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NO 902 / MAY 2008

FISCAL CONSOLIDATION IN THE EURO AREA

LONG-RUN BENEFITS AND SHORT-RUN COSTS

by Günter Coenen, Matthias Mohr and Roland Straub

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LONG-RUN BENEFITS AND SHORT-RUN COSTS[1]

by Günter Coenen[2], Matthias Mohr[3] and Roland Straub[4]

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Abstract

In this paper, we examine the macroeconomic effects of alternative fiscal consolidation policies in the New Area-Wide Model (NAWM), a two-country open-economy model of the euro area developed at the European Central Bank (cf. Coenen et al., 2007). We model fiscal consolidation as a permanent reduction in the targeted government debt-to-output ratio and analyse both expenditure and revenue-based policies that are implemented by means of simple fiscal feedback rules. We find that fiscal consolidation has positive long-run effects on key macroeconomic aggregates such as output and consumption, notably when the resulting improvement in the budgetary position is used to lower distortionary taxes. At the same time, fiscal consolidation gives rise to noticeable short-run adjustment costs in contrast to what the literature on expansionary fiscal consolidations suggests. Moreover, depending on the fiscal instrument used, fiscal consolidation may have pronounced distributional effects.

JEL Classification System: E32, E62

Keywords: DSGE modelling, limited asset-market participation, fiscal policy, fiscal consolidation, euro area

Non-Technical Summary

Since the launch of the Economic and Monetary Union (EMU), deficits and/or debt levels in a number of euro area countries have been lastingly above the reference values of the Maastricht Treaty, which obliges Member States of the European Union to avoid deficits exceeding 3% of GDP and debt levels above 60% of GDP. A breach of the reference values initiates an Excessive Deficit Procedure (EDP) with the aim of examining and correcting the fiscal imbalance in the respective country. Even though the public debate is largely centred on the EDP prescriptions for correcting excessive deficits, an EDP can also be launched in case the debt-to-GDP ratio exceeds the reference value of 60%, unless it is diminishing and approaching the reference value at a satisfactory pace. Indeed, amongst economists the debt level relative to GDP, rather than the deficit, is widely perceived as the more relevant criterion from a longer-term sustainability point of view.

Against this background, we employ a calibrated open-economy model of the euro area—the ECB's New Area-Wide Model (NAWM), as described in Coenen et al. (2007)—to examine the long-run benefits and the short-run adjustment costs of alternative debt consolidation strategies. We model debt consolidation as a gradual reduction in the euro area debt ratio from its current value of about 70% to a value of 60%, and analyse both expenditure and revenue-based consolidation policies that are implemented by means of simple fiscal feedback rules. While the literature suggests the existence of tradeoffs between the short and the long-run effects of fiscal consolidation policies, we are not aware of a systematic model-based examination of the mechanisms behind their macroeconomic impact. In standard neoclassical models featuring a representative household, the role of fiscal policy is extremely limited with government spending typically assumed to be exogenous and lump-sum taxes/transfers balancing the fiscal authority's budget. Thus, Ricardian equivalence holds and the precise level of government debt is inessential since the representative household anticipates the future tax burden originating in the fiscal authority's need to service, and eventually repay government debt. The NAWM departs from this standard setting in two important aspects. First, it distinguishes two types of households which differ with respect to their ability to participate in asset markets, with one type of household only holding money as opposed to also trading bonds and accumulating physical capital. Due to the existence of these two types of households, fiscal policies other than government spending—notably transfers—have real effects even though both types of households are

optimising subject to intertemporal budget constraints. Second, the NAWM incorporates a relative rich set of distortionary taxes, including taxes on consumption purchases, labour and capital income, as well as profits, so that alternative fiscal policies, characterised by the use of distinct instruments, can be analysed.

Employing the NAWM with its enhanced role for fiscal policy, we first confirm that fiscal consolidation has positive long-run effects on key macroeconomic aggregates such as output and consumption, in particular when the resulting improvement in the budgetary position is used to lower distortionary taxes. The key mechanism behind these positive long-run effects is the fact that a reduction in the amount of outstanding government debt gives rise to an improvement in the fiscal authority's budgetary position because interest rate payments on government debt will be lower. This raises the possibility of reducing the level of distortionary taxes, with the result of stimulating economic activity. The positive effects are further strengthened when allowing for a long-run equilibrium response of the real interest rate and/or the net foreign asset position to changes in the targeted government debt-to-output ratio. At the same time, we show that fiscal consolidation gives rise to noticeable short-run adjustment costs, in contrast to what the literature on expansionary fiscal consolidations suggests and regardless of the consolidation policy followed. Moreover, in the presence of heterogenous households, and depending on the fiscal instrument used, fiscal consolidation can have pronounced distributional effects.

1 Introduction

Since the launch of the Economic and Monetary Union (EMU), deficits and/or debt levels in a number of euro area countries have been lastingly above the reference values of the Maastricht Treaty, which obliges Member States of the European Union to avoid deficits exceeding 3% of GDP and debt levels above 60% of GDP. A breach of the reference values initiates an Excessive Deficit Procedure (EDP) with the aim of examining and correcting the fiscal imbalance in the respective country. The Stability and Growth Pact—adopted in 1997 and reformed in 2005—complements the Maastricht Treaty by clarifying the mechanisms of fiscal policy surveillance and co-ordination as well as the rules for the application of the EDP.[1] In this context, all EU Member States are obliged to provide annual stability or convergence programmes with medium-term objectives for fiscal policies and, where applicable, propose concrete adjustment paths towards their achievement.

Even though the public debate is largely centred on the EDP prescriptions for correcting excessive deficits, an EDP can also be launched in case the debt-to-GDP ratio exceeds the reference value of 60%, unless it is diminishing and approaching the reference value at a satisfactory pace. Indeed, amongst economists the debt level relative to GDP, rather than the deficit, is widely perceived as the more relevant criterion from a medium to long-run sustainability point of view. For this reason, we focus our analysis on the prescriptions of the existing European fiscal policy framework for the evolution of the debt-to-GDP ratio. In particular, we employ a calibrated two-country open-economy model of the euro area—the ECB's New Area-Wide Model (NAWM), as described in Coenen et al. (2007)[2]—to examine the long-run benefits and the short-run adjustment costs of alternative debt consolidation strategies.[3] We model debt consolidation as a gradual reduction in the euro area debt

[1] For a comprehensive assessment of the Stability and Growth Pact and its reform see Morris et al. (2006).

[2] The specification of the NAWM builds on recent advances in developing micro-founded dynamic stochastic general equilibrium (DSGE) models suitable for quantitative policy analysis, as exemplified by the closed-economy model of the euro area by Smets and Wouters (2003), the International Monetary Fund's Global Economy Model (GEM; cf. Bayoumi et al., 2004) or the Federal Reserve Board's new open economy model named SIGMA (cf. Erceg et al., 2005). Thus, the NAWM incorporates numerous nominal and real rigidities in an effort to improve its empirical fit regarding both the domestic and international dimension.

[3] In parallel to building the calibrated two-country version of the NAWM, a more parsimoniously specified estimated version has been developed (cf. Christoffel et al., 2007). This version has been devised for forecasting purposes but abstracts from many of the fiscal features considered in the analysis of fiscal consolidation in the current paper.

ratio from its current value of about 70% to a value of 60%, and analyse both expenditure and revenue-based consolidation policies that are implemented by means of simple fiscal feedback rules.

In recent years, a large body of mostly empirical studies has explored the short-run *expansionary* influences of fiscal consolidations on macroeconomic aggregates, notably consumption and output. These studies have largely focused on the impact of government expenditure cuts and suggest that, in contrast to the traditional Keynesian view, the tightening of fiscal spending can stimulate economic activity in the short run.[4] Several theoretical explanations of the so-called non-Keynesian effects of government expenditure cuts have been proposed in the literature (see, for example, Giavazzi and Pagano, 1990 and 1996; Alesina and Perotti, 1997; Alesina and Ardagna, 1998; Perotti, 1999; and Ardagna, 2004). A central explanation is based on the implied wealth effect on consumption: restraining fiscal spending may give rise to expectations of future tax cuts and hence a higher permanent income on the part of households, which would stimulate private consumption and thereby output. Another explanation focuses on the positive effects of a fall in the risk premium that can be brought about by reducing high levels of government debt, with lower interest rates stimulating both consumption and investment. Regarding the role of revenue-based fiscal consolidation, Blanchard (1990) points out that tax increases can also have an expansionary effect on economic activity if they generate expectations of less dramatic tax increases, or even tax reductions in the future.

Even though the literature suggests the existence of tradeoffs between the short and the long-run effects of fiscal consolidation policies, we are not aware of a systematic model-based examination of the mechanisms behind their macroeconomic impact. In standard neoclassical models featuring a representative household, the role of fiscal policy is extremely limited with government spending typically assumed to be exogenous and lump-sum taxes/transfers balancing the fiscal authority's budget. Thus, Ricardian equivalence holds and the precise

[4]Comprehensive surveys of the empirical literature on expansionary fiscal consolidations, with a focus on European economies, can be found in Hemming et al. (2002) and Prammer (2004). Overall, the literature comes to mixed conclusions and expansionary effects of fiscal consolidations seem to pertain to particular circumstances characterised by especially high levels of government debt or a credible change in the fiscal regime.

level of government debt is inessential since the representative household anticipates the future tax burden originating in the fiscal authority's need to service, and eventually repay government debt. The NAWM departs from this standard setting in two important aspects. First, it distinguishes two types of households which differ with respect to their ability to participate in asset markets, with one type of household only holding money as opposed to also trading bonds and accumulating physical capital. Due to the existence of these two types of households, fiscal policies other than government spending—notably transfers—have real effects even though both types of households are optimising subject to intertemporal budget constraints.[5] Second, the NAWM incorporates a relative rich set of distortionary taxes, including taxes on consumption purchases, labour and capital income, as well as profits, so that alternative fiscal policies, characterised by the use of distinct instruments, can be analysed.

Employing the NAWM with its enhanced role for fiscal policy as a laboratory for examining the macroeconomic effects of alternative fiscal consolidation strategies, we first confirm that fiscal consolidation has positive long-run effects on key macroeconomic aggregates such as output and consumption, in particular when the resulting improvement in the budgetary position is used to lower distortionary taxes. The key mechanism behind these positive long-run effects is the fact that a reduction in the amount of outstanding government debt gives rise to an improvement in the fiscal authority's budgetary position because interest rate payments on government debt will be lower. This raises the possibility of reducing the level of distortionary taxes, with the result of stimulating economic activity. The positive effects are further strengthened when allowing for a long-run equilibrium response of the real interest rate and/or the net foreign asset position to changes in the targeted government debt-to-output ratio. At the same time, we show that fiscal consolidation gives rise to noticeable short-run adjustment costs, in contrast to what the literature on expansionary fiscal consolidations suggests and regardless of the consolidation policy followed.[6] Moreover,

[5]This setup extends the non-Ricardian framework proposed by Galí et al. (2007) and analysed empirically in Coenen and Straub (2005) which assumes that one group of households is subject to liquidity constraints and cannot even participate in the money market. These households follow a simple rule of thumb and just consume their after-tax disposable income.

