Danmarks Statistik
MODELGRUPPEN

Arbejdspapir*

Amenu Temesgen Kitesa

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Minor Adjustments and implicit interest rates in ADAM

Resumé:

We calculate the implicit interest rate for financial assets held by public, private and foreign sector. In steady state, the implicit interest rates should be constant and equal to 3.53 percent, which is the steady-state growth of nominal GDP. This is in principle achieved by setting up the financial sector in a simple way and setting the market interest rates to 3.53 percent. In practice, we calculate the discount rate residually to yield an implicit interest rate of 3.53 percent on the public net asset, and we rely on a careful modelling of the financial sector to keep the endogenous discount rate close to 3.53 percent.
Having a constant implicit interest rate in steady state helps us formulating a fiscal reaction function for ADAM.

Keywords: implicit interest rate, steady state

1. Introduction

This paper addresses the size of implicit interest rates for financial assets held by the public, private and foreign sector. The implicit interest rates of financial assets should be constant in steady state and equal to the steady-state 3.53 percent nominal growth rate of GDP, real GDP grows by 1.5 per cent and prizes grow by 2 per cent. In order to address the issue, this paper concentrates on the construction of a baseline. We introduce a few minor changes to the baseline and to the model and elaborate a little on the formulation of the implicit interest rate in order to get 3.53 percent implicit interest rates for all financial assets. Having a relatively clear-cut implicit interest rate of 3.53 percent, helps us formulate a fiscal reaction function that keeps the public debt ratio constant in steady state.

2. On the Baseline

As a starting point, this paper is based on okt14 model and lang100 databank. To achieve the 3.53 percent implicit interest rate for financial assets, we have introduced some changes to the okt14 model that has led us to make a new databank amto100. The new bank includes changes in adjustment terms, modifications to interest income relations and to the equations for transactions in shares and in other assets in public sector.

3. Net Interest Income

In line with previous work by Dessie and Dan 'Formulating a Fiscal Reaction function for ADAM', the public interest revenue equations are set up in a special way (see page 1 and 2). The equations include public interest income from bonds and other assets (Tii_z_os), public interest expenditure on domestic government krone bonds $(Tiid\_os\_z)$, public interest expenditure on foreign loans $(Tiie\_os\_z)$ and total mortgage interest expenditure of financial sector $(Tiim\_cf\_x)$.

However, there are further minor changes to the formulations of net interest income in public sector, private sector and foreign sector. One change is introducing the lagged net stock of other assets, q, instead of its contemporaneous value in the net interest income equations of public, private and foreign sector. This formulation makes it easier to bring the implicit interest rates on financial assets close to 3.53 percent. The net interest income of municipalities, $tiin\_ok$, for example, is re-specified from the following equations

Tiin_ok = iwmm*(Wnq_ok(-1)+Wnq_ok)/2 +biwb*(Wnb_ok(-1)-Wlm_ok_cf(-1)) + dttiin_ok)

in to

Tiin_ok = iwmm*Wnq_ok(-1) +biwb*(Wnb_ok(-1)-Wlm_ok_cf(-1)) + dttiin_ok -------(1)

Similar changes are made for the net interest incomes $tiin\_oo,\ tiin\_cr,\ tiin\_h\ and\ tiin\_e$. At a later stage we may try $(Wq/(1+iwmm)+Wq(-1))/2$ instead of $Wq(-1)$. Because $Wq(-1)$ is stock at period start while Wq is stock at period end, and it seems better to involve the latter and determine the interest income of the period as $iwmm \cdot (Wq/(1+iwmm)+Wq(-1))/2$ rather than $iwmm \cdot Wq(-1)$.

4. Adjustment Terms

The adjustment terms for private consumption (cpuxh), desired private consumption (Cpuxhw), house price (phk), stock of dwellings (fKbh) are set to be constant in the baseline. In addition, the adjustment term for yields on shares and equity in non-financial corporations (tiu_z_cr) is set to zero. These changes to the

adjustment terms bring the implicit interest rates of financial assets closer to 3.53 percent and the net public debt relative to GDP (wn_o/y) closer to a constant level over the steady state.

