Fiscal multipliers in Sweden
- A quantitative model perspective

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1 Introduction

Fiscal policy as a tool for business cycle stabilization has increasingly gained attention in the literature over the last decade. But to be able to use fiscal policy in an effective manner, it is important to know how effective each fiscal instrument is in stabilizing the economy. In this study, the National Institute of Economic Research's DSGE model SELMA is used to calculate fiscal multipliers for the Swedish economy. The multipliers are calculated for temporary fiscal stimulus. In SELMA, the fiscal sector is modelled in extensive detail and the fiscal authority has several instruments at its disposal.[1] Multipliers for GDP and unemployment are calculated for the following fiscal instruments: government consumption, government investment, aggregate transfers, investment tax credit, consumption tax, capital income tax, labor income tax, and social security contributions. These instruments are explicitly modelled in SELMA and can be used by the fiscal authority to affect the economic outcome. The aim of this study is to analyze which instruments in the fiscal authority's toolbox are the most potent, both in the case where the monetary policy rate follows a standard monetary policy rule, and in cases when the monetary policy authority chooses not act or is unable to act.

To evaluate the short-run effectiveness of the fiscal stimulus, multipliers are calculated for two different fiscal stimulus periods: one and two years. After the stimulus period, the stimulus is immediately and completely removed. During the fiscal stimulus period, there is no endogenous adjustment of the fiscal policy to adhere to the government's fiscal policy targets (debt or surplus target). After the stimulus period, the fiscal feedback rule on transfers is activated to return government debt to its target level within a reasonable pace.[2]

In order to analyze how the effectiveness of each fiscal instrument differs by the degree of monetary policy accommodation, different assumptions regarding the timing for monetary policy are evaluated. First, the multipliers are calculated when the monetary policy rule is always active (no monetary policy accommodation). In the second case, monetary policy is accommodative throughout the whole fiscal stimulus period. In the third case, which is only evaluated for two years of fiscal stimulus,monetary policy is accommodative for half of the stimulus period. Furthermore, is is investigated how the fiscal multipliers are affected by the interest rate being at its lower bound.

Our results suggest that government consumption and government investment have

[1] A detailed description of the model can be found in Konjunkturinstitutet (2020).

[2] The debt target as a consolidation instrument is chosen for a clean comparison to other structural models. The fiscal multipliers are however quite similar when using the structural surplus as a fiscal consolidation target instead.

the largest multipliers, both being above one for the case of no monetary policy accommodation. In general, the expenditure side multipliers are larger than the revenue side multipliers. When monetary policy is accommodative, the magnitudes of the multipliers become higher. To further evaluate how the response of monetary policy affects the multipliers, it is analyzed how different assumptions regarding the monetary policy rule affects the multipliers, and show that the response of the monetary policy rate to changes in resource utilization matters significantly for the resulting multiplier in the case of monetary policy accommodation, especially for government consumption and government investment stimulus. Furthermore, it is investigated how the fiscal multipliers are affected by the monetary policy rate being at its lower bound. In that case, the fiscal policy stimulus is generally more effective than in the case of active monetary policy, however not as effective as in the monetary policy accommodation case.

In order to evaluate the SELMA multipliers, they are compared with multipliers from similar structural models and to empirical studies. The comparison begins with the investigation of the main properties of the different compared models, which is done by comparing the dynamics of the other models with SELMA following an interest rate shock. The comparison then continues by the comparison of multiplier values between different structural models. The comparison shows that SELMA multipliers are generally in line with those of similar structural models when the monetary policy is non-accommodative. There are however some deviations in the case with monetary policy accommodation that can be deemed as significant. The analysis shows that SELMA yields a stronger increase in the multipliers compared to other structural models. The reason for this is primarily the first-difference parameter in the monetary policy rule, together with the fact that the stimulus ends at the same time as the monetary policy rule is activated. This leads monetary policy to become expansionary as the stimulus ends. Therefore, it is suggested that 5 quarters and 9 quarters monetary policy accommodation are used in the cases of one and two years fiscal stimulus, respectively. The empirical comparison also shows that the multipliers in SELMA are in line with the literature.

The document proceeds as follows: Section 2 shows a comparison of the key model properties of SELMA with other relevant models. Section 3 explains how the multipliers are calculated while Section 4 shows the resulting multipliers. Section 5 investigates the role of the monetary policy specification and the zero lower bound on fiscal multipliers. Section 6 shows the comparison of SELMA's multipliers with fiscal multipliers calculated using other structural models while Section 7 compare SELMA's multipliers with empirical estimations of multipliers. Section 8 reports the results of several sensitivity analyses which are conducted to evaluate the robustness to different parametrization of the mul-

tipliers reported, and to shed light on the differences of the multipliers calculated with SELMA and other structural models. Finally, Section 9 concludes.

2 Comparison of modelling approaches

In this section, the main assumptions of SELMA are compared with relevant theoretical models used for policy analysis by various policy institutions. These models are Coenen et al. (2013) (henceforth CST 2013) which extended ECB's NAWM with an enriched fiscal sector, Quest III of European Commission, FiMod of the Central Bank of Spain, OECD's OECD Fiscal, and finally the Norwegian fiscal policy model NORA.[3]

A comparison of the key properties of the models is summarized in Table 1.[4] As the table shows, the models have a wide range of assumptions regarding their structure. Among the shown models, CST 2013 is the closest model to SELMA when it comes to the modelling of the fiscal block, while NORA is more closely related than the other models in the sense that it is a small open economy model with independent monetary policy.

2.1 Public capital

All models in this comparison have productive government investment. There are, however, two approaches to introduce government capital into the model. QUEST, FiMod, OECD Fiscal and NORA introduce government capital as an additional TFP term, i.e., government capital (with an exponent that is a calibrated parameter) multiplies the production function. If SELMA would include government capital in the same way as these models, an increase in government investment, and hence in the government capital stock, would have a similar effect as a TFP productivity shock in SELMA.[5] In CST 2013 and in SELMA, public and private capital are instead a combined into a composite capital stock according to the following CES function:

$$\tilde{K}_{f,t} = \left(\alpha_K^{1/\upsilon_K} \left(K_{f,t} \right)^{(\upsilon_K - 1)/\upsilon_K} + (1 - \alpha_K)^{1/\upsilon_K} \left(K_{G,t} \right)^{(\upsilon_K - 1)/\upsilon_K} \right)^{\upsilon_K/(\upsilon_K - 1)}, \qquad (1)$$

where $K_{f,t}$ is the private firm's and $K_{G,t}$ is the public capital stock. CST 2013 use the following parameters: $\alpha_K = 0.9$, and $\upsilon_K = 0.84$ (posterior mode in the estimation). In SELMA, the corresponding values are $\alpha_K = 0.83$, and $\upsilon_K = 0.25$.

[3] See Ratto et al. (2009), Stähler and Thomas (2012), Furceri and Mourougane (2010) and Aursland et al. (2020) for respective references.

[4] For more details about the modelling of the fiscal sector, see A1.

[5] The TFP productivity shock in SELMA is denoted ε_t.

2.2 Public consumption

In both CST 2013 and SELMA, government consumption enters household utility through a composite consumption which consists of private and public consumption.[6] The composite consumption in SELMA and CST 2013 is given by

$$\tilde{C}_{h,t} = \left(\alpha_G^{1/\upsilon_G} \left(C_{h,t}\right)^{(\upsilon_G-1)/\upsilon_G} + (1-\alpha_G)^{1/\upsilon_G} \left(G_t\right)^{(\upsilon_G-1)/\upsilon_G}\right)^{\upsilon_G/(\upsilon_G-1)}, \tag{2}$$

where $C_{h,t}$ is the household's consumption of private goods and G_t is government consumption. CST 2013 use the following parameters $\alpha_G = 0.75$, and $\upsilon_G = 0.29$ (posterior mode in the estimation). In SELMA the corresponding values are $\alpha_G = 0.63$, and $\upsilon_G = 0.29$. Hence, SELMA has the same elasticity of substitution between private and public consumption as in CST 2013.

[6] In FiMod government consumption does also enter the utility function, but in an additively separable fashion. In QUEST and OECD Fiscal, government consumption does not affect utility.

Table 1: Key Model Features

	CST 2013	QUEST	FiMod	OECD Fiscal	NORA	SELMA
Households						
Household types	Infinite horizon Hand-to-mouth	Infinite horizon Collateral constrained Hand-to-mouth	Infinite horizon Hand-to-mouth	Infinite horizon Hand-to-mouth	Infinite horizon Hand-to-mouth	Infinite horizon Hand-to-mouth
Share of Non-Ricardians	18%	20% collat. constrained 20% Hand-to-mouth	40%	25%	30%	35%
Preferences	Separable, log utility of consumption	King, Plosser and Rebelo, JME 1988	Separable, CRRA consumption ($\sigma = 2$)	Separable, log utility of consumption	Separable, CRRA consumption ($\sigma = 1.01$)	Separable, log utility of consumption
Habit formation	Consumption	Consumption, leisure	Consumption	Consumption	Consumption	Consumption
Production						
Production function	Intermediate goods: Cobb-Douglas	Value added: CES nesting Cobb-Douglas Intermediates: CES	Intermediate goods: Cobb-Douglas Final goods: CES	Intermediate inputs: Cobb-Douglas Final goods: CES	Intermediate goods: Cobb-Douglas Final goods: CES	Intermediate inputs: Cobb-Douglas Final goods: CES
Market structure	Intermediates: Monopolistic competition Final goods: Fully competitive	Tradables: Monopolistic competition Non-tradables: Monopolistic competition	Intermediates: Monopolistic competition Final goods: Perfectly competitive	Intermediates: Monopolistic competition Final goods: Monopolistic competition	Intermediates: Monopolistic competition Final goods: Fully competitive (except exports and consumption goods)	Intermediates: Monopolistic competition Final goods: Fully competitive (except exports)

Table 1: Key Model Features (Continued)

	CST 2013	QUEST	FiMod	OECD Fiscal	NORA	SELMA
Fiscal Structure						
Consumption tax	Yes	Yes	Yes	Yes	Yes	Yes
Labor tax	Yes	Yes	Yes	Yes	Yes	Yes
Capital income tax	Yes	Yes	Yes	Yes	Yes	Yes
Property tax	No	Yes	No	No	No	No
Other taxes	Payroll (by firms and households), lump-sum (only Ricardians)	No	Lump-sum (only Ricardians), SSC (by firms)	No	Transfers, lump-sum (only Ricardians), SSC (by firms)	Transfers, lump-sum (only Ricardians), SSC (by firms)
Transfers	Lump-sum (possibly uneven distribution, computed so that $C_{nR}/C_R = 0.8$ in steady state)	Lump-sum, targeted to Non-Ricardians	Lump-sum, targeted to Ricardians(!)	Lump-sum, targeted to Non-Ricardians	Lump-sum, possibly targeted	Lump-sum (possibly uneven distribution, computed so that $C_{nR}/C_R = 0.8$ in steady state)
Productive government investment	Yes (increases capital stock in intermediate good production)	Yes (increases TFP in intermediate good sectors)	Yes (increases TFP in intermediate good production)	Yes (increases TFP in)	Yes (increases TFP in final good production)	Yes (increases capital stock in intermediate good production)
Other fiscal instruments	None	Unemployment benefits, investment subsidies	Public employment and wages	None	Public employment, unemployment benefits	None
Fiscal rule for debt	All fiscal instruments react among other things to real government debt	Tax rate to labor income reacts to debt and/or deficit	All fiscal instruments react among other things to debt over GDP ratio	Lump-sum taxes react to deficit	No	All fiscal instruments react among other things to real government debt
Government consumption in utility	Aggregate consumption enters utility and consists of private and public consumption	No	Separable utility from government services produced by public employees	No	No	Aggregate consumption enters utility and consists of private and public consumption

Table 1: Key Model Features (Continued)

	CST 2013	QUEST	FiMod	OECD Fiscal	NORA	SELMA
Frictions						
Price rigidity	Staggered Calvo price setting	Adjustment costs on price inflation	Staggered Calvo price setting	Adjustment costs on price inflation	Adjustment costs on price inflation	Staggered Calvo price setting
Wage rigidity	Staggered Calvo wage setting	Adjustment costs on wage inflation	Staggered Calvo wage setting	Adjustment costs on wage inflation	Reduced form	Staggered Calvo wage setting
Expenditure adjustment costs	Investment, import content, export market share	Investment, housing investment	Investment	Consumption, investment, import share	Investment, borrowing	Investment
Time-to-build	Several periods in public capital, one quarter in private investment	No		One quarter	Several periods in public capital	One quarter
Monetary Policy						
Rule	Taylor rule with smoothing	Taylor rule with smoothing	Taylor rule with smoothing	Forward-looking interest rate rule with smoothing	Taylor rule with smoothing	Taylor rule with smoothing

3 Defining the multipliers

Two different kinds of multipliers are calculated in this study: the GDP multiplier and the unemployment multiplier. Two criteria are used when defining the multipliers. Firstly, the time horizon for which they are calculated should be relevant for the decision of policy makers. Secondly, they should be defined so that they can be compared to other studies. For the GDP multipliers, the one-year and two-year multipliers reported in Coenen et al. (2012) and Coenen et al. (2013) satisfy both of these criteria. In both of these studies, the GDP multipliers are calculated as the average increase in output from the baseline (steady state) output over one and two years respectively, given a 2-year fiscal stimulus equivalent to 1 percent of baseline GDP. This multiplier definition is equivalent to the present value multiplier using a discount factor of 1. The same definition is used in this study. In addition, one-year multipliers are calculated given a one-year fiscal stimulus.[7] Unemployment multipliers are not as frequently found in the literature as GDP multipliers. One study in which such multipliers are calculated is Monacelli et al. (2010), who defines the multiplier as the peak unemployment effect during the fiscal stimulus period. Others, for example Chun-Hung and Hiroaki (2019), use the present value multiplier instead. In this study, unemployment multipliers are calculated using the average unemployment effect, similar to the GDP multiplier. The reason is that this makes it more comparable to the GDP multiplier used in this study, but also because the average multiplier captures the unemployment effect over the whole relevant time horizon, while the peak multiplier does not necessarily do so.

The multipliers are calculated using anticipated shocks to individual fiscal instruments that are assumed to last for either one or two years.[8] During the stimulus period, the stimulus is fully debt financed with all the fiscal rules being turned off, except for the unemployment automatic stabilizer component on the transfer rule.[9] After the stimulus period (one or two years), the fiscal authority follows a rule on transfers in order to return the debt to its target level in a reasonable pace. This is in line with the experiments made in Coenen et al. (2013). Furthermore, in order to allow for comparison with other models is is assumed that the stimulus equals 1% of steady-state GDP for each instrument.

Is is assumed that a stimulus equal to 1% of steady-state GDP is generated by using one

[7] Another definition that is frequently used in the literature is the cumulative multiplier used by for example Uhlig (2010). This multiplier also takes the long-run output effect into account. Since the primary concern in this study is the business cycles effect, a multiplier definition restricted to a shorter time horizon is chosen instead.

[8] The shocks are unknown to the households and firms before the implementation of the stimulus, but once the stimulus is implemented, all the information about the duration and size is known to them.

[9] A detailed description of the fiscal rules used in SELMA and the corresponding parameter values can be found in Appendix A1.

of the following fiscal instruments in the model: government consumption $\hat{g}_t$, government investment $\hat{I}_t^G$, aggregate transfers $\breve{Tr}_t^{agg}$, investment tax credit $\breve{\tau}_t^I$, consumption tax $\breve{\tau}_t^C$, capital income tax $\breve{\tau}_t^K$, labor income tax $\breve{\tau}_t^W$ and social security contributions $\breve{\tau}_t^{SSC}$. Variables denoted with a "hat" are defined as log-deviations from their respective steady-state values. The steady-state value of the variable is written without any accent, and without any time subscript. The "breve" variables are defined as actual deviations from their steady-state values. Furthermore, some variables are normalized in the steady state. These are denoted with a "bar" on top of the variable. For example $\bar{g}$ is the steady-state level of government consumption, while $\bar{y}$ is the steady-state level of output.

The fiscal stimulus is generated by using shocks x_t to the fiscal instruments mentioned above

$$x_t \in \{\varepsilon_t^g, \varepsilon_t^{IG}, \varepsilon_t^{tragg}, \varepsilon_t^{\tau^C}, \varepsilon_t^{\tau^K}, \varepsilon_t^{\tau^W}, \varepsilon_t^{\tau^{SSC}}, \varepsilon_t^{\tau^I}\}_{t=1}^n, \quad n \in \{4, 8\},$$

where the size of the shock is normalized to be 1% of steady-state GDP, after which the stimulus is immediately and completely removed. Given the size of the fiscal stimulus, and that the economy is assumed to be in its steady state in the period before the fiscal stimulus, $t = 0$, the GDP multiplier can be defined as

$$100\frac{1}{n}\sum_{t=1}^{n}\hat{y}_t \tag{3}$$

where $\hat{y}_t$ is the log deviation of GDP from its steady state value in period t after the stimulus. The unemployment multiplier is defined as

$$100\frac{1}{n}\sum_{t=1}^{n}\breve{un}_t \tag{4}$$

where $\breve{un}_t$ is the deviation of the unemployment rate from its steady-state value.

3.1 Calculating the size of the stimulus

Below follows a description of how the size of the fiscal stimulus for each instrument is calculated.

Expenditures

The size of the government consumption shock ε_t^g is given by

$$\varepsilon_t^g \cdot \bar{g} = 0.01\bar{y} \quad \Leftrightarrow \quad \varepsilon_t^g = \frac{0.01}{\bar{g}/\bar{y}}. \tag{5}$$

Similarly, the shock to government investment ε_t^{IG} is given by

$$\varepsilon_t^{IG} \cdot \bar{I}^G = 0.01\bar{y} \quad \Leftrightarrow \quad \varepsilon_t^{IG} = \frac{0.01}{\bar{I}^G/\bar{y}}. \tag{6}$$

The formula above have to be modified slightly in order to calculate the multipliers for aggregate transfers. Firstly, the aggregate transfers are, in contrast to government consumption and government investment, modelled as actual rather than percentage deviations from the steady state. Secondly, the transfer shock size needs to be adjusted for the tax levied on the transfers, which goes in as a revenue to the public sector, such that the net stimulus is 1% of steady-state GDP. The size of the shock ε_t^{tragg} is given by

$$(1-\tau^{tr})\varepsilon_t^{tragg} = 0.01\bar{y} \quad \Leftrightarrow \quad \varepsilon_t^{tragg} = \frac{0.01}{1/\bar{y}} \frac{1}{1-\tau^{tr}}. \tag{7}$$

where τ^{tr} is the tax rate on transfers.

The shock to the investment tax credit $\breve{\tau}_t^I$ is given by

$$\varepsilon_t^{\tau^I} p^I \bar{I} = 0.01\bar{y} \quad \Leftrightarrow \quad \varepsilon_t^{\tau^I} = \frac{0.01}{\bar{p}^I \bar{I}/\bar{y}}. \tag{8}$$

where p^I is the relative price of investment in the steady state and $\bar{I}$ is private investment.

Revenues

Since the study focuses on fiscal stimulus rather than fiscal consolidation, shocks for the tax rates needs to be negative rather than positive. The taxes are set so that the change in the tax rate times the steady-state tax base equals one percent of steady-state GDP. The tax bases TB^x for the four tax rates $x \in \{C, W, SSC, K\}$ are given by the following equations

$$TB^C = p^C \bar{c}^{agg} \tag{9}$$

$$TB^W = p^C \bar{w} \bar{n} \tag{10}$$

$$TB^{SSC} = p^C \bar{w} \bar{n} \tag{11}$$

$$TB^K = \mu_z^+ \mu_\gamma \left(\bar{r}_K - \iota^K \delta p^K \frac{\mu_\gamma}{\Pi} \right). \tag{12}$$

where p^C is the relative price of consumption, $\bar{c}^{agg}$ is aggregate private consumption, $\bar{w}$ is the real wage, $\bar{n}$ is employment, μ_z^+ is a permanent labor augmenting productivity shock process, μ_γ is an investment specific permanent productivity shock process, $\bar{r}_K$ is the rental cost of capital, p^K is the relative price of capital and Π is gross domestic inflation.

Given the tax bases, the size of shocks can be calculated in the following manner

$$\varepsilon_t^{\tau^x} TB^x = -0.01\bar{y} \quad \Leftrightarrow \quad \varepsilon_t^{\tau^C} = \frac{-0.01}{TB^x/\bar{y}}, \quad x \in \{C, W, SSC, K\}. \tag{13}$$

Table 2 summarizes the steady-state tax bases, together with the base for the investment tax credit.

Table 2: Steady State Tax Bases and Tax Rates in SELMA

Tax base (TB)	Size of Tax Base (in terms of GDP)	Steady-state Tax Rate (TR)	Implied change in TR (pp)
Household Cons.	0.507	17.1	-1.97
Labor Income	0.597	24.7	-1.69
Social Security Contr.	0.597	29.9	-1.69
Physical Capital	0.110	16.9	-12.43
Private Investment	0.191	0.0	5.24

Note: Private investment is not really a tax base, since its associated instrument is not a tax, but rather a tax credit, or subsidy, which goes into the expenditure side of the government budget.

4 Benchmark results

This section presents benchmark fiscal multipliers in SELMA for fiscal stimulus implemented over two different time horizons. First, fiscal multipliers given 1-year fiscal stimulus are reported. Then, fiscal multipliers given 2-year fiscal stimulus are reported. During the fiscal stimulus period (four or eight quarters), it is assumed that the conducted fiscal policy is debt financed. In other words, all fiscal rules are shut off during the stimulus period, except for the unemployment automatic stabilizers, i.e., except for the response of government transfers to changes in the unemployment rate. As the stimulus ends, the debt part of the fiscal rule on transfers is also switched on, returning government debt to its target level in a reasonable pace. The 1-year fiscal multipliers are reported in Table 3 and the 2-year fiscal multipliers are reported in Table 4.

The fiscal multipliers are calculated given three different assumptions regarding the response of monetary policy. In the first case, monetary policy is reacting immediately to the consequences of the fiscal stimulus. In that case, the interest rate follows a Taylor rule. In the second case, monetary policy will be accommodative for four quarters. After four quarters, the interest rate follows the same Taylor rule as in the first case. In the third case, monetary policy will instead be accommodative for eight quarters. The eight-quarter monetary accommodation experiment is only made for the case of 2-year fiscal stimulus. Monetary policy accommodation is defined here as the interest rate being kept at its steady-state level for four and eight quarters respectively. The accommodation cases can be interpreted as the central bank using Odyssean Forward Guidance as a Monetary Policy tool to complement the fiscal stimulus. This will, as will be clear later, generally make the fiscal stimulus more effective. Furthermore, such an experiment also facilitates as a tool for comparison to other structural models, for which similar experiments are made in other studies. Section 5 also investigates how a binding effective lower bound on the interest rate affects the fiscal multipliers.

As can be seen in both Table 3 and Table 4, the expenditure side multipliers are mostly higher than the revenue side multipliers. Looking at the case of no monetary policy accommodation, the government consumption and government investment multipliers are the highest. For 1 year stimulus the two multipliers are of similar size, while the government investment multiplier is higher with 2 years of fiscal stimulus. On the revenue side, the result differs between the GDP multiplier and the unemployment multiplier. For the GDP multiplier, the social security contributions multiplier and the capital tax multiplier are the lowest, giving almost no increase in output. For the unemployment multiplier, the consumption tax and the labor tax have the lowest multiplier. For both of these multipli-

Table 3: Fiscal multipliers in the case of 1 year fiscal stimulus

Panel A: GDP multipliers

	No accommod.	1 year accommod.
Gov. consumption	1.16	1.81
Gov. investment	1.15	1.60
Gov. transfers	0.31	0.47
Investment tax credit	0.32	0.49
Consumption tax	0.32	0.29
Capital tax	0.01	0.01
Labor tax	0.25	0.09
SSC	0.02	0.02

Panel B: Unemployment multipliers

Gov. consumption	-1.14	-1.83
Gov. investment	-0.96	-1.45
Gov. transfers	-0.31	-0.48
Investment tax credit	-0.30	-0.48
Consumption tax	0.09	0.12
Capital tax	-0.01	-0.01
Labor tax	0.31	0.48
SSC	-0.01	-0.02

Notes: This table reports multipliers as defined in equations (3)–(4). For each monetary policy alternative (no accommodation, 1 year accommodation), the table reports multipliers calculated for a one-year stimuli of 1% of steady-state GDP. The reported multiplier is the average response over the first year. In all simulations, the fiscal policy is financed with debt during the first year, i.e., during the fiscal stimulus period. After one year, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

ers, labor supply increases due to the higher effective wage following the tax decrease.[10] Therefore, for these two instruments, unemployment increases rather than decreases, due

[10]The effective wage is here defined as the amount of consumption that can be purchased for one unit of labor.

to the effect on labor supply. Impulse response functions for labor force participation, employment and unemployment for each fiscal instrument can be found in Appendix A3.

Also in the cases of monetary policy accommodation, the expenditure multipliers tend to be higher than the revenue multipliers. As for the case of no monetary policy accommodation, the government consumption and government investment multipliers are the highest. For a 1-year fiscal stimulus, the government consumption multiplier is higher than the government investment multiplier, while they are approximately equal in size for a 2-year fiscal stimulus. Furthermore, both multipliers are significantly higher than their respective no accommodation multipliers. For the unemployment multiplier however, the government consumption multiplier is larger than the government investment multiplier in the case of a 2-year monetary policy accommodation. The reason is that output increases via an increase in capital to a higher degree when public investment is increased, compared to an increase in government consumption.

