Fiscal Multipliers and the Zero Lower Bound[1]

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Abstract

This paper studies the implications of the zero lower bound (ZLB) on interest rates for the size of fiscal multipliers. The analysis is carried out in an extended version of the ECB's New Area-Wide Model, which contains various fiscal instruments. The results show that the size of fiscal multipliers depends heavily on the length of the period during which the interest rate is binding. Government consumption is the most efficient instrument of fiscal policy; the value of its multiplier is well above one and can even be double for a long time at the ZLB. The multiplier for consumption taxes is also influenced substantially by the interest rate constraint, but its value remains below one. The multipliers for social security contributions and labour income taxes are not influenced much. The behaviour of the government investment multiplier is quite tricky: an amplifying effect on output is present only when the economy stays at the zero lower bound for just a few years; when there is a longer time at the ZLB, this multiplier can even be negative.

Keywords: *zero lower bound on interest rate, fiscal multipliers, DSGE model*

JEL Classification: E52, E62

Introduction

Economic policy can be divided into two – fiscal policy and monetary policy. Governments, as representatives of fiscal policy, use various tools to influence the economy such as government spending and taxes. Central banks, as representatives of monetary policy, usually use the nominal interest rate to affect real economic activity and inflation.

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[1] This research was supported by the Norway Grants programme CZ07, grant No.NF-CZ07-INP-3-1592014 and by specific research project No. MUNI/A/0943/2016 at Masaryk University. I would like to thank to two anonymous referees for their valuable feedback.

However, many developed economies have experienced near-zero interest rates in the last few years. This situation, usually called the liquidity trap or the zero lower bound (ZLB) on the interest rate, limits monetary policy choices because the interest rate cannot be significantly negative.[2]

This is especially alarming in periods of recession or periods characterized by low output growth and low inflation (or even deflation). Greater emphasis is therefore put on fiscal policy, which is often evaluated by the size of fiscal multiplier. This raises the question as to whether the size of the multiplier is affected when monetary policy is restricted by the zero lower bound. Numerous papers have attempted to answer this question using stylized small New Keynesian models (Woodford, 2011) or calibrated medium-scale Dynamic stochastic general equilibrium (DSGE) models (e.g. Erceg and Lindé, 2010, and Christiano, Eichenbaum and Rebelo, 2011). They focus particularly on the government spending multiplier.

This paper looks at a broader variety of fiscal tools and explores their power when the economy stays at the ZLB. Concretely, we use an extended version of the ECB's New Area-Wide Model with rich specification of the fiscal sector. This model was developed by Christoffel, Coenen and Arne (2008) and extended for the fiscal sector and estimated by Coenen, Straub and Trabandt (2013) on euro area data. We study the effect of the zero lower bound using the method described by Guerrieri and Iacoviello (2015) for an occasionally binding constraint.

The results show that the effect of the zero lower bound on the size of fiscal multipliers depends on the length of the period during which the economy stays at the ZLB. The longer time the economy spends at the ZLB, the larger the effect on output observed for four out of seven fiscal tools: government consumption, government transfers, consumption taxes, and social security contributions of employers. The most effective fiscal instrument is government consumption, which has the highest multiplicative effect at the ZLB. Government investment takes second place, but its positive effect on output fades out as time at the ZLB increases. In the long-term, its effect can be even negative. The consumption tax multiplier records the largest amplification at the ZLB but its absolute value still remains below one. Other fiscal instruments, such as labour income tax and social security contributions, are only slightly affected by constrained monetary policy.

[2] Negative interest rates are not all that rare, e.g. the central banks of Japan, Sweden, Denmark and Switzerland, as well as the European Central Bank, have all recently set negative interest rates. However, the term zero lower bound is used quite often in the literature; slightly negative or positive interest rates are technically taken as zero rates and interest rates cannot be very negative.

