Do Fiscal Multipliers Vary with Different Character of Monetary-Fiscal Interactions?[1]

*Michal BENČÍK**

Abstract

We investigate the fiscal multiplier in normal times and in the presence of a binding zero lower bound on interest rates with SVARs. We construct shocks to interest rates that compensate their reactions to fiscal expansion and hold them constant we apply the shocks to the United States, the Euro area and Slovakia. We find that for the former case, the multiplier decreases in the ZLB, but it increases sharply in the ZLB for the latter two cases. The sign of its change is determined by the coordination of fiscal and monetary policy i.e. whether the interest rates drop or rise in response to fiscal expansion.

Keywords: *monetary-fiscal interactions, fiscal multipliers, zero lower bound, VAR models, compensating shocks*

JEL Classification: E62, E63, C32

Introduction and Motivation

Fiscal multipliers are of crucial importance both for decisions about stimulation of the economy out of a prolonged slump and for assessing the fiscal contraction during fiscal consolidation that is not going to cause a recession. As numerous summarizing studies show (Coenen et al., 2012; Warmedinger, Checherita-Westphal and Hernández de Cos, 2015; Kilponen et al., 2015), their size varies greatly among countries and among conditions for a given economy. In order to capture this heterogeneity, it is worthwhile to model the multipliers as a function of various circumstances affecting the economy.

The policy interest rates are near zero or zero in the Euro area, the United States, Japan and some smaller countries, therefore technically at the zero lower

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[1] The views expressed in this paper do not necessarily reflect the views of the National Bank of Slovakia or the Eurosystem.

bound (ZLB).[2] This situation has been dealt with by traditional Keynesians many decades ago under the notion of the liquidity trap. It is discussed in the framework of the extended IS-LM model, for example in the textbook by Felderer and Homburg (1992). The main difference in a liquidity trap relative to a standard IS-LM model is that the LM curve is horizontal in its lower portion. The aggregate demand curve is vertical as a consequence and disequilibrium persists in the market of goods. The traditional monetary policy is inefficient in this setup, as the money supply becomes endogenous. However, fiscal policy retains its efficiency. An even more radical setup is presented by Eggertson and Krugman (2010), where the aggregate demand curve is increasing and leads to inefficiency of supply side measures and phenomena such as paradox of flexibility and paradox of toil. DeLong and Summers (2012) study this situation in a simple model with a monetary policy curve with different slopes and IS curve and conclude that the fiscal expansion can be self-financing in some situations.

Christiano, Eichenbaum and Rebelo (2011) prove that the fiscal multiplier in presence of active lower bound is higher, because the interest rate does not rise during fiscal expansion in this environment. However, Muscatelli, Tirelli and Trecroci (2002) have shown that while the reaction of interest rates to a fiscal expansion with no active lower bound is positive for Germany, it can be negative for United States. The aim of this paper is to study the mechanism identified by Christiano, Eichenbaum and Rebelo (2011) in a generalized setting that allows either positive or negative reaction of interest rate to fiscal expansion. The aim of this paper is to study the fiscal multiplier in ZLB in a more general framework than a typical DSGE model. We develop a novel approach that introduces compensating shocks ensuring the constancy of interest rates. We combine these shocks with positive fiscal shocks in moving average representations of structural VARs and derive the size of fiscal multiplier in presence of active lower bound. Based on differences between results for the euro area and United States, we establish the link between the character of the monetary-fiscal interaction and relative size of fiscal multiplier in ZLB.

The rest of the paper is organized as follows: Part 1 reviews the literature. Part 2 presents the method of offsetting (compensating) shocks in a non-technical way. Part 3 discusses the necessary conditions for increase of the fiscal multiplier in the ZLB. Part 4 presents the underlying VAR models. Part 5 presents technical details of the computation of the compensating shocks and multiplier. Part 6 presents the results and the last part concludes.

[2] It is understood that there exists a lower bound for them, it may be zero or somewhat below zero, but in line with the literature we will call it the zero lower bound (ZLB) without implying its value to be exactly zero.

1. Literature Review

A number of empirical studies concerning fiscal policy in a zero lower bound environment emerged following the global financial crisis and the sovereign debt crisis in Europe. The size of fiscal multiplier in the presence of the zero lower bound has been most frequently studied with DSGE models. Christiano, Eichenbaum and Rebelo (2011) use several versions of the DSGE model for this purpose. For a model without capital, the size of multiplier in the ZLB rises with the sensitivity of prices to output and with the probability of the interest rate staying low for longer. A model with capital gives a higher multiplier than the version without capital. According to Christiano, Eichenbaum and Rebelo (2011) the multiplier has a value above one in a DSGE model according to Altig et al. (2011). The multiplier is larger when the lower bound on interest rate is active for longer. On the other hand, the multiplier decreases if the increase in government spending continues after monetary policy had exited the ZLB regime. Other DSGE models often assume that fiscal expansion is inflationary even when lower bound is active, thus fiscal expansion causes the real interest rate to drop in the ZLB regime, forcing the multiplier up. The consequence is that even if the multiplier in the ZLB is large, fiscal tightening is needed after the economy returns to normal in order to pay the additional debt (Woodford, 2011). Thus, only the marginal multiplier in the ZLB is large and the multiplier in the ZLB decreases for big fiscal expansions (Erceg and Linde, 2010). Olivier and Takangmo (2014) present an open economy DSGE model and they show that the multipliers in the ZLB are not higher than usual, because the exchange rate appreciation offsets the effect of fiscal stimulus. Finally, Bilbiie, Monacelli and Perotti (2014) show that fiscal stimuli can be counterproductive even with a large multiplier, if they do not enter the utility function of households. The DSGE models are rightly a popular tool for the analysis of economic policy. However, different settings of their non-linear structure lead to different and sometimes conflicting conclusions and it is practically impossible to determine which set of assumptions is the most realistic one. A loosely related strain of literature explores the effects of monetary policy under the ZLB and the effects of qualitative easing using novel approaches in VAR methodology (Meinusch and Tillmann, 2016 – QUAL VAR (combining binary information about QE announcements with an otherwise standard monetary policy VAR), Nakajima, 2011 – extended TVP (time varying parameters) VAR, Michaelis and Watzka, 2017 – TVP VAR).

