deviation from the base run as percentage of GDP (in the base run). Note again that government expenditures as well as tax rates are not adjusted such that the decreased interest on government bonds directly leads to a decrease in government deficit and therefore in debt. The decrease in debt then implies that the Central Bank will hold less debt.

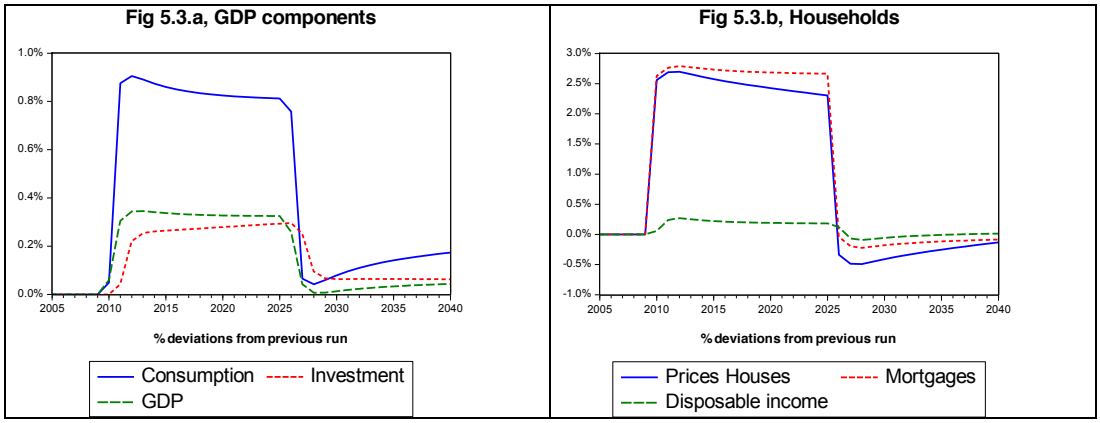
Impact of the interest rate on mortgages

Additional to the decrease on government bonds, we add a decrease of interest rate on mortgages from 2% to 1.5% and back.[34] In Figure 5.3 we display the deviation of the simulation results with the results that are obtained in the previous step.

Consumption (panel A, so relative to the previous simulation) increases because of increased disposable income due to decreased mortgage payments. But because the interest rate on mortgages decreases, also prices of houses increase as well as the level of mortgages (panel B). This increased net wealth of houses is (partly) used by household for consumption purposes. The positive

[34] Actually the decrease is back to 1.875 % instead of 2 %, given the nature of the housing price equation – otherwise we would have an unwarranted ratchet effect.

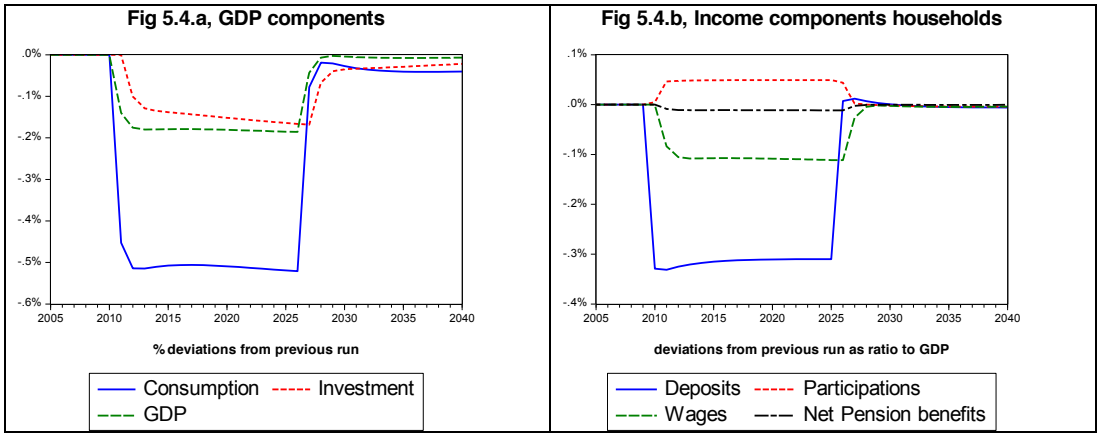
impact on GDP also implies that investment increases. Similar results are found by DNB in its analysis – compare DNB (2017, Box 2).