5. Dividend yield for Municipality domestic and foreign share holdings

Municipalities hold Danish and foreign shares and we suggest using the standard formulation for dividend yield on domestic and foreign shares of municipalities

Tiu_z_ok = iuwsd*Ws_d_ok(-1) + iuwse*Ws_e_ok(-1) ---------- (2)

This allows for normal dividend yield on domestic and foreign share holdings in the municipality sector. At the same time, it ensures that net revenue from interest and dividend (tin_ok) is equal to 3.53 percent of the municipality net debt (wn_ok) in steady state. There may be a problem with Danish shares in municipalities, Ws_d_ok, if the dividend to municipalities is not a standard function of the stock value. We might have to keep municipality shares separate from other Danish shares, maybe exclude these shares from government net assets and put the related dividend in the primary surplus.

6. Discount rate as residual to fix implicit rate on public net asset

The discount rate is determined as in the previous paper by Dessie and Dan except for a minor modification. This modification introduces a dummy in the discount rate relation to avoid large deviations of the discount rate from 3.53 percent at the beginning of the simulation. In the beginning of the simulation, the damenu dummy keeps the discount rate exogenous. In the longer run, the damenu dummy is zero, which makes the discount rate residually defined. However, the discount rate remains close to 3.53 percent because all implicit interest rates are close to 3.53 percent in the long run.

iwdi = damenu*iwdamt+ (1-damenu)* ((iwdamt * wn_o(-1) - ((Tin_o - Tirn_o) - iwdi * (wnq_os(-1) + wnq_os/(1+iwdi)) / 2)) / ((wnq_os(-1) + wnq_os/(1+iwdi)) / 2)) ---------- (3)

Another change is that the net public interest income is defined more simply as (Tin_o-Tirn_o) i.e. only correcting for Tirn_o. This implies that the public primary surplus is defined as public budget (tfn_o) minus net public wealth income (Tin_o) adjusted for wealth income from land and rights (Tirn_o). The wealth income from land and rights (Tirn_o) is reflected in the wealth income for non-financial corporations.

Primary surplus = (tfn_o) - (Tin_o - Tirn_o) ---------- (4)

7. Capital transfer to make public net asset/GDP ratio horizontal

The capital transfer from public to foreign sector is defined in the working paper of Dessie and Dan. Here we adopt the same setup in the baseline construction. The capital transfer from the public to the foreign sector Tk_o_e is used to stabilize the public debt/GDP ratio in the baseline. The capital transfer is determined by:

$$Tk\_o\_e = tssyd * Y \quad \text{---------- (5)}$$

Y is GDP, and $tssyd$ is a factor that makes the capital transfer proportional to GDP. The factor is endogenously modeled by:

$$tssyd = tssyd(-1) - 0.5*\left(ctssyd(-1) - \frac{Tfn\_o(-1) - tin\_o^{*}(-1) + tyd(-1)}{y(-1)} \right)$$ ---------- (6)

$ctssyd$ is the desired value of the factor, tyd is expenditure on unemployment benefits. Thus, the fraction nominator is the primary surplus before outlays to unemployment benefits. This surplus is less cyclical than the normal primary surplus. In the baseline construction, the desired *tssyd* value $ctssyd$ is set to 0.008825, which is close to steady state unemployment benefits as GDP share. This produces a constant public debt ratio. The implied corrected net public interest income is $tin\_o^{*} = Tin\_o - Tirn\_o$. The desired value of the corresponding corrected primary surplus $Tfn\_o - tin\_o^{*}$ is zero, when $ctssyd$ indicates steady-state unemployment benefits as a GDP share. Equations (5) and (6) indicate that if, at time $t-1$, the primary surplus before unemployment benefits $Tfn\_o - tin\_o^{*} + tyd$ over GDP is larger than $ctssyd$, then $tssyd$ will increase at time t and public capital outlays will be higher. Thus, the two auxiliary equations can help us create a steady-state primary surplus of zero in the baseline. Equation (6) is exogenized when we make ADAM experiments on the baseline.

8. Transactions in shares and other assets

The net transactions in other assets, q, and shares, s, by central government and municipalities are re-defined to ensure that the market value of other assets and shares in the public sector grows by 3.53 percent. To achieve this, the following changes are introduced to the baseline model.