In general, the multipliers become larger as the monetary policy accommodation increases. Without monetary policy accommodation, the monetary policy authority conducts a less expansionary policy as a response to the fiscal stimulus, to counteract the inflationary pressures and the increase in resource utilization. With monetary policy accommodation, however, the real interest rates become lower, leading to an increase in private consumption and investment.[11] This is illustrated by Figures 2 and 3 which show how output, unemployment and the real rate respond after a 2-year stimulus to each respective instrument. As can be seen in the figures, the real rate is lower with monetary policy accommodation, leading to higher multipliers. All fiscal instruments except the consumption tax and the labor tax follow the same pattern. The multipliers for those two instruments are instead decreased following the monetary policy accommodation. The reason is that for these two instruments, the stimulus leads the monetary authority to decrease the interest rate in the case of no monetary policy accommodation. This does in turn stem from labor supply increasing following the lower tax rate, which in turn leads to higher unemployment, and hence to a lower interest rate. Therefore, the monetary policy accommodation leads to a higher, rather than a lower, interest rate for those two instruments.

Figure 1, illustrates the output responses given a 2-year fiscal stimulus for each of the fiscal instruments used under the three different monetary policy assumptions. The figure shows that the output effects of the instruments are generally increasing with the monetary policy accommodation. Furthermore, increases in government expenditures have stronger output effects than reductions in government revenues.

[11] The impulse responses of the model variables to the shocks are reported in the Appendix A3.

Table 4: Fiscal multipliers in the case of 2 years fiscal stimulus

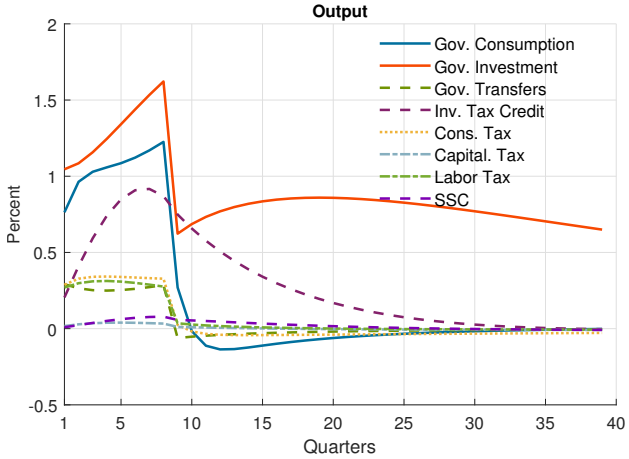
Panel A: GDP multipliers

	No accommod.		1 year accommod.		2 years accommod.	
	1 year	2 years	1 year	2 years	1 year	2 years
Gov. consumption	0.95	1.05	1.43	1.58	2.05	2.33
Gov. investment	1.13	1.31	1.58	1.79	1.96	2.26
Gov. transfers	0.26	0.27	0.38	0.40	0.53	0.58
Investment tax credit	0.49	0.69	0.78	1.01	1.13	1.44
Consumption tax	0.32	0.33	0.29	0.30	0.28	0.28
Capital tax	0.03	0.03	0.05	0.05	0.06	0.07
Labor tax	0.30	0.30	0.18	0.17	0.05	0.00
SSC	0.03	0.05	0.03	0.06	0.03	0.05

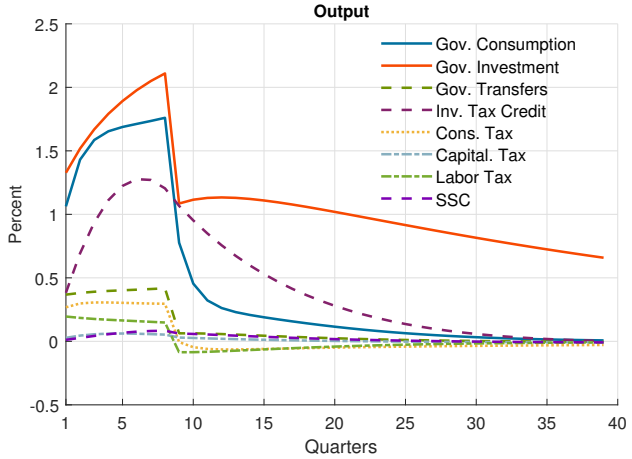
Panel B: Unemployment multipliers

Gov. consumption	-0.90	-1.00	-1.42	-1.56	-2.08	-2.35
Gov. investment	-0.93	-0.86	-1.41	-1.38	-1.81	-1.87
Gov. transfers	-0.25	-0.26	-0.38	-0.39	-0.54	-0.59
Investment tax credit	-0.43	-0.58	-0.75	-0.92	-1.13	-1.38
Consumption tax	0.08	0.06	0.12	0.10	0.13	0.12
Capital tax	-0.03	-0.03	-0.05	-0.05	-0.06	-0.07
Labor tax	0.25	0.25	0.38	0.39	0.53	0.57
SSC	-0.02	-0.03	-0.02	-0.04	-0.02	-0.04

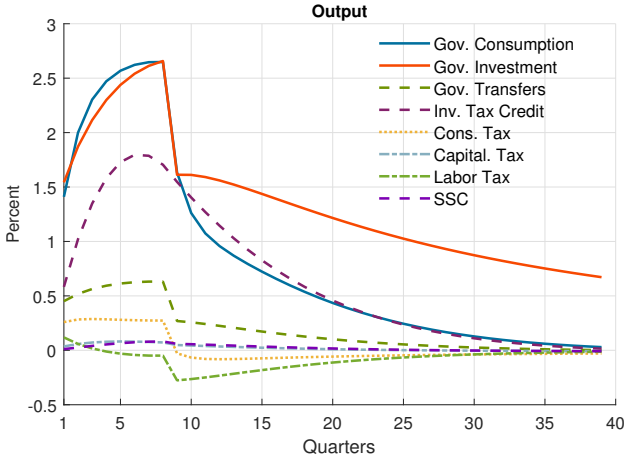
This table reports multipliers as defined in equations (3)–(4). For each monetary policy stance (no accommodation, 1 year accommodation and 2 years accommodation), the table reports two multipliers. The 1 year multiplier is the average output response over the first year of a 1% of GDP steady-state stimulus running for two years, while the 2 year multiplier is the average output response over the first two years of a 1% of steady-state GDP stimulus running for two years. In all simulations, the fiscal stimulus is debt financed. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.



(a) No Accommodation



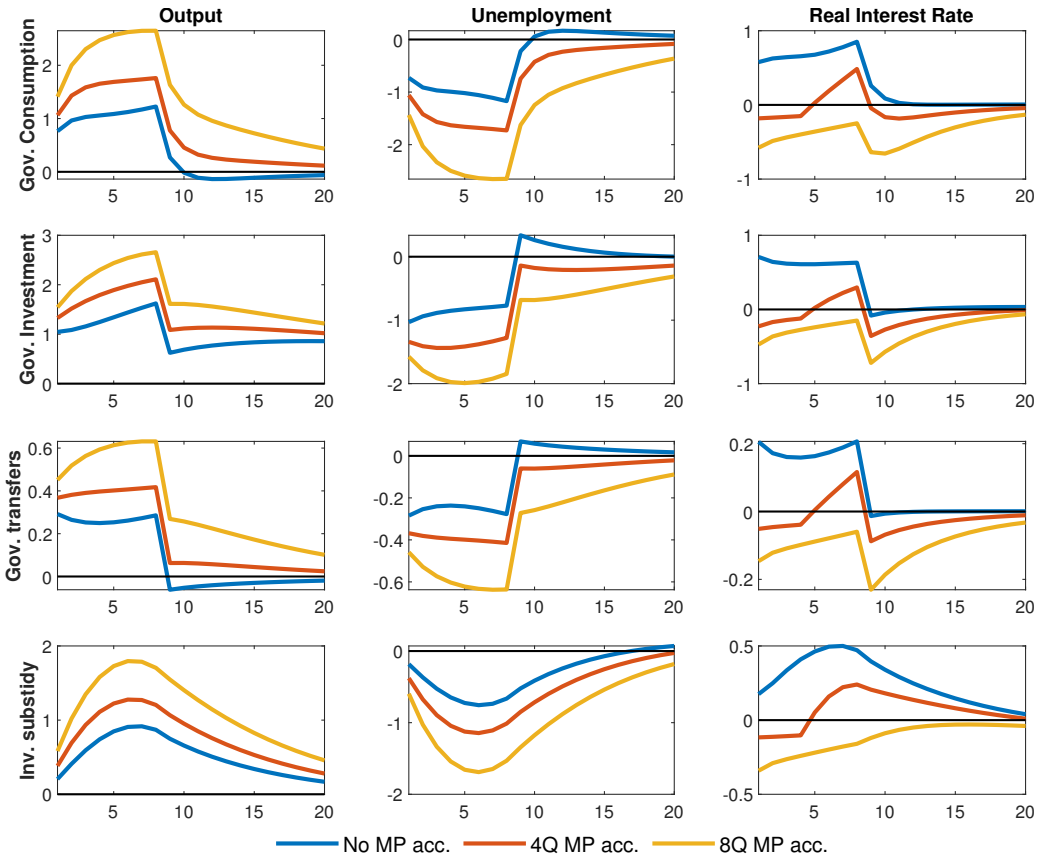
(b) 4Q Accommodation



(c) 8Q Accommodation

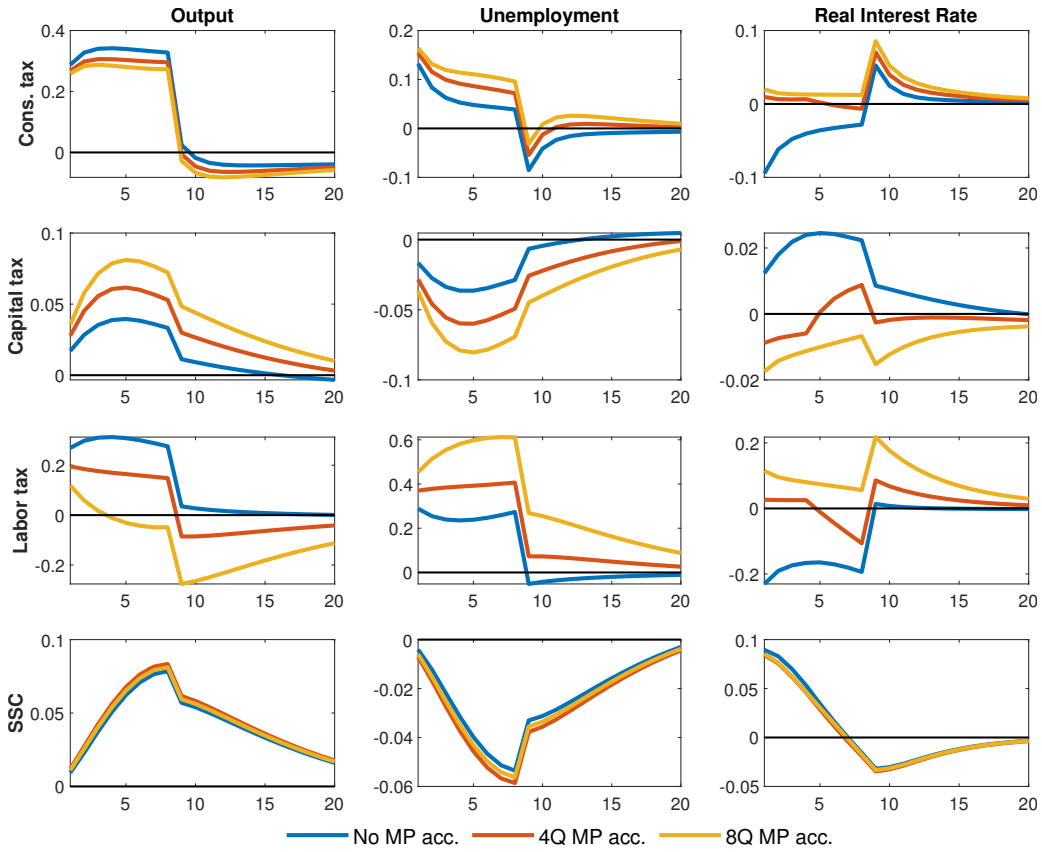
Figure 1: Output Response to Various Fiscal Stimuli

Figure 2: Real GDP, Unemployment and Real Rate for Two-Year Increase in Gov. Expenditure



Note: The real interest rate is presented in annualized numbers.

Figure 3: Real GDP, Unemployment and Real Rate for Two-Year Increase in Gov. Revenue



Note: The real interest rate is presented in annualized numbers.

4.1 Government consumption

Table 5: Import adjusted demand contributions to the Gov. consumption multiplier in the case of 2 years fiscal stimulus

		Due to				
	Output increase	C	I	X	G	IG
No monetary policy acc.	1.05	0.32	-0.12	-0.15	1.00	0.00
4Q monetary policy acc.	1.58	0.48	0.06	0.04	1.00	0.00
8Q monetary policy acc.	2.33	0.69	0.31	0.31	1.00	0.00

As stated in Section 2, SELMA follows Coenen et al. (2013) and introduces non-separable utility of private and public consumption. Furthermore, as in Coenen et al. (2013), the two types of goods are calibrated to be complements. The households have a log utility function of composite consumption $\tilde{C}_{h,t}$, consisting of private consumption $C_{h,t}$ and government consumption G_t. The composite consumption function is given by equation (14), where $\alpha_G = 0.63$ and $\upsilon_G = 0.29$. As shown in Section 8, this feature

increases the multiplier compared to the case with separable consumption utility.

$$\tilde{C}_{h,t} = \left(\alpha_G^{1/\upsilon_G} \left(C_{h,t}\right)^{(\upsilon_G-1)/\upsilon_G} + (1-\alpha_G)^{1/\upsilon_G} \left(G_t\right)^{(\upsilon_G-1)/\upsilon_G}\right)^{\upsilon_G/(\upsilon_G-1)} \tag{14}$$

An increase in government consumption leads to a higher marginal utility of private consumption, due to the complementarity between public and private consumption goods. Therefore, private consumption increases. The increase in the demand for consumption goods leads to an increase of intermediate goods demand, putting an upwards pressure on domestic prices and a downwards pressure on unemployment (via higher demand for labor and thus higher employment). Therefore, in the case of no monetary policy accommodation, the central bank increases the interest rate. This leads to a lower demand for investment. Furthermore, the exchange rate appreciates following the monetary policy rate increase, which leads to a lower demand for exports. The decrease in demand for export and investment dampens the output response following the government consumption shock in the case of no monetary policy accommodation.

In the case of one and two years of monetary policy accommodation, the lack of response from the central bank leads to a lower rather than a higher real rate. The lower real rate leads to an additional increase in private consumption. Furthermore, the conducted monetary policy is boosting investment demand rather than dampening it. In addition, it leads to a depreciation of the real exchange rate rather than an appreciation, boosting export demand as well. Therefore, the GDP multipliers in the case of monetary policy accommodation are higher than in the case of no monetary policy accommodation. The additional demand in the economy leads to further increased demand for labor, which is why unemployment is also lower in the monetary policy accommodation cases. Hence, the unemployment multipliers are higher with monetary policy accommodation than in the case of no monetary policy accommodation.

4.2 Government investment

Table 6: Import adjusted demand contributions to the Gov. investment multiplier in the case of 2 years fiscal stimulus

		Due to				
	Output increase	C	I	X	G	IG
No monetary policy acc.	1.31	0.04	0.21	0.06	0.00	1.00
4Q monetary policy acc.	1.79	0.18	0.38	0.23	0.00	1.00
8Q monetary policy acc.	2.26	0.32	0.55	0.40	0.00	1.00

As for government consumption, SELMA follows Coenen et al. (2013) and introduces non-separable private and public capital. As in Coenen et al. (2013), the two types of capital are calibrated to be complements. The firms have a Cobb-Douglas production function, where composite capital $\tilde{K}_{f,t}$ and labor are combined. The composite capital consists of private private capital $K_{f,t}$ and government capital $K_{G,t}$. The composite capital function is given by equation (15), where $\alpha_K = 0.83$ and $\upsilon_K = 0.25$. As shown in Section 8, this feature increases the multiplier compared to the standard case with separable public and private capital.

$$\tilde{K}_{f,t} = \left(\alpha_K^{1/\upsilon_K} \left(K_{f,t}\right)^{(\upsilon_K-1)/\upsilon_K} + (1-\alpha_K)^{1/\upsilon_K} \left(K_{G,t}\right)^{(\upsilon_K-1)/\upsilon_K}\right)^{\upsilon_K/(\upsilon_K-1)} \tag{15}$$

An increase in government investment leads to a higher marginal productivity of private capital, due to the complementarity between public and private capital. Therefore, also private investment increases. The higher demand for investment leads to a higher demand for labor, leading to an a lower unemployment rate via higher employment. In the case of no monetary policy accommodation, the central bank increases the interest rate as a response to the lower unemployment, leading to an appreciation of the exchange rate. Furthermore, domestic inflation is low, partly due to the higher public capital stock leading to higher composite capital, making the firms more productive, and partly due to the contractionary monetary policy. The lower domestic inflation leads to lower costs for export firms who reduce their prices. Therefore, also exports increase. The contribution of household consumption to the multiplier is quite small. Ricardian households decrease their consumption due to the contractionary monetary policy. The Non-Ricardian households do however increase their consumption due to the higher employment.

In the case of one and two years of monetary policy accommodation, the lack of response of the central bank leads to a lower real interest rate, boosting private investment even further, but also increasing Ricardian consumption. Furthermore, the exchange rate is depreciated instead of appreciated with monetary policy accommodation, which leads to higher exports, boosting output even further. Employment increases even further than in the case of no monetary policy accommodation, due to the higher demand for intermediate goods, translating into a higher demand for labor. Therefore, unemployment decreases even further compared to the case of no monetary policy accommodation.

4.3 Government transfers

An increase in the government transfers goes primarily to Non-Ricardian households. These increase their consumption one-to-one with the increase in income. The additional demand leads to an upwards pressure on prices as well as an increase in the demand for labor. The increase in the demand for labor leads to a lower unemployment rate. In the case of no monetary policy accommodation, the central bank increases the interest rate due to the lower unemployment rate and the upwards pressure on prices. This leads to a slight contraction in investment and exports (where exports are negatively affected by the appreciation of the exchange rate as well as an increase in costs of inputs, leading them to increase their prices). Furthermore, the increase in the interest rate leads to a lower Ricardian consumption.

In the cases of monetary policy accommodation, the real rate is lower than in the case of no accommodation. Therefore, private investment is higher. Furthermore, the exchange rate depreciates due to the monetary policy accommodation, leading to higher exports. In addition, Ricardian consumption is also higher due to the more expansionary monetary policy. The higher demand leads both the GDP multiplier and the unemployment multiplier to increase relative to the case of no accommodation.

4.4 Investment tax credit

The investment tax credit effectively pushes down the cost for investment. Therefore, private investment is significantly increased, leading to a higher demand for domestic goods and hence a higher demand for labor. The higher demand for labor leads to higher employment, and thus lower unemployment. In the case of no monetary policy accommodation, the central bank increases the interest rate due to the lower unemployment. This leads to an appreciation of the exchange rate, depressing exports. Furthermore, it leads to lower Ricardian consumption. Even if the Non-Ricardian households increase their consumption due to higher employment, total household consumption still falls.

When monetary policy is accommodative, the real rate is lower than in the case of no monetary policy accommodation. The lower rate leads to even higher private investment, but also to higher Ricardian consumption and exports. Hence, the GDP multiplier is higher than in the case of no monetary policy accommodation. Furthermore, the increase in goods demand leads to an increased demand for labor, leading to higher employment, and hence to a lower unemployment rate.

4.5 Consumption tax

A decrease in the consumption tax leads to an increase in consumption demand for both Ricardian and Non-Ricardian households during the stimulus period. The lower effective price of consumption, i.e., the price of consumption including the consumption tax (which is paid for by the households), during the stimulus period increases demand for both types of households. Furthermore, the increase in the price of leisure relative to consumption that follows from the tax decrease leads to a higher labor supply. The labor supply increase does in turn lead to higher unemployment, even though employment increases following the stimulus. Investment decreases slightly following the tax decrease in the case of no monetary policy accommodation. The reason is that the lower consumption tax reduces the demand for savings, hence, the demand for investment. With no monetary policy accommodation, the central bank conducts a slightly expansionary monetary policy. It does however not have any significant effect on the exchange rate, nor on exports.

When monetary policy is accommodative, the interest rate is higher than in the case of no monetary accommodation. This does not lead to any significant change in the demand for consumption. It does however affect investment negatively, leading to slightly lower output. Furthermore, the lower output means a lower demand for labor, and hence a lower employment. Therefore, unemployment is slightly higher than in the case of no monetary policy accommodation.

It is also worth to note that the consumption tax for modelling reasons is paid by the households (like a sales tax) rather than by the firms (like a VAT). This feature implies that a tax decrease immediately decreases the effective price of consumption. If the tax instead would be modelled as a VAT, the price decrease would be delayed due to the price stickiness.[12] This way of modelling would therefore lead to a smaller increase in the demand for consumption goods.

4.6 Capital tax

A decrease in the capital tax rate does only have a significant effect on the rate of private investment. Other variables are fairly unchanged during the stimulus period. Since investment is relatively small as a share of GDP, the increase in investment does only have a small positive effect on output.

[12]To be more precise, the tax need to be levied on the intermediate good firms for it to have a delayed effect on the effective price on consumption, since the consumption good producer do not face sticky prices while the intermediate good producer does.

4.7 Labor tax

A decrease in the labor tax rate leads to higher Non-Ricardian consumption. Therefore, household consumption increases. Ricardian consumers are not as strongly affected since the income effect is only temporary and they smooth their consumption over time. The effective wage increase does however lead to an increase in the labor supply. Since the increase in labor supply is higher than the increase in employment, unemployment increases. In the case of no monetary policy accommodation, the central bank responds to the higher unemployment by decreasing the interest rate. The decrease in the interest rate does in turn lead to slightly higher investment, and to slightly higher exports via the depreciation of the exchange rate that follows from the interest rate decrease. The increase in consumption, investment and exports leads to a higher output.

When monetary policy is accommodative, the real interest rate becomes higher than in the case of no monetary policy accommodation. The higher real interest rate leads to lower private investment, but also to slightly lower exports, due to the exchange rate appreciation that follows from the higher interest rate. Hence, the positive effect on output is dampened in the case of one and two years of monetary policy accommodation compared to the case of no monetary policy accommodation. The negative effect on output from the conducted monetary policy leads to a lower demand for labor, and hence a lower employment. Therefore, the unemployment rate is higher than in the case of no monetary policy accommodation.

4.8 Social security contributions

The reduction in social security contributions reduces the marginal costs for intermediate good firms. This puts a downwards pressure on the domestic prices. However, due to the price stickiness in the economy, the downwards pressure is quite small. Therefore, the demand for intermediate goods is not significantly affected, leading to a small positive effect on output and employment, and hence also a small effect on unemployment.

Since the effect on the economy from the reduction in social security contributions is so small, there is practically no difference between the case of no monetary policy accommodation and the cases of one and two years of monetary policy accommodation.

5 The role of monetary policy for the fiscal multipliers

The interest rate is one of the key variables in the economy, since it determines the economic agents' consumption and savings decisions. This means that the path of interest rates during and after a fiscal stimulus is also very important for the size of the fiscal multipliers. If interest rates increase following a fiscal stimulus, the overall positive effect of the stimulus on aggregate output is lower than it would otherwise be. The reason is that higher interest rates have a negative effect on private consumption, investment, and on exports via the exchange rate.

Interest rates, in particular short term interest rates, in the economy are mainly determined by the monetary policy decisions. In a typical New Keynesian model, a monetary policy rule governs the interest rate. In SELMA, the following Taylor-type monetary policy rule specification is utilized

$$\breve{i}_t = \rho \breve{i}_{t-1} + (1-\rho)(r_\pi \hat{\Pi}^{a,C}_{t-1} + r_{un} u\breve{n}_{t-1}) + r_{\Delta\pi}(\hat{\Pi}^{C}_{t} - \hat{\Pi}^{C}_{t-1}) + r_{\Delta un}(u\breve{n}_t - u\breve{n}_{t-1}) + \epsilon_t \quad (16)$$

where the policy rate, $\breve{i}_t$ responds to lagged annual inflation, $\hat{\Pi}^{a,C}_{t-1}$, and lagged deviation of unemployment $u\breve{n}_{t-1}$ from their respective target rates (or equilibrium rates) and to the quarterly change in inflation and unemployment, $\hat{\Pi}^{C}_{t} - \hat{\Pi}^{C}_{t-1}$ and $u\breve{n}_t - u\breve{n}_{t-1}$. Recall also that the rule is parameterized according to the estimated values in the Riksbank model MAJA. This section presents multipliers for different monetary policy specifications and compares them with the benchmark results in order to be able to understand the role of the monetary policy specification on the size of the fiscal multipliers.

In this section, the focus in on the multipliers for a 2-year fiscal stimulus. Table 7 shows GDP multipliers for all eight fiscal instruments given a fiscal stimulus of two years. The left-hand-side of the table shows multipliers for no monetary policy accommodation and the right-hand-side of the table shows multipliers for two years monetary policy accommodation. The first column on the left-hand-side shows the benchmark multiplier values that are also shown in Section 4. The second column shows multipliers for a monetary policy specification where the interest rate smoothing parameter is set to zero, which leads to no persistency in the interest rate. The third column shows multipliers for the specification with no first-difference variables in the Taylor rule, where the Riksbank responds only to deviations in lagged annual inflation and the unemployment rate from their respective targets. The fourth column presents multiplier values for an even simpler specification where the Riksbank only responds to the deviation of lagged inflation from its

target, thus being completely inattentive to resource utilization. The last column shows results for a specification where the Riksbank responds to the output gap instead of the unemployment gap. For this specification, the coefficients for the output gap and the first-differenced output term are set to be the same as the coefficients for unemployment in the benchmark calibration.