Impact of interest rate on deposits

Additional to changes in previous simulations, we now decrease the interest rate on bank deposits, both for household deposits and for foreign deposits (from 2% to 1.5%) and at the same time we also decrease the interest rate on central bank deposits by banks (from 1% to 0.5%).

The decrease of interest on deposits by households leads to a decrease in their (disposable) income and therefore a decrease in consumption – see Figure 5.4A. Because of the decreased income, also house prices decrease, though only slightly.

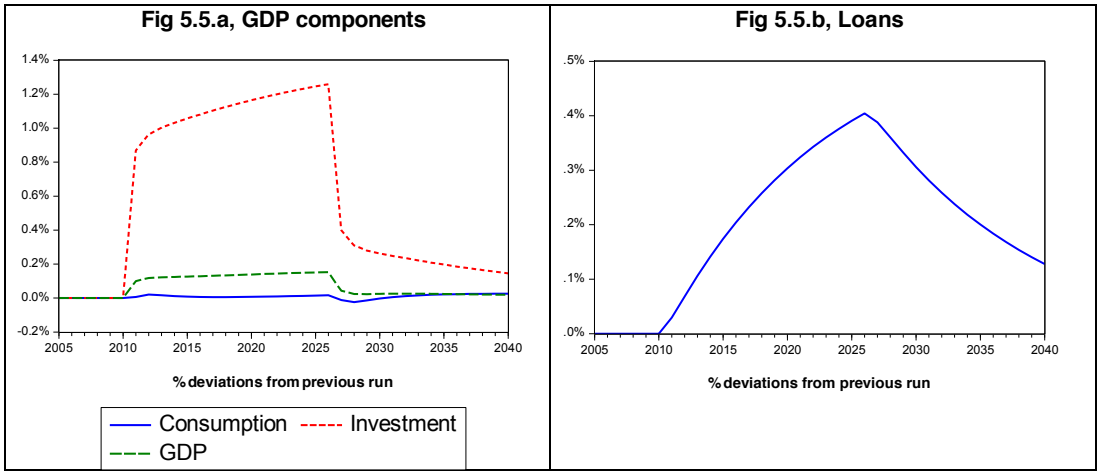


Since the interest rate on deposits decreases, income of banks increases. This is partly offset by the decrease in income of banks from their deposits at the central bank. However, changes in income of banks are only very modest, less than 0.5% of their income and about 0.01% of GDP. As a consequence the income transferred to households and pension funds is also very modest.

Finally, the increased income from participations observed in Figure 5.4B also follows from the change in the composition of the portfolio of households, where the share of participations increases relative to that of deposits.

Impact of the interest rate on loans

Also decreasing the interest rate on loans clearly has a positive effect on investment as can be seen in Figure 5.5, panel A. This enhances GDP and consumption growth. Since we assume fixed proportions on the liabilities side of firms, firms will finance the increased investment by loans and equity in equal proportions to the previous run –see Figure 5.5 B.



Impact of the price of equity and participations

DNB (2017) presents a scenario in which the capital market interest rate increases with 100 basis points. They then add to that an exogenous decrease in the price of equity, which follows from simulations with another model (DNB, 2017, p. 29). We mimic the effect presented by DNB, albeit in the opposite direction and taking only half per cent of their exogenous impact, since we decrease the interest rate by 50 basis points. The resulting impact is presented in Table 9, as a percentage deviation of the base run.