1. Literature Review

Many papers have looked at the effects of the ZLB on the size of fiscal multipliers. They have largely found that fiscal multipliers are larger when the economy is at the ZLB, although with some exceptions. Woodford (2011) provides a detailed analysis of a stylized New Keynesian model and discusses the various factors on which the size of the multiplier depends. The ZLB makes the multiplier higher than one and government purchases increase the economic welfare. Christiano, Eichenbaum and Rebelo (2011), using a medium-scale DSGE model, also find that the government spending multiplier is larger than one when the ZLB binds. The impact multiplier is roughly 1.6 and has a peak value of about 2.3. Furthermore, the value of this multiplier positively depends on the period for which the zero bound is expected to bind, therefore the timing of government spending is important. Erceg and Lindé (2010) also argue that the spending multiplier is much higher when the economy is in the liquidity trap than in normal conditions. However, the value of that multiplier decreases with the level of government spending, as the economy can exit from the liquidity trap with large fiscal impulses. The multiplier values in their study vary from 1.2 to 3.3 depending on the size of the stimulus. Fernández-Villaverde et al. (2012) find that the fiscal multiplier is around three times larger at the ZLB (and well above one) but its size decreases with time the economy stays at the ZLB. They also distinguish between the marginal multiplier and the average multiplier; the former is much larger than the latter. Aruoba, Cuba-Borda and Schorfheide (2014) estimate a New Keynesian model on data for the USA and Japan. They show that the size of the fiscal multiplier depends on the economy's regime. In a deflationary regime (such as in Japan) the ZLB has no effect on the size of the multiplier while in a targeted-inflation regime (such as in the US) the multiplier is doubled. Eggertsson (2011) analyses more fiscal instruments in a standard New Keynesian DSGE model and finds that the government spending multiplier becomes almost five times larger at zero interest rates. However, the opposite is true for tax multipliers, e.g. a labour tax cut is expansionary at positive interest rates, but becomes contractionary at the ZLB, meaning that the tax multiplier is negative. Kilponen et al. (2015) explores multipliers of government expenditures and three type of taxes under passive monetary policy (the zero lower bound) in fifteen DSGE models used by the European System of Central Banks. They find that the ZLB can have a sizable effect on multipliers in the short term if the fiscal change is implemented simultaneously in the single euro area member country and in the euro area as a whole. Significant amplification is observed also for non-euro area countries with independent monetary policy. However, if the fiscal change if carried out only in a euro area member country, the effect of the ZLB is negligible.

2. Model and Solution

The model that is used to analyse fiscal multipliers at the zero lower bound was developed for the European Central Bank (ECB) by Christoffel, Coenen and Arne (2008) and extended for the fiscal sector by Coenen, Straub and Trabandt (2013). It is called the New Area-Wide Model (NAWM) and is classified as a large scale model. We will describe the model only briefly in this section, and for the full details we refer to the original papers by Christoffel, Coenen and Arne (2008) for the core model and Coenen, Straub and Trabandt (2013) for its extension to the fiscal sector.

The core model includes four types of agents: households, firms, and fiscal and monetary authorities. The production side includes tradable intermediate goods (some of which are exported) and non-tradable goods comprising private consumption and investment goods and public consumption and investment goods. Final goods are made by combining domestic and foreign intermediate goods. There are various types of nominal and real rigidities. Nominal rigidities include monopolistic setting of prices (in various sectors) and wages according to Calvo (1983). Real rigidities are introduced through habit formation in household consumption and generalized adjustment costs in investment, imports and exports. The external sector is represented by a structural VAR model. The monetary authority sets the nominal interest rate according to a modified Taylor rule. The fiscal authority purchases public consumption and investment goods, issues domestic bonds and levies several types of distortionary taxes. The role of fiscal policy in the model economy is enhanced through several channels: (i) the introduction of non-Ricardian households, (ii) government consumption valued by households in a non-separable way, (iii) public capital that is subject to time-to-build technology, (iv) time-varying distortionary tax rates and (v) fiscal rules that endogenously determine the behaviour of different fiscal instruments.

The whole log-linearized model consists of seventy six equations and identities and was estimated by Coenen, Straub and Trabandt (2013) using Bayesian techniques on data for the euro area in the period 1985Q1 to 2010Q2. Concretely, the authors used twenty-five quarterly time series, eight of which were new fiscal data for both revenues and expenditures. We use their estimates for our analysis of the multipliers at the zero lower bound. This is a deliberate choice for several reasons: first, it means that our results can be directly compared with their study; second, the data they used for the fiscal variables are hard to obtain in an up-to-date form; and third, during the period they estimated the model, the zero lower bound was not perceived as a problem for monetary policy and thus did not affect the estimation results. For more

details about the process of estimation and the results, see Coenen, Straub and Trabandt (2013).