First, the net transaction of other assets, $tfnq\_os$, owned by central government is defined by:

Tfnq_os = 0.0353*(wnq_oo(-1) + wnq_ok(-1) + wnq_os(-1)) - tfnq_oo - tfnq_ok ---------- (7)

This implies that the general government's total net transactions in other asset Tfnq_os + tfnq_oo + tfnq_ok is 3.53 percent of total other net assets in the public sector. This will secure a steady state for the q assets in the total public sector.

Second, the transaction into domestic shares by the central government is formulated similarly as

Tfs_x_os = 0.0353*(ws_x_oo(-1) + ws_d_ok(-1) + ws_x_os(-1)) - Tfs_x_oo - Tfs_d_ok ---------- (8)

Third, the transaction in foreign shares by municipalities, Tfs_e_ok, is re-modelled so that the acquisition of foreign shares grows by 3.53 percent of foreign share holdings in municipalities. The two other public sectors do not possess foreign shares. The change is from

Tfs_e_ok = (1-bwnb_ok)*bwse_ok*Tfnf_ok

to

Tfs_e_ok = 0.0353*(ws_e_ok(-1)) ---------- (9)

The purchase of domestic shares by municipality sector, Tfs_d_ok, is defined residually in the sense that the remaining net amount of the sector goes to the acquisition of domestic shares after the purchase of bonds and foreign shares. The re-specification of net transaction of domestic shares is from

Tfs_d_ok = (1-bwnb_ok)*(1-bwse_ok)*Tfnf_ok

in to

Tfs_d_ok = tfnf_ok -tfnb_ok - tfs_e_ok ---------- (10)

We retain the ADAM equations on determining the bond transactions and holdings, and we do that while noting that the central government in ADAM issues bonds to secure the marginal financing of the total government sector. Consequently, if total government net asset, wn_o, is constant relative to GDP in steady state, the total government net holding of instruments relative to GDP will be constant in steady state as well (c.f. figure 2). With the above adjustments to the baseline and the model, it is possible to achieve a constant public net asset ratio wn_o/y, e.g. by choosing an appropriate income tax rate, without imposing a constant net asset ratio in public sub sectors: Funds, wn_oo/y, municipalities, wn_ok/y and central government wn_os/y. This is illustrated in figure 1, and it implies a zero primary surplus in the total public sector at steady state given r = g.

Figure 1: Net asset to GDP ratio

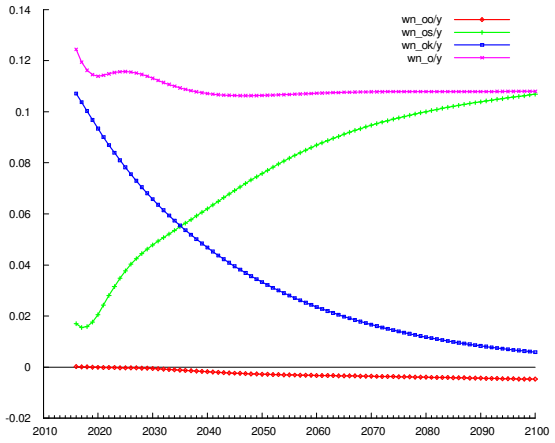
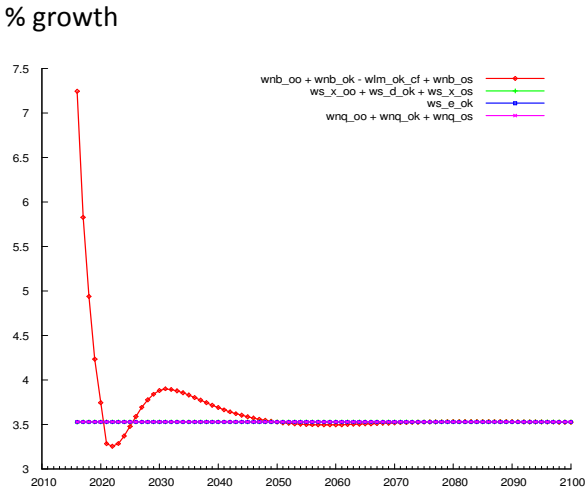