Table 9 Assumed impact of a decrease of the interest rate by 50 basis points (percentage deviation from base run)

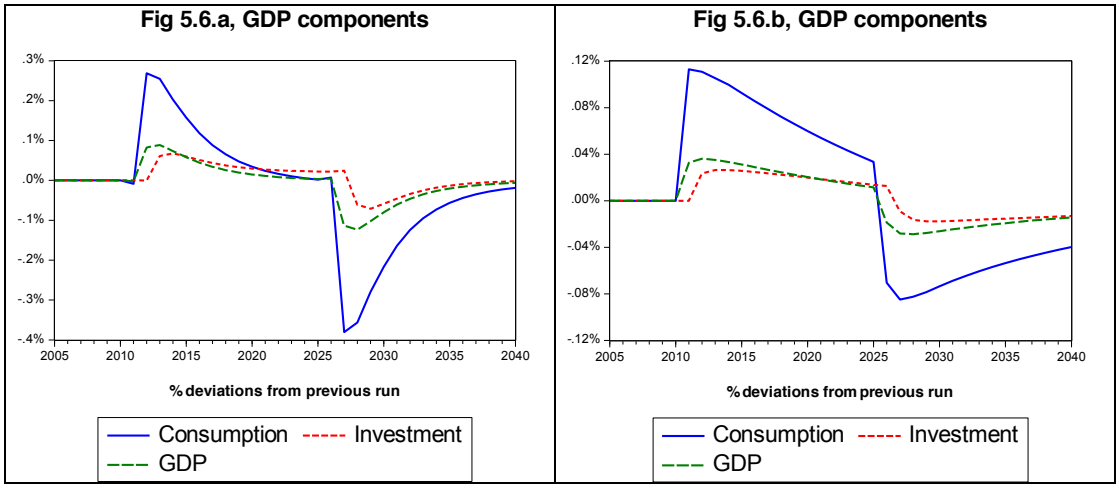
Year	*1*	*2*	*3*	*4*
Equity price	+ 7.5	+ 7.9	+ 8.0	+ 8.1
Exports	+ 0.8	+ 1.6	+ 1.4	+ 1.0

Source: DNB (2017, Table 5)

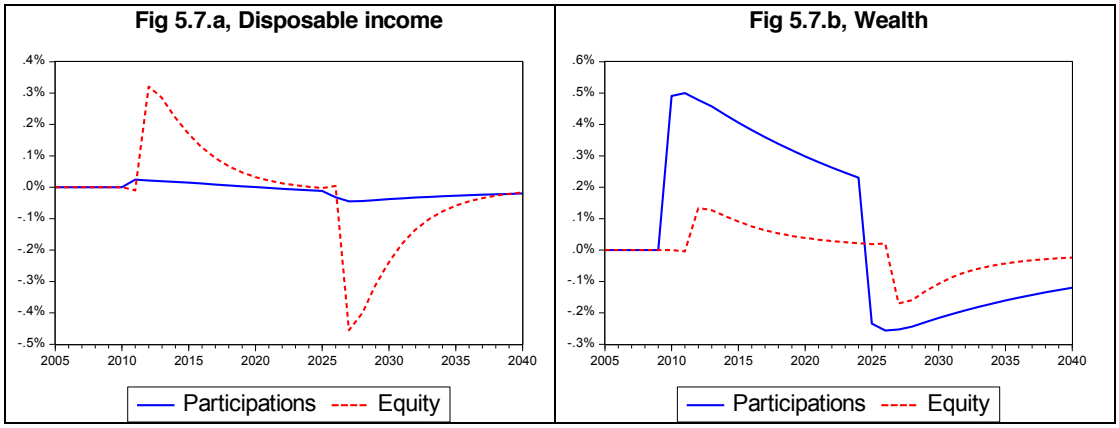
We use the change in the equity price presented in Table 9 to mimic the change in equity price from 2010 onwards. From 2015 onwards, we keep the equity prices at the same level (as in 2014) until the shock is reversed in 2025 after which we use the same pattern to let the equity prices move back to their original values.