[6]The magnitude of the adjustment costs depends on the existence of nominal and real rigidities within the NAWM. In the absence of these rigidities, fiscal consolidation policies would lead to adjustment paths

in the presence of heterogenous households, and depending on the fiscal instrument used, fiscal consolidation may have pronounced distributional effects.

The remainder of the paper is organised as follows. Sections 2 briefly reviews the evolution of government-debt ratios in the euro area over the last twenty-five years. Section 3 provides a short description of the NAWM and devises alternative strategies for achieving fiscal consolidation. Section 4 employs the NAWM to examine the long-run benefits of the alternative consolidation strategies, while Section 5 gauges the short-term adjustment costs and the distributional effects. Finally, Section 6 provides some additional sensitivity analysis, and Section 7 summarises our conclusions.

2 The Evolution of Government Debt in the Euro Area

As documented in Table 1, the government debt-to-GDP ratio in the euro area followed an upward trend over the 1980s and the first half of the 1990s, eventually levelling off at around 70% afterwards. The debt ratio continuously built up in the 1980s, not only during periods of economic slowdown—as a tax-smoothing strategy would suggest—but also during periods with buoyant growth. It exceeded 60% in 1992, continued to climb until 1996-97, and declined slowly thereafter.

The evolution of the debt ratio for the euro area as a whole masks marked differences in the development of debt ratios across the individual euro area countries. For example, while a number of countries—notably those which experienced accelerating increases in their debt ratios in the course of the 1980s and the first half of the 1990s, such as Belgium and Italy—introduced measures to curb and cut back public debt, other countries, such as France and Germany, have hardly seen any significant improvement in their fiscal positions so far. Consequently, with the deceleration of consolidation efforts observed over recent years more widely—exceptions are Spain, Ireland and Finland—the need for fiscal consolidation continues to weigh heavily on the euro area.

Figure 1 provides a more detailed analysis of the factors behind the evolution of the

that are characterised by sizeable impact responses and overshooting—outcomes that we consider as rather implausible from an empirical perspective.

Table 1: Debt Ratios in the Euro Area and the European Union 1980-2005

	1980	1990	1995	2000	2005
Euro area	33.7	57.9	72.2	69.2	70.8
Belgium	74.1	125.7	129.7	107.7	93.3
Germany	31.2	42.3	55.5	59.2	67.7
Greece	20.8	35.3	55.1	56.7	66.8
Spain	16.4	42.6	62.5	59.2	43.2
France	20.8	35.3	55.1	56.7	66.8
Ireland	69.0	93.1	81.0	37.8	27.6
Italy	56.9	94.7	121.2	109.2	106.4
Luxembourg	9.9	4.7	5.8	5.3	6.2
Netherlands	44.1	73.7	74.0	53.6	52.9
Austria	35.4	56.1	67.9	65.8	63.0
Portugal	30.6	55.3	61.0	50.4	63.9
Finland	11.4	14.1	56.5	44.3	41.1
EU15	37.8	53.1	69.5	63.0	64.6
Denmark	39.1	62.0	72.5	51.7	35.8
Sweden	40.0	42.0	73.0	52.3	50.3
United Kingdom	52.4	33.5	51.0	41.2	42.8

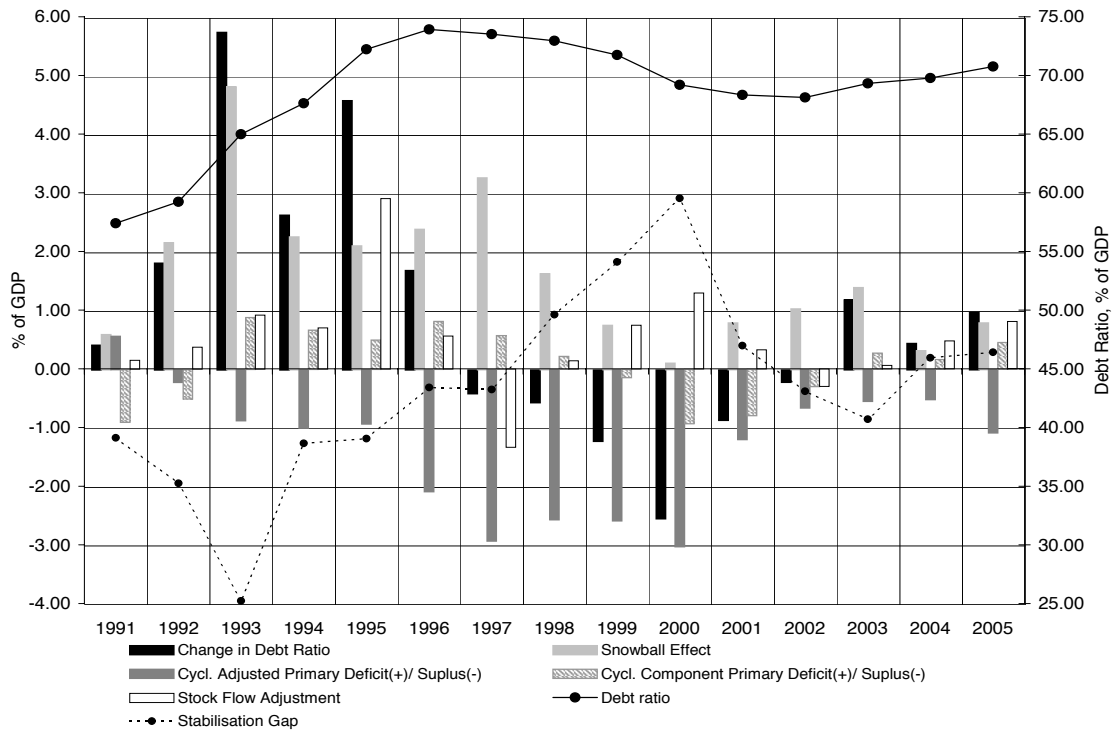
Notes: Debt figures in the Maastricht delineation, expressed in percent of GDP. The figures are based on ESA (European System of Accounts) 79 until 1993 and on ESA 95 from 1994 onwards. Debt figures for Germany before 1991 refer to West-Germany.

Source: European Commission, AMECO (Annual Macroeconomic Data) database Spring 2006.

euro area debt ratio from 1991 onwards by breaking it down into its various components: the cyclically adjusted primary deficit, the cyclical component of the primary deficit, the impact of the interest rate-growth differential—the so-called snowball effect—and, as a residual item, the stock-flow adjustment.[7] Throughout the period 1991-2005, the interest rate-growth differential contributed to the build-up of the debt ratio, in particular during the years 1993-1997, which are characterised by subdued growth and comparatively high

[7]The stock-flow adjustment captures the effects from the accumulation of financial assets, changes in the value of foreign debt due to exchange-rate changes and remaining statistical adjustments. While such effects do not influence the primary surplus, they do affect the stock of debt. Indeed, over the period 1991-2005, the stock-flow adjustment had a positive impact for most of the period, explaining 7.7 percentage points of the total increase in the debt ratio.

Figure 1: Components of the Euro Area Debt Ratio 1991-2005



Notes: Debt figures according to the Maastricht definition. The figures are based on ESA (European System of Accounts) 79 until 1993 and on ESA95 from 1994 onwards.

Source: European Commission, AMECO (Annual Macroeconomic Data) database Spring 2006, own computations.

interest rates. The impact of unfavourable cyclical conditions shows up as well in the positive contributions of the cyclical component of the primary deficit in that period. Lower cyclical deficits or cyclical surpluses in subsequent years reflect the recovery in growth. The improvements in growth, as well as steadily falling real interest rates, gave rise to a smaller snowball effect on the increase in the debt ratio thereafter.

In the period 1996-2000, we observe a significant impact of fiscal consolidation measures on the debt ratio, with cyclically adjusted primary surpluses varying between 2 and 3% of GDP. However, the development of the "debt stabilisation gap"—defined as the difference between the debt-neutral primary deficit, which would keep the debt ratio constant, and the cyclically adjusted primary deficit—indicates that an effective structural reduction in the

debt ratio set in only in 1998 when the gap turned positive. In 2000, we observe the highest contribution of fiscal policy measures to the reduction in the debt ratio, partly owing to extraordinary proceeds from UMTS (Universal Mobile Telecommunications System) licence sales, which accounted for additional revenues of about 1% of GDP in the euro area. The stabilisation gap fell in subsequent years and turned negative again in 2002-2003, indicating that the fiscal policy stance fell short of compensating for the autonomous increase in the debt ratio induced by the interest rate-growth differential. Fiscal policies in the euro area contributed only marginally to curbing public debt in 2004 and 2005 which then stabilised around 70-71% of GDP.

In the following we will use the NAWM to examine the macroeconomic effects of alternative fiscal consolidation strategies aimed at gradually reducing the current debt-to-GDP ratio of about 70% to 60%.

3 Fiscal Consolidation in the New Area-Wide Model

In this section, we first provide a brief description of the New Area-Wide Model (NAWM), with a particular emphasis on those features that give rise to a meaningful role for fiscal policy. We then outline the implementation of the alternative fiscal consolidation strategies that we want to analyse.[8]

3.1 A Sketch of the Model

The baseline version of the NAWM consists of two symmetric countries of different size: the euro area and the United States, the latter representing the rest of the industrialised world. International linkages arise from the trade of goods and international assets, allowing for imperfect exchange-rate pass-through and imperfect risk sharing. In each country, there are four types of economic agents: households, firms, a fiscal and a monetary authority. Extending the setup in Coenen and Straub (2005), the NAWM features two distinct types of households which differ with respect to their ability to participate in asset markets, with one

[8] While Appendix A provides additional information on the budget constraints of households and the fiscal authority, together with a table summarising the calibration of the fiscal sector, the reader is referred to Coenen et al. (2007) for a detailed description of the complete model and its calibration.

type of household only holding money as opposed to also trading bonds and accumulating physical capital. Thus, also households with limited access to asset markets can smooth consumption by adjusting their holdings of money. Nevertheless, due to the existence of these two types of households, fiscal policies other than government spending—notably transfers—have real effects even though both types of households are optimising subject to intertemporal budget constraints.[9] Further, it is assumed that both types of households supply differentiated labour services and act as wage setters in monopolistically competitive markets by charging a markup over their marginal rate of substitution. Specifically, wage setting is characterised by sticky nominal wages and indexation, eventually resulting in two separate wage Phillips curves.

In calibrating the behaviour of the two types of households, we set the size of the group of households with limited ability to participate in asset markets to one-fourth, in line with the estimates reported in Coenen and Straub (2005), while all other structural parameters are assumed to be identical across households. Moreover, in order to establish a more pronounced role of transfer payments made by the fiscal authority, we assume that transfers, in per-capita terms, are unevenly distributed across the two types of households, favouring the constrained households with limited asset-market participation over the unconstrained ones in a proportion of three to one. This also helps to guarantee that the levels of consumption and hours worked are not too dissimilar across households.