Figure 2: Instrument break down of public net assets

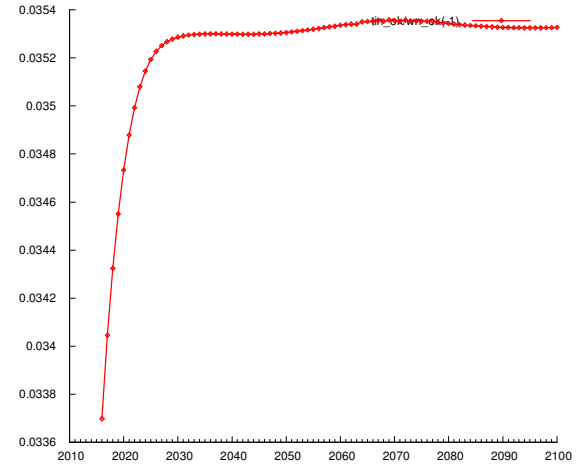


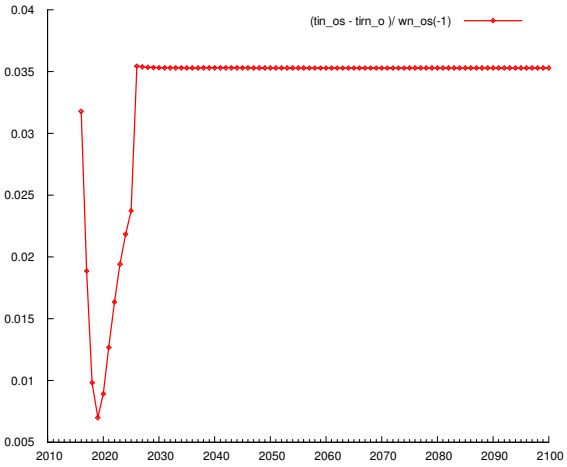
As shown in the figure 2, the total public net asset of bonds, domestic shares, foreign shares and other assets all grow at 3.53 percent in steady state, so that the split on financial instruments goes in steady state.

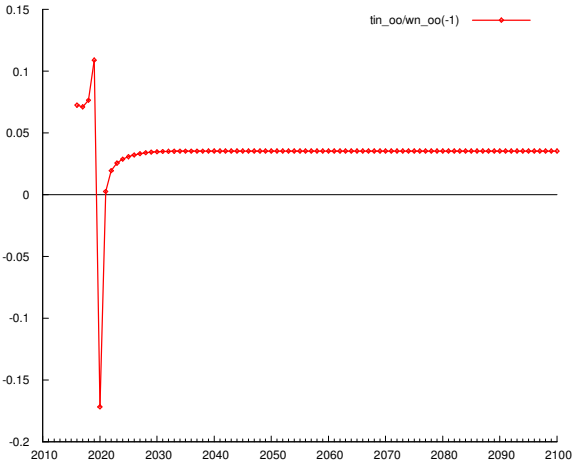
9. Inspecting 33 implicit interest rates

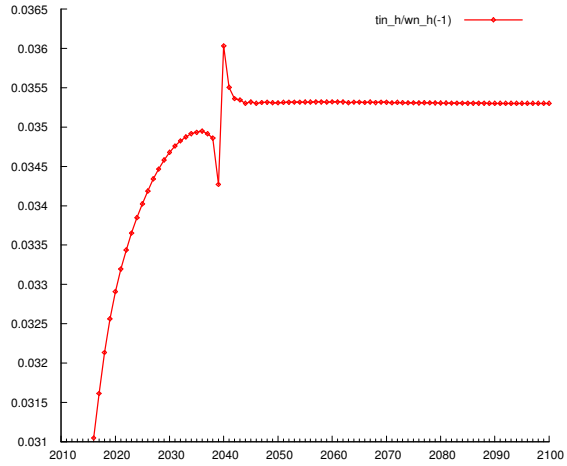
The model's determination of implicit interest rates is presented in table 1 and 2 at the end of the paper. The modifications to the okt14 model mentioned above gives us implicit interest rates very close to 3.53 percent in public, private and foreign sector except for interest income in municipalities (tiin_ok) where the implicit interest rate is 3.65 at steady state and thus somewhat higher than the nominal GDP growth. Other deviations from 3.53 percent comprise the implicit interest rate on total net assets of financial corporations (tin_cf), on interest bearing assets (i.e. excluding shares) of financial corporations (tiin_cf) and on total foreign sector net asset (tin_e) that are equal to 3.50 percent in steady state.