The impact of the equity price is presented in Figure 5.6a. The change in equity price induces an increase in net wealth of households due to reduced claims of pension funds. This leads to capital gains on pension claims which influence consumption positively. Moreover households will hold more participations as a consequence of their increased net wealth, which also increases disposable income – see Figure 5.7a. However, in the end the negative net equity wealth held abroad implies

positive net-dividend payments towards foreign countries by pension funds and firms, which has a decreasing impact on GDP, consumption and investment.



We also apply the change in the price of equity on participations, in the same way as discussed above for equity. We recognise that this exaggerates the impact of the interest rate on the true price of participations, since participations are only based on equity prices to the extent that the underlying portfolio contains equity – the remaining part consists of bonds and other financial assets. But the transmission mechanisms of the price of participations can be identified nonetheless.

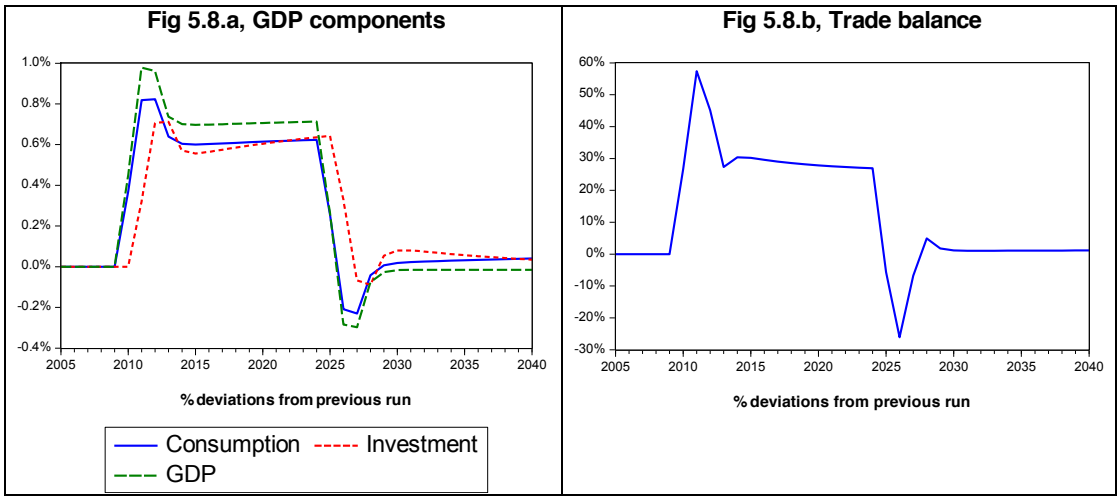


The impact of the price of participations is presented in Figure 5.6B. Its overall effect is much smaller compared to that of equity, but it is also longer lasting. The reason is that next to the impact on pension claims, which is similar to the effect of the equity price increase described above, there is also a direct effect on participations which also leads to a stronger wealth effect on consumption – see Figure 5.7B.[35] Moreover, the decreasing impact of increased dividend payments abroad is much less in the case of the increased price of participations, since equity is only affected indirectly.