Regarding firms, the NAWM distinguishes between producers of tradable differentiated intermediate goods and producers of three non-tradable final goods: a private consumption good, a private investment good, and a public consumption good. The intermediate-good producers sell their differentiated outputs in both domestic and foreign markets under monopolistic competition, while the final-good producers operate under perfect competition and take prices as given. It is assumed that the intermediate-good producers set different prices in domestic and foreign markets, by charging a markup over marginal cost but pricing in local currency. In both markets, there is sluggish price adjustment due to staggered price contracts and indexation, yielding two separate price Phillips curves.

[9] See Appendix A for details on the distinct budget constraints of the two types of households, highlighting the differences between the intertemporal choices that they can make.

The fiscal authority purchases units of the public consumption good and makes transfer payments to the two types of households in unevenly distributed amounts. These expenses are financed by different types of distortionary taxes, including taxes on consumption purchases, labour and capital income, as well as profits.[10] A simple feedback rule is assumed to stabilise the government debt-to-output ratio by appropriately adjusting a suitable fiscal instrument. The alternative fiscal instruments that we consider are detailed below.

Finally, the monetary authority is assumed to follow an inertial Taylor-type interest-rate rule featuring interest-rate smoothing, which is specified in terms of annual consumer-price inflation and quarterly output growth.

3.2 Implementation

We model fiscal consolidation as a permanent reduction in the fiscal authority's target for the long-run debt-to-output ratio and analyse both expenditure and revenue-based consolidation strategies that are implemented by means of simple fiscal feedback rules.

On the expenditure side, we consider two alternative instruments: real transfers, TR_t^r, and real government consumption, G_t^r.[11] In the case of a transfer-based consolidation strategy, we assume that the fiscal authority adjusts real transfer payments as a fraction of steady-state real output, $tr_t = TR_t^r / Y^r$, according to the following rule:

$$tr_t - tr_t^* \quad = \quad \phi_B \left(B_{Y,t} - B_{Y,t}^* \right). \tag{1}$$

Here, $B_{Y,t}^*$ is the fiscal authority's target for the government debt-to-output ratio, while $B_{Y,t} = B_t^r / Y^r$ refers to the ratio of real debt to steady-state real output. The term tr_t^* denotes the debt-neutral level of the transfer ratio that, after all transient dynamics have died out, is consistent with the target debt ratio $B_{Y,t}^*$.

Similarly, in the case of a consolidation strategy based on government consumption, we assume that the fiscal authority adjusts real government consumption spending as a fraction

[10] See Appendix A for details on the fiscal authority's budget constraint and the calibration of the model's fiscal sector.

[11] Note that, whenever we refer to a real quantity, the underlying nominal variable is deflated by the model-based measure of the consumer price index.

of steady-state real output, $g_t = G_t^r / Y^r$:

$$g_t - g_t^* \quad = \quad \phi_B \left(B_{Y,t} - B_{Y,t}^* \right), \tag{2}$$

where g_t^* denotes the debt-neutral level of the government consumption ratio.

On the revenue side, we consider two alternative consolidation strategies that prescribe adjustments in the consumption tax rate, τ_t^C:

$$s_{C,t} \left(\tau_t^C - \tau_t^{C,*} \right) \quad = \quad \phi_B \left(B_{Y,t} - B_{Y,t}^* \right), \tag{3}$$

or, alternatively, in the labour income tax rate, τ_t^N:

$$s_{WN,t} \left(\tau_t^N - \tau_t^{N,*} \right) \quad = \quad \phi_B \left(B_{Y,t} - B_{Y,t}^* \right). \tag{4}$$

Here, $s_{C,t}$ and $s_{WN,t}$ refer to real private consumption expenditure (net of taxes) and (pre-tax) real wage income (that is, the relevant tax bases), both defined as a fraction of steady-state real output. The terms $\tau_t^{C,*}$ and $\tau_t^{N,*}$ denote the debt-neutral consumption and labour income tax rates, respectively.

In the long run, a reduction in the amount of outstanding government debt, as implied by the alternative consolidation strategies (1) to (4), gives rise to an improvement in the budgetary position because interest rate payments on government debt will be lower. Such an improvement in the budgetary position can ultimately be used to *increase* transfers or government consumption, as captured by a rise in the debt-neutral expenditure ratios, tr_t^* and g_t^*. Alternatively, it can be used to *lower* consumption and labour income taxes, as captured by a decline in the debt-neutral tax rates, $\tau_t^{C,*}$ or $\tau_t^{N,*}$. As will be shown below, these shifts in the debt-neutral levels of the fiscal instruments are the causes that do generate the long-run benefits of fiscal consolidation policies in our setting. Of course, one can also consider combinations of the alternative consolidation strategies. For example, one may want to implement an expenditure-based consolidation strategy, where the fiscal authority uses the improvement in the budgetary position to reduce distortionary taxes in the long run, while returning the expenditure ratio to the initial level.[12]

[12] Conceivably, the instruments at the disposal of the fiscal authority are much richer than the expenditure and tax instruments considered in this study. For example, as pointed out to us by a referee, enhanced

Alternative frameworks, such as overlapping-generations models, may suggest even larger effects of fiscal consolidation policies by accounting for a dependency of the real equilibrium interest rate on the level of government debt, which is absent in our setting. To the extent that such a dependency has been widely documented in the empirical literature,[13] we allow upward deviations of the targeted debt ratio from some neutral level, B_Y^0, to have a direct, albeit small effect on the real equilibrium interest rate, the latter being equal to the inverse of the households' discount rate in our model:

$$rr_t^* \;=\; \beta_t^{-1} \;=\; \beta^{-1} + \eta_{rr^*} \max\left[B_{Y,t}^* - B_Y^0,\, 0\right]. \tag{5}$$

Here, $\eta_{rr^*} > 0$ measures the sensitivity of the real equilibrium rate to changes in the targeted long-run debt ratio. In calibrating this sensitivity parameter, we choose a value of 0.625×10^{-3} which implies that a one percentage-point reduction in the annual government debt ratio in excess of its neutral level results in a decline of the annualised equilibrium interest rate by one basis point. This effect is clearly at the lower end of the range of estimates reported in the literature and should thus be seen as a cautious attempt to capture the influence of government debt on the equilibrium real rate.[14]

Similarly, we allow for a link between government-debt imbalances and the desired net holdings of foreign assets. Specifically, the desired net foreign asset position—expressed in domestic currency and defined relative to nominal steady-state output, $B_{Y,t}^{F,*}$—is assumed to evolve according to

$$B_{Y,t}^{F,*} \;=\; B_Y^{F,0} - \eta_{B^{F,*}}\left(B_{Y,t}^* - B_Y^0\right), \tag{6}$$

where $\eta_{B^{F,*}} > 0$ measures the sensitivity of the desired net foreign asset position to changes in the targeted debt ratio; and $B_Y^{F,0}$ indicates the neutral net foreign asset position.

subsidies to firms' research and development activities (R&D), while having an adverse impact on the fiscal authority's budget in the short run, are likely to make a positive contribution to consolidating the budget in the longer term, to the extent that R&D subsidies would accelerate economic growth and ultimately generate higher tax revenues. Similarly, shifting expenditure from government consumption to investment would have beneficial effects on economic activity and tax revenues, even if the overall expenditure were to remain unchanged (see Straub and Tchakarov, 2007, for an analysis based on the NAWM).

[13] For example, Laubach (2003), using US data over the 1985-2003 period, finds that a percentage-point increase in the projected debt-to-GDP ratio raises expected long-term interest rates by about four to five basis points. Similar findings are reported by Ardagna et al. (2005) and Kinoshita (2006) using panel data for a large set of OECD countries.

[14] Of course, the sensitivity parameter itself may depend in a nonlinear fashion on the deviation of the debt target from the neutral level, with higher levels of government debt having a disproportionately larger effect on the equilibrium rate.

By linking the net foreign asset position to changes in government debt, fiscal consolidation policies can have lasting effects on the trade balance, which otherwise would need to be offset to guarantee that the actual net holdings of foreign assets would return to a neutral level of zero.[15] This reflects the fact that a desired net foreign asset position different from zero generates additional income for domestic households in form of returns on the net holdings of foreign assets, even in the steady state.

Our specification of the link between debt imbalances and the net foreign asset position follows Faruqee et al. (2007). If the targeted debt ratio is lowered, the risk premium encountered by domestic investors will fall, leading to an increase in the net acquisition of foreign assets. In calibrating this link, we assume $B_Y^{F,0} = 0$ and set the sensitivity parameter $\eta_{B^{F,*}}$ equal to 0.25, which is half the size of the value assumed in Faruqee et al. (2007), in line with our cautious approach to capturing off-model effects.

In the following, we will examine the long-run benefits and the short-run adjustment costs of the alternative consolidation strategies (1) to (4) using both the baseline version of the NAWM and its extended version featuring an equilibrium real interest rate that varies positively and a desired net foreign asset position that varies negatively with the targeted debt ratio, as prescribed by equations (5) and (6), respectively.

In implementing the alternative consolidation strategies, we will assume that the fiscal authority's target for the debt-to-output ratio, $B_{Y,t}^*$, approaches the neutral level B_Y^0 gradually according to the following law of motion:

$$B_{Y,t}^* = (1 - \rho_B)\, B_Y^0 + \rho_B\, B_{Y,t-1}^*, \tag{7}$$

starting from some initial value B_{Y,t_0}^*.

We further assume that $B_Y^0 = 4 \times 60\%$ and fix ρ_B at $0.5^{1/16}$, implying that half of the adjustment in the targeted debt ratio is achieved after four years, three-fourth after eight years and so on.[16] Finally, regardless of the type of fiscal instrument used, we set the feedback parameter ϕ_B equal to one. This guarantees that the actual debt ratio closely

[15] Technically, this is achieved by the introduction of a financial intermediation cost—interpretable as a "risk premium"—that is incurred by domestic households when trading in foreign assets. It depends on the deviation of actual from desired net holdings of foreign assets and guarantees that the latter follow a stationary process so that the model converges to a well defined steady state.

[16] The duration of the consolidation affects the adjustment dynamics, but not the steady state.

tracks the gradual reduction in the target ratio throughout the consolidation period.

4 Long-Run Benefits of Fiscal Consolidation

In this section, we employ the NAWM to analyse the long-run effects of a permanent reduction in the government debt-to-output ratio from 70 to 60%, as implied by the alternative fiscal consolidation strategies discussed in the previous section. All effects are reported as percentage changes relative to the initial steady state, except for the effects on the fiscal instruments which are reported as percentage-point changes.