The estimated model is simulated with parameters set to their posterior modes and using the *Occbin* toolbox developed by Guerrieri and Iacoviello (2015). Their algorithm uses a piecewise linear perturbation method that is able to solve dynamic models with an occasionally binding constraint. This method provides a very good approximation of a dynamic programming solution but is much easier to implement and much faster, even for models with many state variables. This toolbox is thus suitable for studying the nonlinearities connected with the zero lower bound on the interest rate in a large scale DSGE model.

The model's behaviour is studied by impulse responses in reaction to one standard deviation of fiscal shocks. The shocks follow a first-order autoregressive process, e.g. for government consumption, the shock takes the following (log-linear) form:

$$\hat{g}_t = \rho_G \hat{g}_{t-1} + \hat{\eta}_t^G \tag{1}$$

where

$\hat{g}_t$ – expressed as deviation from the steady-state,

$\hat{\eta}_t^G$ – an unanticipated shock to government consumption.

A present-value multiplier for each fiscal instrument is then calculated as in Uhlig (2010) and Coenen, Straub and Trabandt (2013). E.g. the multiplier for government consumption is

$$M_t^{PV} = \left(\sum_{t=0}^{T} \frac{(y_t - y)}{(1+r)^t} \right) / \left(\sum_{t=0}^{T} \frac{(g_t - g)}{(1+r)^t} \right) \tag{2}$$

where

y_t and g_t – the actual values of output and government consumption,

y and g – the corresponding steady state values,

r – the steady-state real interest rate on government bonds.[3]

Multipliers for the other fiscal instruments are calculated accordingly. The fiscal impulses (higher budget spending or lower tax revenues) are debt-financed and we assume a feedback rule for lump-sum taxes that ensures debt stabilization. The analysis with simple feedback rules for all fiscal instruments is discussed in section 4 and in the Appendix.

[3] The impulse responses are calculated as percentage deviations from steady-states, but these deviations are transformed into units of output using steady-state ratios.

3. Results of the Simulations

The model is modified for the purpose of the toolbox and is simulated in reaction to fiscal impulses of one standard deviation. The impulse responses are evaluated for two cases: when the interest rate is positive, and when the interest rate is constant at the zero lower bound. This is done by using an auxiliary shock that brings the economy to the ZLB.[4] In the benchmark simulation it is assumed that the economy remains at the ZLB for two years; the influence of longer spells at the ZLB is examined later in this section.

Figure 1 shows the economy's reaction to a shock in government consumption. The y-axis shows percent or percentage point deviation from the baseline case.[5] The baseline is the situation when the interest rate is binding at zero (dashed line) or not binding (solid line). Total consumption denotes the consumption of both Ricardian and non-Ricardian households, total investment is the aggregate of private domestic and imported investment. As the impulse responses are evaluated against the baseline case, the size of the studied fiscal shock does not matter. In other words, we rule out the possibility that the economy can exit the liquidity trap because of a large fiscal impulse.[6]

We can see that in situations when the interest rate is not binding (solid line), increased government consumption increases total consumption and output. Investment declines because the nominal and (more importantly) real interest rates rise. The inflation reaction is initially negative, but quantitatively small.

For a binding interest rate (dashed line), a government consumption shock of the same size has a larger positive impact on consumption and output. The inflation rate rises, which initially decreases the real interest rate as the nominal interest rate is fixed at zero. The crowding-out effect is dampened and investment decreases less than in the non-binding case. Private consumption is enhanced as it is complement to government consumption. All these effects result in a larger increase in output compared to that with an unrestricted interest rate.

The sizes of the fiscal multipliers calculated using equation (2) are quoted in Table 1. For each fiscal instrument, the first line corresponds to the case with a non-binding interest rate, and the second and the third lines correspond to cases when the interest rate is binding for two and four years respectively.[7] Let us

[4] For this purpose, transitory technology shocks are used. However, the type of auxiliary shock does not affect the results.

[5] The fiscal shock is expressed in percent of GDP.