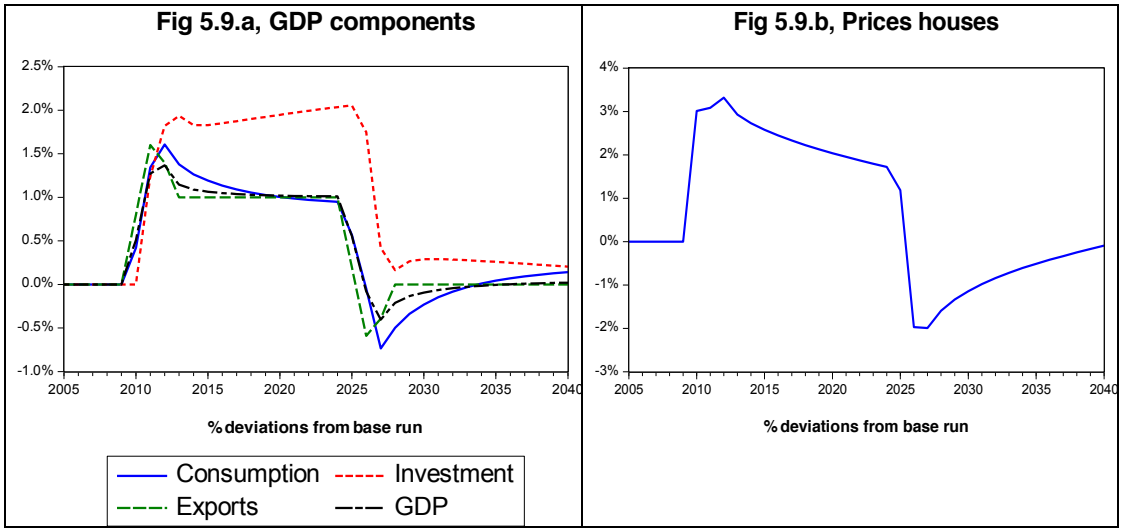
[35] The impact of the price of equity and participations in Figure 5.7 is in compared to the previous run – i.e. equity is compared to the interest rate on loans and participations is compared to equity.

Impact of exports

We use the change in the export price presented in Table 9 to mimic the change in exports from 2015 onwards. Similar to the changes in the equity prices, we keep the exports at the same level from 2015 until 2025 after which the exports return to the original values, using the same pattern as before. The results are presented in Figure 5.8. Not surprisingly exports have a direct lasting positive impact on GDP. Moreover, one observes an increase in the trade balance since the initial impulse comes from exports and imports follow GDP.



5.3 The overall impact of a decrease in the interest rate



The overall impact of a decrease in the interest rate is presented in Figure 5.9A. It leads to GDP growth of initially 1.4 per cent, which gradually decreases to 1 per cent. The underlying effects are presented in Table 10, which summarises the separate interest rate and price effects, discussed above, together with the impact of exports. From the table one observes that the main driver of

changes in GDP is exports, which given the open nature of the Dutch economy is not really surprising. Next to that the change in the mortgage rate is very important through its strong impact on consumption. The loans rate has a strong impact on investment. More surprising results are the negative impact of the deposits rate on GDP and the low impact of the interest rate on government bonds.

Table 10 Summary of simulation results and cumulated effect

	IMPACT ON >	GDP		CONSUMPTION		INVESTMENT	
	Year>	2012	2024	2012	2024	2012	2024
DUE TO CHANGE IN:							
INTEREST RATE	Government bonds	0,00	-0,01	-0,01	-0,03	0	-0,01
	Mortgages	0,34	0,33	0,91	0,81	0,22	0,29
	Deposits	-0,18	-0,18	-0,51	-0,52	-0,1	-0,16
	Loans	0,12	0,15	0,02	0,01	0,96	1,23
PRICE	Equity	0,08	0	0,27	0,01	0	0,02
	Participations	0,04	0,01	0,11	0,04	0,02	0,01
	Exports	0,96	0,71	0,82	0,62	0,71	0,65
CUMULATED		**1,37**	**1,01**	**1,61**	**0,95**	**1,82**	**2,04**

Interestingly enough, the findings are in the same range as those of DNB (2017, Table 6), who for year 2 – 4 finds an increase in GDP of 0.65 to 0.85 per cent compared to the base run, an increase in consumption of 0.75 to 1.8 per cent and an increase in investment of 0.8 to 2.5. Contrary to our model DNB finds a decline in the balance of trade due to a larger increase in imports and a wage increase – the latter is exogenous in our model. One observes that the driver of the modified impact on GDP after 4 years in DNB follows from the decline in the balance of trade. In our model, however, the modified impact on GDP follows from the dynamics of the portfolio adjustments to the changes in the interest rates and equity prices. These adjustments influence each strongly other through the stock-flow consistency of the model as our detailed simulation results did show.

6 Conclusion

<these will follow>

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