Table 7: GDP Multipliers in SELMA with different MP rule specifications

	No accommod.					2 years accommod.				
	Bench.	No persist.	No diff.	No unemp.	Respond y	Bench.	No persist.	No diff.	No unemp.	Respond y
Gov. consumption	1.05	1.00	1.02	1.40	1.03	2.33	1.36	1.36	1.44	2.26
Gov. investment	1.31	1.29	1.26	1.56	0.79	2.26	1.60	1.57	1.63	1.43
Gov. transfers	0.27	0.26	0.25	0.34	0.26	0.58	0.35	0.34	0.35	0.57
Inv. tax credit	0.69	0.62	0.71	1.04	0.56	1.44	0.84	0.93	1.09	1.22
Consumption tax	0.33	0.33	0.34	0.33	0.25	0.28	0.31	0.32	0.33	0.56
Capital tax	0.03	0.03	0.03	0.04	0.03	0.07	0.04	0.04	0.04	0.07
Labor tax	0.30	0.30	0.31	0.21	0.17	0.00	0.22	0.23	0.22	0.35
SSC	0.05	0.05	0.06	0.08	0.04	0.05	0.03	0.03	0.03	0.05

Notes: This table reports multipliers as defined in equations (3)–(4). The table reports GDP and unemployment multipliers calculated for a two-year stimuli of 1% of steady-state GDP for both normal episodes where economy at the steady state and the recession state where interest rate is at the effective lower bound. The 2 year multiplier is the average output and unemployment response for the first two years. In all simulations, for the first two years the fiscal policy is responding with only autostabilizers. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

Table 8: Unemployment Multipliers in SELMA with different MP rule specifications

	No accommod.					2 years accommod.				
	Bench.	No persist.	No diff.	No unemp.	Respond y	Bench.	No persist.	No diff.	No unemp.	Respond y
Gov. consumption	-1.00	-0.94	-0.97	-1.37	-0.97	-2.35	-1.33	-1.33	-1.42	-2.27
Gov. investment	-0.86	-0.84	-0.82	-1.14	-0.34	-1.87	-1.18	-1.15	-1.21	-1.02
Gov. transfers	-0.26	-0.24	-0.24	-0.33	-0.25	-0.59	-0.34	-0.34	-0.34	-0.57
Inv. tax credit	-0.58	-0.50	-0.61	-0.96	-0.44	-1.38	-0.74	-0.84	-1.01	-1.15
Consumption tax	0.06	0.06	0.05	0.06	0.15	0.12	0.08	0.08	0.06	-0.18
Capital tax	-0.03	-0.03	-0.03	-0.04	-0.03	-0.07	-0.04	-0.04	-0.04	-0.07
Labor tax	0.25	0.25	0.24	0.34	0.40	0.57	0.33	0.33	0.34	0.20
SSC	-0.03	-0.04	-0.04	-0.07	-0.02	-0.04	-0.01	-0.01	-0.01	-0.03

Notes: This table reports multipliers as defined in equations (3)–(4). The table reports GDP and unemployment multipliers calculated for a two-year stimuli of 1% of steady-state GDP for both normal episodes where economy at the steady state and the recession state where interest rate is at the effective lower bound. The 2 year multiplier is the average output and unemployment response for the first two years. In all simulations, for the first two years the fiscal policy is responding with only autostabilizers. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

Table 9: GDP Multipliers in SELMA with different MP rule specifications

GDP multipliers

	9 quarters accommod.				
	Bench.	No persist.	No diff.	No unemp.	Respond y
Gov. consumption	1.82	1.43	1.11	1.45	1.77
Gov. investment	1.54	1.63	1.37	1.63	0.76
Gov. transfers	0.36	0.36	0.28	0.35	0.36
Invest. tax credit	1.47	0.90	0.75	1.09	1.24
Consumption tax	0.37	0.31	0.33	0.34	0.40
Capital tax	0.06	0.05	0.04	0.04	0.06
Labor tax	0.21	0.21	0.28	0.22	0.22
SSC	0.04	0.03	0.05	0.02	0.04

Notes: This table reports multipliers as defined in equations (3)–(4). The table reports GDP multipliers calculated for a two-year stimuli of 1% of steady-state GDP. In all simulations, for the first two years the fiscal policy is responding with only autostabilizers. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

For the specification with no interest rate persistency, multipliers are slightly lower than in the benchmark case for stimuli with fiscal expenditures but they are around the same levels as the benchmark case for stimuli with fiscal revenues. Since both inflation and resource utilization increase during an expenditure side stimulus, the Riksbank responds to it by raising the repo rate. If the monetary rule specification does not have a smoothing parameter, the interest rate increases faster than in the benchmark case following the stimulus. Thus, monetary policy is relatively more contractionary than in the benchmark case, which leads to slightly lower multipliers.

For the specification with no first-difference variables in the policy rule, multipliers are almost unchanged compared to the benchmark case. These results are, at first glance, counterintuitive, because in this specification Riksbank does not respond to any contemporaneous variable, which means a more accommodative stance than the benchmark specification following a stimulus. Hence, one would expect lower multiplier values for this specification. These results are partially determined by the experiment design. Recall that in our experiments the fiscal stimulus is implemented for two years without any persistency, which causes a sharp increase in aggregate demand when the stimulus starts,

and sudden drop in aggregate demand due to the end of the stimulus after eight quarters. This sudden negative end-of-stimulus effect offsets the positive effect of any expenditure side stimulus at the beginning. For this reason, multipliers are practically unchanged compared to the benchmark specification.

The specification with no response to the unemployment rate yields higher multipliers for expenditure side stimuli. In this specification, monetary policy responds only to inflation, and thus during any demand side economic boom, where both resource utilization and inflation increase, monetary policy is less contractionary than the benchmark. Less contractionary monetary policy leads to higher multipliers during a demand side economic boom. On the revenue side, multipliers are unchanged compared to the benchmark, except for labor tax multiplier which is slightly lower. Remember that during a fiscal stimulus with a labor tax cut, in SELMA, unemployment increases mostly due to an increase in the labor force participation. A monetary policy rule specification with no response to the unemployment rate would be more contractionary than the benchmark specification.

Finally, multipliers for a monetary policy rule specification where the Riksbank responds to the output gap instead of the unemployment gap are calculated. In this specification, the multipliers are not significantly different from the benchmark, except for the government investment where the multiplier is significantly lower. One reason behind this result is the difference between the behaviour of output and unemployment during the stimulus period. Government investment stimulus leads to higher capital accumulation than benchmark during the stimulus period. In this case the two measures of resource utilization go in the opposite direction, output increases but employment relatively decreases. For this reason, in particular after the fiscal stimulus, the benchmark specification where the Riksbank responds to unemployment is relatively more expansionary than the specification where the Riksbank instead responds to the output gap. The capital stock continues to be high even after the stimulus, which helps not only to produce more output but also causes a shift of firms' demand for labor to capital due to ample amount of capital. As a result, the monetary policy stance continues to be more accommodative with a specification using the unemployment rate as a measure of resource utilization than with a specification using the output gap. This after-stimulus accommodative policy has an additional positive effect on the increase in investment and consumption during the stimulus. On the revenue side, consumption tax cut and labor tax cut stimuli lead to slightly lower multipliers for this specification. The reason is that a fiscal stimulus using one of these taxes as an instrument leads to a higher unemployment rate even if output (and thus employment) increases. The reason is that the labor force participation increases, see section 4 for details. Thus, the policy rule specification where the interest

rate responds to the output gap rather than to unemployment is more contractionary and leads to lower multipliers.

The right-hand-side of the table presents multipliers for 2 years of monetary policy accommodation. There are two main observations to highlight for this part of the table. First, multipliers are consistently larger in the case of 2 years of monetary policy accommodation for fiscal expenditure side stimuli. Second, multipliers in the benchmark specification and in the specification where the Riksbank responds to the output gap are consistently and significantly higher than for the other monetary policy specifications.

The explanation for the observation that expenditure side multipliers are consistently higher for 2 years of monetary policy accommodation are given previously. Recall from section 4 that fiscal stimulus using fiscal expenditure instruments leads to an increase in both inflation and resource utilization. The Riksbank responds to this by increasing the repo rate, which also leads to an increase in the real interest rate. On the other hand, if monetary policy does not respond to high inflation and resource utilization as it happens during monetary accommodation period, the nominal and real interest rates are lower than in the no accommodation case, and as a result, any increases in investment and consumption are not offset by the higher interest rate, which leads to higher multipliers.

The second observation that was highlighted for 2 years of monetary policy accommodation is that the fiscal multipliers in the benchmark specification and in the specification where the Riksbank responds to the output gap are consistently and significantly higher than for the other monetary policy specifications. It must be noted that these two specifications have one feature in common that other specifications do not. In these two specifications the repo rate is, to a large extent, determined by the response of the rate to the first-differenced resource utilization component of the monetary policy rule immediately after the stimulus period ends, which causes the higher multipliers for these specifications. The strength of the Riksbank response to the first-differenced resource utilization component of monetary policy rule is highly connected to the length of the Riksbank's accommodative policy implementation period. Remember that the experiments are set up such that the monetary policy accommodation ends in exactly the same period as the fiscal stimlulus ends. Furthermore, all fiscal stimuli end suddenly, without any persistency. The first-differenced resource utilization component in the interest rate rule leads the interest rate to change significantly at the end of the fiscal stimulus, especially for government consumption and government investment. Moreover, given our assumptions, the Riksbank returns to its active policy after eight quarters of accommodation. Hence, the repo rate just after the stimulus is mainly determined by the first-differenced resource utilization component, because the component for the lagged repo rate is zero due to

the accommodation policy. Furthermore, the changes in other components are relatively small. Moreover, the persistency component in the interest rate suggests small changes with respect to these components. This situation and design of the experiment creates an inconsistency in the passive monetary policy implementation. The reason is that in these experiments, the Riksbank does not respond to large changes in the first-differenced resource utilization component at the beginning of stimulus period because of its monetary policy stance, which is accommodative, but when it comes to the end of the stimulus period, monetary policy takes into account the change in first-differenced resource utilization component and responds to it. However, given the monetary policy stance of being passive to fiscal stimulus, one would expect, or it would be more a consistent policy stance, that the Riksbank does not respond to first-differenced resource utilization component at the end of the stimulus period as well.

The experiment is designed according to the thought that monetary policy would also not respond to the large change in resource utilization at the end of stimulus. Since that change is also due to fiscal stimulus, monetary policy is assumed to be accommodative for nine quarters instead of eight quarters for a fiscal stimulus period of eight quarters. The fiscal multipliers from this experiment is presented in Table 9, where multipliers for the benchmark specification and the specification where the Riksbank responds to the output gap are significantly lower than in earlier experiments.[13]

Regarding the unemployment multipliers, the pattern is the same as for the GDP multipliers when comparing different monetary policy specifications, see Table 8. For example, more contractionary monetary policy with a monetary policy rule specification using the output gap during a fiscal stimulus with consumption tax cut or labor income tax cut leads to higher unemployment rate than in the benchmark specification.[14]

5.1 The lower bound on the policy rate and the fiscal multiplier

This section presents an analysis of the fiscal multipliers when the interest rate is at its effective lower bound, which is associated with the economy going into a deep recession. The deep recession, that makes the policy rate hit its lower bound, is constructed with the help of a large negative consumption preference shock. The shock size is calibrated to a level which assures that the policy interest rate is at the lower bound for 9 quarters

[13]For completeness, a similar table as Table 9 is reported for one year fiscal stimulus with 5 quarters monetary accommodation in the appendix in Table A3. The effect on the multiplier from adding an additional quarter of monetary policy accommodation in the case of 1 year fiscal stimulus is similar to the 2 year stimulus case.

[14]Recall that positive numbers in the table indicate an increase in the unemployment rate.

in the absence of any fiscal stimulus. Table 10 shows the 2-year fiscal multipliers both in normal episodes and in recessions where the lower bound is binding for at least a few quarters during the stimulus period. The recession multipliers are higher than multipliers in normal episodes for all expenditure side stimuli. The reason is that in recessions where the interest rate is at its lower bound, monetary policy is not as responsive to fiscal stimulus and the crowding out effect of the stimulus is partially or fully dismissed. The mechanism that the binding lower bound introduces to the model dynamics is similar to the mechanism where monetary policy is accommodative during the fiscal stimulus periods. The difference between these two monetary policies is that in the lower bound case, monetary policy is active and the interest rate endogenously changes with model dynamics, but of course the policy rate doesn't change as long as the lower bound binds, whereas in the latter case monetary policy is inactive no matter how the economy behaves in all periods during the fiscal stimulus. The commitment of the central bank to low levels of policy rate for a certain period of time leads to higher fiscal multipliers for the monetary policy accommodation case compared to the lower bound case.

As a comparison between Table 9, which shows fiscal multipliers under a accommodative policy with monetary policy accommodation and Table 10, which shows multipliers in a recession with effective lower bound, shows, there is a significant difference between two cases, in particular for fiscal spending side multipliers. Given that SELMA is log-linearized and simulations are deterministic, the difference between multipliers in two cases is mainly caused by the number of periods that the policy rate is unchanged during or after the stimulus. In the effective lower bound case, it is likely that the monetary policy rate will, for some periods during the fiscal stimulus, change if the monetary policy rule suggests an interest rate above the effective lower bound. However, in the monetary policy accommodation case, the Riksbank commits to not changing the policy rate for a certain number of periods. The number of periods that the policy interest rate stays at the lower bound is very important for fiscal multipliers. Especially for expenditure side multipliers, the longer the lower bound binds, the more effective is the fiscal stimulus. Two important factors stand out as determinants of how long the lower bound binds. The first factor is the depth of the recession (the size of the shock in our experiments) and the second factor is how close is the effective lower bound is at the starting point. If the recession is moderate or the effective lower bound is far enough from the monetary policy rate level at the onset of the recession, the fiscal stimulus could lead the economy to leave the lower bound earlier. As a result, SELMA suggests that fiscal multipliers calculated in these types of recessions would be close to fiscal multipliers calculated in normal episodes.

Table 10: Multipliers in SELMA in normal episodes and at lower bound

	GDP multiplier		Unemployment multiplier	
	Normal episodes	Lower bound	Normal episodes	Lower bound
Expenditure multipliers				
Gov. consumption	1.05	1.24	-1.00	-1.20
Gov. investment	1.31	1.48	-0.86	-1.05
Gov. transfers	0.27	0.33	-0.26	-0.32
Investment tax credit	0.69	0.82	-0.58	-0.72
Revenue multipliers				
Consumption tax	0.33	0.32	0.06	0.07
Capital tax	0.03	0.04	-0.03	-0.04
Labor tax	0.30	0.23	0.25	0.32
SSC	0.05	0.05	-0.03	-0.03

Notes: This table reports multipliers as defined in equations (3)-(4). The table reports GDP and unemployment multipliers calculated for a two-year stimuli of 1% of steady-state GDP for both normal episodes where economy is in its steady state and the recession state where the interest rate is at its effective lower bound. The 2-year multiplier is the average output and unemployment response for the first two years. In all simulations, for the first two years the fiscal policy is responding with only autostabilizers. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

6 Multiplier comparison to other structural models

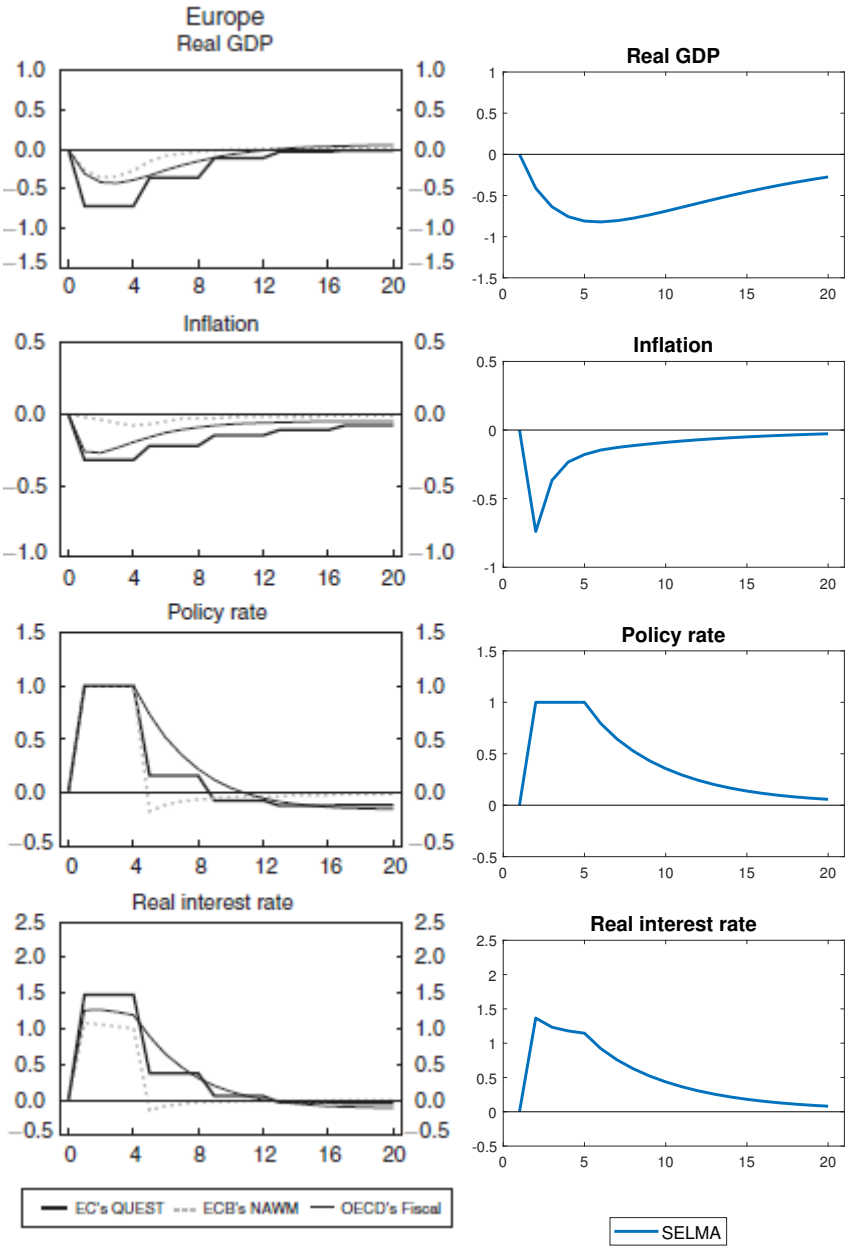
This section presents a comparison of the multipliers in SELMA with multipliers in other structural models used by policy institutions. As far as we are aware of, there is a lack of published evidence of unemployment multipliers calculated in models used by policy institutions. Therefore, the focus in this analysis is on the GDP multipliers.

The comparison of the GDP multipliers is made for the case of 2-year fiscal stimulus. Both the one and two-year multipliers in the cases of no monetary policy accommodation and 2 years monetary policy accommodation in SELMA are compared with similar multipliers from four different studies: Coenen et al. (2013) (CST 2013), Coenen et al. (2012) (AEJ:Macro), ECB (2010) (ECB MB) and Kilponen et al. (2015) (ECB WP). In CST 2013, the fiscal sector part of the New Area Wide Model (NAWM) has been enriched and multipliers are calculated for Euro area. The reported multipliers are calculated using a standardized monetary policy rule that only responds to inflation (with a coefficient of 1.5) and output growth (with a coefficient of 0.125). In AEJ:Macro, an average of several models used by different policy institutions across Europe and US are reported. In that study, the reported multipliers are based on each model's own estimated or calibrated monetary policy rules. In this comparison, the focus is on the multipliers calculated for the European economies in AEJ:Macro. These are EC's QUEST, ECB's NAWM, IMF's GIMF, and OECD's OECD Fiscal. In ECB MB, the minimum and maximum multipliers are shown for the same EU policy models that are used in AEJ:Macro, and results for more horizons than in AEJ:Macro are shown. ECB WP calculates multipliers for the Euro area using the CST 2013 model with a slightly different calibration than in CST 2013. ECM MB also report the NAWM results separately from the other models. These multipliers are also included in the comparison. They are called ECB MB (NAWM) in the comparison tables below. In addition, the section includes a special comparison with the Norwegian fiscal policy model NORA, since it is a model which is particularly close to SELMA. In Aursland et al. (2020), the multipliers are calculated somewhat differently, which is why the comparison between SELMA and NORA is done separately from the comparison between SELMA and the other models.

Due to the importance of the conducted monetary policy for the result, the section begins with a comparison of the economic response to a monetary policy shock in SELMA with the models in AEJ:Macro. The response is illustrated in Figure 4. The figure shows that the output response from a monetary policy shock in SELMA is generally stronger than in the other models. Furthermore, it is more persistent, affecting output significantly

for a long period. This result is not directly linked to the immediate inflation response, but rather to the fact that monetary policy is more persistent in SELMA, keeping real rates high for a longer time after the shock has disappeared. This is one important reason for why the output response is stronger in SELMA than in the other models.

Figure 4: Comparison between AEJ:macro models for Europe and SELMA, Monetary Policy shock for two years



Note: In SELMA, the fiscal rule is set such that the automatic stabilizers are on, and that transfers are adjusted so that the debt-to-GDP returns to its steady-state level in a reasonable pace.

Given that SELMA has a stronger output response than the other models following a monetary policy shock, SELMA is expected to have a larger difference between multipliers when monetary policy is accommodative and when monetary policy is not accommodative than in the models in AEJ:Macro. The reason for this is that for all instruments other

than SSC, the labor tax and the consumption tax, the monetary authority conducts a less expansionary monetary policy following the fiscal stimulus. An accommodative policy can then be seen as expansionary monetary policy shocks keeping the interest rate at its steady-state value. Since the economic response of a monetary policy shock is stronger in SELMA than in the other models, the multipliers in SELMA are expected to increase more than in the other models going from no monetary policy accommodation to two years of monetary policy accommodation.

The multiplier values in the above mentioned studies are compared with the multipliers for 2-year fiscal stimulus that are reported in Section 4. The comparison tables show the 1-year multipliers given a 2-year stimulus, and 2-year multipliers.

6.1 Government consumption

Table 11: Government Consumption Multiplier Comparison

	No accommodation		2 years accommodation	
	1 year	2 years	1 year	2 years
SELMA	0.95	1.05	2.05	2.33
CST 2013 (NAWM)			1.55	1.62
AEJ:Macro			1.52	
ECB MB		0.7-0.8		1.1-1.7
ECB WP (NAWM)	0.98	0.91	1.39	1.3
ECB MB (NAWM)		0.8		1.2

Notes: CST 2013 reports their multipliers in Panel B, table 4 in Coenen et al. (2013), and use a Monetary Policy rule with only an contemporaneous inflation response of 1.5 and an output growth reponse of 0.125. AEJ:Macro reports the average first-year multipliers for the EU models (see Table 3 in Coenen et al. (2012)). ECB MB show the min-max results of the exercise in AEJ:Macro with the EU models. ECB MB shows the results from the NAWM model with a standardized Taylor rule and ECB MB (ECB) focuses on the results from the NAWM model which are reported separately in ECB MB.

SELMA's government consumption multiplier in the no accommodation case is generally in line with the multipliers in the other studies, although they are slightly higher. The reason for the relatively high multiplier stems from the fact that public and private consumption are complements. None of the models in AEJ:Macro and ECB MB have non-separable utility in private and public consumption. As is shown in Section 8.1, the non-separability together with the complementarity between public and private consumption goods increases the multiplier significantly, since it leads to a crowding-in rather than

a crowding-out of private consumption. CST 2013 has a similar modelling approach as SELMA, and has the same complementarity. CST 2013 does however not report the no monetary policy accommodation multipliers.

In the case of two years monetary policy accommodation, the increase in the multiplier is substantial, and the multiplier is significantly larger than in the other models. One important reason for this, except for the fact that private and public consumption are complements in the model, is the conduction of monetary policy. In CST 2013, a standardized Taylor rule is used, which decreases the effect of monetary accommodation substantially. A similar rule in SELMA would yield only a small increase in the multiplier from its no accommodation values, which is implied by the results in Section 5. As Section 5 shows, both a reduction in the persistence of the interest rate and a removal of the first-difference parameters decreases the monetary accommodation multiplier significantly. Furthermore, as reported in AEJ:Macro, none of the four EU models seem to have any weight on any first-difference parameters in their monetary policy rules.

6.2 Government investment

Table 12: Government Investment Multiplier Comparison

	No accommodation		2 years accommodation	
	1 year	2 years	1 year	2 years
SELMA	1.13	1.31	1.96	2.26
CST 2013 (NAWM)			1.08	1.08
AEJ:Macro			1.48	
ECB MB		0.8-1.1		1.1-1.6
ECB WP (NAWM)				
ECB MB (NAWM)		0.9		1.1

Notes: CST 2013 reports their multipliers in Panel B, table 4 in Coenen et al. (2013), and use a Monetary Policy rule with only an contemporaneous inflation response of 1.5 and an output growth response of 0.125. AEJ:Macro reports the average first-year multipliers for the EU models (see Table 3 in Coenen et al. (2012)). ECB MB show the min-max results of the exercise in AEJ:Macro with the EU models. ECB MB shows the results from the NAWM model with a standardized Taylor rule and ECB MB (ECB) focuses on the results from the NAWM model which are reported separately in ECB MB.

The multipliers for a government investment shock with no accommodation are generally in line with the multipliers from other studies, but as for the government consumption multiplier, it is is slightly higher than in the compared models. One important reason

for the difference is the treatment of government capital across the different models.[15] In some models included in AEJ:Macro, government capital enters the production function as an multiplicative TFP term while CST 2013 and SELMA have a CES capital aggregate of private and public capital entering the production function. The reason for the large multiplier in SELMA can be attributed to the complementarity between public and private capital.