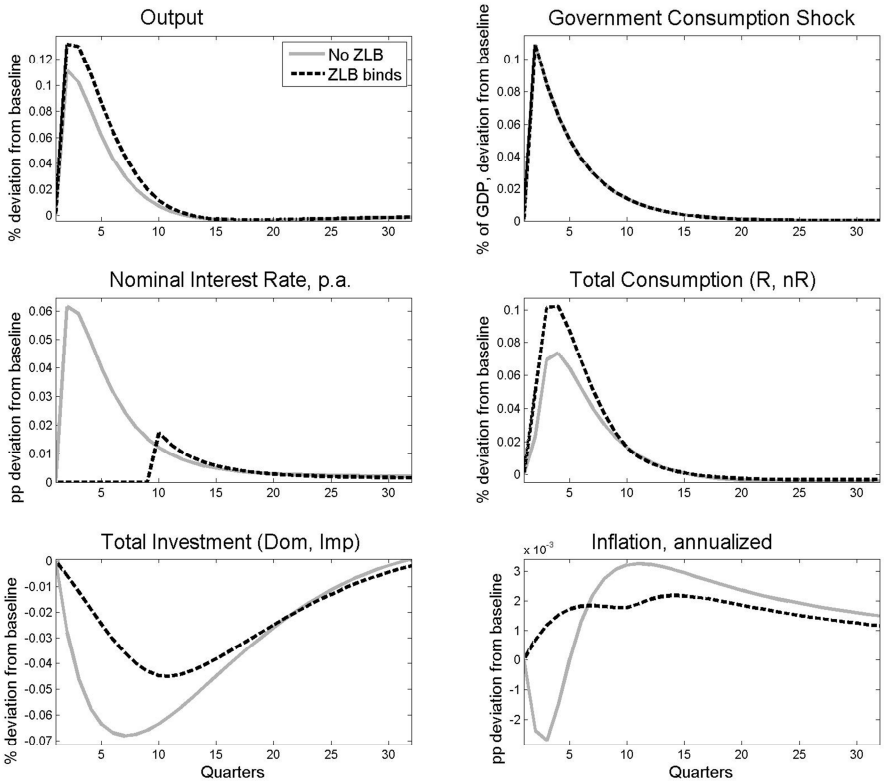
[6] This is a topic for further research.

[7] The multipliers for the non-binding case should be identical to the results in Panel A of Table 4 in Coenen, Straub and Trabandt (2013). However, there is a small discrepancy in the consumption tax multiplier, which is smaller by two hundredths in our calculations.

briefly describe the "no ZLB" results. The largest multiplier is identified for government consumption and is higher than one in both the short and medium term. This is mainly caused by a high degree of complementarity between public and private consumption. The multiplier for government investment is less than one in the short run but increases to 1.13 in the long-run. This sluggish response is caused by a high investment adjustment cost. On the other hand, the government transfers multiplier is very small. On the revenue side, only the multiplier for consumption taxes is slightly substantial.

F i g u r e 1

IRFs to Government Consumption Shock with and without Binding Interest Rate



Source: Author's calculations.

Let us turn to the effect of the zero lower bound when the interest rate is binding for two years (every second line of the table). We observe an increase in all the fiscal multipliers. Due to the ZLB, the government consumption multiplier is now larger than one over the whole horizon. The increase is nearly half in the long-term. Similarly, the multiplier for government investment is larger than

one at impact and in the short term, with a slight decrease below unity in the medium term, but an increase in the long-term. This is because the crowding-out effect for private investment is muted at the ZLB, which enhances output. The complementarity between private and public capital also has an effect, but this starts later due to the investment adjustment cost. The multiplier for government transfers increases marginally because the share of non-Ricardian households is small. An important amplification in the consumption taxes multiplier is identified, by nearly half in the longer term. At the ZLB, the transmission channel is similar to government consumption shock, hence it has a similar effect. Nevertheless, the absolute value of this multiplier remains small, below unity. The other revenue side multipliers are not influenced much, as the impact on inflation (and hence on the real interest rate with a fixed nominal rate) is small. This is because these shocks affect both labour supply and labour demand, with opposing effects on wages and thus inflation.