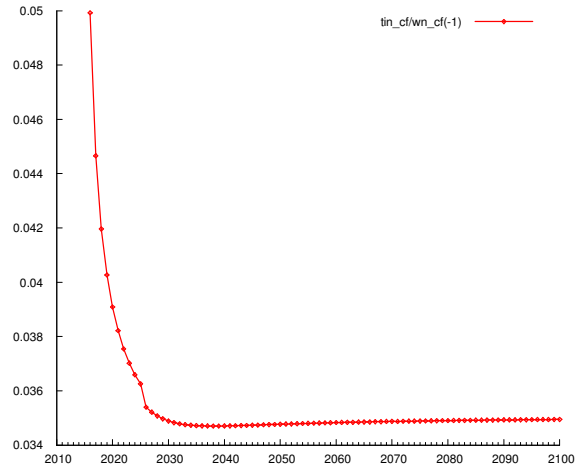
Figure 3: Implicit interest rate concerning interest incomes and dividends

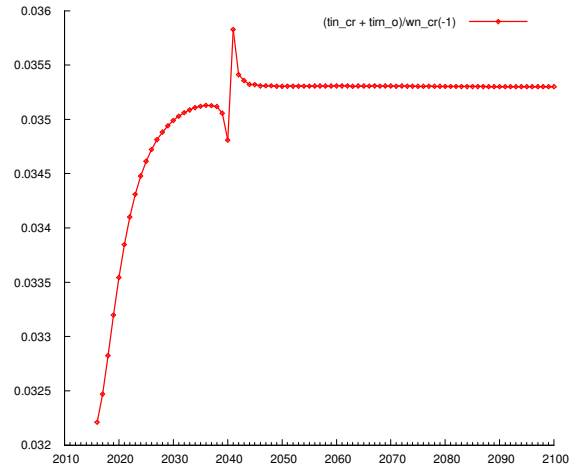


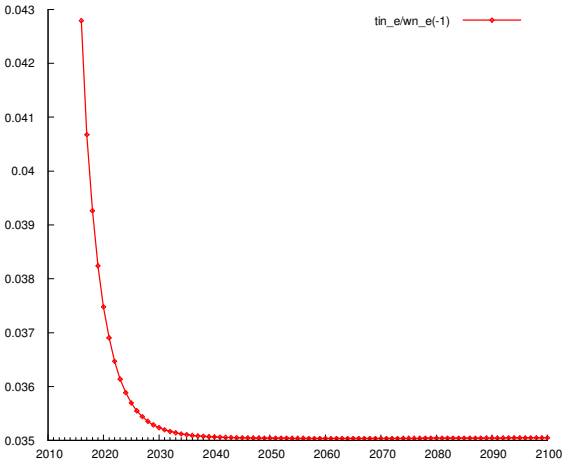












The net interest incomes of all sectors, (tiin_oo+tiin_ok+tiin_os+tiin_h+tiin_cf+tiin_cr+tiin_e) sum to zero, because interest incomes balance interest outlays. Similarly, the net incomes of interest and dividend, (tin_o+tin_h+tin_cf+tin_cr+tin_e) are equal to zero. The sum of net lending (tfn_cr + tfn_cf + tfn_o + tfn_h + tfn_e) in all five sectors also sum to zero. While the total stock of net assets (wn_oo+wn_ok+wn_os+wn_h+wn_cf+wn_cr+wn_e) equal wg_e_cf, which is the gold stock.

The following section presents the size of all implicit interest rates in table 1 and 2. Numbers in square brackets in text match numbers in box in the tables1 and 2.

Public funds: The interest rate and dividend incomes in public funds have a 3.53 percent implicit interest rates. The dividend yield (tiu_z_oo) which is based on the share holdings has an implicit interest rate of 3.53 percent [number 2]. Similarly, the interest income from bond holdings and claims of other assets by the Funds yields 3.53 percent implicit interest rate [number 1]. And the implicit interest rate on net revenue from interest and dividends from on the total net asset of Funds is 3.53 percent [number 3].