Just as for government consumption, the multiplier in the case of two-year monetary policy accommodation is higher than in the comparable multipliers from other studies. Just as for government consumption, this can, in addition to the complementarity between public and private capital, primarily be attributed to the monetary policy rule. Furthermore, the complementarity between private and public capital is higher in SELMA than in CST 2013. The parameter υ_K determines whether the two types of capital are net compliments ($\upsilon_K < 1$) or net substitutes ($\upsilon_K > 1$). SELMA and CST 2013 estimates the value of this parameter in the Euro Area to be 0.84, while in SELMA the parameter is set lower, to 0.25. Table 22 provides a sensitivity analysis with respect to the alternative values of the elasticity of substitution between public and private capital.

6.3 Government transfers

In the case of no monetary policy accommodation, the multipliers for an increase in government transfers are slightly higher than the multipliers from the other studies. One important explanatory factor for this result is that the majority of the transfer stimulus goes to the Non-Ricardian households, which means that a majority of the transfer stimulus directly affect demand for private consumption. This can be compared to CST 2013, where the share is significantly lower. In Table 23, it is shown that as the share of transfers going to Non-Ricardian households decrease, the transfer multiplier also decrease. In addition, the share of Non-Ricardian households in SELMA is 0.35 which is higher than the share in CST 2013 (0.18). This also contributes to a higher multiplier compared to CST 2013. In Table 20, transfer multipliers in SELMA with different shares of Non-Ricardian and Ricardian households are reported.

In the case of two years of monetary policy accommodation, the multipliers in SELMA are higher than the multipliers in the other studies. One important reason for the large multiplier increase is the specification of the Taylor rule. As is shown in Section 5, removing the first-difference parameters or the persistence in the monetary policy rule, making it more in line with the other studies in this section, reduces the impact of monetary

[15] See Section 2 and Table 1 for details.

Table 13: Government Transfers Multiplier Comparison

	No accommodation		2 years accommodation	
	1 year	2 years	1 year	2 years
SELMA	0.26	0.27	0.53	0.58
CST 2013 (NAWM)			0.07	0.06
AEJ:Macro			0.29	
ECB MB		0.0-0.2		0.1-0.5
ECB WP (NAWM)				
ECB MB (NAWM)		0.1		0.3

Note: In SELMA, the share of the transfers outside of the steady state that goes to Non-Ricardians and Ricardians are 0.75 and 0.25 respectively. CST 2013 reports their multipliers in Panel B, table 4 in Coenen et al. (2013), and use a Monetary Policy rule with only an contemporaneous inflation response of 1.5 and an output growth response of 0.125. AEJ:Macro reports the average first-year multipliers for the EU models (see Table 3 in Coenen et al. (2012)). ECB MB show the min-max results of the exercise in AEJ:Macro with the EU models. ECB MB shows the results from the NAWM model with a standardized Taylor rule and ECB MB (ECB) focuses on the results from the NAWM model which are reported separately in ECB MB.

accommodation significantly.

6.4 Targeted government transfers

When the transfers are given exclusively to the Non-Ricardian households, the multipliers in SELMA are roughly in line with the multipliers in the other studies. This is true for both the case of no monetary policy accommodation and for the case of two years monetary policy accommodation. One reason for why the results might differ between models is the share of Non-Ricardian households and their share of total consumption in steady state. As can be seen in Table **??**, the share of Non-Ricardians in SELMA is higher than in the other models. Thus, when the transfers are only given to Non-Ricardians, the effect of this will be higher on output due to their consumption behaviour.

6.5 Investment tax credit

For the investment tax credit multiplier, the evidence from other models is limited. The only comparison that can be made is between SELMA and ECB MB (NAWM). In the case of no monetary policy accommodation, the multiplier is lower in SELMA than in NAWM. One reason for this is that SELMA has a higher investment adjustment cost than in

Table 14: Targeted Government Transfers Multiplier Comparison

	No accommodation		2 years accommodation	
	1 year	2 years	1 year	2 years
SELMA	0.44	0.44	0.90	0.98
CST 2013 (NAWM)				
AEJ:Macro			1.12	
ECB MB		0.1-0.6		0.6-1.2
ECB WP (NAWM)				
ECB MB (NAWM)				

Note: In this experiment, 100% of the transfers outside of steady-state goes to Non-Ricardian households. CST 2013 reports their multipliers in Panel B, table 4 in Coenen et al. (2013), and use a Monetary Policy rule with only an contemporaneous inflation response of 1.5 and an output growth response of 0.125. AEJ:Macro reports the average first-year multipliers for the EU models (see Table 3 in Coenen et al. (2012)). ECB MB show the min-max results of the exercise in AEJ:Macro with the EU models. ECB MB shows the results from the NAWM model with a standardized Taylor rule and ECB MB (ECB) focuses on the results from the NAWM model which are reported separately in ECB MB.

Table 15: Investment Tax Credit Multiplier Comparison

	No accommodation		2 years accommodation	
	1 year	2 years	1 year	2 years
SELMA	0.49	0.69	1.13	1.44
CST 2013 (NAWM)				
AEJ:Macro				
ECB MB				
ECB WP (NAWM)				
ECB MB (NAWM)		1.0		2.0

Note: In SELMA, the share of the transfers outside of the steady state that goes to Non-Ricardians and Ricardians are 0.75 and 0.25 respectively. CST 2013 reports their multipliers in Panel B, table 4 in Coenen et al. (2013), and use a Monetary Policy rule with only an contemporaneous inflation response of 1.5 and an output growth response of 0.125. AEJ:Macro reports the average first-year multipliers for the EU models (see Table 3 in Coenen et al. (2012)). ECB MB show the min-max results of the exercise in AEJ:Macro with the EU models. ECB MB shows the results from the NAWM model with a standardized Taylor rule and ECB MB (ECB) focuses on the results from the NAWM model which are reported separately in ECB MB.

NAWM, implying that a temporary stimulus has more limited effects in SELMA. In the appendix, the results of a sensitivity analysis with lower investment adjustment cost is reported. In this sensitivity analysis the value of the investment adjustment cost parameter is reduced from 8.4 to 5.2, which is the estimated value used in NAWM. The results show that the multiplier for the investment tax credit increases with a lower adjustment cost. With NAWM's adjustment cost, the SELMA multiplier in the case of no monetary accommodation becomes virtually identical to NAWM's. It does however become higher in the case of two years monetary accommodation. Again, this larger increase in multipliers in SELMA as compared to NAWN when the monetary policy becomes accommodative can, at least partly, be attributed to differences in the conduction of monetary policy in the two models.

6.6 Consumption tax

Table 16: Consumption Tax Multiplier Comparison

	No accommodation		2 years accommodation	
	1 year	2 years	1 year	2 years
SELMA	0.32	0.33	0.28	0.28
CST 2013 (NAWM)			0.46	0.48
AEJ:Macro			0.66	
ECB MB		0.2-0.3		0.4-1.0
ECB WP (NAWM)	0.48	0.62	0.78	0.92
ECB MB (NAWM)		0.3		0.4

Note: In SELMA, the share of the transfers outside of the steady state that goes to Non-Ricardians and Ricardians are 0.75 and 0.25 respectively. CST 2013 reports their multipliers in Panel B, table 4 in Coenen et al. (2013), and use a Monetary Policy rule with only an contemporaneous inflation response of 1.5 and an output growth response of 0.125. AEJ:Macro reports the average first-year multipliers for the EU models (see Table 3 in Coenen et al. (2012)). ECB MB show the min-max results of the exercise in AEJ:Macro with the EU models. ECB MB shows the results from the NAWM model with a standardized Taylor rule and ECB MB (ECB) focuses on the results from the NAWM model which are reported separately in ECB MB.

The consumption tax multiplier in SELMA in the case of no monetary policy accommodation is generally in line with the corresponding multipliers in the other studies. There is however a large difference regarding the multiplier in the case of two years monetary policy accommodation. While the multiplier increases in other models, it decreases

slightly in SELMA. The reason for this difference can be attributed to the conduct of monetary policy, the modelling of unemployment in SELMA, and the first-difference terms in the monetary policy rule. As the consumption tax is decreased, labor supply in SELMA increases, leading to higher unemployment. As unemployment, as well as the growth of unemployment, enters the monetary policy rule in SELMA, the higher unemployment leads to more expansionary monetary policy. In the case of two years accommodation, this expansionary monetary policy is not anymore conducted. Furthermore, as the stimulus ends, unemployment jumps down again, leading to less contractionary monetary policy after the stimulus period in the case of two years accommodation, leading to a further contraction of consumption demand and output.

6.7 Capital tax

Table 17: Capital Tax Multiplier Comparison

	No accommodation		2 years accommodation	
	1 year	2 years	1 year	2 years
SELMA	0.03	0.03	0.06	0.07
CST 2013 (NAWM)				
AEJ:Macro				
ECB MB				
ECB WP (NAWM)	0.12	0.1	0.19	0.17
ECB MB (NAWM)		0.1		0.1

Note: In SELMA, the share of the transfers outside of the steady state that goes to Non-Ricardians and Ricardians are 0.75 and 0.25 respectively. CST 2013 reports their multipliers in Panel B, table 4 in Coenen et al. (2013), and use a Monetary Policy rule with only an contemporaneous inflation response of 1.5 and an output growth response of 0.125. AEJ:Macro reports the average first-year multipliers for the EU models (see Table 3 in Coenen et al. (2012)). ECB MB show the min-max results of the exercise in AEJ:Macro with the EU models. ECB MB shows the results from the NAWM model with a standardized Taylor rule and ECB MB (ECB) focuses on the results from the NAWM model which are reported separately in ECB MB.

The capital tax multiplier is significantly lower in SELMA than in NAWM, which is the only model comparison for this tax. One reason for this difference is due to a higher investment adjustment cost calibration in SELMA than in NAWM. In the appendix, a sensitivity analysis is reported that is conducted by lowering the investment adjustment cost parameter value from 8.7 to 5.2 and the results show that the capital tax multiplier

becomes larger with a lower investment adjustment cost (even though the difference is relatively small).

6.8 Labor tax

Table 18: Labor Tax Multiplier Comparison

	No accommodation		2 years accommodation	
	1 year	2 years	1 year	2 years
SELMA	0.30	0.30	0.05	0.00
CST 2013 (NAWM)			0.12	0.12
AEJ:Macro			0.53	
ECB MB		0.1-0.3		0-0.8
ECB WP (NAWM)	0.11	0.19	0.04	0.12
ECB MB (NAWM)		0.1		0

Note: In SELMA, the share of the transfers outside of the steady state that goes to Non-Ricardians and Ricardians are 0.75 and 0.25 respectively. CST 2013 reports their multipliers in Panel B, table 4 in Coenen et al. (2013), and use a Monetary Policy rule with only an contemporaneous inflation response of 1.5 and an output growth response of 0.125. AEJ:Macro reports the average first-year multipliers for the EU models (see Table 3 in Coenen et al. (2012)). ECB MB show the min-max results of the exercise in AEJ:Macro with the EU models. ECB MB shows the results from the NAWM model with a standardized Taylor rule and ECB MB (ECB) focuses on the results from the NAWM model which are reported separately in ECB MB.

The multiplier for the labor income tax is largely in line with the other studies in the case of no monetary policy accommodation. Regarding the multiplier in the case of two years of monetary policy accommodation, the multipliers in the other model studies vary quite significantly, and it is hard to find a consensus. It does however seem that the multiplier tend to decrease with monetary accommodation, but not in all cases. As can be seen in the ECB MB study, the maximum multiplier value in the case of two years accommodation is significantly higher than the maximum multiplier in the case of no monetary policy accommodation, implying that for at least one model, the multiplier is increased when monetary policy is accommodative. The reason for why the SELMA multiplier is decreasing with monetary accommodation is the same as for the consumption tax. Unemployment increases as labor supply increases following the labor tax decrease, leading to more expansionary monetary policy. With two years monetary policy accommodation, this positive effect is removed. Furthermore, the sharp drop in unemployment

after the stimulus ends leads to even more contractionary policy after the stimulus, having a negative effect on the economy also during the stimulus period. Another feature that differs between the models, and that affects the multiplier value, is the share of Non-Ricardians. A higher share of Non-Ricardian households leads to a higher multiplier, since their marginal propensity to consume is one. Thus the stimulus will, via the decrease in the labor income tax, have a direct impact on their consumption. This can be contrasted to Ricardian households who want to smooth the consumption increase that the temporary increase in income yields over time.

6.9 Social security contributions

Table 19: Social Security Contributions Multiplier Comparison

	No accommodation		2 years accommodation	
	1 year	2 years	1 year	2 years
SELMA	0.03	0.05	0.03	0.05
CST 2013 (NAWM)				
AEJ:Macro				
ECB MB				
ECB WP (NAWM)				
ECB MB (NAWM)		0.3		0.1

Note: In SELMA, the share of the transfers outside of the steady state that goes to Non-Ricardians and Ricardians are 0.75 and 0.25 respectively. CST 2013 reports their multipliers in Panel B, table 4 in Coenen et al. (2013), and use a Monetary Policy rule with only an contemporaneous inflation response of 1.5 and an output growth response of 0.125. AEJ:Macro reports the average first-year multipliers for the EU models (see Table 3 in Coenen et al. (2012)). ECB MB show the min-max results of the exercise in AEJ:Macro with the EU models. ECB MB shows the results from the NAWM model with a standardized Taylor rule and ECB MB (ECB) focuses on the results from the NAWM model which are reported separately in ECB MB.

As for the investment tax credit and the capital tax, the evidence from other studies regarding the social security contributions (SSC) multiplier is limited. The only comparison study is ECB MB (NAWM). Compared to NAWM, the multiplier in SELMA is lower, both in the case of no monetary accommodation and in the case of two years accommodation. The reason for the small effect on the SELMA multiplier stems from the high price stickiness in the model. After two years, less than half of the firms have been able to reset their prices. Furthermore, given the high stickiness, the firms that are allowed during the

stimulus period might not want to lower their price very much, since they know that tax, and hence the firms' costs, will increase again in the future.

6.10 Multiplier comparison with the Norwegian fiscal model NORA

This subsection contains a comparison between SELMA's fiscal multipliers and multipliers calculated using the Norwegian fiscal model NORA, see Aursland et al. (2020). NORA is also a DSGE type small open economy model with a rich fiscal sector. This is however not the only reason for comparing SELMA with NORA. Norway is one of Sweden's largest trading partners and the two economies have similar characteristics.[16] Both countries have their own monetary system and are thus able to conduct independent monetary policy. Moreover, labor market institutions and wage negotiation processes are very similar to each other, which preserve the Scandinavian nature of consensus in the wage setting and the aim for contributing to a low unemployment rate. However, Sweden and Norway have significant differences in their economic structure and economic policy making as well. Norway is a country endowed with rich natural resources, especially in oil and gas. To avoid falling into a Dutch disease trap and mitigate the business cycles caused by oil sector developments, economic policy separates the mainland economy from the oil sector. For example, fiscal policy is designed in a such a way that oil-money is not transferred directly to the central government budget. Instead, revenues from oil and gas are parked in the national wealth fund, which invests only in foreign assets. Each year the Norwegian government makes transfers from the wealth fund to the budget under the guidelines of a fiscal rule. Given the ample resources, debt financing of fiscal expenditures is not an option for Norwegian fiscal policy. Sweden, on the other hand, is an energy importer and fiscal policy actively uses debt financing. Moreover Sweden has a larger trade openness than Norway and thus GDP in Sweden co-moves with global GDP more than Norwegian GDP does.

Given this background information on the differences between Sweden and Norway, the fiscal multipliers of NORA and SELMA are compared. For this purpose, the results in Aursland et al. (2020) are used for NORA's fiscal multipliers. Since Aursland et al. (2020) uses a different definition of the multipliers than what is used in other sections in this study, this subsection adopts the definition of the multiplier in Aursland et al. (2020).

[16] A comprehensive comparison of Swedish and Norwegian economies is beyond the scope of this paper, for this reason, only some differences are highlighted, that are considered to be important for the multiplier comparison analysis.

The definition is given by

$$PVM(k) = \frac{\sum_{j=0}^{k}(\prod_{i=0}^{j}(r_{t+i})^{-1})\Delta Y_{t+j}}{\sum_{j=0}^{k}(\prod_{i=0}^{j}(r_{t+i})^{-1})\Delta G_{t+j}}. \tag{17}$$

where r_{t+1} is the real interest rate, ΔY_{t+j} is the difference between output with fiscal stimulus and output without fiscal stimulus, and ΔG_{t+j} is the difference between government consumption with fiscal stimulus and government consumption without fiscal stimulus. The discussion of differences between multipliers in SELMA are left to earlier sections. This subsection compares present value multipliers for government consumption of the two models in two different episodes, normal episodes and recessions. It must be noted that for NORA, government consumption refers to government purchases of goods and services excluding the public wage bill, which is a subset of government consumption. To make the comparison as close as possible, a similar experiment as in Aursland et al. (2020) is conducted for SELMA, where discretionary government spending stimulus arrives gradually and peaks at 1% of GDP after five periods. It is also assumed that government spending gradually dies out with an AR parameter of 0.80. Given that the two models have significant differences, there is a trade off between getting experiments as close to those in NORA as possible and having a reasonable size recession or to study the chosen effective lower bound. For this reason there are small differences in the rest of the experiment set up. In NORA, a recession is constructed with a large negative consumption preference shock that lasts for three quarters and the size of the shock is calibrated to a magnitude that makes interest rate reaches its lower bound and stays there around 10 quarters under active monetary policy rule without a stimulus. In SELMA, a similar type of shock is used as in NORA. The shock lasts for 5 quarters and its size is calibrated to stay at the lower bound for 6 quarters. Given this calibration of shocks, the lower bound is reached in the 6th quarter in NORA, but the effective lower bound is reached in the first quarter in SELMA. In NORA, the government pursues a balanced budget each period and spending is financed by transfers to Ricardian households, whereas in SELMA government spending is financed by debt in the short run. We believe these small differences in the experiment set up does not matter much for the general comparison in this section.

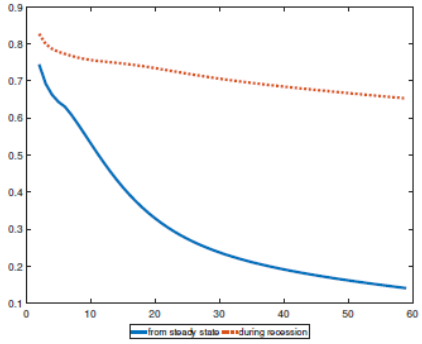
Concerning the comparison of the government consumption multipliers of NORA and SELMA, there is one critical modelling difference between two models that plays a large role in explaining the difference between multipliers. The public-private consumption complementarity in household utility is a central model property in SELMA but does not exist in NORA. This feature is expected to be associated with higher multipliers. To make

the point clear, Figure 5 shows both the benchmark SELMA and a version of SELMA where the complementarity parameter, α_G, is set to a value close to 1, which leads the increased government consumption to have an arbitrarily small direct effect on private consumption.

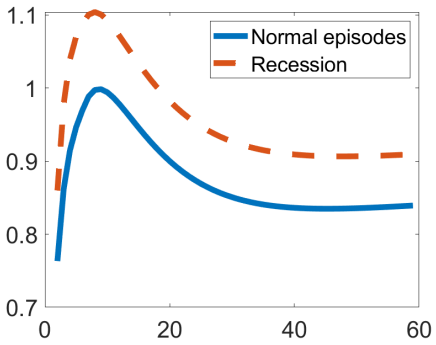
Figure 5 shows that the government consumption multiplier is significantly higher in benchmark SELMA than in NORA. However, when the weight of government consumption in the utility function $1-\alpha_G$ is set to a very low level, the two models provide similar patterns in present value multipliers.

Figure 5: Present-value fiscal multiplier for government purchases

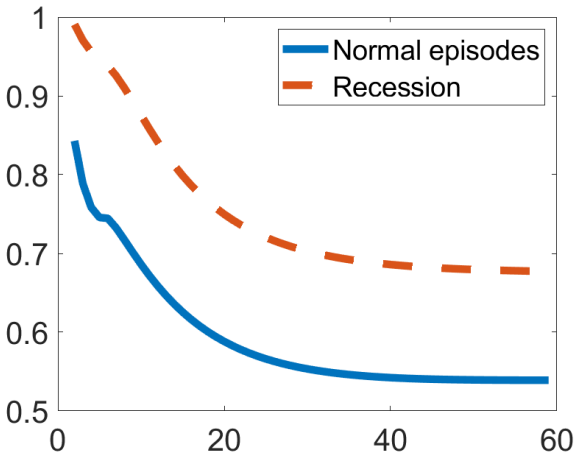
(a) NORA gov. consumption multiplier



(b) SELMA gov. consumption multiplier



(c) SELMA gov. consumption multiplier, $\alpha_G \approx 1$



As Figure 5 shows, multipliers are higher in a deep recession in both models. Why this is the case was discussed previously. Another noticeable difference is that SELMA multipliers are higher than NORA multipliers. Even if the complementarity between public consumption and private consumption is removed, the multiplier of government consumption is higher in SELMA than in NORA. Another important reason for higher multipliers in SELMA is that there is full home bias in government consumption, whereas in NORA, approximately 25 percent of government purchases are imported. The higher the home bias, the higher the government consumption multiplier would be because more

domestic resources would be utilized to meet the increased aggregate demand after an increased government consumption. The last difference to highlight is that during normal episodes the multiplier flattens over time in SELMA but it is downward-sloping in NORA. The reason behind this difference is that in NORA output goes to negative territory in the medium term after a government consumption stimulus, whereas in SELMA government consumption stimulus does not have any negative effects on the output until the stimulus disappears.

7 Multiplier comparison with empirical studies

This section contains a comparison between the multipliers in SELMA and the multipliers estimated by empirical studies for Sweden, Europe and some for the US.

Most empirical papers report their results in terms of present value or undiscounted cumulative multipliers. These two are often very similar across horizons up to five years, with only a small difference between peak and average multipliers. SELMA's multipliers are computed according to the formula in equation (3) for GDP and equation (4) for unemployment. Since the fiscal shock is constant over the stimulus period, the SELMA multiplier is equivalent to the undiscounted cumulative multiplier, as shown by the equation below.

$$100\frac{1}{n}\sum_{i=1}^{n}\hat{y}_{t+i} = \frac{\sum_{i=1}^{n}\hat{y}_{t+i}}{n0.01} = \frac{\sum_{i=1}^{n}(y_{t+i}-\bar{y})}{n0.01\bar{y}} = \frac{\sum_{i=1}^{n}(y_{t+i}-\bar{y})}{\sum_{i=1}^{n}0.01\bar{y}}.$$

The multiplier values from the different empirical studies are compared to the multipliers reported in Section 4.

7.1 GDP multipliers

The exact magnitude of government spending or consumption multipliers does of course depend on the country at study, the method and on the time horizon. The comparison in this study focuses mainly on studies that use structural VARs (as opposed to the so-called "narrative approach") in order to identify government spending shocks and on studies that do not exclusively look at the US.

7.1.1 Government consumption

Ramey (2019) gives an overview across studies that provide multipliers for a variety of samples, identification methods and countries. She finds that government spending multipliers are generally around one or below. Gechert and Rannenberg (2018) conduct a meta-regression analysis of 98 empirical studies for several different countries. For the government consumption multiplier they find an average of 0.4 during normal times (i.e., no recession). Caldara and Kamps (2017) use a structural VAR model, on US data, with three different identification strategies to calculate tax and spending multipliers. Their estimates of the fiscal rules imply positive spending multipliers for about 5 years after the fiscal shock. The spending multipliers range between 1.0 and 1.3 for the first year after the shock. Dong et al. (2021)'s literature review of fiscal multipliers, including both Ramey (2019) and Caldara and Kamps (2017), find that most estimates of the average

output multiplier of government purchases, despite significant differences in samples and identification methods, range between 0.9 and 1.3 in developed countries. These figures typically average out responses in expansionary and recessionary periods and in periods of accommodative and tight monetary policy.

Ilzetzki et al. (2013) investigate the government consumption multiplier and, using data from 44 countries, find multipliers in the range of 0.3 to 0.7 for high income countries. The cumulative multiplier rises to 0.66 in the long-run (over 5 years). However, these results depends on the exchange rate regime. For developed countries with flexible exchange rates, they find negative multipliers that are significantly different from zero. For developed countries under fixed exchange rate regimes, the impact multiplier (i.e., the change in output in the first quarter relative to the stimulus in the first quarter) is 0.15 and the long-run multiplier (defined here as the cumulative change in output after five years relative to the cumulative stimulus after five years) is 1.4.

Corsetti et al. (2012) uses a panel of OECD countries to identify fiscal shocks as residuals from an estimated spending rule and find a government spending multiplier of 0.7. However, they also find that the results crucially depend on the currency regime. For Sweden, Hjelm and Stockhammar (2016) find a cumulative multiplier for 8 quarters of 1.6 during the period of a flexible exchange rate regime. However, their point estimates that are used to calculate the cumulative multipliers are not significantly different from zero at any horizon. The 2-year multiplier computed with SELMA, which is 1.1 in the case of no accomodation falls within the range of the studies mentioned here.[17]

7.1.2 Government investment

There is surprisingly little recent aggregate evidence on multipliers for public investment. As one example, Ilzetzki et al. (2013) found multipliers for public investment that ranged between 0.4 in the short-run (i.e., the effect during the first quarter) to 1.6 in the long-run (i.e., the cumulative effect over five years) in their panel of countries. For high income countries, the cumulative multiplier is close above one after eight quarters. Their multiplier on government investment is larger than that of government consumption, however, the difference is only statistically significant for developing countries. Gechert and Rannenberg (2018) find an average multiplier for government investment of 1.4.

Hjelm and Stockhammar (2016) find that the multiplier for government investment is around 2 during the flexible exchange rate regime. Similar to the findings in Ilzetzki et al. (2013), the multiplier for government investment is higher then the one for government consumption. Also here, it should be noted that the point estimates are not significantly

[17] See tables 3 and 4 for all multipliers.

different from zero at any horizon. According to Dong et al. (2021) evidence on investment expenditure typically reports higher multipliers than overall spending multipliers, which is because government capital is complementary to private capital.