T a b l e 1

Fiscal Multipliers for Various Fiscal Instruments

	1Q	4Q	8Q	16Q	Long-run	Max
Government consumption	1.02	1.15	1.11	0.98	0.84	1.15
ZLB binds 2 years	1.21	1.48	1.48	1.34	1.21	1.50
ZLB binds 4 years	1.26	1.62	1.73	1.70	1.59	1.74
Government investment	0.95	0.85	0.77	0.74	1.13	1.13
ZLB binds 2 years	1.05	1.01	0.95	0.92	1.22	1.22
ZLB binds 4 years	1.04	0.99	0.92	0.85	1.13	1.13
Government transfers	0.06	0.05	0.04	0.04	0.03	0.06
ZLB binds 2 years	0.06	0.06	0.06	0.05	0.05	0.06
ZLB binds 4 years	0.06	0.06	0.07	0.06	0.06	0.07
Consumption taxes	0.24	0.26	0.24	0.19	0.13	0.26
ZLB binds 2 years	0.30	0.36	0.35	0.28	0.19	0.36
ZLB binds 4 years	0.35	0.45	0.48	0.44	0.33	0.48
Labour income taxes	0.11	0.09	0.08	0.08	0.10	0.11
ZLB binds 2 years	0.12	0.11	0.10	0.10	0.12	0.12
ZLB binds 4 years	0.12	0.11	0.09	0.09	0.11	0.12
SSC: employees	0.11	0.10	0.09	0.09	0.10	0.11
ZLB binds 2 years	0.13	0.12	0.11	0.11	0.12	0.13
ZLB binds 4 years	0.13	0.12	0.11	0.10	0.12	0.13
SSC: employers	–0.01	0.00	0.03	0.07	0.07	0.07
ZLB binds 2 years	–0.01	0.00	0.02	0.06	0.06	0.07
ZLB binds 4 years	–0.01	0.00	0.03	0.08	0.08	0.08

Note: Values in the table are present-value fiscal multipliers, i.e. discounted by the steady state real interest rate for government bonds. SSC refers to social security contributions.

Source: Author's calculations.

As we will see later on, the effect of the ZLB on the size of the multiplier depends on the length of time the economy stays at the ZLB. A longer time at the ZLB is technically simulated using a stronger auxiliary shock. Agents thus

anticipate that the economy will stay at the ZLB for a longer time and this immediately influences their behaviour. However, the piecewise linear solution employed here cannot replicate a full non-linear solution in which expectations are influenced by the probability that some future shocks will take the economy to the ZLB again (a precautionary motive). As Guerrieri and Iacoviello (2015) argue, the policy functions for the piecewise and non-linear solutions are very similar and this effect may not be very important. Seen from another perspective, our results may be thought of as the lower bound of the ZLB's effect on fiscal multipliers.[8]

Every third row of Table 1 shows the fiscal multipliers when the economy is at the ZLB for four years. We can see further improvement in the government consumption multiplier (which is nearly doubled in the long-run) and in the consumption taxes multiplier (2.5 times higher in the long-run). Interestingly, the multipliers are already higher at impact and during the first two years, which points to the fact that expectations regarding the severity of the ZLB constraint matter. Christiano, Eichenbaum and Rebelo (2011) reached a similar conclusion from their model. The government investment multiplier is still higher compared to the non-binding interest rate case, but the positive effect of the ZLB starts to fade out. This is caused by the fact that this shock decreases inflation for a longer time, which rises the real interest rate (with the nominal rate stuck at zero) and has a negative effect on private investment and hence also on output. This is the same effect that enhances output in the ZLB case for a government consumption shock, where real interest rate decreased, but here it works the other way around because the real interest rate increases.