Municipalities: The dividend income (tiu_z_ok) of municipalities comes from the domestic and foreign share holdings. The implicit interest rate on dividend income is 3.53 percent [number 5]. The mortgage interest income in municipalities is included when determining the implicit interest rate on bonds and other assets (tiin_ok/(wnq_ok(-1) + wnb_ok(-1)-wlm_ok_cf(-1))). This implicit interest rate is marginally higher than 3.53 percent [number 4]. However, the total municipality net revenue from interest rate and dividends, (tin_ok/wn_ok(-1)), is yielding very close to 3.53 percent over the long run [number 6].

Central Government: The interest payment to abroad (Tiie_os_z) [number 9] and to domestic lenders (Tiid_os_z) [number 10] are based on foreign and domestic government bond holdings. The implicit interest rate is 3.53 percent. In addition, the interest income (Tii_z_os) of the central government coming from the pension fund's bond portfolio (Wb_z_os) and other claims (Wnq_os) is also 3.53 percent in steady state [number 7]. The dividend income of central government, (Tiu_z_os) comes from central government share holdings (Ws_x_os) yielding an implicit interest rate of 3.53 percent [number 11]. The net interest income (tiin_os) of the central government on bonds and other assets yields an implicit interest rate of 3.53 percent [number 8]. The net revenue (tin_os - tirn_o) of central government relative its net debt (wn_os) yields a

3.53 percent implicit interest rate [number 12]. The income from lands and rights (tirn_o) are included in the revenue of non-financial corporations.

Households: Households generate income from shares in the form of dividend income (Tiu_z_h) from pension deposits in life insurance and pension funds in Danish and foreign shares (wsp_d_cf and wsp_e_cf) in the form of interest income on pension deposit in bonds (wbp_z_cf). The implicit interest rate on these interest income and net asset is 3.53 percent [number 15]. Similarly, the net interest revenue (tiin_h) on bonds, pensions and other assets yields a 3.53 percent implicit interest rate [number 13]. The net revenue from interest and dividends (tin_h) has also an implicit interest rate of 3.53 percent [number 17].

Financial Corporations: The dividend expenditure of the financial sector (Tiu_cf_z) is a payment going to the holders of shares and equities issued by the financial corporations (Ws_cf_z). It provides an implicit interest rate of 3.53 percent [number 22]. The dividend income (tiu_z_cf) of the financial sector is based on the sector's own Danish and foreign share holdings (wsr_d_cf and wsr_e_cf) plus pension bank deposits in Danish and foreign shares (wscp_d_cf and wscp_e_cf) plus the pension deposits of life insurance and pension funds in Danish and foreign shares (wsp_d_cf and wsp_e_cf). The implicit interest rate on this dividend income is 3.53 percent [number 23]. The financial sector also pays mortgage interest (tiim_cf_x) on mortgage bonds issued by the cf sector (wbm_cf_z), and the implicit interest rate is 3.53 percent [number 20]. The net interest income of financial corporations (tiin_cf) comes from the net bond holdings owned by the cf sector (wnbr_cf), from pension funds and life insurance companies' pension deposits in bonds (wbp_z_cf) minus pension bank deposits in Danish and foreign shares (wscp_d_cf and wscp_e_cf) and from the cf sectors' net stock of other claims (wnq_cf).

Note that we include the pension funds and life insurance companies' pension deposits in bonds in the net asset yielding Tiin_cf but we do not include pension deposits in bonds in banks and we actually subtract the banks' pension deposits in shares, i.e. we subtract wscp_d_cf and wscp_e_cf. This is done because the interest and dividend incomes from banks' pension deposits go as interest payments to the pension holders, i.e. the households and to a lesser extent foreigners. Thus, the cf sector's Tii-income on bonds in banks' pension deposits is balanced out by Tii outlays to deposit holders, and also the Tiu-income on shares in banks' pension deposits is balanced by Tii outlays to the deposit holders. Consequently, the banks' pension deposits in bonds and shares are balanced by a costumers' deposit on the banks' balance. The cf sector's net asset yielding Tiin_cf implies an interest rate of 3.5 percent [number 21], which is a little lower than the 3.53 percent required. That can be explained by the relatively high implicit interest rate for Tiin_ok in municipalities.