4.1 Baseline Results

In Table 2, we show the results for the baseline version of the NAWM. Interestingly, a permanent reduction in government debt resulting from the transfer-based consolidation strategy has a negative long-run effect on output, despite the fact that lower government debt and hence lower interest rate payments allow for an increase in fiscal transfers to households by about 0.3% of steady-state output in the long run.[17] The reason is that the increase in transfers, which raises the disposable income of households, triggers a decline in labour supply for any given wage rate.[18] The initial reduction in labour supply is partly offset by an increase in the households' after-tax real wage, but in equilibrium hours worked are nonetheless somewhat lower than in the initial steady state. Given the fall in hours worked, however, the marginal product of capital is reduced leading to a decline in investment and thus in the economy's capital stock. Consequently, output decreases in the long run. As economic activity falters, overall income falls and consumption, investment as well as imports decline. With reduced imports, the relative price of imports must fall in order to restore the long-run equilibrium which is characterised by balanced trade. The implied improvement in the terms of trade (defined as the domestic price of imports relative to the price of exports in domestic currency) is accompanied by an even stronger fall in exports.

[17] Throughout, the notion of output refers to the model-based measure of real GDP, consistent with the model's aggregate resource constraint.

[18] Notice that the positive income effect on the part of the unconstrained households is partly offset by a decline in their interest income. The latter effect arises regardless of the particular consolidation strategy chosen.

Table 2: Long-Run Effects of Fiscal Consolidation in the Euro Area

	Fiscal policy mix			
	(B_Y, tr)	(B_Y, g)	(B_Y, τ^C)	(B_Y, τ^N)
Euro area				
Output	-0.13	0.14	0.04	0.12
Consumption	-0.13	-0.27	0.04	0.11
Investment	-0.09	0.13	0.03	0.08
Exports	-0.11	0.02	0.03	0.10
Imports	-0.04	0.01	0.01	0.03
Hours worked	-0.15	0.15	0.04	0.14
Real wage				
After-tax real wage	0.03	-0.01	0.41	0.65
Effective labour cost	0.02	-0.00	-0.01	-0.02
Terms of trade	-0.08	0.02	0.02	0.07
United States				
Output	-0.01	0.00	0.00	0.01
Consumption	-0.01	0.00	0.00	0.01
Memo item				
Fiscal instrument	0.29	0.25	-0.49	-0.51

Notes: For the baseline version of the NAWM, this table indicates the steady-state effects on selected domestic and foreign variables of a permanent reduction in government debt relative to output (B_Y) from 70 to 60% using alternative fiscal instruments (transfers, tr, government consumption spending, g, consumption tax, τ^C, and labour income tax, τ^N). All effects are reported as percentage changes relative to the initial steady state, except for the effects on the fiscal instruments which are reported as percentage-point changes.

Although of small size, the resulting effect on output and consumption in the United States (representing the rest of the industrialised world) is negative.

A different picture emerges, if the fiscal authority uses government consumption expenditure as the instrument for achieving fiscal consolidation. In contrast to the transfer-based strategy, which affects aggregate outcomes indirectly through its effect on the households' budget constraints, the government consumption-based strategy has a direct positive long-run impact on aggregate demand, as the improvement in the fiscal position results in an

increase in the debt-neutral level of government consumption by about 0.25% of steady-state output. The increase in government consumption absorbs part of the economy's resources, thereby generating a negative wealth effect on the part of households. As households feel poorer, they cut back consumption purchases and increase labour supply. Given the increase in labour supply, hours worked do rise in equilibrium, while real wages fall by a small amount. Investment increases as the rise in hours worked has a positive impact on the marginal product of capital, making investment more attractive. Consequently, as both capital and labour services are used more intensely, output rises as well. The increase in output enables the economy to increase exports, while the impact on imports is relatively subdued mainly reflecting the decline in consumption purchases. To ensure balanced trade in the long run, the relative price of exports needs to fall in equilibrium and hence the terms of trade deteriorate.

Turning to the revenue based-consolidation strategies that are implemented using either consumption or labour income taxes as fiscal instrument, we note that their qualitative effects are quite similar. This result is not surprising, as both instruments affect the decisions of households along the same consumption-leisure margin. Specifically, as lower interest payments on government debt permit the fiscal authority to reduce either the consumption or the labour income tax rate in the long run by about 0.5 percentage points, the opportunity cost of leisure rises and hence households increase their supply of labour services. In equilibrium, firms' effective labour costs fall while hours worked turn out to be higher. At the same time, the households' after-tax real wage increases markedly, reflecting the reduction in tax rates. The implied rise in households' wage income boosts consumption under both consolidation strategies. This effect is further strengthened by the positive impact of the increase in hours worked on the marginal product of capital, which in turn fosters capital accumulation. The increase in hours worked and the enhanced capital stock give rise to higher output, matching the increase in aggregate demand. To balance the demand-driven increase in imports, the terms of trade yet again need to worsen, which boosts exports relative to imports.

4.2 Extended Results

In Table 3, we document the long-run effects of the alternative fiscal consolidation strategies that materialise in the modified version of the NAWM allowing for a long-run equilibrium response of both the real interest rate and the net foreign asset position to changes in the government debt-to-output ratio. While the economic mechanisms described above are still present, it is apparent that the endogenous responses of the equilibrium real interest rate and the desired net foreign asset position do enhance the effectiveness of the alternative consolidation strategies by a notable degree.

The increased effectiveness of both expenditure and revenue-based consolidation policies is best demonstrated by the strong positive effect of fiscal consolidation on investment.[19] The latter is about 1% higher when compared with the initial steady state, regardless of the nature of the consolidation strategy. In general, the endogenous response of the equilibrium real interest rate reduces the opportunity cost of investment. Accordingly, capital accumulation is boosted. In addition, in all cases but one, the long-run effects on both hours worked and real wages are positive. The only exception is the transfer-based consolidation policy. In this case, the decline in labour supply is pervasive, and the implied increase in the real wage leads to an even stronger rise in firms' effective labour costs. Another important observation is the sizeable effect of fiscal consolidation on imports. This effect can be explained by recalling that, in the extended model, a decrease in euro area government debt implies a rise in the desired net foreign asset position vis-à-vis the United States (representing the rest of the industrialised world). The resulting increase in interest income on foreign assets enables domestic households to finance a lasting trade deficit, with imports being noticeably higher relative to the initial steady state.

In conclusion, regardless of the strategy chosen, the long-run effects of fiscal consolidation on economic activity are found to be positive, at least when taking into account a small endogenous response of the equilibrium real interest rate and/or the net foreign asset position. The effects on output reach from around 0.2% in the case of a transfer-based

[19] The debt-neutral levels of transfers and government consumption, relative to steady-state output, rise by about 0.3 and 0.25 percentage points, respectively, while the consumption and labour income tax rates can be lowered by about 0.5 percentage points.

Table 3: Long-Run Effects of Fiscal Consolidation with Endogenous Equilibrium Real Interest Rate and Endogenous Net Foreign Asset Position

	Fiscal policy mix			
	(B_Y, tr)	(B_Y, g)	(B_Y, τ^C)	(B_Y, τ^N)
Euro area				
Output	0.18	0.46	0.35	0.44
Consumption	0.04	-0.11	0.21	0.29
Investment	1.04	1.27	1.16	1.21
Exports	0.10	0.24	0.24	0.32
Imports	0.70	0.75	0.75	0.77
Hours worked	-0.19	0.12	0.01	0.11
Real wage				
After-tax real wage	0.36	0.33	0.76	1.00
Effective labour cost	0.37	0.35	0.34	0.33
Terms of trade	0.08	0.17	0.18	0.22
United States				
Output	0.06	0.07	0.07	0.07
Consumption	-0.08	-0.06	-0.06	-0.05
Memo item				
Fiscal instrument	0.30	0.25	-0.50	-0.52

Notes: For the extended version of the NAWM with an equilibrium real interest rate that varies positively and a desired net foreign asset position that varies negatively with the target level of government debt, this table indicates the steady-state effects on selected domestic and foreign variables of a permanent reduction in government debt relative to output (B_Y) from 70 to 60% using alternative fiscal instruments (transfers, tr, government consumption spending, g, consumption tax, τ^C, and labour income tax, τ^N). All effects are reported as percentage changes relative to the initial steady state, except for the effects on the fiscal instruments which are reported as percentage-point changes.

consolidation strategy to about 0.5% in the case that the fiscal authority uses either government consumption or the labour income tax as its instrument. When the improvement in the fiscal position is used to lower distortionary taxes on either consumption purchases or labour income, consumption increases by roughly 0.25%.

Nevertheless, while the overall impact is positive in the long run, a comprehensive analysis of the alternative fiscal consolidation strategies also requires considering the implied

short-run adjustment costs, as well as distributional effects, that may vary across strategies considerably. This will be the focus of the next section.

5 Short-Run Adjustment Costs and Distributional Effects

While a reduction in government debt enables the fiscal authority to increase expenditure and/or to reduce taxes in the long run, fiscal consolidation usually requires a substantial cut in expenditure or a significant rise in tax rates in the short run. Therefore, in order to provide a comprehensive analysis, we must consider also the adjustment costs and, possibly, the distributional effects that alternative fiscal strategies may generate.

Obviously, the short-run adjustment costs implied by fiscal consolidation policies depend in important ways on the timing and the horizon of their implementation. Here, we assume that the reduction in government debt is gradually phased in—in line with the provisions of the fiscal policy framework in the euro area—but fully anticipated. Specifically, we assume that half of the reduction in the fiscal authority's debt target occurs in the course of the first four years, that three-fourth are implemented by the end of the eighth year, and so on.[20] Moreover, we assume that the gradual reduction in the debt target is instantaneously matched by adjustments in the debt-neutral level of the respective instrument.

5.1 The Main Mechanisms

To facilitate the understanding of the adjustment dynamics triggered by our alternative consolidation strategies, we first provide a short description of the main economic mechanisms through which expenditure and revenue-based consolidation affects the economy intertemporally. A more detailed discussion then follows in the next two sections.

First, expenditure-based consolidation policies, which operate through changes in either transfers or government consumption, affect macroeconomic outcomes mainly through their impact on households' wealth and the implied responses of labour supply and private consumption. More specifically, expenditure-based consolidation has either a sizeable direct effect (in the case of transfers) or a marked indirect effect (in the case of government

[20] See Appendix B for the derivation of a consolidation path in the euro area, assuming that the individual euro area countries pursue fiscal policies in accordance with the European framework of fiscal surveillance.

consumption) on the intertemporal budget constraints of households, and thereby on their permanent income. If permanent income declines, the households will choose less consumption and less leisure and thereby increase labour supply. The converse holds in the case of an increase in permanent income. Thus, the households' choices for consumption and labour supply move in opposite directions after income shocks, reflecting the fact that both consumption and leisure are normal goods.