The effect of a longer spell at the ZLB is further illustrated in Figure 2, which shows how the multipliers develop as the economy stays at the ZLB for a longer time. The values are depicted for two, four, eight and twelve years at the ZLB (four distinct lines). The x-axis shows time after the fiscal shock. The government investment multiplier starts to fall after four years at the ZLB and is even negative when the economy stays at the ZLB for 12 years. A similar adverse effect can be observed for the labour income tax and employees SSC multipliers, but to lesser extent. The other multipliers are enhanced by a longer time at the ZLB; the largest improvement is seen for the consumption taxes multiplier (nearly doubled at impact and more than six times larger in the long-run).[9] However, its absolute value still remains below one. Similarly, the government transfers

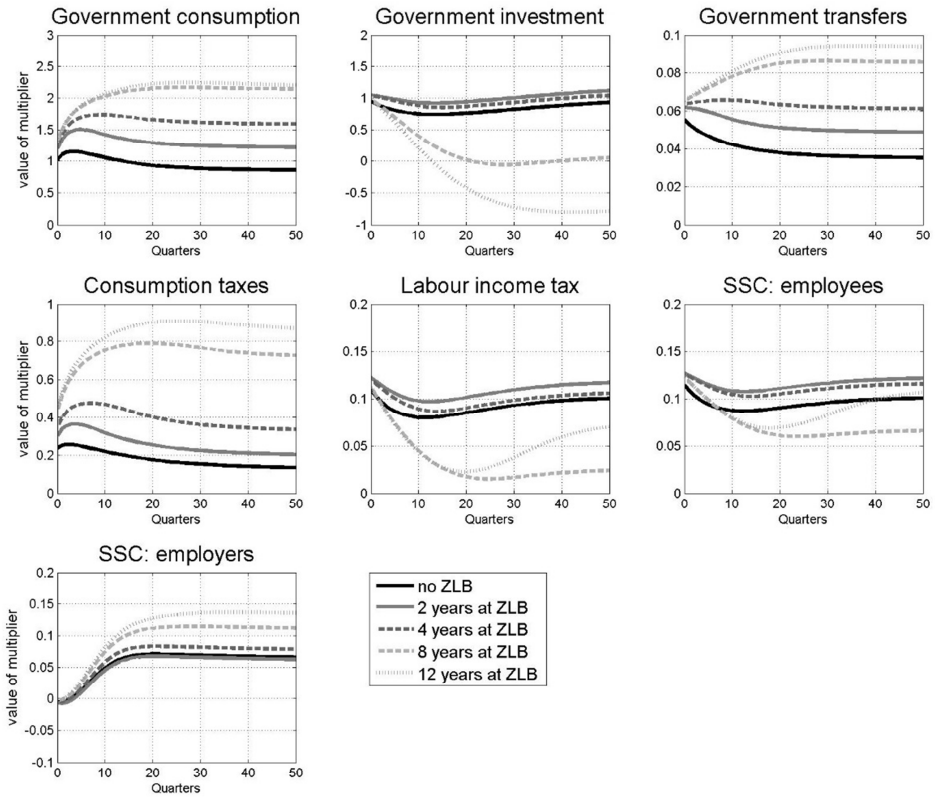
[8] An alternative solution method for large-scale models with an occasionally binding constraint was developed by Holden (2016). Its advantage over the method developed by Guerreri and Iacoviello (2015) is that it can take future uncertainty into account. Exploration of this method is a topic for further research.

[9] See Table A.1 in the appendix for the exact values of the multipliers.

multiplier increases substantially, but is very small in absolute terms. Government consumption is probably the most effective fiscal policy tool. When the economy is at the ZLB and is expected to stay there for a long time, the value of this multiplier is greater than two and can peak at 2.25 in the long-term.

F i g u r e 2

Fiscal Multipliers with Respect to Time Spent at the ZLB



Source: Author's calculations.

Note that several multipliers have a hump shaped pattern, i.e. the peak is several quarters behind the initial impulse. Typical examples are the multipliers for government consumption and consumption taxes. Some other multipliers have an inversed hump shaped pattern: their value decreases after impact and after reaching the trough, increases again. Examples of this are the government investment and labour tax multipliers. These shapes are caused by various implementation lags and by real and nominal rigidities inherited in the model.

4. Sensitivity Analysis

A sensitivity analysis of the results with respect to different parameter settings can be performed, but the parameters influence the value of the multipliers in both the binding and non-binding cases, which makes the comparison difficult. For the sake of transparency, we only look at the government consumption multiplier – the most effective fiscal tool.