The corresponding 2-year multiplier computed with SELMA is 1.3 in the case of no accommodation and are in line with the results found by Ilzetzki et al. (2013).

7.1.3 Taxes and transfers

Concerning tax multipliers, Gechert and Rannenberg (2018) compute the average multiplier (across studies and multipliers for different taxes) and find it to be 0.3. The tax multipliers found by Caldara and Kamps (2017) range between 0.5 and 0.7 for the first year after the shock.

For indirect taxes Hjelm and Stockhammar (2016) report a multiplier of around 2 (with point estimates significantly different from zero in the first three quarters). For direct taxes they find negative multipliers of around -1 (with point estimates significantly different from zero after six quarters). All numbers are computed under the flexible exchange rate regime.

Ramey (2019) also presents estimates of tax multipliers. However, most of the time-series evidence is based on narrative methods of identification and the estimates are for long-run multipliers (cumulative over five years) which provide a less relevant comparison to the two-year multipliers computed with SELMA. The estimates for narrative methods are generally quite high (between 2 and 3), in contrast to calibrated and estimated DSGE models which imply smaller multiplies, typically below unity for both labor and capital tax multipliers. Other studies such as Barro and Redlick (2011) find smaller estimates of 1.1 at a one year horizon (regression on US data). Mountford and Uhlig (2009)'s VAR model estimates on US data range from 0.3 (after one quarter) to 3.4 (after three years). It is worth noting that Ramey (2019) also presents estimates based on quantitative models and those estimates are much lower, between 0 and 1. van der Wielen (2020) summarises different studies of tax and government spending multiplier estimates by identification procedure and definition. Similar to Ramey (2019), they find that for tax-based measures, multipliers calculated using structural identification are smaller (in absolute terms) as opposed to the narrative approach. These findings are supported by Dong et al. (2021) stating that the evidence on multipliers of tax rate changes is more varied. Studies using the narrative approach often report very high multipliers between 2 and 3, while studies using estimated or calibrated structural models typically find multipliers below 1 for both labor and capital tax multipliers.

Concerning transfer multipliers, Ramey (2019) only cites the study of Coenen et al.

(2012). They look at multipliers computed with various DSGE models and find multipliers ranging between 0.2 (no accommodation) and 0.6 (with accommodation). Gechert and Rannenberg (2018) do not report any transfer multipliers based only on their VAR sample. Although, from the whole sample of studies they find an average multiplier of 0.3 for transfers. For Sweden, Hjelm and Stockhammar (2016) report a multiplier for government transfer of 1.5 (with no point estimates significantly different from zero).

These estimates can be compared to the tax multipliers in SELMA which are 0.3 for indirect taxes (consumption) and range from close to 0 (capital tax) to 0.3 (labor tax) for direct taxes. For government transfers, the multipliers in SELMA are 0.3 in the case of no accommodation, which is well in line with the findings in Coenen et al. (2012) and Gechert and Rannenberg (2018).

It should be noted that the empirical literature faces some challenges. For example, empirical studies are not well suited to analyze a situation in which fiscal and monetary policy is anticipated to be conducted differently than in the past. Another challenge is to identify situations in which only one fiscal instrument has changed while all the others were kept constant. In addition, it can be difficult to clearly differentiate between the first-order effects of a change in one fiscal instrument and the second-order effects of changes in other fiscal instruments caused by the change in the fiscal variable of interest.

7.2 Unemployment multipliers

This subsection contains a comparison of the unemployment multipliers in SELMA with the multipliers estimated by some empirical studies. The empirical evidence exploring the effect of fiscal policy on unemployment is much more limited than that of GDP. Due to the scarcity of empirical evidence, the comparison in this section is no longer restricted to studies using structural VAR models and other data than for US, as was the case in the previous section. In addition the focus will be on unemployment multipliers calculated for government spending, as this is most common in the empirical literature.

Holden and Sparrman (2018) investigate the effect of government purchases on unemployment in 20 OECD countries using panel data estimation. They find that increased government purchases lead to lower unemployment; an increase equal to one percent of GDP reduces unemployment by about 0.3 percentage points in the same year (irrespective of using fixed effects or IV estimation). The effects increases somewhat in year 2, and then decreases gradually and vanish after 10 years.

Ramey (2012) also finds that higher public purchases leads to lower unemployment, using structural and expectational VAR analyses on US data. Most estimates imply

that an increase in government spending of one percentage point of GDP lowers the unemployment rate at peak by between 0.2 to 0.5 percentage points. Monacelli et al. (2010) find a larger effect also using a VAR model in US data; an increase in government spending equal to one percent of GDP leads to a fall in the rate of unemployment of 0.6 percentage points (at peak which occur after ten quarters). The cumulative multipliers range between -0.4 and -0.6 at year 2.

Brückner and Pappa (2012) study the effects of fiscal expansions on unemployment for 10 OECD countries using structural VAR models. Contrary to the previously mentioned studies, they find that increased government purchases often increases the unemployment rate, with a typical estimate from the impulse responses implying that a 10 percent increase in government expenditure increases the unemployment rate at peak (which varies from 3-16 quarters) of around 0.2-0.5 percent. The increase in unemployment were, for several OECD countries, associated with significant increases in employment and, in particular, with significant increases in labor force participation.

Chun-Hung and Hiroaki (2019) study the effects of a government spending shock on the US labor market by using a DSGE model. Their findings are that an increase in government spending increases the job finding rate and reduces the separation rate, and therefore lowers the unemployment rate.

IMF (2010) look at historical accounts and records for tax hikes and spending cuts in 17 OECD countries and find that a fiscal consolidation of 1 percent of GDP raises the unemployment rate by 0.28 percentage points within two years. Woo et al. (2017) using almost the same method find evidence that a 1 percent GDP consolidation increases unemployment by 0.19 percentage points in the same year and 1.5 percentage points cumulative over 5 years.

The unemployment multiplier computed with SELMA is around -0.9 to 1.0 for government spending (consumption and investment) in the case of no accommodation. This is stronger than most of the studies mentioned above. The SELMA multiplier for government transfers on unemployment is -0.3 and more in line with the empirical literature.

7.3 Do multipliers differ between recessions and booms?

Another strand of the literature is the state-dependence of fiscal shocks. In theory, the case for non-linear multipliers is rather straightforward – the greater amount of idle resources in the economy and the more muted the monetary policy response, the lesser crowding out and hence the larger multipliers. Weather fiscal multipliers are lager during recessions than during other parts of the economic cycle has been confirmed in several empirical

studies, however there is no consensus around this question.

Some literature support the view that the effect of fiscal policy is stronger during a downturn, for example Auerbach and Gorodnichenko (2012b) and Fazzari et al. (2015), while other studies challenge this view, for example Ramey and Zubairy (2018). In the meta study by Gechert and Rannenberg (2018) they find that the GDP multipliers of some fiscal instruments (government consumption and transfers) increase in economic downturns while other GDP multipliers decrease (investments and taxes). Hjelm and Stockhammar (2016) find no general results concerning the effects of the state of the business cycle that hold for all fiscal instruments. Using an output gap from a HP filter, the multipliers stemming from shocks to consumption, investments and indirect taxes are higher in slumps. Using the output gap from NIER, multipliers stemming from shocks to indirect and direct taxes are higher in slumps.

Furthermore, the empirical evidence seem to depend on the method of identification. Studies based on narratively-identified shocks usually find spending multipliers below one for both booms and recessions, as in Owyang et al. (2013) and Ramey and Zubairy (2018). Studies based on recursive identification on the other hand find that the multiplier is largest and above one during periods of recessions, see Auerbach and Gorodnichenko (2012b), Auerbach and Gorodnichenko (2012a) and Fazzari et al. (2015). Ramey (2019) also state that the evidence on state-dependent multipliers varies between studies and the results is found to be very fragile to small changes in specification or to improvements in the methods for computing the multipliers from the basic estimates. Concluding that the evidence for multipliers above one during recessions or times of slack is typically not robust.

For taxes, Ramey (2019) find that despite method (time series evidence, theory or estimated DSGE models) multipliers are greater in magnitude during expansions than recession. Suggesting that tax multipliers may be procyclical. Same result is found for Canada in Owyang et al. (2013). The estimated effect on unemployment due to a rise in government purchases in Holden and Sparrman (2018) is found to be countercyclical. The effect is greater in downturns, when the output gap is negative, than in booms.

8 Sensitivity analysis

This section presents a sensitivity analysis for the multipliers in the model. The sensitivity analysis aims to show how robust the multipliers in SELMA are to changes in some parameter values. Furthermore, this exercise helps to explain the differences between the multipliers in SELMA and the other structural models that are used as a comparison in Section 6. The analysis in this section is done using 2-year stimulus multipliers in Section 4.

Table 20 shows how the GDP and unemployment multipliers for several fiscal instruments are affected by various assumptions regarding the model parameters. These alternative assumptions partly reflect the various differences in the GDP multipliers calculated by other structural models of the Euro area. The table focuses on the two-year multipliers in the case of two years monetary accommodation.[18]

The benchmark case, which is shown in Column I, is the 2-year multiplier with two years of monetary policy accommodation. As shown in Section 6, SELMA's multipliers tend to be a little higher, or located toward the higher end compared to other models, especially with monetary policy accommodation. This result stems from alternative modelling assumptions. Column II shows the multipliers when there is no monetary policy accommodation. As can be seen in Column II, the variable interest rate generally leads to lower multipliers since the real rates are higher compared to the Benchmark case.

In the benchmark case, it is assumed that there are 35% Non-Ricardians in the economy. In order to test how the share of Non-Ricardians affects the result, a sensitivity analysis is conducted in which it is assumed that there is a larger share of Non-Ricardians (85%) and a smaller share of Non-Ricardians (15%) in the model economy than in the benchmark case. Simultaneously, the relative individual consumption of the Non-Ricardian household to the Ricardian household in the steady state is held constant at 80% in the sensitivity analysis. Column III shows that the multipliers become larger when there are more Non-Ricardian households, reflecting the fact that liquidity constrained households are not able to smooth consumption. The opposite is true when there are less Non-Ricardians. Then the multipliers become smaller (Column IV). The largest difference in the multiplier values due to changes in the share of Non-Ricardians are seen for government transfers and the taxes of consumption and labor income. This is to be expected since they have a direct effect on the liquidity constrained households' disposable income, and hence on their consumption.

Another important difference in terms of parameter values among structural models

[18]The results for all monetary policy alternatives are reported in the Appendix.

is related to the stickiness parameter for prices. In the benchmark case, the Calvo price stickiness of the intermediate good firms is calibrated to 0.94. In the sensitivity analysis reported in the Column V, it is assumed that the price stickiness parameter decreases to 0.85. With a higher price flexibility, the multiplier values decrease, except for the SSC, where it instead increases. This result is not in line with other model results such as in for example ECB MB, where an increased price flexbility instead leads to increased multipliers. The reason for their result lies in the movements of the real interest rate. With more flexible prices, the inflation response after the fiscal stimulus is stronger, leading to a larger reduction in the real interest rate. Thus, the response in output becomes stronger. One reason for the lower multipliers in SELMA is that the sticky wage setting makes real wages fall as the reduced stickiness leads to higher inflation. The lower real wage has a negative effect on Non-Ricardian consumption demand, lowering the multipliers.

Table 20: SELMA GDP Multipliers Sensitivity Analysis

Panel A: GDP multipliers

			Non-Ric. share		Lower stickiness			
	Benchmark	No MP acc.	High	Low	Price	Wage	Both	$\chi^N = 1$
	I	II	III	IV	V	VI	VII	VIII
Government consumption	2.33	1.05	2.14	2.38	2.19	2.83	2.43	2.41
Government investment	2.26	1.31	2.45	2.21	2.18	2.62	2.37	2.31
Government transfers	0.58	0.27	0.98	0.32	0.54	0.70	0.60	0.60
Investment tax credit	1.44	0.69	1.61	1.39	1.34	1.74	1.48	1.44
Consumption tax	0.28	0.33	0.68	0.15	0.27	0.26	0.26	0.57
Capital tax	0.07	0.03	0.08	0.06	0.06	0.08	0.07	0.07
Labor tax	0.00	0.30	0.58	-0.21	0.01	-0.11	-0.04	-0.02
Social security contributions	0.05	0.05	0.07	0.04	0.18	0.06	0.16	0.05

Panel B: Unemployment multipliers

Government consumption	-2.35	-1.00	-2.15	-2.40	-2.28	-2.50	-2.34	-2.81
Government investment	-1.87	-0.86	-2.07	-1.82	-1.83	-1.98	-1.88	-2.26
Government transfers	-0.59	-0.26	-0.99	-0.32	-0.57	-0.62	-0.58	-0.71
Investment tax credit	-1.38	-0.58	-1.54	-1.33	-1.32	-1.45	-1.33	-1.55
Consumption tax	0.12	0.06	-0.29	0.25	0.12	0.12	0.12	-0.67
Capital tax	-0.07	-0.03	-0.08	-0.06	-0.07	-0.07	-0.07	-0.09
Labor tax	0.57	0.25	-0.02	0.78	0.56	0.60	0.57	0.68
Social security contributions	-0.04	-0.03	-0.06	-0.02	-0.11	-0.03	-0.09	-0.06

Since nominal rigidities play an important role in the dynamics of the model economy, a sensitivity analysis is conducted in which the flexibility in the wage setting is increased. This is done to investigate how robust the results are for changes in this parameter. The results are shown in Column VI. In the benchmark calibration, the Calvo wage stickiness is calibrated to 0.86. In the sensitivity analysis reported in the Column VI it is assumed that the Calvo wage stickiness parameter has decreased to 0.7. More flexible wages leads to higher multiplier values for all instruments but the consumption tax and the labor tax. The reason for the higher multipliers is that the higher wage inflation leads to a higher price inflation, in turn reducing the real interest rates in the case of 8Q MP accommodation. This does in turn lead to higher output. One important reason for why the consumption and labor tax have lower multipliers is that a reduction in these taxes leads to a higher effective real wage, which has a direct effect on Non-Ricardian consumption. With more flexible wages, there is a faster downwards adjustment in the wage following the tax decrease, which leads to lower consumption demand from the Non-Ricardian households. Furthermore, the lower inflation that follows from the stronger wage adjustment leads to higher real interest rates, further dampening aggregate demand.

It is also investigated how the result differs if both stickiness parameters are lower, and are set to the same values as in the two previous sensitivity analyses. The results are shown in column VII. The results reflect that decreased price stickiness yields lower multipliers while decreased wage stickiness yields higher multipliers. The resulting multipliers are higher, but less so than in the higher flexibility in the wage setting case.

Finally, column VIII contains a sensitivity analysis of the persistence of the wealth effect parameter, χ^N. In the benchmark calibration, this is set to a low number, implying only a small temporary wealth effect from the fiscal stimulus. The GDP multipliers are fairly similar between the two different calibrations, except for the consumption tax multiplier that doubles in size. The unemployment multiplier, however, is generally higher as $\chi^N = 1$. The reason is that as the wealth effect becomes stronger, labor supply starts to respond negatively to the shocks, leading to a lower unemployment. Hence, the unemployment multiplier becomes larger. The reason for why the consumption tax yields a higher multiplier when the wealth effect has a full and immediate impact on labor supply is that the monetary policy response immediately after the stimulus differs between the two calibrations. In the benchmark case, unemployment increases due to an increase in labor supply following the fiscal stimulus. Unemployment then falls back immediately after the stimulus ends. As a response, the interest rate increases in the benchmark case. In the $\chi^N = 1$ case however, the labor supply response reverses following the stimulus, since the wealth effect leads households to decrease their labor supply. This means that

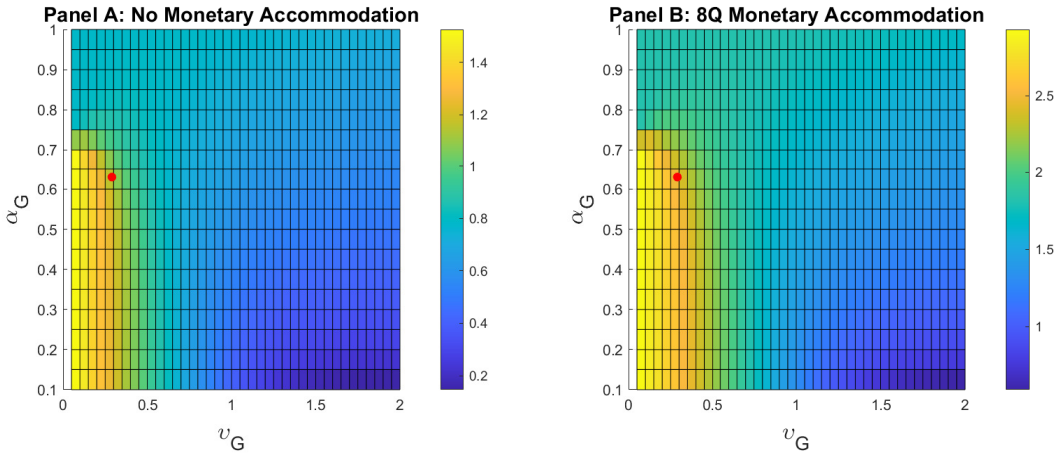
unemployment is lower during the stimulus and increases sharply as the stimulus ends. This does in turn lead to a lower interest rate, boosting the economy during the stimulus period, resulting in a higher multiplier.

8.1 Elasticity of substitution between private and public consumption

In SELMA, households gain utility from both private and public consumption. Including public consumption into the utility function transforms the government consumption from wasteful to productive. Moreover, since government consumption is modelled as a complement to private consumption, a higher government consumption directly leads to higher private consumption. Therefore, this section contains an investigation of how much the government consumption multiplier in SELMA is affected by this assumption.

Table 21 and Figure 7 present the sensitivity analysis of the government consumption multiplier with regards to the elasticity of substitution between private and public consumption (υ_G) and with regards to the weight on private consumption in the composite consumption (α_G).

Figure 6: GDP multiplier for different values of υ_G and α_G



Note: The red dot shows the benchmark calibration.

As can be seen in Table 21, a higher υ_G leads to a lower government consumption multiplier. This is because as υ_G increases the private and public consumption become net substitutes which leads to a crowding out effect of increased public consumption on private consumption. Hence, the increase in output as a response to the fiscal stimulus is dampened in comparison to the benchmark case. On the other hand, as υ_G decreases, the complementarity between the two types of goods increases, and the increase in the private consumption as a response to the fiscal stimulus is enhanced. Thus, higher GDP

Table 21: Sensitivity analysis of Government consumption multiplier in SELMA

Panel A: GDP multipliers

	No accommod.		1 year accommod.		2 years accommod.	
	1 year	2 years	1 year	2 years	1 year	2 years
$\upsilon^G = 0.29$, $\alpha^G = 0.63$ (BM)	0.95	1.05	1.43	1.58	2.05	2.33
$\upsilon^G = 0.05$, $\alpha^G = 0.63$	1.53	1.52	2.05	2.13	2.66	2.93
$\upsilon^G = 1.00$, $\alpha^G = 0.63$	0.58	0.65	0.91	1.01	1.40	1.62
$\upsilon^G = 1.50$, $\alpha^G = 0.63$	0.54	0.58	0.84	0.92	1.28	1.47
$\upsilon^G = 0.29$, $\alpha^G = 0.001$	1.11	1.20	1.63	1.78	2.26	2.55
$\upsilon^G = 0.29$, $\alpha^G = 0.99999$	0.80	0.79	1.18	1.21	1.65	1.82

Panel B: Unemployment multipliers

$\upsilon^G = 0.29$, $\alpha^G = 0.63$ (BM)	-0.90	-1.00	-1.42	-1.56	-2.08	-2.35
$\upsilon^G = 0.05$, $\alpha^G = 0.63$	-1.46	-1.45	-2.04	-2.11	-2.70	-2.95
$\upsilon^G = 1.00$, $\alpha^G = 0.63$	-0.55	-0.61	-0.90	-0.99	-1.42	-1.63
$\upsilon^G = 1.50$, $\alpha^G = 0.63$	-0.51	-0.55	-0.83	-0.90	-1.30	-1.48
$\upsilon^G = 0.29$, $\alpha^G = 0.001$	-1.05	-1.14	-1.62	-1.75	-2.29	-2.57
$\upsilon^G = 0.29$, $\alpha^G = 0.99999$	-0.77	-0.76	-1.17	-1.20	-1.67	-1.83

This table reports multipliers as defined in equations (3)–(4). For each monetary policy stance (no accommodation, 1 year accommodation and 2 years accommodation), the table reports two multipliers. The 1 year multiplier is the average output response over the first year of a 1% of GDP steady-state stimulus running for two years, while the 2 year multiplier is the average output response over the first two years of a 1% of steady-state GDP stimulus running for two years. In all simulations, the fiscal stimulus is debt financed. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

multipliers are observed. The additional demand for output does in turn lead to a higher demand for labor, hence a lower unemployment.

8.2 Elasticity of substitution between private and public capital

In SELMA, the capital used in the production function of the intermediate good producers is a composite of public and private capital. As for the public consumption case, including public capital into the firms' production function transforms the government investment from wasteful to productive. The sensitivity of the multipliers in SELMA with respect to this assumption is investigated in this section.

Table 22 includes a sensitivity analysis of the government investment multiplier with regards to the elasticity of substitution between private and public capital (υ_K) and with regards to the weight on private capital in the composite capital (α_K). For the sake of comparison, wthe values used in Coenen et al. (2013) is included in the last row.

Table 22: Sensitivity analysis of Government Investment multiplier in SELMA

Panel A: GDP multipliers

	No accommod.		1 year accommod.		2 years accommod.	
	1 year	2 years	1 year	2 years	1 year	2 years
$\upsilon^K = 0.25$, $\alpha^K = 0.83$ (BM)	1.13	1.31	1.58	1.79	1.96	2.26
$\upsilon^K = 0.25$, $\alpha^K = 0.99999$	0.77	0.78	1.17	1.20	1.69	1.85
$\upsilon^K = 0.70$, $\alpha^K = 0.83$	0.95	1.02	1.35	1.46	1.75	1.96
$\upsilon^K = 0.05$, $\alpha^K = 0.83$	1.49	1.85	2.08	2.48	2.61	3.10
$\upsilon^K = 0.84$, $\alpha^K = 0.9$ (CST)	0.85	0.88	1.24	1.31	1.71	1.89

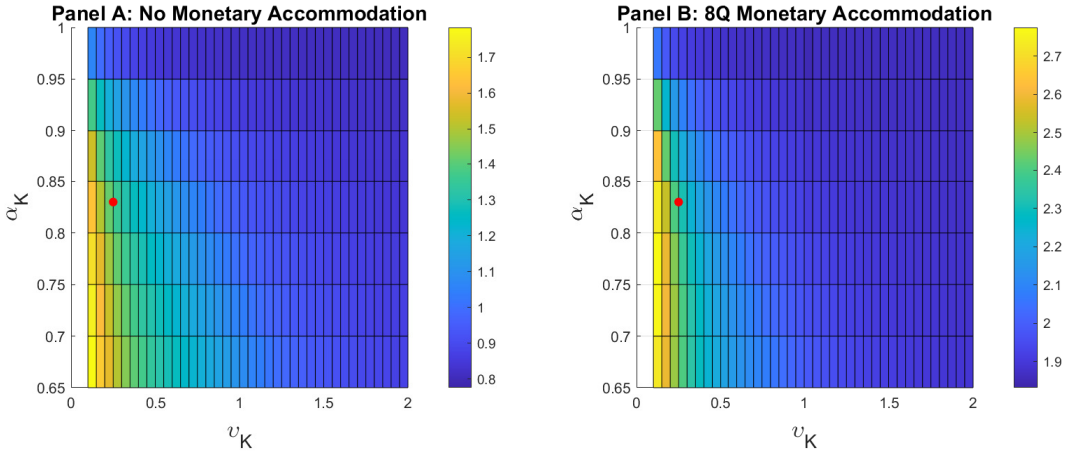
Panel B: Unemployment multipliers

$\upsilon^K = 0.25$, $\alpha^K = 0.83$ (BM)	-0.93	-0.86	-1.41	-1.38	-1.81	-1.87
$\upsilon^K = 0.25$, $\alpha^K = 0.99999$	-0.88	-0.88	-1.38	-1.42	-2.03	-2.22
$\upsilon^K = 0.70$, $\alpha^K = 0.83$	-0.89	-0.83	-1.35	-1.34	-1.81	-1.90
$\upsilon^K = 0.05$, $\alpha^K = 0.83$	-1.20	-1.24	-1.84	-1.92	-2.41	-2.59
$\upsilon^K = 0.84$, $\alpha^K = 0.9$ (CST)	-0.88	-0.86	-1.37	-1.38	-1.93	-2.07

This table reports multipliers as defined in equations (3)–(4). For each monetary policy stance (no accommodation, 1 year accommodation and 2 years accommodation), the table reports two multipliers. The 1 year multiplier is the average output response over the first year of a 1% of GDP steady-state stimulus running for two years, while the 2 year multiplier is the average output response over the first two years of a 1% of steady-state GDP stimulus running for two years. In all simulations, the fiscal stimulus is debt financed. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

As can be seen in Table 22, a lower value of υ^K, hence a lower elasticity of substitution between the two types of capital, leads to a higher multiplier. A higher complementarity implies that the marginal product of private capital increases more with the stimulus, leading to an increase in private investment demand, hence a higher multiplier. When the share of private capital in the composite capital α^K moves towards one, public capital can be interpreted as wasteful spending, yielding a similar multiplier as in the government consumption case with $\alpha^G \approx 1$.

Figure 7: GDP multiplier for different values of υ_K and α_K



Note: The red dot shows the benchmark calibration.