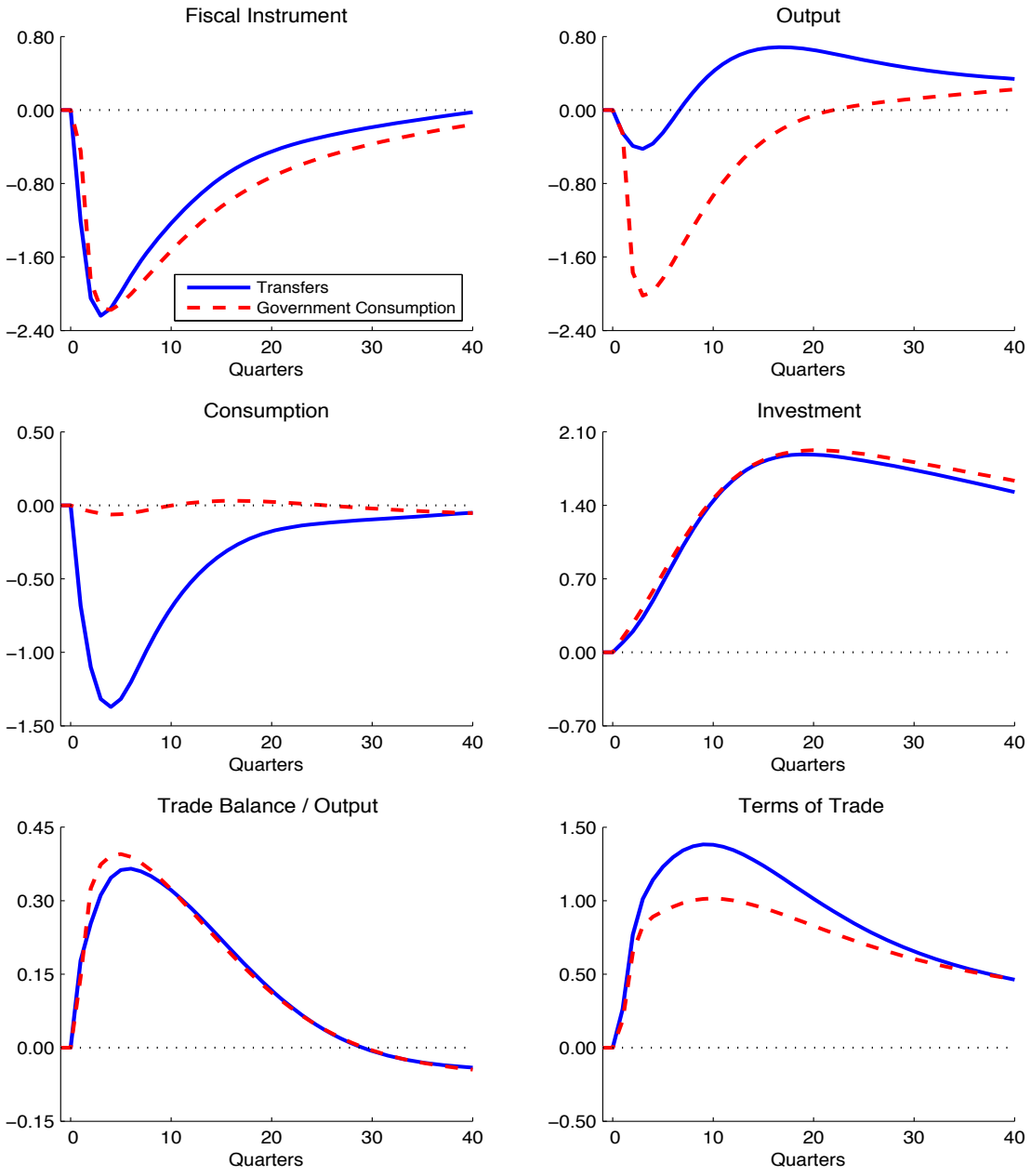
Second, and in contrast to the first mechanism, revenue-based consolidation policies affect macroeconomic outcomes mainly by changing the intertemporal price of consumption and leisure for households. Specifically, in our setting the revenue-based consolidation policies imply, after a significant initial rise to achieve consolidation, a gradual *decline* in distortionary taxes. As a result, forward-looking households that anticipate this decline have an incentive to postpone both consumption and labour supply.

5.2 Expenditure-Based Consolidation

Focusing on the extended version of the NAWM, Figure 2 exhibits the profile of the short-run adjustment dynamics for the expenditure-based consolidation policies, while Figure 3 depicts the implied distributional effects.

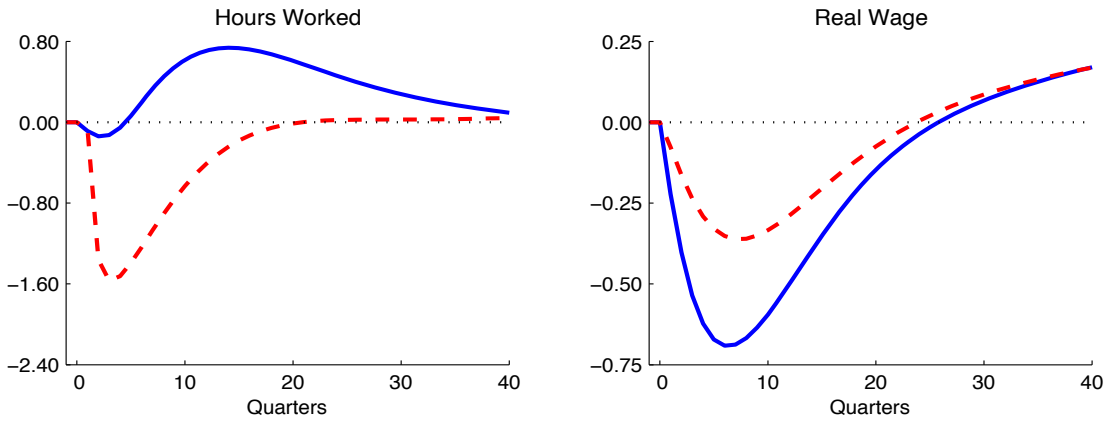
Starting with the effects of the transfer-based fiscal consolidation policy, Figure 2 reveals that the pronounced initial reduction in transfers needed to bring down government debt results in a rather modest fall in output. This fall in output is caused by a sharp decline in consumption, whereas both investment and net trade rise. As shown in Figure 3, the reduction in transfers has a considerably stronger impact on the constrained household with limited access to asset markets (i.e., household J). The sign and the magnitude of the household-specific responses to changes in the fiscal stance are largely shaped by the asymmetric distribution of transfers in the model. In particular, the members of the constrained household respond to the initial decline in transfer income by strongly reducing consumption purchases. At the same time, despite a substantially lower real wage, they increase the number of hours worked in an attempt to smooth consumption by increasing their wage income. In contrast, consumption purchases on the part of the unconstrained household are largely unaffected by the fall in transfers, even though hours worked and real

Figure 2: Adjustment Dynamics of Expenditure-Based Consolidation Policies



Notes: For the extended version of the NAWM with an endogenous equilibrium real interest rate and an endogenous desired net foreign asset position, this figure depicts the adjustment dynamics of selected domestic variables following a gradually phased-in permanent reduction in the government debt-to-output ratio from 70 to 60% using alternative expenditure-based fiscal instruments. All dynamic effects are reported as percentage deviations from the initial steady state, except for the effects on the fiscal instruments and the trade balance-to-output ratio which are reported as percentage-point changes.

Figure 2: Adjustment Dynamics of Expenditure-Based Consolidation Policies (cont.)

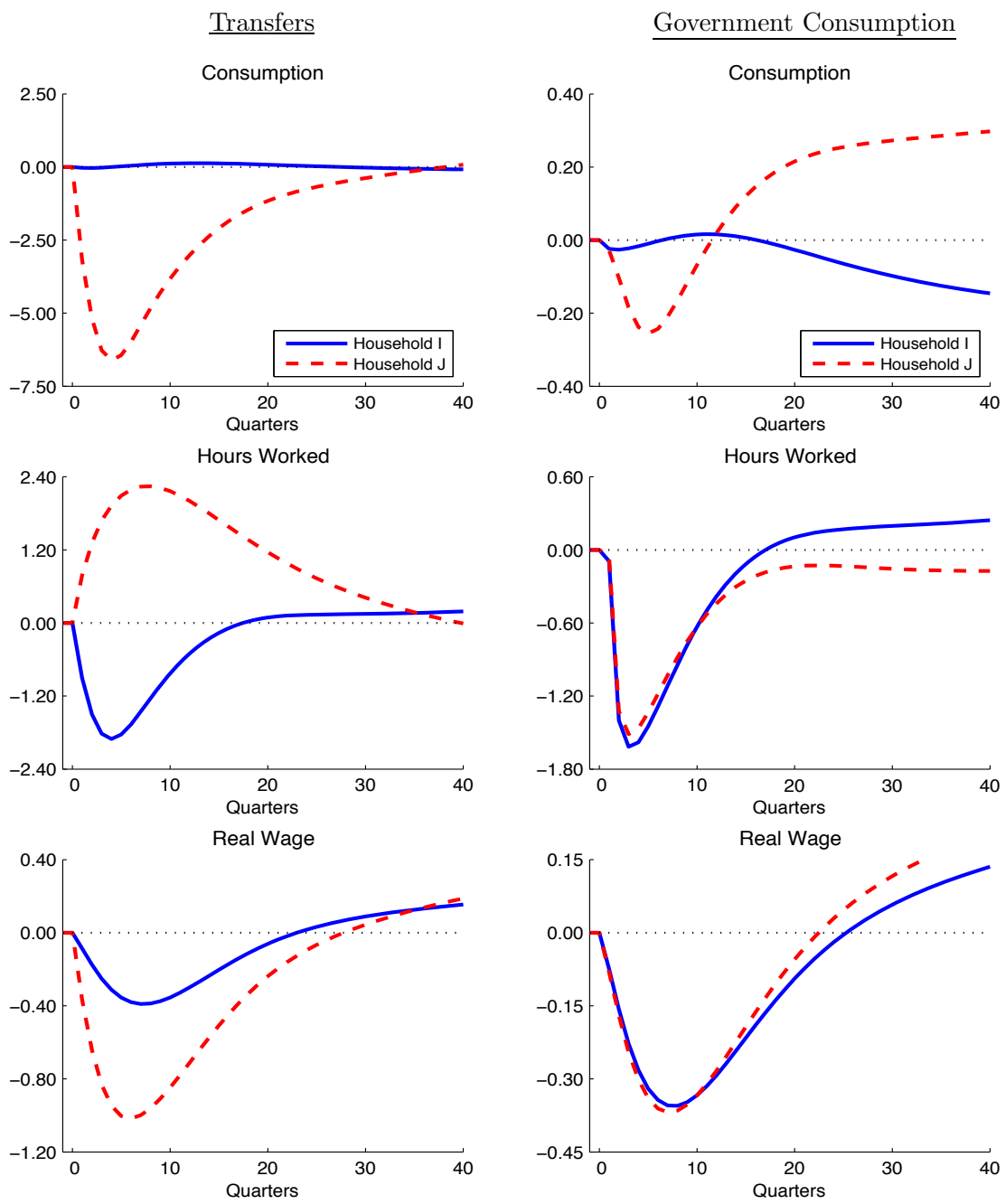


Notes: See above.

wages fall. This reflects the favourable prospects of higher capital income in the future. Hence, the unconstrained household increases investment purchases, anticipating positive developments in the opportunity cost of capital formation that are triggered by the endogenous decline in the equilibrium real interest rate. The fall in aggregate consumption, which outweighs the increase in investment over short and medium-term horizons, dampens imports and hence gives rise to a temporary trade balance surplus. The improvement in the trade balance is accompanied by a depreciation of the terms of trade. To the extent that the desired net foreign asset position increases following the reduction in government debt, the trade balance surplus declines gradually, resulting eventually in a lasting trade deficit financed by higher interest rate earnings on the domestic holdings of foreign assets.