Table 2 shows the values for different settings of the parameters. When prices and wages are more flexible (the Calvo parameter is set to 0.5 which means that contracts are changed every two quarters), the multiplier slightly decreases, but the binding interest rate rises its value substantially, by half in the medium term. When the labour share of non-Ricardian households is larger (0.5 instead of 0.18), the multiplier substantially increases, but even though the ZLB has an amplifying effect it is not as strong as in the previous case (in relative terms). When the aggregate consumption index is Cobb-Douglas and government consumption goods are not valued by households, the multiplier is almost half the size compared to the benchmark (and smaller than one), but the ZLB increases its value by almost half. Finally, when a standard Taylor monetary rule is used (without interest rate smoothing, weights to inflation 1.5 and output 0.125), the multiplier is slightly higher than the benchmark. The ZLB once again makes the government consumption multiplier stronger, this time by one third on average.

T a b l e 2

Government Consumption Multiplier, Different Parameter Settings

	1Q	**4Q**	**8Q**	**16Q**	**Long-run**	**Max**
No ZLB, benchmark estimation	1.02	1.15	1.11	0.98	0.84	1.15
More flexible wages and prices						
No ZLB	1.01	1.08	0.95	0.78	0.50	1.09
ZLB binds	1.31	1.59	1.42	1.12	0.89	1.59
Larger share of non-Ricardian households						
No ZLB	1.14	1.22	1.14	1.01	0.89	1.22
ZLB binds	1.31	1.53	1.51	1.36	1.24	1.54
C-D aggregate, non-valued G						
No ZLB	0.59	0.65	0.63	0.56	0.49	0.65
ZLB binds	0.71	0.87	0.88	0.79	0.72	0.89
Standard Taylor rule						
No ZLB	1.06	1.23	1.22	1.14	1.07	1.24
ZLB binds	1.24	1.55	1.61	1.55	1.50	1.62

Source: Author's calculations.

Table A.2 in the Appendix shows the multipliers for the fiscal instruments with estimated parameters for the pre-announcement effect and with feedback rules.[10] The fiscal multipliers for the non-binding case (the first lines in the table)

are all slightly higher or lower, and develop differently over time.[11] However, the effect of the ZLB is amplifying for all the fiscal instruments, especially for consumption taxes and government consumption and investment.

Finally, we make a brief comparison with other studies. Our results are largely in line with other authors' findings for the ZLB's effects on the multipliers. E.g. Christiano, Eichenbaum and Rebelo (2011) found that the size of the government spending multiplier at the ZLB is between 1 and 2.3. Eggertsson (2011) also found that the government spending multiplier is high at the ZLB (2.3), but found that the labour tax multiplier was negative at the ZLB (–1.1). Contrary to this, our study finds that this multiplier has a small but positive value. The average value of the government spending multiplier in Erceg and Lindé (2010) is 1.6, which roughly corresponds to our results. Meanwhile, Kilponen et al. (2015) explored the behaviour of the NAWM model for a case of passive monetary policy and also found that the government consumption multiplier was amplified (with values of 1.39 and 1.30 in the first and second years after the shock). They found that the consumption tax multiplier was also enhanced by the ZLB but still remained below unity (0.78 and 0.92). Contrary to our results, their study found that the labour tax multiplier was muted under the ZLB.[12]

Conclusion

This study examined the size of various fiscal multipliers when monetary policy is constrained by the zero lower bound on the interest rate, using a model of the euro area with a richly specified fiscal sector and a broad set of fiscal data. The results show that the most effective fiscal policy tool at the ZLB is government consumption. If the economy is expected to stay in the liquidity trap for a long time, this multiplier is much higher and can exceed a value of two. The government investment multiplier's value is also amplified by the ZLB, but only when the economy stays at the ZLB for no more than a few years. A very significant amplification effect is seen for the consumption taxes multiplier, but its value remains below unity. Similarly, the government transfers multiplier increases substantially in relative terms, yet its absolute value remains very small. The other fiscal instruments examined are found to be only negligibly influenced by the ZLB.

[10] See Appendix for a more detailed explanation of the fiscal rules. In the previous simulations these effects were switched off in order to enable comparison with the results in Coenen, Straub and Trabandt (2013).

[11] The multiplier for government investment at impact is even negative, due to a strong pre-announcement effect.

[12] Kilponen et al. (2015) explore fiscal tightening and their multipliers have negative signs. Here, I present their results in absolute values.