The interest income on pension deposits in financial corporations (tip_cf_z) based on pension reserves (wp_cf_x) yields an implicit interest rate of 3.53 percent [number 18 and 19]. The rate of return on pension and life insurance (iuwp) can also be used as an implicit interest rate on pension interest rate and pension funds of financial corporations. The financial corporations' net revenue (tin_cf) from interest and dividends relative to net worth of financial corporations, (wn_cf) excluding the gold (wg_e_cf) produces an implicit interest rate of 3.5 percent [number 24].

Non-financial corporations: the dividend income of non-financial corporations (Tiu_z_cr) which comes from the domestic and foreign shareholding (Ws_d_cr and Ws_e_cr) yields an implicit interest rate of 3.53 percent

[number 26]. Similarly, the dividend outlays of non-financial corporations (Tiu_cr_z) on shares and equities issued by non-financial corporations (Ws_cr_z) are also set to yield an implicit interest rate of 3.53 percent [number 27]. On top of that, the implicit interest rate of interest income to non-financial corporations (tiin_cr) from holdings of bonds and other assets (Wnq_cr + Wnb_cr - Wlm_cr_cf) corresponds to the required implicit interest rate of 3.53 percent [number 25]. Net revenue from interest and dividends (tin_cr) and income from land and rights (tirn_o) of non-financial corporations relative to the net debt of non-financial corporations also yields an implicit interest rate of 3.53 percent [number 28].

Foreign sector: the dividend income (tiu_z_e) [number 32] and outlay (Tiu_e_z) [number 31] of the foreign sector relative to the foreign holding of Danish shares (Ws_e_z) and Danish holdings of foreign shares (ws_z_e), respectively, are both yielding an implicit interest rate of 3.53 percent. In addition, the central government interest payment abroad (tiie_os_z) on foreign debt (wbe_os_z) also gives a 3.53 percent implicit interest rate [number 30]. The net interest income of foreign sector (tiin_e) on bond and other assets holdings of foreign sector (Wnq_e(-1) + Wnb_e(-1)-Wlm_e_cf(-1)+ Wp_cf_e(-1)) has a 3.53 percent implicit interest rate [number 29], however, the net revenue from interest and dividends (tin_e) of the foreign sector is only 3.5 percent of the corresponding net asset [number 33] in the long run. That is 0.03 percent lower than the required implicit interest rate.

Table 1: Implicit Interest rates

	Interest income on Bonds and other assets	Dividend income on shares	Total net revenue on shares and dividends
Funds	1 $\frac{tiin\_oo}{(wnq\_oo(-1)+wnb\_oo(-1))}$	2 $\frac{tiu\_z\_oo}{ws\_x\_oo(-1)}$	3 $\frac{tin\_oo}{wn\_oo(-1)}$
	Interest income on Bonds and other assets	Dividend income on shares	Total
Municipality	4 $\frac{tiin\_ok}{(wnq\_ok(-1)+wnb\_ok(-1)-wlm\_ok\_cf(-1))}$	5 $\frac{tiu\_z\_ok}{(ws\_d\_ok(-1)+ws\_e\_ok(-1))}$	6 $\frac{tin\_ok}{wn\_ok(-1)}$
	Interest income Foreign and domestic bonds, interest outlays	Dividend income on shares	Total net revenue on shares and dividends
Central Government	7 $\frac{tii\_z\_os}{(wnq\_os(-1)+wb\_z\_os(-1))}$ 8 $\frac{tiin\_os}{(wnq\_os(-1)+wnb\_os(-1))}$ 9 $\frac{tiie\_os\_z}{wbe\_os\_z(-1)}$ 10 $\frac{tiid\_os\_z}{wbd\_os\_z(-1)}$	11 $\frac{tiu\_z\_os}{ws\_x\_os(-1)}$	12 $\frac{(tin\_os-tirn\_o)}{wn\_os(-1)}$
	Interest income on Bonds, pensions and other assets	Dividend income on shares and pension	Total net revenue on shares and dividends
Households	13 $\frac{tiin\_h}{(wnq\_h(-1)+wnbr\_h(-1)+wbp\_z\_h(-1)-wlm\_h\_cf(-1)+wcp\_cf\_h(-1))}$ 14 $\frac{tiip\_h}{wbp\_z\_h(-1)}$	15 $\frac{tiu\_z\_h}{(wsr\_d\_h(-1)+wsp\_d\_h(-1)+wsr\_e\_h(-1)+wsp\_e\_h(-1))}$ 16 $\frac{tiup\_h}{(wsp\_d\_h(-1)+wsp\_e\_h(-1))}$	17 $\frac{tin\_h}{wn\_h(-1)}$