Considering the adjustment dynamics in the case of a consolidation policy based on adjustments in government consumption, we observe a persistent fall in output which exceeds -2 percent initially, while consumption is found to be hardly affected. This subdued effect on consumption arises because the consumption responses on the part of the two types of households largely offset each other. While the positive wealth effect induced by the reduction in government spending helps the unconstrained household to stabilise consumption purchases, a marked decline in wage income leads to a sizeable reduction in consumption

Figure 3: Distributional Effects of Expenditure-Based Consolidation Policies



Notes: For the extended version of the NAWM with an endogenous equilibrium real interest rate and an endogenous desired net foreign asset position, this figure depicts the distributional effects on selected household-specific variables of a gradually phased-in permanent reduction in the government debt-to-output ratio from 70 to 60% using alternative expenditure-based fiscal instruments All dynamic effects are reported as percentage deviations from the initial steady state.

purchases on the part of the constrained household. The decline in wage income, which affects both types of households alike, reflects the shortfall in aggregate demand following the reduction in government consumption which in turn triggers a decline in both hours worked and real wages. The responses of the remaining variables are largely similar to those observed for the transfer-based consolidation strategy.

Overall, the main difference concerning the effects of the government consumption-based consolidation strategy relative to the effects of the transfer-based strategy relates to the negative impact of the former strategy on aggregate demand. The decline in aggregate demand results in a strong and persistent fall in labour demand, an effect which is not generated in the case of the transfer-based strategy.

5.3 Revenue-Based Consolidation

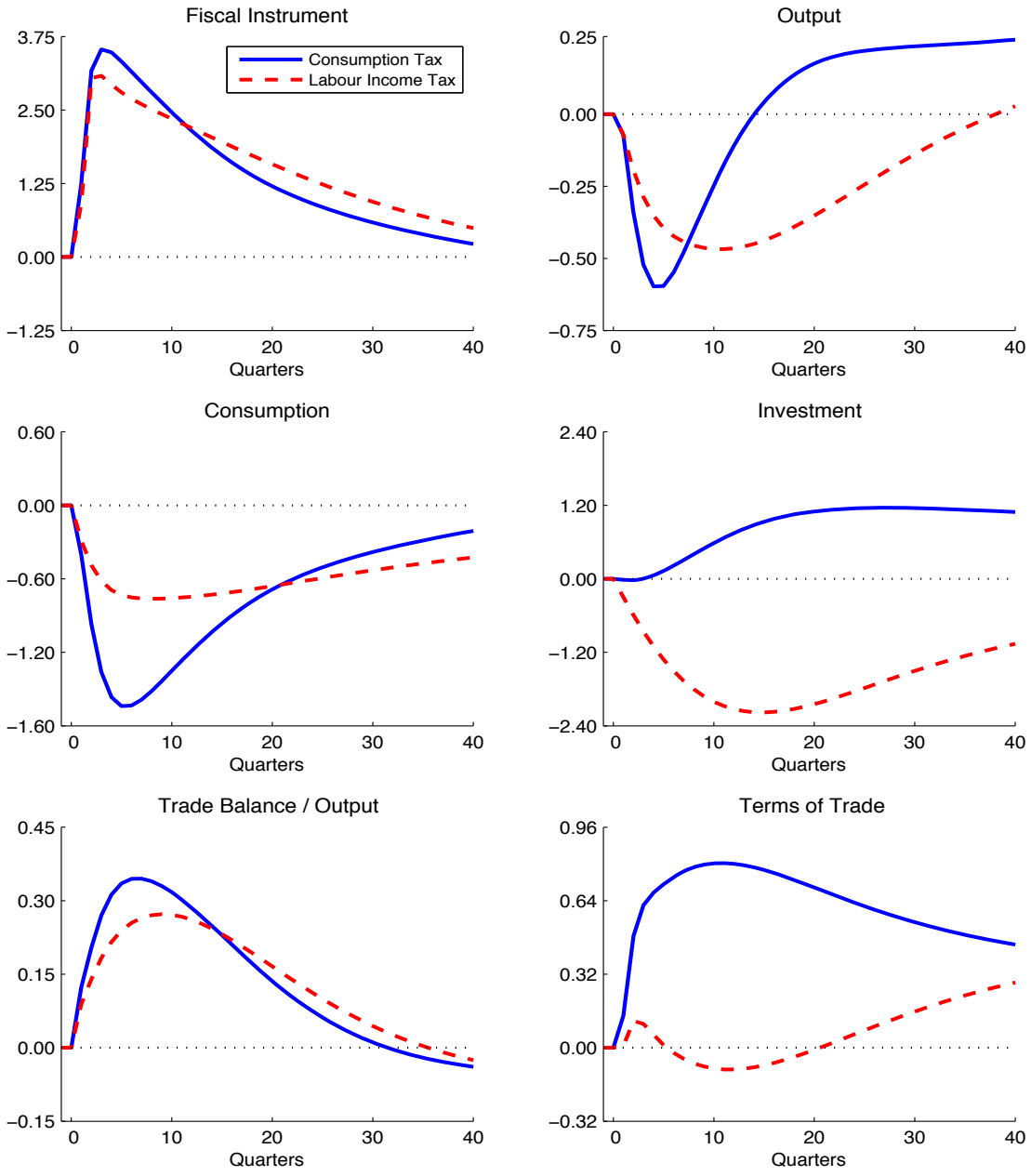
We now turn to the analysis of the adjustment dynamics and the distributional effects generated by the revenue-based consolidation strategies. The relevant findings are summarised in Figures 4 and 5 below.

When using the consumption tax as the fiscal instrument, the desired reduction in government debt requires a sharp initial increase in the consumption tax rate. In our set up, the response of the consumption tax rate peaks at about 3.5 percentage points, before gradually approaching its new debt-neutral level below the initial steady state.[21] The increase in the consumption tax rate today, and the anticipation of a lower tax rate in the future, dampens aggregate consumption in the short to medium run, while boosting investment lastingly. The reason is that the anticipated decline in the consumption tax increases the price of consumption today relative to the price of consumption in the future.[22] Both types of households cut back consumption purchases in the course of the adjustment process. However, while the unconstrained household reduces the number of hours worked, the constrained household tends to work even more. This different pattern reflects the fact that the permanent income of the unconstrained household increases in view of the

[21] To ascertain that the increase in the consumption tax rate is not unrealistic recall that the value-added tax in Germany was raised by 3 percentage points in 2007.

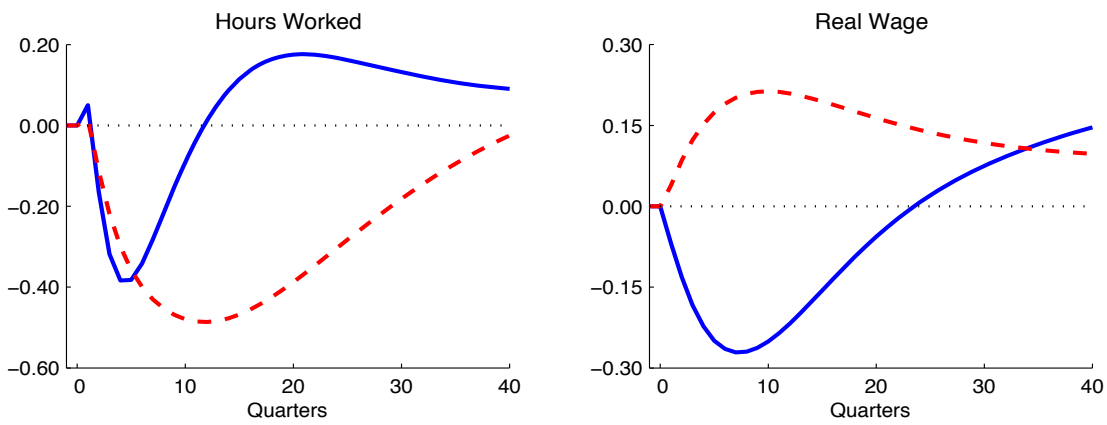
[22] Specifically, a change in the consumption tax rate acts likes a persistent preference shock, as discussed for instance in Smets and Wouters (2003).

Figure 4: Adjustment Dynamics of Revenue-Based Consolidation Policies



Notes: For the extended version of the NAWM with an endogenous equilibrium real interest rate and an endogenous desired net foreign asset position, this figure depicts the adjustment dynamics of selected domestic variables following a gradually phased-in permanent reduction in the government debt-to-output ratio from 70 to 60% using alternative revenue-based fiscal instruments. All dynamic effects are reported as percentage deviations from the initial steady state, except for the effects on the fiscal instruments and the trade balance-to-output ratio which are reported as percentage-point changes.

Figure 4: Adjustment Dynamics of Revenue-Based Consolidation Policies (cont.)