8.3 Sensitivity analysis for the distribution of transfers out of steady-state

For transfers, the share of the transfers that goes to different households, Ricardian households $\left(1-\tilde{\omega}^{dyn}\right)$ vs. Non-Ricardian households $\tilde{\omega}^{dyn}$, matters significantly for the efficiency of the stimulus. The reason is that Ricardian households are unaffected by the additional government stimulus while the Non-Ricardian households increase their consumption 1-to-1 with any increase in transfers. To investigate to which degree the assumption affects the transfer multiplier, the share of transfers outside of the steady-state that goes to Non-Ricardian households is varied. The results are reported in Table 23. In the benchmark setting $\tilde{\omega}^{dyn} = 0.75$, implying that around 60 percent of any additional aggregate transfers outside of the steady-state level go to Non-Ricardian households.

The first row in Table 23 shows the GDP multipliers for government transfers when none of the transfers are given to Non-Ricardians. As expected, when all the transfers are targeted towards the Ricardian households, the multiplier becomes zero. As $\tilde{\omega}^{dyn}$ increases, an increasingly larger share of the transfers go to the Non-Ricardian households. The additional demand for consumption that the increase of $\tilde{\omega}^{dyn}$ leads to does in turn mean a higher demand for consumption, and hence to a lower unemployment. As expected, the multipliers are the highest when all transfers goes to Non-Ricardian households. This is because all of the transfers received by the Non-Ricardians are spent on private consumption, which boosts aggregate demand.

Table 23: Sensitivity analysis of transfer multiplier in SELMA

Panel A: GDP multipliers

	No accommod.		1 year accommod.		2 years accommod.	
	1 year	2 years	1 year	2 years	1 year	2 years
$\tilde{\omega}^{dyn} = 0.00$	0.00	0.00	0.00	0.00	0.00	0.00
$\tilde{\omega}^{dyn} = 0.25$	0.07	0.07	0.10	0.10	0.14	0.15
$\tilde{\omega}^{dyn} = 0.50$	0.15	0.15	0.22	0.23	0.31	0.34
$\tilde{\omega}^{dyn} = 0.75$ (BM)	0.26	0.27	0.38	0.40	0.53	0.58
$\tilde{\omega}^{dyn} = 1.00$	0.42	0.42	0.61	0.63	0.83	0.91

Panel B: Unemployment multipliers

$\tilde{\omega}^{dyn} = 0.00$	0.00	0.00	0.00	0.00	0.00	0.00
$\tilde{\omega}^{dyn} = 0.25$	-0.06	-0.06	-0.10	-0.10	-0.14	-0.15
$\tilde{\omega}^{dyn} = 0.50$	-0.15	-0.15	-0.22	-0.23	-0.31	-0.34
$\tilde{\omega}^{dyn} = 0.75$ (BM)	-0.25	-0.26	-0.38	-0.39	-0.54	-0.59
$\tilde{\omega}^{dyn} = 1.00$	-0.40	-0.41	-0.61	-0.62	-0.85	-0.92

This table reports multipliers as defined in equations (3)–(4). For each monetary policy stance (no accommodation, 1 year accommodation and 2 years accommodation), the table reports two multipliers. The 1 year multiplier is the average output response over the first year of a 1% of GDP steady-state stimulus running for two years, while the 2 year multiplier is the average output response over the first two years of a 1% of steady-state GDP stimulus running for two years. In all simulations, the fiscal stimulus is debt financed. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

8.4 Shutting off the automatic stabilizers for two years

In SELMA, the transfers to households increase as unemployment increases, and vice versa. This feature is included to capture the automatic stabilizers on the expenditure side in Sweden, which primarily work via changes in payouts of unemployment benefits as the unemployment rate changes. To test for the sensitivity of the multipliers regarding this feature, and to make sure that this feature does not distort the comparison to the other models, the automatic stabilizers are shut off during the two fiscal stimulus years in this sensitivity analysis. The sensitivity analysis shows that the multipliers values are quite similar to the benchmark case, where the automatic stabilizers are always on. The results are reported in Table 24.

Table 24: Sensitivity analysis of automatic stabilizers in SELMA

Panel A: GDP multipliers

	No accommod.		1 year accommod.		2 years accommod.	
	1 year	2 years	1 year	2 years	1 year	2 years
Gov. consumption	0.97	1.07	1.48	1.63	2.14	2.45
Gov. investment	1.15	1.33	1.62	1.84	2.03	2.35
Gov. transfers	0.27	0.27	0.40	0.41	0.56	0.61
Investment tax credit	0.50	0.70	0.80	1.04	1.19	1.51
Consumption tax	0.32	0.33	0.29	0.29	0.27	0.27
Capital tax	0.03	0.03	0.05	0.05	0.06	0.07
Labor tax	0.29	0.29	0.17	0.16	0.02	-0.03
SSC	0.03	0.05	0.04	0.06	0.03	0.06

Panel B: Unemployment multipliers

Gov. consumption	-0.92	-1.01	-1.46	-1.60	-2.17	-2.47
Gov. investment	-0.95	-0.88	-1.45	-1.42	-1.89	-1.96
Gov. transfers	-0.26	-0.26	-0.39	-0.41	-0.57	-0.62
Investment tax credit	-0.44	-0.59	-0.77	-0.95	-1.18	-1.45
Consumption tax	0.08	0.06	0.12	0.10	0.14	0.12
Capital tax	-0.03	-0.03	-0.05	-0.05	-0.06	-0.07
Labor tax	0.26	0.26	0.39	0.40	0.55	0.59
SSC	-0.02	-0.03	-0.02	-0.04	-0.02	-0.04

This table reports multipliers as defined in equations (3)–(4). For each monetary policy (no accommodation, 1 year accommodation and 2 years accommodation), the table reports two multipliers. The 1 year multiplier is the average output response over the first year of a 1% of GDP steady-state stimulus running for two years, while the 2 year multiplier is the average output response the first two years of a 1% of steady-state GDP stimulus running for two years. In all simulations, the fiscal policy rules are completely deactivated for the first two years. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace and the transfers to households responds to unemployment.

9 Conclusions

In this study, fiscal multipliers for temporary fiscal stimulus are reported. The fiscal stimulus is conducted over periods of one and two years, respectively. GDP and unemployment multipliers are calculated for the following fiscal instruments: government consumption, government investment, transfers to households, consumption tax, capital income tax, labor income tax, social security contributions, and investment tax credit. The fiscal multipliers are calculated both for when the monetary policy rule is active all the time, and for when monetary policy is accommodative, i.e., when the monetary policy rule is shut off during the fiscal stimulus period. The multipliers are then validated in several ways. First, the importance of the Taylor rule specification for the resulting fiscal multipliers is analyzed, and then the fiscal multipliers in SELMA are compared with the multipliers in other structural models and to empirical studies.

The comparison to other studies shows that the fiscal multipliers in SELMA are generally in line with the fiscal literature, both in comparison with the multipliers in other structural models and in comparison with the results in the empirical literature. In the case of no monetary policy accommodation, when the Taylor rule is active throughout the whole fiscal stimulus period, the multipliers are largely in line with other structural models, but have slightly higher multipliers for government consumption and investment. The difference can be attributed to the assumptions of complementarity of public and private consumption in the utility function and complementarity of public and private capital in the production function. The increase in the multipliers that these assumptions lead to does however mean that the resulting multipliers are more in line with the empirical literature. Just as in SELMA, the empirical literature finds government consumption and investment multipliers that are close to one or slightly higher. Furthermore, the multipliers for the tax instruments are in line with the literature.

It is also shown that for 2 years of fiscal stimulus and 2 years of monetary policy accommodation, which is the main experiment that is conducted in this paper to measure fiscal multipliers due to purposes of good comparison of SELMA multipliers with other structural models, the multipliers for government consumption and investment increase significantly. The large increase in the multipliers stems from the first-difference parameter on unemployment in the Taylor rule, together with the fact that the fiscal policy stimulus and the monetary policy accommodation both starts and ends in the same period. As the fiscal stimulus ends, there is a sharp increase in unemployment, leading monetary policy to become expansionary at the end of the fiscal stimulus in the case of monetary policy accommodation. The end-of-stimulus monetary policy response boosts private

sector demand during the stimulus, increasing output and decreasing unemployment. The additional monetary policy accommodation due to end-of-stimulus sharp drop in resource utilization after the fiscal stimulus is found to be unrealistic, leading to fiscal multipliers that are unreasonably high. To remedy this, it is suggested that 9 quarters of monetary policy accommodation is used instead, which remedies most of the unrealistic interest rate response, which in turn leads to multipliers that are more reasonable. The result from adding an extra quarter of monetary policy accommodation can also be generalized to 5 quarters monetary policy accommodation in the one year fiscal stimulus case.

In addition, fiscal multipliers when the interest rate is bound by its effective lower bound are calculated. In the exercise, it is found that the fiscal multipliers are lower than in the monetary policy accommodation case. One important reason is that, compared to the monetary policy accommodation case, where the central bank commits to not change the policy rate during the stimulus period, the interest rate can be increased as the fiscal stimulus is implemented, leading to smaller multipliers.

Bibliography

Auerbach, A. J. and Y. Gorodnichenko (2012a, June). Fiscal Multipliers in Recession and Expansion. In *Fiscal Policy after the Financial Crisis*, NBER Chapters, pp. 63–98. National Bureau of Economic Research, Inc.

Auerbach, A. J. and Y. Gorodnichenko (2012b, May). Measuring the output responses to fiscal policy. *American Economic Journal: Economic Policy 4*(2), 1–27.

Aursland, T. A., I. Frankovic, B. Kanik, and M. Saxegaard (2020). State-dependent fiscal multipliers in nora - a dsge model for fiscal policy analysis in norway. *Economic Modelling 93*, 321–353.

Barro, R. J. and C. J. Redlick (2011). Macroeconomic effects from government purchases and taxes. *The Quarterly Journal of Economics 126*, 51–102.

Brückner, M. and E. Pappa (2012). Fiscal expansions, unemployment, and labor force participation: theory and evidence. *International Economic Review 53*(4), 1205–1228.

Caldara, D. and C. Kamps (2017). The Analytics of SVARs: A Unified Framework to Measure Fiscal Multipliers. *Review of Economic Studies 84*(3), 1015–1040.

Chun-Hung, K. and M. Hiroaki (2019, June). Fiscal stimulus and unemployment dynamics. *The B.E. Journal of Macroeconomics 19*(2), 1–19.

Coenen, G., C. J. Erceg, C. Freedman, D. Furceri, M. Kumhof, R. Lalonde, D. Laxton, J. Lindé, A. Mourougane, D. Muir, S. Mursula, C. de Resende, J. Roberts, W. Roeger, and S. Snudden (2012, January). Effects of Fiscal Stimulus in Structural Models. *American Economic Journal: Macroeconomics 4*(1), 22–68.

Coenen, G., R. Straub, and M. Trabandt (2013). Gauging the effects of fiscal stimulus packages in the euro area. *Journal of Economic Dynamics and Control 37*(2), 367–386.

Corsetti, G., A. Meier, and G. J. Müller (2012). What determines government spending multipliers? *Economic Policy 27*, 521–565.

Dong, W., G. Dunbar, C. Friedrich, D. Matveev, R. Priftis, and L. Shao (2021, March). Complementarities Between Fiscal Policy and Monetary Policy—Literature Review. Discussion Papers 2021-4, Bank of Canada.

ECB (2010, July). The Effectiveness of Euro Area Fiscal Policies. Monthly bulletin.

Fazzari, S. M., M. James, and P. Irina (2015, June). State-dependent effects of fiscal policy. *Studies in Nonlinear Dynamics & Econometrics 19*(3), 285–315.

Furceri, D. and A. Mourougane (2010, May). The effecs of fiscal policy on output: A DSGE analysis. OECD Economics Department Working Paper 770.

Gechert, S. and A. Rannenberg (2018). Which fiscal multipliers are regime-dependent? a meta-regression analysis. *Journal of Economic Surveys 32*(4), 1160–1182.

Hjelm, G. and P. Stockhammar (2016). Short run effects of fiscal policy on GDP and employment: Swedish evidence. NIER Working Paper 147.

Holden, S. and V. Sparrman (2018). Do government purchases affect unemployment? *Scandinavian Journal of Economics 120*(1), 124–158.

Ilzetzki, E., E. G. Mendoza, and C. A. Végh (2013). How big (small?) are fiscal multipliers? *Journal of Monetary Economics 60*, 239–254.

IMF (2010). *Chapter 3 Will It Hurt? Macroeconomic Effects of Fiscal Consolidation*, pp. 93–124. USA: International Monetary Fund.

Kilponen, J., M. Pisani, S. Schmidt, V. Corbo, T. Hledik, J. Hollmayr, S. Hurtado, P. Júlio, D. Kulikov, M. Lemoine, M. Lozej, H. Lundvall, and J. R. Maria (2015, March). Comparing fiscal multipliers across models and countries in Europe. Working Paper Research 278, European Central Bank.

Konjunkturinstitutet (2020). SELMA: Technical documentation. memo DNR 2020-511.

Monacelli, T., R. Perotti, and A. Trigari (2010, July). Unemployment fiscal multipliers. *Journal of Monetary Economics 57*(5), 531–553.

Mountford, A. and H. Uhlig (2009). What are the effects of fiscal policy shocks? *Journal of Applied Econometrics 24*, 960–992.

Owyang, M. T., V. A. Ramey, and S. Zubairy (2013). Are government spending multipliers greater during periods of slack? evidence from twentieth-century historical data. *The American Economic Review 103*(3), 129–134.

Ramey, V. (2012). Government spending and private activity. NBER Working Paper 17787.

Ramey, V. (2019). Ten years after the financial crisis: What have we learned from the renaissance in fiscal research. NBER Working Paper 25531.

Ramey, V. A. and S. Zubairy (2018). Government Spending Multipliers in Good Times and in Bad: Evidence from US Historical Data. *Journal of Political Economy 126*(2), 850–901.

Ratto, M., W. Roeger, and J. in't Veld (2009). Quest III: An estimated open-economy DSGE model of the euro area with fiscal and monetary policy. *Economic Modelling 26*, 222–233.

Stähler, N. and C. Thomas (2012). FiMod — a DSGE model for fiscal policy simulations. *Economic Modelling 29*, 239–261.

Uhlig, H. (2010, May). Some Fiscal Calculus. *American Economic Review 100*(2), 30–34.

van der Wielen, W. (2020). The macroeconomic effects of tax changes: Evidence using real-time data for the european union. *Economic Modelling 90*, 302–321.

Woo, J., E. Bova, T. Kinda, and Y. S. Zhang (2017, June). Distributional Consequences of Fiscal Adjustments: What Do the Data Say? *IMF Economic Review 65*(2), 273–307.

A Appendices

A1 Public expenditures and fiscal rules

A1.1 CST 2013

The government purchases the public consumption good, the public investment good and makes transfer payments (to both households). The public consumption good enters the household's utility function. Aggregate consumption consists of private and public consumption. Public investments increase the public capital stock. The aggregate capital stock consists of private capital services and the public capital stock.

Fiscal instruments follow the prescriptions of a simple feedback rule with a uniform specification. Specifically, instruments react to their own lagged values, to real government debt (B_t/P_t) and to output. For example, for government consumption the log-linear specification of the rule is given by

$$\hat{g}_t = \rho_G \hat{g}_{t-1} + \theta_{G,B}\hat{b}_t + \theta_{G,Y}\hat{y}_t + (1-\psi_G)\hat{\eta}_t^G + \psi_G \hat{\eta}_{t-1}^G,$$

where $\hat{}$ denotes log-deviations from the values implied by the model's balanced growth path, or steady state. η is an unanticipated shock to government consumption, representing a discretionary fiscal impulse. On the revenue side, for example, the rule for the labor tax has the following specification

$$\breve{\tau}_t^N = \rho_N \breve{\tau}_{t-1}^N + \theta_{N,B}\hat{b}_t + \theta_{N,Y}\hat{y}_t + (1-\psi_N)\hat{\eta}_t^N + \psi_N \hat{\eta}_{t-1}^N,$$

where $\breve{}$ denotes percentage-point deviations from the steady-state tax rate.

A1.2 QUEST

The government purchases a consumption good and an investment good. There are transfers (only to the liquidity constrained household) that provide income for unemployed and pensioners. Those act as automatic stabilizers. The generosity of the social benefit system is characterized by three parameters: the fraction of the non-employed which receive unemployment benefits and the level of payments for unemployed and pensioners. In other words, the number of non-participants, POP^{NPART}, is treated as a government decision variable. It is assumed that unemployment benefits and pensions are indexed to wages with replacement rates b^U and b^R respectively and the following linear transfer rule is

formulated

$$TR_t = b^U W_t \left(POP_t^W - POP_t^{NPART} - L_t\right) + b^R W_t POP_t^P + u_t^{TR}.$$

Government consumption (c^G) and government investment (i^G) can temporarily deviate from their long run targets, cgy and igy, (expressed as ratios to GDP in nominal terms) in response to fluctuations of the output gap. Due to information and implementation lags the response may occur with some delay. This feature is captured by a distributed lag of the output gap in the reaction function

$$\Delta c_t^G = \left(1 - \tau_{\text{Lag}}^{CG}\right) \overline{\Delta c^G} + \tau_{\text{Lag}}^{CG} \Delta c_{t-1}^G + \tau_{\text{Adj}}^{CG} \left(cgy_{t-1} - \overline{cgy}\right) + \sum_j \tau_j^{CG} ygap_{t-j} + u_t^{CG}$$

$$\Delta i_t^G = \left(1 - \tau_{\text{Lag}}^{IG}\right) \overline{\Delta i^G} + \tau_{\text{Lag}}^{IG} \Delta i_{t-1}^G + \tau_{\text{Adj}}^{IG} \left(igy_{t-1} - \overline{igy}\right) + \sum_j \tau_j^{IG} ygap_{t-j} + u_t^{IG}$$

There is a lump-sum tax (paid by both households) used for controlling the debt to GDP ratio. The consumption and capital income taxes follow a linear scheme, while the labor income tax is progressive. The progressivity is modelled in the following way

$$t_t^w = \tau_0^w Y_t^{\tau_1^w} U_t^{TW} \quad \Leftrightarrow \quad t_t^w = \tau_0^w + \tau_0^w \tau_1^w ygap_t,$$

where the second expression stems from a first-order Taylor approximation around a zero output gap. τ_0^w measures the average tax rate, and τ_1^w the degree of progressivity.

A1.3 FiMod

The government has five instruments on the expenditures side: public purchases, public investment, public sector wages, public employment, and lump-sum subsidies (only to the Ricardian household). Unemployment benefits are paid to both households and the benefit is a calibrated parameter.

Households derive utility from government services that are produced by public employees. The model neglects the possibility that government services indirectly foster private-sector productivity. Public investment increases the public capital stock which is assumed to be productivity enhancing. It is used in the production of intermediate goods with the following production function

$$y_t(j) = \varepsilon^a \cdot \left(k_{t-1}^g\right)^\eta \cdot \left[\tilde{k}_t(j)\right]^\alpha \cdot \left[l_t(j)\right]^{1-\alpha},$$

where k^g_{t-1} is the public capital stock available in period t.

The worker can be in one of three states: unemployed, employed in the public sector, or employed in the private sector. Unemployment is the residual state in the sense that a worker whose employment relationship ends flows back into unemployment. Unemployed workers look for job opportunities. They find them either in the public sector or in the private sector. Workers do not direct search to either the public or the private sector and are, thus, matched randomly. Wages in both sectors can differ. Wages in the private sector are the outcome of a negotiation while the government sets the wages in the public sector (the wage being one of the five expenditure instruments).

All instruments follow a rule that depends on the long-run target of the instrument, the ratio of public debt over GDP, the initial steady-state long-run target of the debt ratio and a shock. For tax rate the rule is

$$X_t = \bar{X} + \rho_X \left(X_{t-1} - \bar{X}\right) + (1-\rho_X)\varphi_X e^{aux}_X \left(\frac{b_{t-1}}{Y^{tot}_{t-1}} p^{1-\omega-\psi}_{B,t-1} - \omega^b\right) + \varepsilon^X_t.$$

For other instruments the rule is

$$\frac{X_t}{\bar{X}} = \left(\frac{X_{t-1}}{\bar{X}}\right)^{\rho_X} \left(\frac{b_{t-1}}{\omega_b Y^{tot}_{t-1}} p^{1-\omega-\psi}_{B,t-1}\right)^{(1-\rho_x)\varphi_X} \cdot \exp\left(\varepsilon^X_t\right),$$

where where $\bar{X}$ denotes the corresponding long-run target, ρ_X the smoothing parameter, $b_{t-1}p^{1-\omega-\psi}_{B,t-1}/Y^{tot}_{t-1}$ is the ratio of public debt over GDP in period $t-1$, ω^b is the initial steady-state long-run target for the debt ratio, φ_X measures the responsiveness of the corresponding instrument to deviations in the debt ratio from its long-run target, and ε^X_t is an iid shock. e^{aux}_X aux is an exogenous auxiliary variable for simulation purposes.

A1.4 OECD Fiscal

One of the key features of the model is that the interest rate on government debt is explicitly modelled. The spread between the interest rate on government debt and the policy rate is assumed to be a function of future expected deficits (this quarter's expectation on next quarter's deficit)

$$ig_t - i_t = \theta E_t d_{t+1}.$$

This term can be interpreted as a risk premium on government bonds reflecting market expectations on long-term public debt sustainability.

Government spending is given by the sum of discretionary government consumption, unemployment benefits, government investments and transfers. Government consumption does not affect the household's utility.

Automatic stabilizers for both expenditure and revenue are explicitly modelled. On the spending side, unemployment benefits depend on the cyclical position of the economy as measured by the output gap

$$ub_t = \varepsilon \log(GAP_t).$$

Benefits are paid to the liquidity-constrained household when the household does not work.

A lump-sum stabilization tax paid by the Ricardian household is included to avoid explosive debt levels

$$T_t^b = \tau_1 \left(\frac{B_t}{Y_t} - b^* \right).$$

A1.5 SELMA

The government uses the tax revenue and issues bonds to finance expenditures. The expenditures consist of government consumption, government investments, lump-sum transfers and an investment tax credit as well as interest payments on government debt.

Fiscal policy can be conducted using the following different instruments:

$$x_t \in \left\{ g_t,\, I_t^G,\, tr_t^{agg},\, T_t,\, \tau_t^I,\, \tau_t^C,\, \tau_t^W,\, \tau_t^K,\, \tau_t^{TR},\, \tau_t^{SSC} \right\}.$$

g_t and I_t^G are the government consumption and government investment per capita, and, $\tau_t^I, \tau_t^C, \tau_t^W, \tau_t^K, \tau_t^{TR}, \tau_t^{SSC}$ are the different tax rates in the economy. T_t is the lump-sum tax in units of domestically produced intermediate goods. Likewise, tr_t^{agg} is the aggregate transfers in units of domestically produced intermediate goods. The equations for each of the instruments can be divided into two different parts: an AR(1) process and a fiscal feedback rule, so that $x_t = x_t^{AR} + x_t^{Rule}$. The AR(1) part, which exists for all instruments except for the lump-sum tax, can be described by

$$x_t^{AR} = (1 - \rho_x)x + \rho_x x_{t-1} + \varepsilon_t^x.$$

The fiscal feedback rule consists of three elements: the deviation of the government debt level as percent of GDP from its target $b_{\bar{y},t} - b_{\bar{y},t}^{Target}$, the deviation of the structural government surplus as percent of steady state GDP from its target $Stsurp_{\bar{y}.t} - Stsurp_{\bar{y},t}^{Target}$, and a log deviation of unemployment $\breve{un}_t$ or output $\hat{y}_t$ from its steady state levels . The surplus target is defined on the structural surplus, i.e., the cyclically adjusted budget balance, net of the influence of economic cycle on the public finances.

A fiscal rule equation has been defined for nine of the instruments. The investment sub-

sidy has not been assigned a rule. For eight of them, $x_t^{Rule} \in \{g_t,\, I_t^G,\, T_t,\, \tau_t^C,\, \tau_t^W,\, \tau_t^K,\, \tau_t^{TR},\, \tau_t^{SSC}\}$, the rule is given by

$$x_t^{Rule} = \mathcal{F}_{x,b}\left(b_{\bar{y},t} - b_{\bar{y},t}^{Target}\right) + \mathcal{F}_{x,surp}\left(Stsurp_{\bar{y},t} - Stsurp_{\bar{y},t}^{Target}\right) + \mathcal{F}_{x,y}\hat{y}_t.$$

The first two terms on the right-hand-side of the equations are supposed to capture the Swedish fiscal framework, which includes a surplus target and a debt anchor. This kind of feedback for the debt level can be found also in, e.g., CST 2013. The third and last part of the equation is supposed to capture automatic stabilizers.

The ninth rule is the transfer rule, in which transfers are normalized by steady-state GDP, $\overline{y}$

$$tr_t^{agg,Rule} = \bar{y}\mathcal{F}_{tr,b}\left(b_{\bar{y},t} - b_{\bar{y},t}^{Target}\right) + \bar{y}\mathcal{F}_{tr,surp}\left(Stsurp_{\bar{y},t} - Stsurp_{\bar{y},t}^{Target}\right) + \bar{y}\mathcal{F}_{tr,un}\breve{un}_t.$$

Table A1 shows the current values of the parameters used in the fiscal rules.