Several related topics deserve further research. Our analysis did not consider the possibility that the economy could escape the zero lower bound as a result of a large fiscal impulse. This deserves to be explored, in connection with determining the optimal size of the fiscal stimulus. Furthermore, the central banks can use (as the ECB has done) unconventional monetary policy tools, such as quantitative easing and forward guidance (see e.g. McKay, Nakamura and Steinsson, 2016); it would be worth exploring the effects of a fiscal stimulus in connection with such monetary policy interventions.

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Appendix

Table A.1

Fiscal Multipliers for Various Fiscal Instruments, 12 Years at the ZLB

	1Q	4Q	8Q	16Q	Long-run	Max
Government consumption	1.02	1.15	1.11	0.98	0.84	1.15
ZLB binds	1.32	1.75	1.97	2.17	2.20	2.25
Government investment	0.95	0.85	0.77	0.74	1.13	1.13
ZLB binds	0.96	0.77	0.45	–0.15	–0.68	0.96
Government transfers	0.06	0.05	0.04	0.04	0.03	0.06
ZLB binds	0.07	0.07	0.08	0.09	0.09	0.09
Consumption taxes	0.24	0.26	0.24	0.19	0.13	0.26
ZLB binds	0.45	0.65	0.77	0.88	0.86	0.91
Labour income taxes	0.11	0.09	0.08	0.08	0.10	0.11
ZLB binds	0.11	0.09	0.06	0.03	0.07	0.11
SSC: employees	0.11	0.10	0.09	0.09	0.10	0.11
ZLB binds	0.12	0.11	0.09	0.07	0.11	0.12
SSC: employers	–0.01	0.00	0.03	0.07	0.07	0.07
ZLB binds	0.00	0.01	0.05	0.11	0.13	0.13

Source: Author's calculations.

Fiscal Rule

An example of the fiscal rule for government consumption (in log-linear form) is given by:

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

where government consumption $\hat{g}_t$ (expressed as deviation from the steady state) depends on its lagged value, on government debt, $\hat{b}_t$ (expressed as deviation from the target), and the output gap, $\hat{y}_t$. In this formulation, the fiscal instrument can either stabilize or destabilize the debt and can be pro- or countercyclical, depending on the parameter values ($\theta_{G,B}$ and $\theta_{G,Y}$); $\hat{\eta}_t^G$ is an unanticipated shock to government consumption and represents a discretionary fiscal impulse. Next, a pre-announcement effect one quarter ahead with weight ψ_G is allowed, which means that the fiscal impulse can have a partial effect before its realization. The agents foresee fiscal changes and their proportional distribution between the current and future periods based on publicly available information about spending legislation (e.g. in the press).

The estimated fiscal rule parameters were taken from Coenen, Straub and Trabandt (2013). Sizable feedback coefficients were found for government investment and transfers; the same fiscal instruments showed quite significant pre-announcement effects.

Table A.2

Fiscal Multipliers with Fiscal Rules for Instruments, 2 Years at the ZLB

	1Q	4Q	8Q	16Q	Long-run	Max
Government consumption	1.02	1.16	1.13	1.00	0.86	1.16
ZLB binds	1.21	1.49	1.50	1.37	1.26	1.52
Government investment	–0.65	0.81	0.75	0.68	1.01	1.01
ZLB binds	0.71	1.03	0.99	0.94	1.26	1.26
Government transfers	0.08	0.07	0.05	–0.01	–0.03	0.08
ZLB binds	0.12	0.09	0.07	0.02	–0.01	0.12
Consumption taxes	0.21	0.27	0.25	0.18	0.07	0.27
ZLB binds	0.32	0.40	0.39	0.30	0.17	0.41
Labour income taxes	0.12	0.12	0.10	0.06	0.07	0.12
ZLB binds	0.14	0.15	0.13	0.10	0.11	0.15
SSC: employees	0.12	0.12	0.09	0.04	0.04	0.12
ZLB binds	0.14	0.14	0.11	0.07	0.07	0.14
SSC: employers	0.01	0.02	0.02	0.02	0.01	0.03
ZLB binds	0.00	0.01	0.02	0.01	0.00	0.02

Source: Author's calculations.