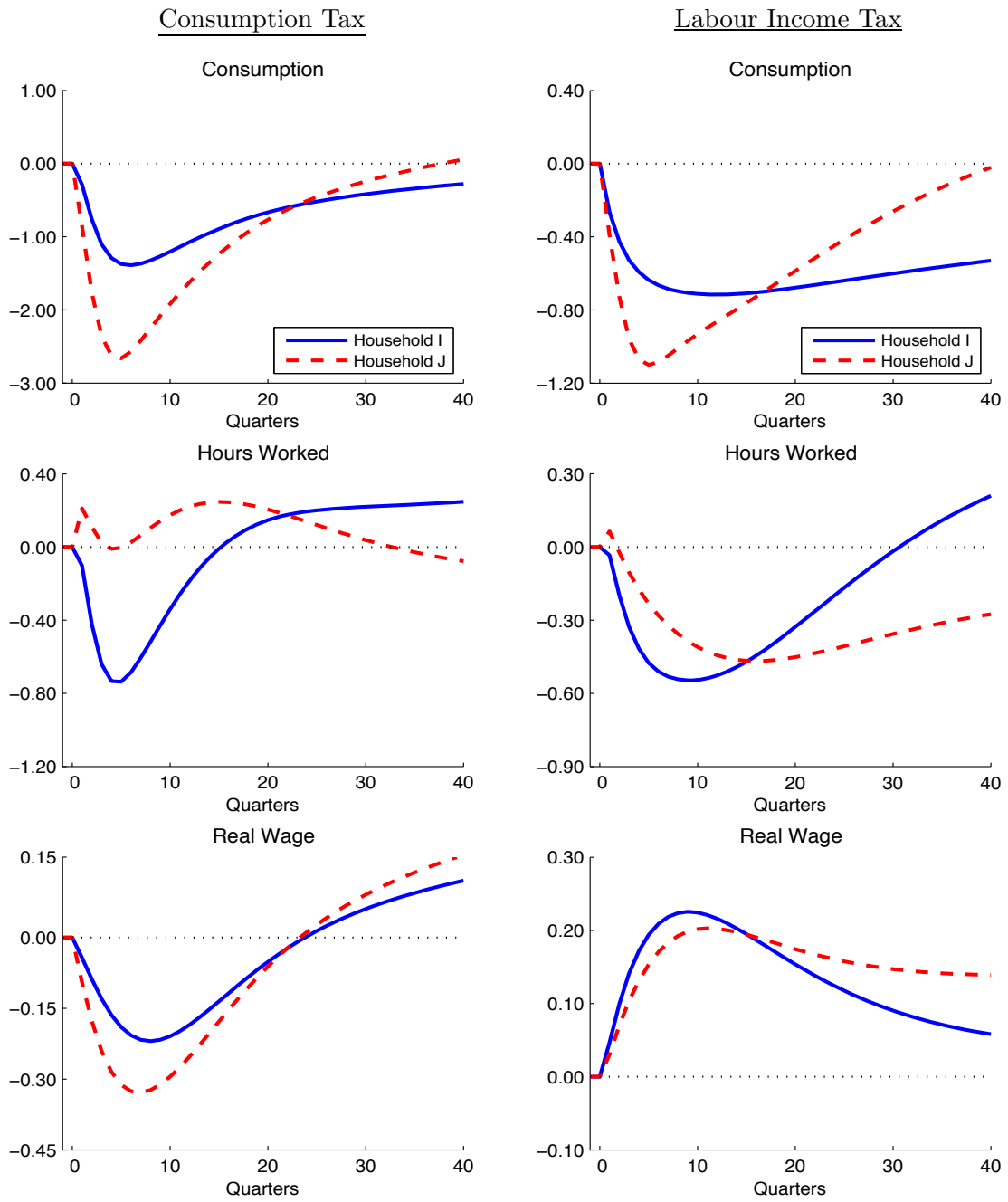
Notes: See above.

rise in the economy's capital stock, while the constrained household needs to rely mainly on adjusting the supply of labour services to smooth consumption. This in turn explains the more drawn out response of consumption on the part of the unconstrained household following the increase in the consumption tax. By means of its effect on imports, the dynamic response of aggregate consumption shapes the response of the trade balance, which records an initial surplus that gradually turns into a deficit as consumption approaches its new steady state.

Finally, using the labour income tax as fiscal instrument, the initial increase in the tax rate on labour income amounts to roughly 3 percentage points. While both consumption and labour income taxes affect the marginal rate of substitution between consumption and leisure, the labour income tax does not influence directly the intertemporal price of consumption. Consequently, consumption falls by less, whereas the rise in labour income taxes discourages work effort more persistently. It also gives rise to a noticeable decline in investment. The negative responses of both consumption and investment translate into a persistent negative response of output, while the decline in labour supply leads to rise in (pre-tax) real wages in equilibrium.

Comparing the alternative revenue-based consolidation policies, it is interesting to point

Figure 5: Distributional Effects of Revenue-Based Consolidation Policies



Notes: For the extended version of the NAWM with an endogenous equilibrium real interest rate and an endogenous desired net foreign asset position, this figure depicts the distributional effects on selected household-specific variables of a gradually phased-in permanent reduction in the government debt-to-output ratio from 70 to 60% using alternative revenue-based fiscal instruments. All dynamic effects are reported as percentage deviations from the initial steady state.

out the differences in the response of the trade balance and the terms of trade. First, the increase in the consumption tax rate results in a sharper fall in consumption, causing a more pronounced drop in imports and thus a larger improvement in the trade balance. The resulting trade balance surplus is accompanied by a sizeable deterioration of the terms of trade. Second, the increase in the labour income tax has not only a negative impact on consumption and hours worked, but also on investment, reducing at least temporarily the production capacity of the economy during the adjustment towards the new steady state. The latter leads to a persistent reduction of both import and export volumes resulting in a somewhat lower trade surplus. Overall, as the negative impact on exports is more pronounced and more persistent, the relative price of exports needs to rise generating a temporary improvement in the terms of trade and limiting thereby the negative impact of the increase in the labour income tax on the trade balance.

6 Sensitivity Analysis

We finally provide some additional sensitivity analysis regarding the importance of the assumed duration of the alternative fiscal consolidation policies for our results. To this end, we vary the time horizon over which the fiscal authority intends to reach the new target for the government debt ratio.

Table 4 reports the minima of output, consumption and hours worked within the first 16 quarters following the implementation of the different consolidation policies as well as the cumulated impact over the first 16 quarters. As expected, a shorter consolidation period (measured by the consolidation half-life; that is, the time by which half of the reduction in the targeted debt ratio is accomplished) gives rise to larger output and consumption losses and a larger decline in hours worked. We note that the quarter in which the minimum is reached is not very much affected by the length of the consolidation period, with the exception of the labour income tax-based consolidation. Furthermore, the impact on the minima of changing the length of the consolidation period is roughly proportional: doubling the duration of the consolidation period scales down the short-run effects by around a factor of 2 in case that transfers, government consumption or consumption taxes are used as the

Table 4: Adjustment Cost of Fiscal Consolidation Measures in the Euro Area

Fiscal policy mix		Half-life of consolidation in quarters: 16 quarters Minimum		16 quarters Cum. impact	8 quarters Minimum		8 quarters Cum. impact	32 quarters Minimum		32 quarters Cum. impact
(B_Y, tr)	Output	-0.42	(4)	2.20	-0.99	(4)	0.74	-0.14	(4)	2.08
	Consumption	-1.37	(5)	-12.79	-2.54	(4)	-20.78	-0.70	(6)	-7.16
	Hours worked	-0.13	(3)	5.35	-0.54	(3)	4.69	–	–	4.30
(B_Y, g)	Output	-2.02	(4)	-17.01	-3.89	(4)	-28.90	-1.02	(5)	-8.97
	Consumption	-0.06	(5)	-0.28	-0.19	(5)	-1.32	-0.02	(7)	0.00
	Hours worked	-1.57	(4)	-12.20	-3.17	(4)	-22.51	-0.73	(5)	-5.63
(B_Y, τ^C)	Output	-0.62	(5)	-4.60	-1.24	(5)	-8.56	-0.31	(6)	-2.22
	Consumption	-1.64	(6)	-19.02	-2.79	(5)	-29.21	-0.96	(7)	-11.42
	Hours worked	-0.38	(5)	-2.05	-0.90	(5)	-5.58	-0.14	(6)	-0.23
(B_Y, τ^N)	Output	-0.49	(12)	-6.06	-0.59	(9)	-7.56	-0.36	(13)	-4.29
	Consumption	-0.76	(9)	-10.30	-0.93	(6)	-12.11	-0.63	(12)	-8.40
	Hours worked	-0.49	(13)	-5.61	-0.63	(10)	-7.76	-0.32	(15)	-3.40

Notes: For the extended version of the NAWM with an endogenous equilibrium interest real interest rate and an endogenous desired net foreign asset position, this tables indicates summary statistics characterising the adjustment cost that are incurred when implementing a gradually phased-in permanent reduction in government debt relative to output (B_Y) from 70 to 60% using alternative fiscal instruments (transfers, tr, government consumption spending, g, consumption tax, τ^C, and labour income tax, τ^N). The length of the consolidation period is measured by the consolidation half-life h (with $h = 16$, 8 or 32 quarters); that is, the time by which half of the reduction in the debt-to-output ratio is accomplished. The minimum indicates the lowest value within the first h quarters, with figures in parentheses denoting the quarter in which the minimum is attained. The cumulated impact indicates percentage deviations from the initial steady state, cumulated over the first h quarters. In the case of the transfer-based consolidation strategy with $h = 32$, the effect on hours worked is positive over the first $h = 32$ quarters and therefore the minimum is not reported.

instrument, and by a factor of about 1.5 in case the labour income tax is used. This reflects the fact that the effects arising from the nonlinearities in the model are rather modest.

7 Conclusions

While there is a broad consensus amongst policymakers in the euro area that fiscal imbalances, as exemplified by excessive government debt-to-GDP ratios, are detrimental to

growth and macroeconomic stability, there is still a lack of common understanding of the nature of the long-run benefits and the short-run costs of fiscal consolidation. To shed some light on these issues from the perspective of a modern microfounded model, we examined the macroeconomic effects of alternative consolidation policies using the NAWM.

Regarding the potential long-run benefits of fiscal consolidation, we demonstrated that both expenditure and revenue-based consolidation measures can have an economically significant impact on macroeconomic aggregates, at least in an extended version of our model with endogenous responses of the equilibrium real interest rate and the net foreign asset position to reductions in government debt. Depending on the implemented consolidation scheme, however, there are notable differences in the magnitude, and sometimes also in the sign, of the long-run responses of macroeconomic variables. For example, revenue-based consolidation policies, characterised by changes in distortionary consumption or labour income taxes, generate positive long-run responses of output, consumption, investment and hours worked. In contrast, expenditure-based policies associated with adjustments in transfers and government spending, while having positive long-run effects on output and investment, differ regarding their long-run effects on consumption and hours worked. In particular, a transfer-based consolidation policy leads to a fall in hours worked, while a government consumption-based consolidation policy dampens private consumption.

Furthermore, we evaluated the potential short-run costs of alternative fiscal consolidation measures and the implied distributional effects by analysing the adjustment paths of key macroeconomic variables following the announcement of a gradual reduction in government debt. We demonstrated that fiscal consolidation policies, in general, give rise to noticeable short-run adjustment costs in contrasts to what the literature on expansionary fiscal consolidations suggests. Moreover, we showed that fiscal consolidation policies may have pronounced distributional effects to the extent that households differ with regard to their ability to participate in asset markets and their dependence on fiscal transfers. However, the magnitude of both short-run adjustment costs and distributional effects are found to depend in important ways on the particular consolidation strategy.

Obviously, the objective of our paper has been to provide a positive analysis of the

macroeconomic effects of alternative fiscal consolidation policies. A normative analysis would depend on how society weighs the long-run benefits of fiscal reforms relative to the short-run adjustments costs and possible distributional effects. This could be an interesting extension of our paper which we leave for future research.

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Appendix A

This appendix provides details on the distinct budget constraints of the two types of households in an attempt to highlight the differences between the intertemporal choices that they can make. The two households—denoted by I and J—are of normalised size $1-\omega$ and ω, respectively, with ω generally being referred to as the fraction of households with limited ability to participate in asset markets. The appendix also reports the budget constraint of the fiscal authority and details the calibration of the fiscal sector. For a detailed description of the complete model and its calibration see Coenen et al. (2007).

The Households' Budget Constraints

The members of household I are indexed by $i \in [0, 1-\omega]$. They have access to financial markets, where they buy and sell domestic government bonds, $B_{i,t+1}$, and internationally traded bonds, $B^F_{i,t+1}$. They accumulate physical capital, $K_{i,t}$, the services of which they rent out to firms, and hold money, $M_{i,t}$, for transaction purposes. The various assets enable the members of household I to smooth consumption over time.