Table 2: Implicit Interest rates

	Interest outlay on bonds, shares and mortgages, interest income	Dividend payment and dividend income on shares	Total net revenue on shares and dividends
Financial Corporations	18 $\frac{tip\_cf\_z}{(wsp\_d\_cf(-1)+wsp\_e\_cf(-1)+wbp\_z\_cf(-1))}$ 19 $\frac{tip\_cf\_z}{wp\_cf\_x(-1)}$ 20 $\frac{tiim\_cf\_x}{wbm\_cf\_z(-1)}$ 21 $\frac{tiin\_cf}{(wnbr\_cf(-1)-wlm\_cf\_cf(-1)-wscp\_d\_cf(-1)-wscp\_e\_cf(-1)+wbp\_z\_cf(-1)+wnq\_cf(-1))}$	22 $\frac{tiu\_cf\_z}{ws\_cf\_z(-1)}$ 23 $\frac{tiu\_z\_cf}{(wsr\_d\_cf(-1)+wscp\_d\_cf(-1)+wsr\_e\_cf(-1)+wscp\_e\_cf(-1)+wsp\_d\_cf(-1)+wsp\_e\_cf(-1))}$	24 $\frac{tin\_cf}{(wn\_cf(-1)-wg\_e\_cf(1))}$
	Interest income on Bonds and other assets	Dividend payment and dividend income on shares	Total net revenue on shares and dividends
Non-Financial Corporations	25 $\frac{tiin\_cr}{(wnq\_cr(-1)+wnb\_cr(-1)-wlm\_cr\_cf(-1))}$	26 $\frac{tiu\_z\_cr}{(ws\_d\_cr(-1)+ws\_e\_cr(-1))}$ 27 $\frac{tiu\_cr\_z}{ws\_cr\_z(-1)}$	28 $\frac{(tin\_cr+tirn\_o)}{wn\_cr(-1)}$
	Net interest income on Bonds, pensions and other assets	Dividend payment and dividend income on shares	Total net revenue on shares and dividends
Foreign sector	29 $\frac{tiin\_e}{(wnq\_e(-1)+wnb\_e(-1)-wlm\_e\_cf(-1)+wp\_cf\_e(-1))}$ 30 $\frac{tiie\_os\_z}{wbe\_os\_z(-1)}$	31 $\frac{tiu\_e\_z}{ws\_e\_z(-1)}$ 32 $\frac{tiu\_z\_e}{ws\_z\_e(-1)}$	33 $\frac{tin\_e}{wn\_e(-1)}$

10. Conclusion

The changes to the okt14 model and construction of a new baseline helps us get implicit interest rates of 3.53 percent in steady state. The 3.53 percent is equal to the nominal GDP growth rate, and an interest rate of this size represents a growth-corrected interest rate of zero. The clearest exception concerns interest income to municipalities (tiin_ok) where the implicit interest rate is 3.65 in steady state. At the same time, the implicit interest rate for net wealth revenue of financial corporations (tin_cf), interest income of financial corporations (tiin_cf) and net wealth revenue of foreign sector (tin_e) are equal to 3.50 percent in steady state. These deviations can occur if e.g. the calculated implicit bond yield biwb deviates slightly from 3.53 and the sector in question holds large assets in biwb-assets and large liabilities in other financial assets, implying a small net asset as denominator for the implicit interest rate calculation. This is a numerical problem but not necessarily a deep problem.

It is not important per se that every implicit interest rate on any small net asset is precisely equal to the growth rate of GDP. However, it is essential for the macro calculations with the fiscal reaction function that the implicit interest rate on the public total net asset government is equal to the GDP growth rate in steady state. Otherwise the calculations become more difficult. The identity between steady state growth and interest rate on public net asset is secured by the residual calculation of the discount rate, as explained in the paper. .

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