Table A1: Fiscal Rule Parameterization

Parameter	Value
$\mathcal{F}_{x,b}$	0
$\mathcal{F}_{x,surp}$	0
$\mathcal{F}_{x,un}$	0
$\mathcal{F}_{tr,b}$	-0.01
$\mathcal{F}_{tr,surp}$	0
$\mathcal{F}_{tr,un}$	0.106

The current calibration implies

$$x_t^{Rule} = 0$$

and

$$tr_t^{agg,Rule} = -0.01\bar{y}\left(b_{\bar{y},t} - b_{\bar{y},t}^{Target}\right) + 0.106\bar{y}\breve{un}_t.$$

There is a mapping between the debt-target and the surplus target. This mapping needs to hold in the steady state, since a certain level of debt in percent of GDP in the long run implies a unique surplus in percent of GDP. The mapping between the debt target and the surplus target is defined as

$$Stsurp_{\bar{y},t}^{Target} = \left(\frac{1}{\mu_{z^+}\Pi} - 1\right) b_{\bar{y},t}^{Target}.$$

	No accommod.		1 year accommod.		2 years accommod.	
	2 year	4 years	2 year	4 years	2 year	4 years
Gov. consumption	1.05	0.99	1.58	1.91	2.33	3.33
Gov. investment	1.31	2.07	1.79	2.91	2.26	3.79
Gov. transfers	0.27	0.23	0.40	0.45	0.58	0.79
Investment tax credit	0.69	1.18	1.01	1.75	1.44	2.55
Consumption tax	0.33	0.30	0.30	0.24	0.28	0.21
Capital tax	0.03	0.04	0.05	0.07	0.07	0.10
Labor tax	0.30	0.31	0.17	0.09	0.00	-0.22
SSC	0.05	0.09	0.06	0.10	0.05	0.10

Table A2: 2-year and 4-year multipliers

A2 Additional tables: 4-year multipliers and 1 year fiscal stimulus with 5Q MP accommodation

This section reports some additional tables: 4-year GDP multipliers together with the 2-year multipliers and 1 year stimulus multipliers with five quarters of monetary policy accommodation.

A3 Impulse response functions

In this section, impulse response functions for 2-year fiscal stimulus are reported for shocks to various fiscal instruments.

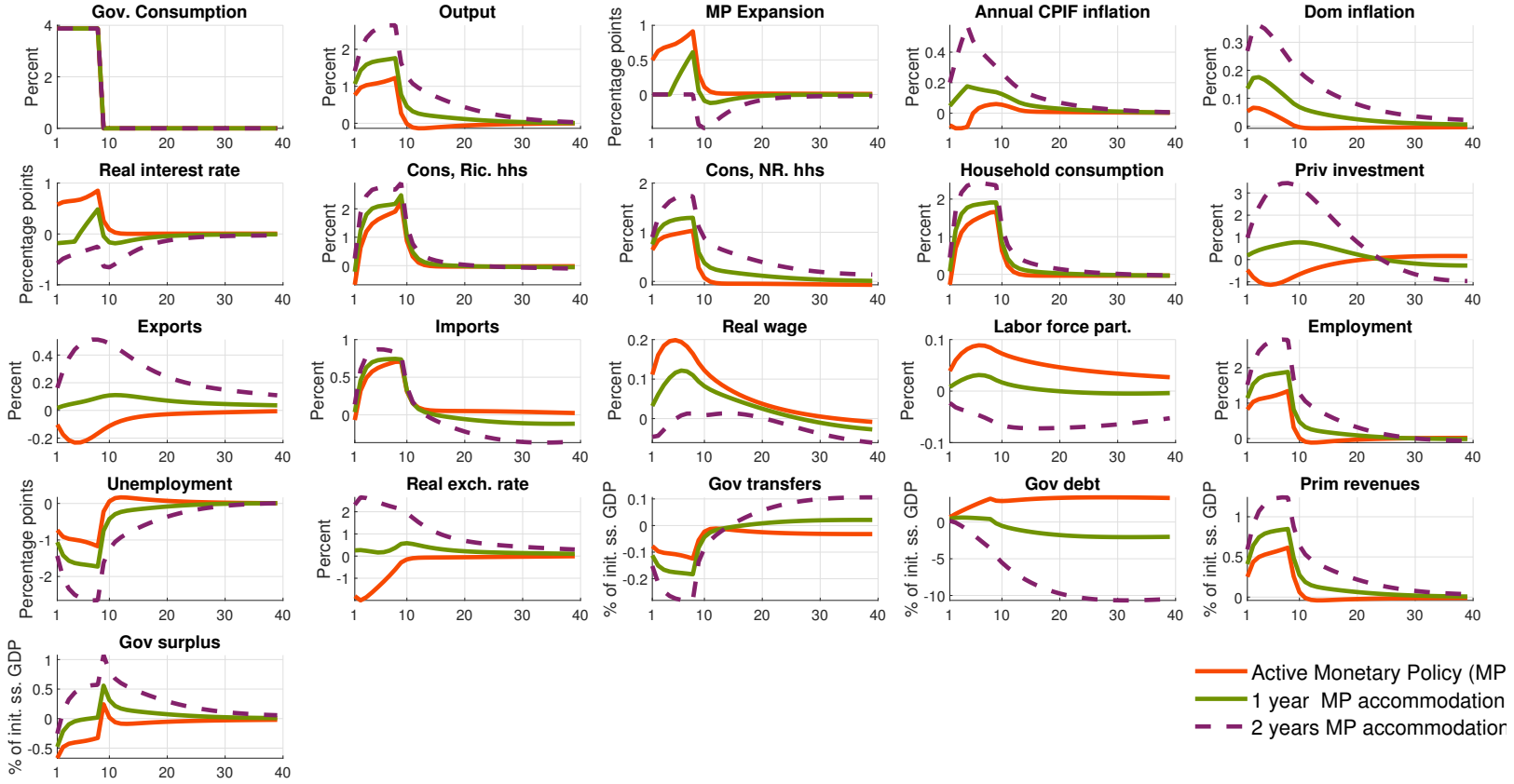
Panel A: GDP multipliers

	No accommod.	1 year accommod.	5Q accommodation
Gov. consumption	1.16	1.81	1.52
Gov. investment	1.15	1.60	1.20
Gov. transfers	0.31	0.47	0.35
Investment tax credit	0.32	0.49	0.50
Consumption tax	0.32	0.29	0.34
Capital tax	0.01	0.01	0.01
Labor tax	0.25	0.09	0.21
SSC	0.02	0.02	0.02

Panel B: Unemployment multipliers

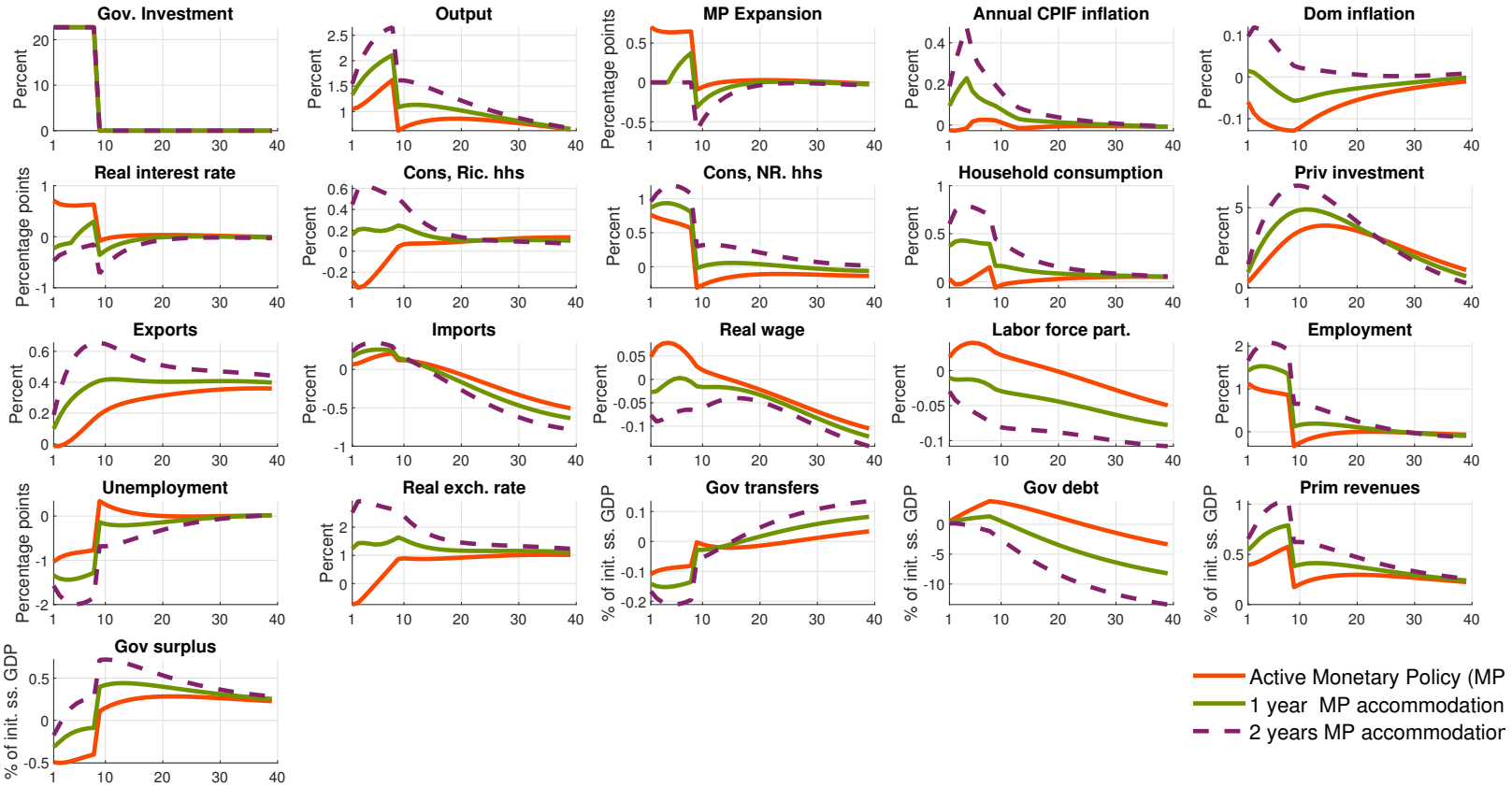
Gov. consumption	-1.14	-1.83	-1.53
Gov. investment	-0.96	-1.45	-1.02
Gov. transfers	-0.31	-0.48	-0.35
Investment tax credit	-0.30	-0.48	-0.49
Consumption tax	0.09	0.12	0.06
Capital tax	-0.01	-0.01	-0.01
Labor tax	0.31	0.48	0.35
SSC	-0.01	-0.02	-0.01

Table A3: 1 year stimulus multipliers with 5Q MP accommodation



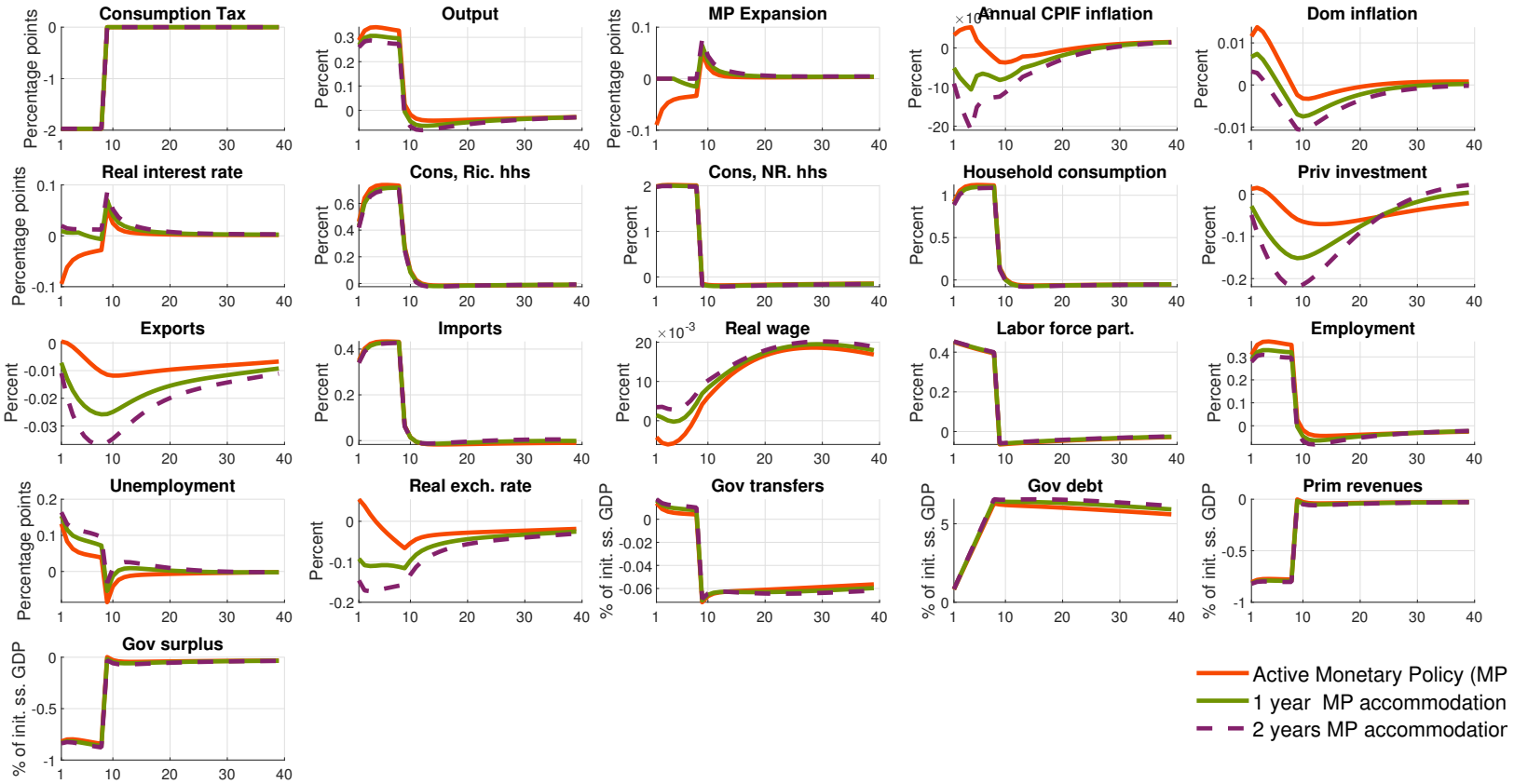
Note: The monetary policy rate in Home and Foreign, all inflation rates and the government bond interest rate are all presented in annualized q/q values

Figure A1: Government Consumption



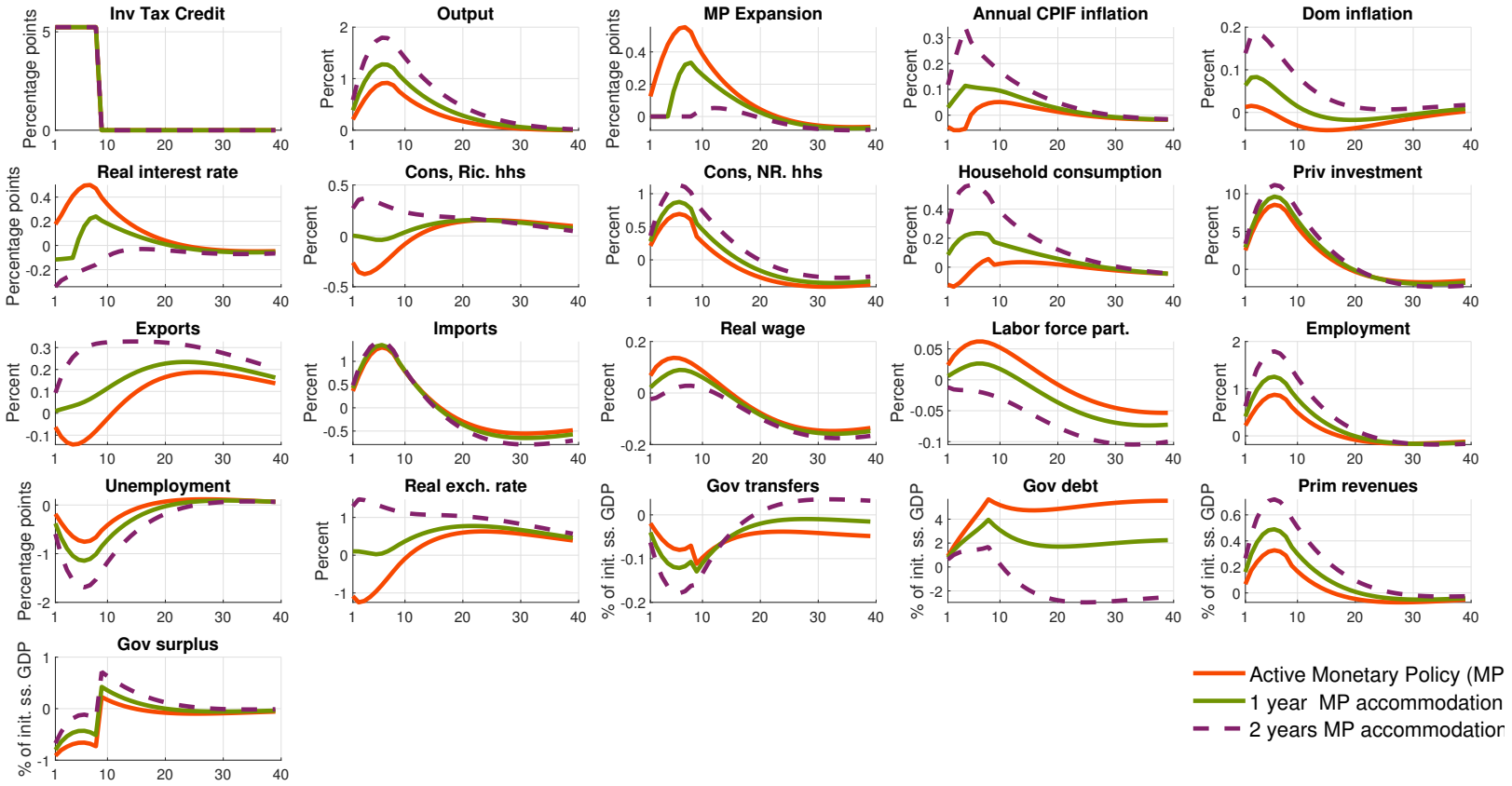
Note: The monetary policy rate in Home and Foreign, all inflation rates and the government bond interest rate are all presented in annualized q/q values

Figure A2: Government Investment



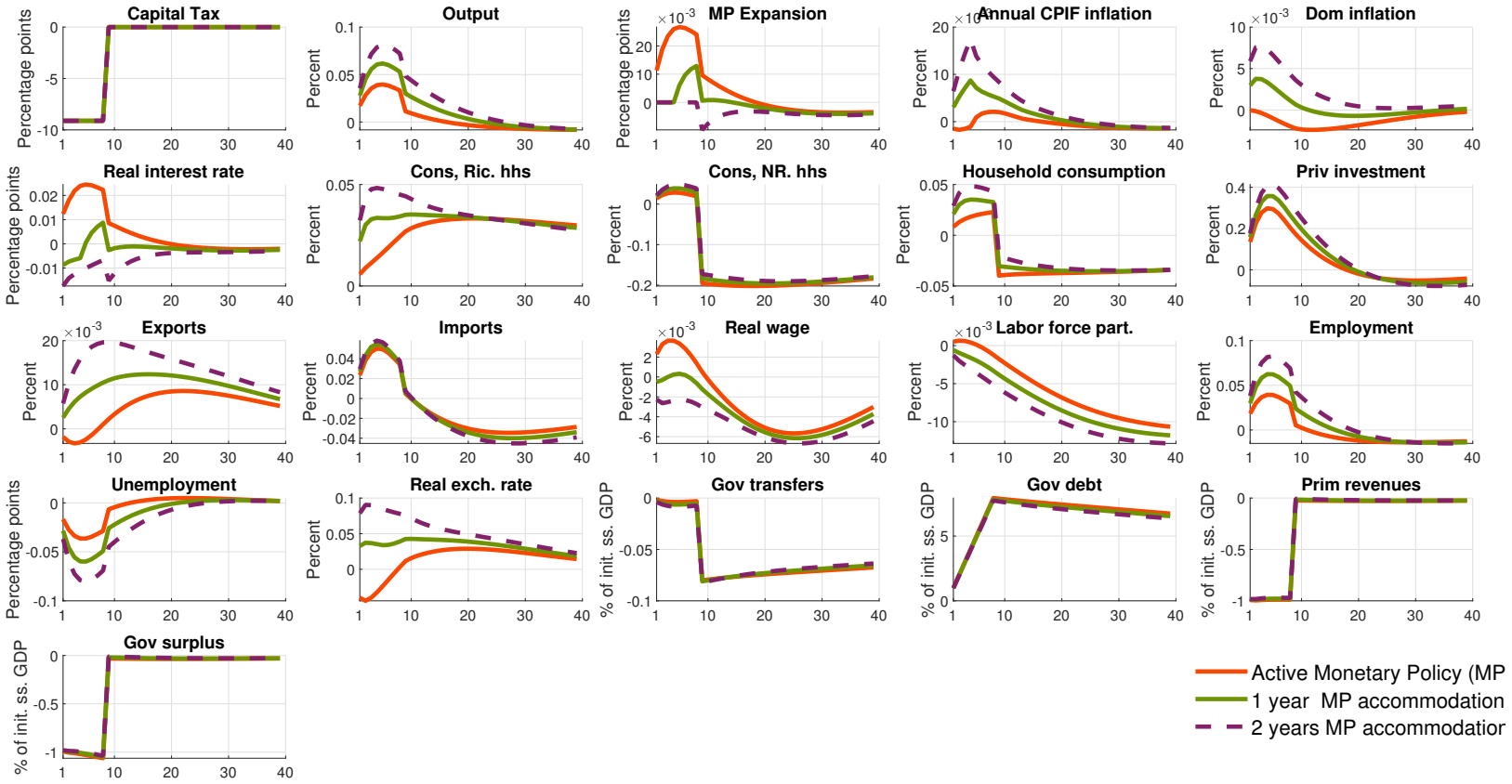
Note: The monetary policy rate in Home and Foreign, all inflation rates and the government bond interest rate are all presented in annualized q/q values

Figure A3: Consumption Tax



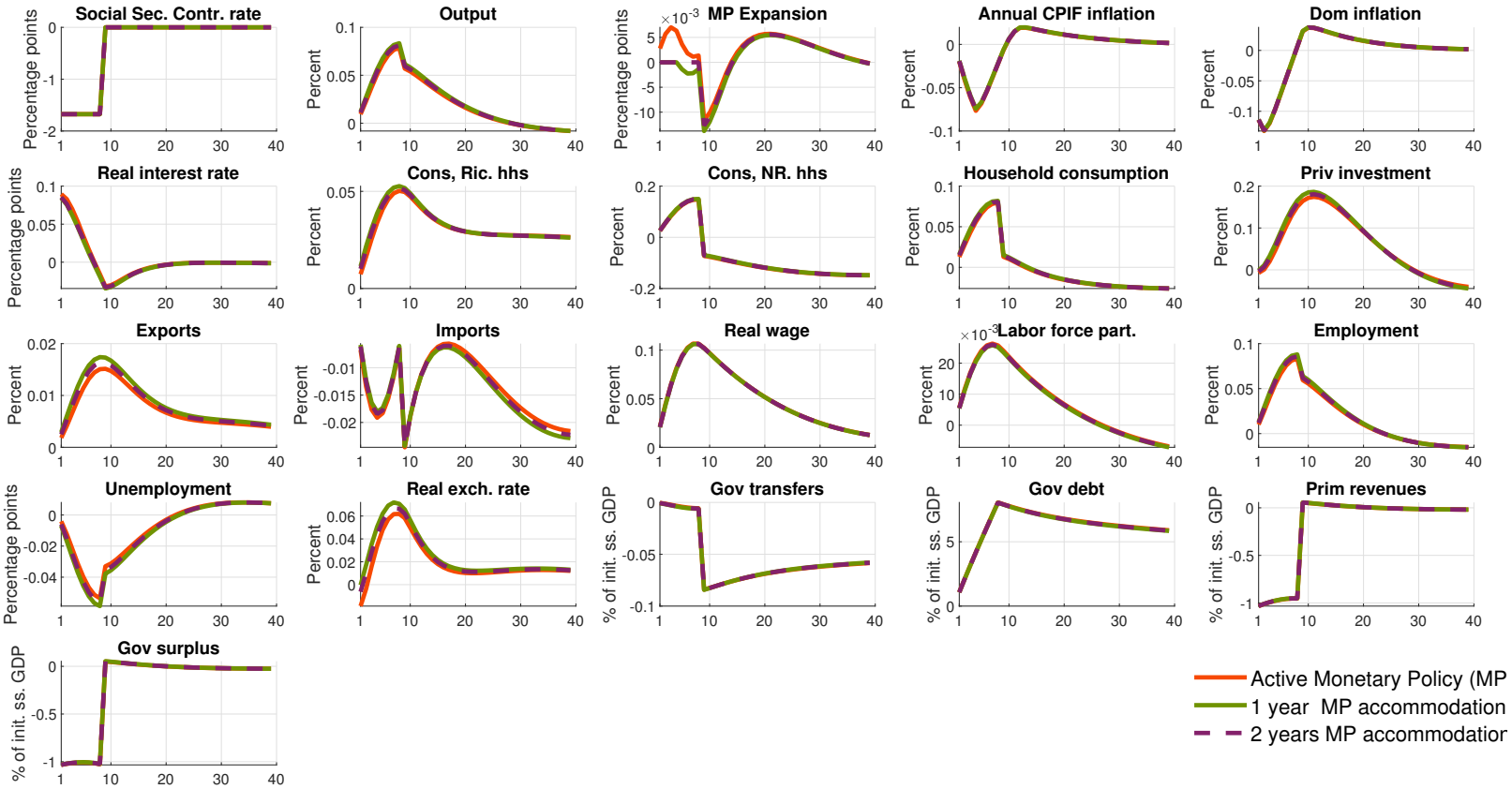
Note: The monetary policy rate in Home and Foreign, all inflation rates and the government bond interest rate are all presented in annualized q/q values