In choosing their allocations, the members of household I face the following period-by-period budget constraint:

$$\begin{aligned}(1+\tau^C_t+\Gamma_v(v_{i,t}))\,P_{C,t}\,C_{i,t}+P_{I,t}\,I_{i,t} \\ +R_t^{-1}B_{i,t+1}+((1-\Gamma_{B^F}(B^F_t))\,R^F_t)^{-1}S_t\,B^F_{i,t+1}+M_{i,t}+\Xi_{i,t}+\Phi_{i,t} \\ =(1-\tau^N_t-\tau^{W_h}_t)\,W_{i,t}\,N_{i,t}+(1-\tau^K_t)\,(R^K_t\,u_{i,t}-\Gamma_u(u_{i,t})\,P_{I,t})\,K_{i,t} \\ +\tau^K_t\,\delta\,P_{I,t}\,K_{i,t}+(1-\tau^D_t)\,D_{i,t}+TR_{i,t}+B_{i,t}+S_t\,B^F_{i,t}+M_{i,t-1},\end{aligned} \tag{A.1}$$

where $P_{C,t}$ and $P_{I,t}$ are the prices of a unit of the private consumption good and the investment good, respectively, while $C_{i,t}$ and $I_{i,t}$ represent the household member's purchases of those goods. R_t and R^F_t denote, respectively, the risk-less returns on domestic government bonds and internationally traded bonds. Internationally traded bonds are denominated in foreign currency and, thus, their domestic value depends on the nominal exchange rate S_t (expressed in terms of units of home currency per unit of foreign currency). $N_{i,t}$ denotes the labour services provided to firms at wage rate $W_{i,t}$; R^K_t indicates the rental rate for the effective capital services rent to firms, $u_{i,t}\,K_{i,t}$, and $D_{i,t}$ are the dividends paid by household-owned firms. As regards the provision of effective capital services, varying the intensity of capital utilisation is subject to a proportional cost $\Gamma_u(u_{i,t})$.

The purchases of the consumption good are subject to a proportional transaction cost, $\Gamma_v(v_{i,t})$, which depends on consumption-based velocity, $v_{i,t}=(1+\tau^C_t)P_{C,t}C_{i,t}/M_{i,t}$; that is, the inverse of the household member's money-to-consumption ratio. Similarly, $\Gamma_{B^F}(B^F_t)$ represents a financial intermediation premium that the household member must pay when taking a position in the international bond market. The incurred premium is rebated in a lump-sum manner, which is indicated by $\Xi_{i,t}$.

The fiscal authority absorbs part of the gross income of the household member to finance its expenditure. In this context, τ_t^C denotes the consumption tax rate levied on consumption purchases; and τ_t^N, τ_t^K and τ_t^D are the tax rates levied on the different sources of household income; that is, wage income $W_{i,t}\,N_{i,t}$, rental capital income $R_t^K\,K_{i,t}$ and dividend income $D_{i,t}$. Here, we assume that the utilisation cost of physical capital, $\Gamma_u(u_{i,t})$, and physical capital depreciation, $\delta\,K_{i,t}$, are exempted from taxation. $\tau_t^{W_h}$ is the additional pay-roll tax rate levied on wage income (representing the household member's contribution to social security). The term $TR_{i,t}$ indicates transfer payments from the fiscal authority.

Finally, it is assumed that household member i holds state-contingent securities, $\Phi_{i,t}$. These securities are traded amongst all members of household I and provide insurance against individual wage-income risk. This guarantees that the marginal utility of consumption out of wage income is identical across individual household members. As a result, all members of household I will choose identical allocations in equilibrium.[23]

The members of household J are indexed by $j \in (1-\omega,\,1]$. They cannot trade in financial and physical assets. Nevertheless, they can intertemporally smooth consumption by adjusting their holdings of money, albeit to a limited extent. Thus, the members of household J are subject to the following period-by-period budget constraint:

$$\begin{aligned}(1+\tau_t^C+\Gamma_v(v_{j,t}))\,P_{C,t}\,C_{j,t}+M_{j,t} \\ =\,(1-\tau_t^N-\tau_t^{W_h})\;W_{j,t}\,N_{j,t}+TR_{j,t}+M_{j,t-1}+\Phi_{j,t}\end{aligned} \tag{A.2}$$

with notation completely analogous to that for the members of household I.

The Fiscal Authority's Budget Constraint

Aggregating across households, the fiscal authority's period-by-period budget constraint has the following form:

$$\begin{aligned}&P_{G,t}\,G_t+TR_t+B_t+M_{t-1} \\ &=\tau_t^C\,P_{C,t}\,C_t+(\tau_t^N+\tau_t^{W_h})\left(\int_0^{1-\omega}W_{i,t}\,N_{i,t}\,di+\int_{1-\omega}^{1}W_{j,t}\,N_{j,t}\,dj\right)+\tau_t^{W_f}\,W_t\,N_t \\ &\quad+\tau_t^K\,(\,R_t^K\,u_t-(\Gamma_u(u_t)+\delta)\,P_{I,t}\,)\,K_t+\tau_t^D\,D_t+R_t^{-1}B_{t+1}+M_t,\end{aligned} \tag{A.3}$$

where all quantities are expressed in per-capita-terms, with the exception of labour services and wages, which are differentiated across the members of the two households. Accordingly, the fiscal authority purchases units of a public consumption good, G_t with a unit price $P_{G,t}$, makes transfer payments TR_t, issues bonds to refinance its debt, B_t, earns seignorage on outstanding money holdings, M_{t-1}, and raises taxes with details on the latter given above, except for the firms' contribution rate to social security, denoted by $\tau_t^{W_f}$, which is charged on firms' labour cost $W_t\,N_t$.

[23] The existence of state-contingent securities is assumed for analytical convenience and renders the model tractable under staggered wage setting when household members are supplying differentiated labour services.

The Calibration of the Fiscal Sector

The NAWM's fiscal sector is calibrated so that it is consistent with the "neutral" Maastricht reference value for the debt-to-output ratio of $B_Y = 4 \times 60\%$ in steady state. The calibration of the government consumption-to-output ratio (g) is based on national accounts data, while the values for the tax rates on households' consumption purchases (τ^C) and labour income (τ^N), and for households' and firms' contribution rates to social security (τ^{W_h} and τ^{W_f}), are taken from OECD sources (cf. OECD, 2004a, 2004b). In contrast, the tax rate on capital income (τ^K) is calibrated such that it brings the implied investment-to-output ratio in line with the national accounts, while the tax rate on dividend income (τ^D) is set to zero for simplicity. Finally, the transfers-to-output ratio (tr) is chosen so that the fiscal authority's budget is balanced at the neutral debt-to-output ratio.

Table A: The Steady-State Calibration of the Fiscal Sector within the NAWM

	Value		
Parameter	Euro area	United States	Description
B_Y	240.0	240.0	Government debt-to-output ratio
g	18.0	16.0	Government consumption-to-output ratio
tr	$19.5^{\dagger}$	$8.0^{\dagger}$	Government transfers-to-output ratio
τ^C	18.3	7.7	Consumption tax rate
τ^N	12.2	15.4	Labour income tax rate
τ^{W_h}	11.8	7.1	Social security rate of households
τ^{W_f}	21.9	7.1	Social security rate of firms
τ^K	$18.4^{\ddagger}$	$18.4^{\ddagger}$	Capital income tax rate
τ^D	0.0	0.0	Dividend tax rate

Notes: This table summarises the steady-state calibration of the NAWM's fiscal sector. The superscript '†' indicates that the transfer ratio tr has been calibrated such that the fiscal authority's budget is balanced at the neutral debt-to-output ratio B_Y, whereas the superscript '‡' indicates that the capital income tax rate has been chosen such that the implied investment-to-output ratio is consistent with the national accounts.

Appendix B

In this appendix, we derive a plausible path for debt consolidation in the euro area, assuming that the euro area countries pursue fiscal policies in accordance with the European framework of fiscal surveillance. Specifically, in line with the prescriptions of the Excessive Deficit Procedure (EDP), we assume that countries subject to an EDP (Germany, France, Italy, Greece, and Portugal) adjust their budget balances following the respective Council recommendations. Countries not in excessive deficit but with budgetary imbalances are assumed to adjust their deficits by 0.50% of GDP until a budgetary position close to balance or in surplus is achieved. The remaining countries (Ireland, Finland, and Luxembourg) would not adjust.

Table B.1: Projected Deficit Adjustments in the Euro Area 2006-2009

	2006	2007	2008	2009
Euro area	0.5	0.4	0.4	0.4
Belgium	0.0	0.0	0.0	0.0
Germany	0.5	0.5	0.5	0.5
Greece	1.5	0.5	0.5	0.5
Spain	0.0	0.0	0.0	0.0
France	0.5	0.5	0.5	0.5
Ireland	0.0	0.0	0.0	0.0
Italy	0.8	0.8	0.5	0.5
Luxembourg	0.5	0.5	0.0	0.0
Netherlands	0.0	0.0	0.0	0.0
Austria	0.5	0.5	0.0	0.0
Portugal	0.7	0.7	0.7	0.5
Finland	0.0	0.0	0.0	0.0

Notes: All figures in percent of GDP. In the case of Germany, the Council recommendation foresees a budgetary improvement by 1% of GDP cumulatively in the period 2006-2007.

Source: Own computations.

As indicated in Table B.1, these requirements imply a reduction in the euro area deficit-to-GDP ratio by 0.50 percentage points in 2006, and by 0.40 percentage points in each year over the period 2007-2009. The implied primary surplus triggers a decline in the debt ratio to the extent that it exceeds the debt-neutral primary surplus.[24]

[24]The debt neutral primary surplus would keep the debt ratio constant. It is computed assuming a potential output growth rate of 1.7%, a trend inflation rate of 2%, and an interest rate on government bonds of 5%.

Table B.2: Projected Decline in the Euro Area Debt Ratio 2005-2013

	Primary surplus			Debt	
Year	Change	Level	Debt-neutral level	Change	Level
2005		0.9			70.70
2006	0.5	1.4	0.92	−0.48	70.22
2007	0.4	1.8	0.91	−0.89	69.33
2008	0.4	2.2	0.90	−1.30	68.03
2009	0.4	2.6	0.88	−1.72	66.32
2010	0.0	2.6	0.86	−1.74	64.58
2011	0.0	2.6	0.84	−1.76	62.82
2012	0.0	2.6	0.82	−1.78	61.04
2013	0.0	2.6	0.79	−1.81	59.23

Notes: All figures in percent of GDP. The debt-neutral primary surplus would keep the debt ratio constant. It is computed on the basis of a potential growth rate of 1.7%, a trend inflation rate of 2%, and an interest rate on government bonds of 5%.

Source: Own computations.

Table B.2 shows that the debt ratio would fall to below the 60% reference value of the Maastricht Treaty after 8 years, broadly in line with the pattern of the gradual fiscal consolidation strategies that we consider in this paper.

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