Figure A4: Investment Tax Credit



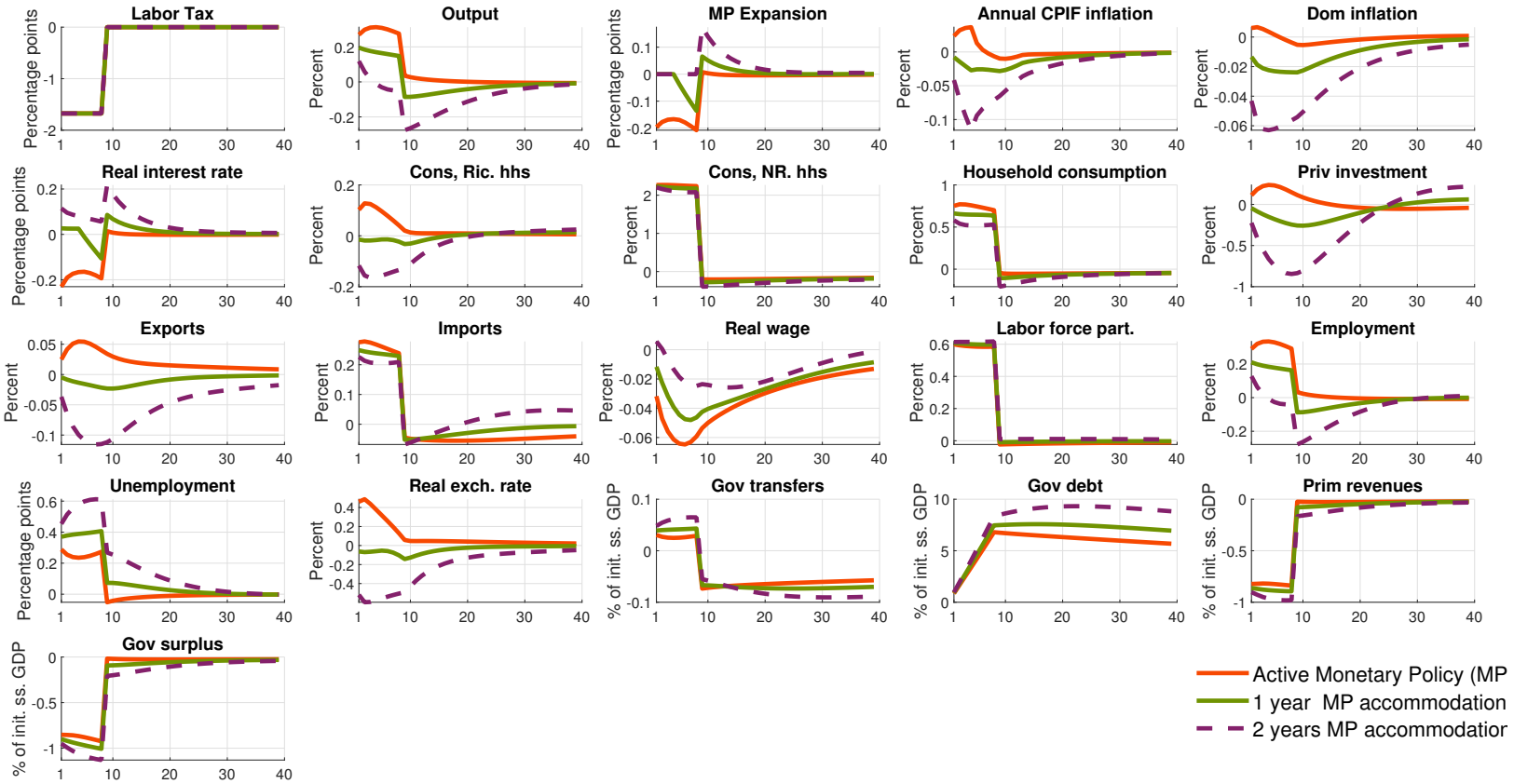
Note: The monetary policy rate in Home and Foreign, all inflation rates and the government bond interest rate are all presented in annualized q/q values

Figure A5: Capital Tax



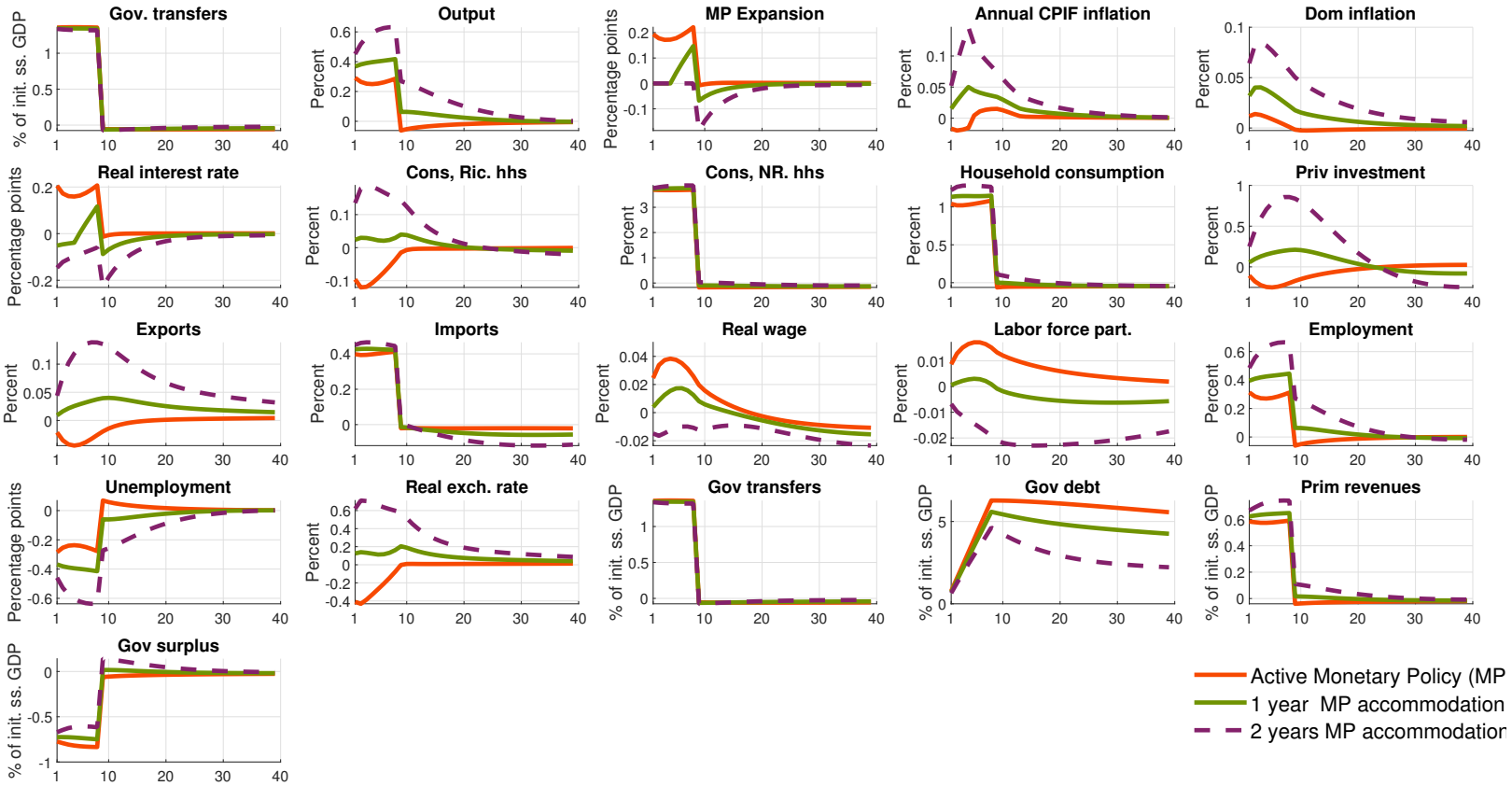
Note: The monetary policy rate in Home and Foreign, all inflation rates and the government bond interest rate are all presented in annualized q/q values

Figure A6: Social Security Contributions



Note: The monetary policy rate in Home and Foreign, all inflation rates and the government bond interest rate are all presented in annualized q/q values

Figure A7: Labor Income Tax



Note: The monetary policy rate in Home and Foreign, all inflation rates and the government bond interest rate are all presented in annualized q/q values

Figure A8: Government Transfers

Table A4: Sensitivity analysis of $\chi_N = 1$

Panel A: GDP multipliers

	No accommod.		1 year accommod.		2 years accommod.	
	1 year	2 years	1 year	2 years	1 year	2 years
Gov. consumption	1.00	1.09	1.42	1.56	2.10	2.41
Gov. investment	1.15	1.32	1.56	1.77	2.00	2.31
Gov. transfers	0.27	0.27	0.38	0.39	0.55	0.60
Investment tax credit	0.52	0.71	0.76	0.99	1.13	1.44
Consumption tax	0.24	0.26	0.34	0.37	0.51	0.57
Capital tax	0.03	0.03	0.04	0.05	0.06	0.07
Labor tax	0.29	0.29	0.18	0.17	0.03	-0.02
SSC	0.02	0.04	0.03	0.05	0.03	0.05

Panel B: Unemployment multipliers

Gov. consumption	-0.68	-0.84	-1.43	-1.56	-2.59	-2.81
Gov. investment	-0.77	-0.76	-1.50	-1.46	-2.25	-2.26
Gov. transfers	-0.20	-0.22	-0.40	-0.40	-0.68	-0.71
Investment tax credit	-0.28	-0.46	-0.71	-0.88	-1.33	-1.55
Consumption tax	-0.17	-0.20	-0.35	-0.37	-0.63	-0.67
Capital tax	-0.03	-0.03	-0.06	-0.06	-0.09	-0.09
Labor tax	0.20	0.22	0.39	0.40	0.65	0.68
SSC	-0.02	-0.04	-0.03	-0.05	-0.04	-0.06

This table reports multipliers as defined in equations (3)–(4). For each monetary policy stance (no accommodation, 1 year accommodation and 2 years accommodation), the table reports two multipliers. The 1 year multiplier is the average output response over the first year of a 1% of GDP steady-state stimulus running for two years, while the 2 year multiplier is the average output response over the first two years of a 1% of steady-state GDP stimulus running for two years. In all simulations, the fiscal stimulus is debt financed. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

Table A5: Sensitivity analysis of More Non-Rics in SELMA

Panel A: GDP multipliers

	No accommod.		1 year accommod.		2 years accommod.	
	1 year	2 years	1 year	2 years	1 year	2 years
Gov. consumption	1.03	1.05	1.43	1.51	1.91	2.14
Gov. investment	1.31	1.46	1.75	1.96	2.13	2.45
Gov. transfers	0.49	0.48	0.67	0.69	0.89	0.98
Investment tax credit	0.60	0.80	0.89	1.15	1.25	1.61
Consumption tax	0.53	0.53	0.58	0.58	0.66	0.68
Capital tax	0.04	0.04	0.05	0.06	0.07	0.08
Labor tax	0.57	0.57	0.57	0.57	0.58	0.58
SSC	0.04	0.06	0.04	0.07	0.05	0.07

Panel B: Unemployment multipliers

Gov. consumption	-0.98	-1.00	-1.42	-1.49	-1.94	-2.15
Gov. investment	-1.10	-1.01	-1.58	-1.55	-1.99	-2.07
Gov. transfers	-0.47	-0.46	-0.66	-0.69	-0.90	-0.99
Investment tax credit	-0.53	-0.69	-0.86	-1.06	-1.24	-1.54
Consumption tax	-0.12	-0.13	-0.17	-0.19	-0.25	-0.29
Capital tax	-0.04	-0.04	-0.06	-0.06	-0.07	-0.08
Labor tax	-0.00	-0.00	-0.01	-0.01	-0.02	-0.02
SSC	-0.02	-0.04	-0.03	-0.05	-0.04	-0.06

This table reports multipliers as defined in equations (3)–(4). For each monetary policy stance (no accommodation, 1 year accommodation and 2 years accommodation), the table reports two multipliers. The 1 year multiplier is the average output response over the first year of a 1% of GDP steady-state stimulus running for two years, while the 2 year multiplier is the average output response over the first two years of a 1% of steady-state GDP stimulus running for two years. In all simulations, the fiscal stimulus is debt financed. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

Table A6: Sensitivity analysis of Less Non-Rics in SELMA

Panel A: GDP multipliers

	No accommod.		1 year accommod.		2 years accommod.	
	1 year	2 years	1 year	2 years	1 year	2 years
Gov. consumption	0.92	1.04	1.42	1.58	2.07	2.38
Gov. investment	1.08	1.27	1.53	1.74	1.91	2.21
Gov. transfers	0.14	0.14	0.21	0.21	0.29	0.32
Investment tax credit	0.46	0.65	0.75	0.97	1.10	1.39
Consumption tax	0.27	0.27	0.21	0.21	0.16	0.15
Capital tax	0.03	0.03	0.04	0.05	0.05	0.06
Labor tax	0.21	0.21	0.04	0.03	-0.15	-0.21
SSC	0.03	0.05	0.03	0.05	0.02	0.04

Panel B: Unemployment multipliers

Gov. consumption	-0.87	-0.98	-1.41	-1.56	-2.10	-2.40
Gov. investment	-0.88	-0.82	-1.36	-1.33	-1.77	-1.82
Gov. transfers	-0.13	-0.14	-0.21	-0.21	-0.30	-0.32
Investment tax credit	-0.40	-0.54	-0.71	-0.88	-1.09	-1.33
Consumption tax	0.14	0.12	0.20	0.18	0.25	0.25
Capital tax	-0.02	-0.03	-0.04	-0.04	-0.05	-0.06
Labor tax	0.34	0.34	0.52	0.53	0.73	0.78
SSC	-0.01	-0.03	-0.02	-0.03	-0.01	-0.02

This table reports multipliers as defined in equations (3)–(4). For each monetary policy stance (no accommodation, 1 year accommodation and 2 years accommodation), the table reports two multipliers. The 1 year multiplier is the average output response over the first year of a 1% of GDP steady-state stimulus running for two years, while the 2 year multiplier is the average output response over the first two years of a 1% of steady-state GDP stimulus running for two years. In all simulations, the fiscal stimulus is debt financed. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

Table A7: Sensitivity analysis of Less Price Stickiness in SELMA

Panel A: GDP multipliers

	No accommod.		1 year accommod.		2 years accommod.	
	1 year	2 years	1 year	2 years	1 year	2 years
Gov. consumption	0.91	0.99	1.36	1.47	1.96	2.19
Gov. investment	1.12	1.30	1.53	1.74	1.90	2.18
Gov. transfers	0.26	0.25	0.37	0.37	0.51	0.54
Investment tax credit	0.46	0.65	0.73	0.94	1.08	1.34
Consumption tax	0.31	0.32	0.28	0.28	0.27	0.27
Capital tax	0.03	0.03	0.04	0.05	0.06	0.06
Labor tax	0.29	0.29	0.18	0.17	0.05	0.01
SSC	0.13	0.18	0.15	0.21	0.13	0.18

Panel B: Unemployment multipliers

Gov. consumption	-0.88	-0.96	-1.38	-1.49	-2.04	-2.28
Gov. investment	-0.91	-0.85	-1.37	-1.34	-1.79	-1.83
Gov. transfers	-0.25	-0.25	-0.37	-0.38	-0.53	-0.57
Investment tax credit	-0.41	-0.55	-0.72	-0.87	-1.10	-1.32
Consumption tax	0.09	0.07	0.12	0.11	0.14	0.12
Capital tax	-0.03	-0.03	-0.05	-0.05	-0.06	-0.07
Labor tax	0.26	0.26	0.38	0.39	0.53	0.56
SSC	-0.08	-0.12	-0.10	-0.14	-0.08	-0.11

This table reports multipliers as defined in equations (3)–(4). For each monetary policy stance (no accommodation, 1 year accommodation and 2 years accommodation), the table reports two multipliers. The 1 year multiplier is the average output response over the first year of a 1% of GDP steady-state stimulus running for two years, while the 2 year multiplier is the average output response over the first two years of a 1% of steady-state GDP stimulus running for two years. In all simulations, the fiscal stimulus is debt financed. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

Table A8: Sensitivity analysis of Less Wage Stickiness in SELMA

Panel A: GDP multipliers

	No accommod.		1 year accommod.		2 years accommod.	
	1 year	2 years	1 year	2 years	1 year	2 years
Gov. consumption	1.00	1.10	1.56	1.72	2.48	2.83
Gov. investment	1.16	1.34	1.69	1.91	2.27	2.62
Gov. transfers	0.27	0.28	0.41	0.43	0.64	0.70
Investment tax credit	0.53	0.73	0.88	1.12	1.39	1.74
Consumption tax	0.32	0.33	0.29	0.29	0.27	0.26
Capital tax	0.03	0.03	0.05	0.06	0.07	0.08
Labor tax	0.29	0.28	0.15	0.14	-0.06	-0.11
SSC	0.03	0.05	0.04	0.06	0.04	0.06

Panel B: Unemployment multipliers

Gov. consumption	-0.88	-0.96	-1.43	-1.52	-2.28	-2.50
Gov. investment	-0.91	-0.83	-1.41	-1.35	-1.96	-1.98
Gov. transfers	-0.25	-0.25	-0.38	-0.39	-0.59	-0.62
Investment tax credit	-0.42	-0.55	-0.76	-0.90	-1.24	-1.45
Consumption tax	0.08	0.06	0.11	0.09	0.14	0.12
Capital tax	-0.03	-0.03	-0.05	-0.05	-0.07	-0.07
Labor tax	0.25	0.25	0.38	0.38	0.57	0.60
SSC	-0.02	-0.03	-0.02	-0.04	-0.02	-0.03

This table reports multipliers as defined in equations (3)–(4). For each monetary policy stance (no accommodation, 1 year accommodation and 2 years accommodation), the table reports two multipliers. The 1 year multiplier is the average output response over the first year of a 1% of GDP steady-state stimulus running for two years, while the 2 year multiplier is the average output response over the first two years of a 1% of steady-state GDP stimulus running for two years. In all simulations, the fiscal stimulus is debt financed. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

Table A9: Sensitivity analysis of Less Wage and Price Stickiness in SELMA

Panel A: GDP multipliers

	No accommod.		1 year accommod.		2 years accommod.	
	1 year	2 years	1 year	2 years	1 year	2 years
Gov. consumption	0.93	0.99	1.41	1.48	2.27	2.43
Gov. investment	1.13	1.30	1.58	1.75	2.14	2.37
Gov. transfers	0.26	0.25	0.38	0.37	0.58	0.60
Investment tax credit	0.47	0.64	0.77	0.94	1.25	1.48
Consumption tax	0.32	0.32	0.28	0.29	0.26	0.26
Capital tax	0.03	0.03	0.05	0.05	0.07	0.07
Labor tax	0.29	0.29	0.17	0.17	-0.02	-0.04
SSC	0.13	0.18	0.15	0.20	0.12	0.16

Panel B: Unemployment multipliers

Gov. consumption	-0.84	-0.90	-1.35	-1.39	-2.21	-2.34
Gov. investment	-0.88	-0.81	-1.35	-1.26	-1.91	-1.88
Gov. transfers	-0.24	-0.23	-0.36	-0.36	-0.57	-0.58
Investment tax credit	-0.39	-0.50	-0.70	-0.80	-1.19	-1.33
Consumption tax	0.09	0.07	0.12	0.10	0.14	0.12
Capital tax	-0.03	-0.03	-0.04	-0.05	-0.06	-0.07
Labor tax	0.25	0.24	0.37	0.37	0.56	0.57
SSC	-0.07	-0.11	-0.09	-0.13	-0.06	-0.09

This table reports multipliers as defined in equations (3)–(4). For each monetary policy stance (no accommodation, 1 year accommodation and 2 years accommodation), the table reports two multipliers. The 1 year multiplier is the average output response over the first year of a 1% of GDP steady-state stimulus running for two years, while the 2 year multiplier is the average output response over the first two years of a 1% of steady-state GDP stimulus running for two years. In all simulations, the fiscal stimulus is debt financed. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

Table A10: Sensitivity analysis of MP rule persistence parameter = 0 in SELMA

Panel A: GDP multipliers

	No accommod.		1 year accommod.		2 years accommod.	
	1 year	2 years	1 year	2 years	1 year	2 years
Gov. consumption	0.90	1.00	0.99	1.06	1.28	1.36
Gov. investment	1.10	1.29	1.20	1.35	1.44	1.60
Gov. transfers	0.25	0.26	0.28	0.27	0.35	0.35
Investment tax credit	0.43	0.62	0.47	0.65	0.65	0.84
Consumption tax	0.33	0.33	0.32	0.32	0.31	0.31
Capital tax	0.03	0.03	0.03	0.03	0.04	0.04
Labor tax	0.31	0.30	0.28	0.29	0.22	0.22
SSC	0.04	0.05	0.03	0.05	0.01	0.03

Panel B: Unemployment multipliers

Gov. consumption	-0.84	-0.94	-0.94	-1.00	-1.26	-1.33
Gov. investment	-0.88	-0.84	-1.00	-0.91	-1.26	-1.18
Gov. transfers	-0.24	-0.24	-0.27	-0.26	-0.35	-0.34
Investment tax credit	-0.37	-0.50	-0.42	-0.53	-0.61	-0.74
Consumption tax	0.08	0.06	0.09	0.07	0.10	0.08
Capital tax	-0.03	-0.03	-0.03	-0.03	-0.04	-0.04
Labor tax	0.24	0.25	0.27	0.26	0.34	0.33
SSC	-0.03	-0.04	-0.02	-0.03	-0.00	-0.01

This table reports multipliers as defined in equations (3)–(4). For each monetary policy stance (no accommodation, 1 year accommodation and 2 years accommodation), the table reports two multipliers. The 1 year multiplier is the average output response over the first year of a 1% of GDP steady-state stimulus running for two years, while the 2 year multiplier is the average output response over the first two years of a 1% of steady-state GDP stimulus running for two years. In all simulations, the fiscal stimulus is debt financed. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

Table A11: Sensitivity analysis of Growth Parameters in Taylor Rule in SELMA

Panel A: GDP multipliers

	No accommod.		1 year accommod.		2 years accommod.	
	1 year	2 years	1 year	2 years	1 year	2 years
Gov. consumption	0.99	1.02	1.08	1.11	1.28	1.36
Gov. investment	1.14	1.26	1.25	1.37	1.41	1.57
Gov. transfers	0.27	0.25	0.29	0.28	0.34	0.34
Investment tax credit	0.55	0.71	0.59	0.75	0.73	0.93
Consumption tax	0.33	0.34	0.32	0.33	0.31	0.32
Capital tax	0.03	0.03	0.03	0.04	0.04	0.04
Labor tax	0.29	0.31	0.27	0.28	0.23	0.23
SSC	0.04	0.06	0.03	0.05	0.02	0.03

Panel B: Unemployment multipliers

Gov. consumption	-0.94	-0.97	-1.04	-1.07	-1.26	-1.33
Gov. investment	-0.94	-0.82	-1.06	-0.94	-1.23	-1.15
Gov. transfers	-0.26	-0.24	-0.29	-0.27	-0.34	-0.34
Investment tax credit	-0.50	-0.61	-0.54	-0.65	-0.70	-0.84
Consumption tax	0.08	0.05	0.09	0.07	0.10	0.08
Capital tax	-0.03	-0.03	-0.03	-0.03	-0.04	-0.04
Labor tax	0.26	0.24	0.29	0.27	0.33	0.33
SSC	-0.02	-0.04	-0.02	-0.03	-0.00	-0.01

This table reports multipliers as defined in equations (3)–(4). For each monetary policy stance (no accommodation, 1 year accommodation and 2 years accommodation), the table reports two multipliers. The 1 year multiplier is the average output response over the first year of a 1% of GDP steady-state stimulus running for two years, while the 2 year multiplier is the average output response over the first two years of a 1% of steady-state GDP stimulus running for two years. In all simulations, the fiscal stimulus is debt financed. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.

Table A12: Sensitivity analysis of adjustment cost parameter in SELMA

Panel A: GDP multipliers

	No accommod.		1 year accommod.		2 years accommod.	
	1 year	2 years	1 year	2 years	1 year	2 years
Gov. consumption	0.91	1.01	1.45	1.60	2.21	2.53
Gov. investment	1.13	1.32	1.64	1.88	2.15	2.50
Gov. transfers	0.26	0.26	0.39	0.40	0.57	0.63
Investment tax credit	0.70	0.98	1.20	1.53	1.83	2.30
Consumption tax	0.33	0.33	0.29	0.29	0.27	0.27
Capital tax	0.04	0.05	0.07	0.08	0.09	0.10
Labor tax	0.31	0.31	0.18	0.16	0.01	-0.04
SSC	0.03	0.05	0.03	0.05	0.03	0.06

Panel B: Unemployment multipliers

Gov. consumption	-0.86	-0.96	-1.43	-1.57	-2.23	-2.54
Gov. investment	-0.92	-0.87	-1.46	-1.45	-2.00	-2.10
Gov. transfers	-0.25	-0.25	-0.39	-0.40	-0.58	-0.64
Investment tax credit	-0.63	-0.83	-1.16	-1.41	-1.82	-2.21
Consumption tax	0.08	0.06	0.12	0.10	0.14	0.13
Capital tax	-0.04	-0.04	-0.07	-0.07	-0.09	-0.10
Labor tax	0.24	0.25	0.38	0.39	0.56	0.61
SSC	-0.01	-0.03	-0.02	-0.04	-0.02	-0.04

This table reports multipliers as defined in equations (3)–(4). For each monetary policy stance (no accommodation, 1 year accommodation and 2 years accommodation), the table reports two multipliers. The 1 year multiplier is the average output response over the first year of a 1% of GDP steady-state stimulus running for two years, while the 2 year multiplier is the average output response over the first two years of a 1% of steady-state GDP stimulus running for two years. In all simulations, the fiscal stimulus is debt financed. After two years, the fiscal rule on transfers is activated such that the debt-to-GDP ratio goes back to its steady-state level in a reasonable pace.