Scholars hold different opinions about optimal tools. According to Eggertson (2010), tax breaks connected with capital formation are the most efficient. General spending and tax breaks for VAT are according to this study less efficient and direct taxes are even counterproductive (as they cause deflation). Contrary to this, according to Albertini, Poirier and Roulleau-Pasdeloup (2014), multipliers are the highest for spending that is unproductive and does not substitute for private consumption. McManus, Gulcin Ozkan and Trzeciakiewicz (2014) find that multipliers on public investments are the highest; interestingly, tax hikes on consumption lead to increasing output. Different conclusions are the result of differences in the model structure, but a detailed analysis and comparison of cited models is beyond the scope of this paper. Meta-analysis by Gechert, Hallett and Rannenberg (2015) contradicts Eggertson (2010), finding expenditure multipliers systematically higher than tax multipliers. Gechert, Hallett and Rannenberg (2015) also show that public investment has a higher effect than consumption expenditure. Due to the ambiguity in the literature, we focused on the textbook case, using government spending as our policy tool.

If the economy in question is a member of a monetary union, the monetary authority is likely to set the common monetary policy according to the situation in the whole monetary union while changes in fiscal policy in a single member country may have limited impact on monetary policy setting. This can lead to twofold conclusions. Kilponen et al. (2015) state that the multiplier in the ZLB in single member countries is not greater than usual (below unity), because the interest rates react to aggregate output gap and not necessarily to the output gap of the country in question even in normal times. Contrary to this, Zeman (2016) finds that the multiplier is above unity, because the interest rate does not react to output expansion and crowding out is limited or even absent (basically for the same reason as Christiano, Eichenbaum and Rebelo, 2011). However, Kilponen et al. (2015) also find scope for a large multiplier for a fiscal stimulus coordinated across countries. Farhi and Werning (2016) summarize the values of multipliers for the liquidity trap and currency unions. The multipliers in liquidity trap (analogous to ZLB) are mostly greater than unity, the multipliers for currency union are mostly between zero and unity. The conclusions for a monetary union in ZLB are thus somewhat unclear. The need for coordination of fiscal policy within monetary unions is confirmed by Müller, Hettig nad Mueller (2015), who find that the Nash equilibrium resulting from non-cooperation of fiscal authorities in member countries, leads to suboptimal results.

Coordination of fiscal and monetary policies can be studied in various ways: from the point of view of game theory (Blinder, 1982) or from the point of view of minimalization of costs of public debt (Laurens and de la Piedra, 1998). For our purposes, Muscatelli, Tirelli and Trecroci (2011) is of great importance. The authors show that, although the offsetting character of monetary policy (to fiscal expansion) is usually assumed (as in Christiano, Eichenbaum and Rebelo, 2011), it is not always the case.

From a practical point of view, fiscal policy in the Euro area was constrained by the loss of confidence in sovereign credit during a considerable part of the crisis and the downturn in output had to be countered by monetary policy only. Therefore, in the euro area, the policies were offsetting each other, while policy-makers called for the cooperation between fiscal policy and monetary policy.[3] Such an offsetting character of fiscal and monetary policies has not been so common also in the US. Recently however, the ongoing rate rises in the US were underpinned, among other factors, by the expectation of expansionary fiscal policy in the near future. The policies were thus de facto also offsetting each other. For the most of the history however, fiscal and monetary policies in United States has been mostly coordinated.

2. The Compensating Shocks[4]

We assume that in normal times the decisions of the central bank about the policy interest rate are based on current business cycle considerations (for example gaps and neutral rate in the Taylor rule) and that the policy rate is at the level desired by the central bank. On the contrary, when the zero lower bound is binding, the desired policy rate is too low and thus unattainable, becoming the shadow rate and the true policy rate is at the lower bound. The difference between the real policy rate and the shadow rate is the interest rate gap.

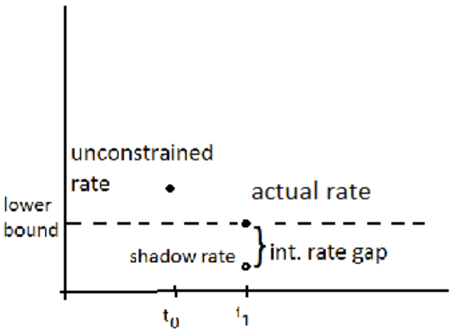
We assume that the central bank has a fairly stable reaction function to economic shocks. In this situation, however, it cannot put its desired policy rate into practice. If the ZLB is binding and the central bank wishes to raise the interest rate by a small amount (for example, because it anticipates mild inflationary pressures), the shadow rate will shift towards the lower bound, the real policy rate stays constant at the lower bound and the interest rate gap diminishes. Compared to normal times, the policy mix is looser, because the policy interest rate should have risen rather than remain fixed. If the ZLB is binding and the central bank wishes to decrease the interest rate, the shadow rate will drop further away from the lower bound, the real policy rate stays constant at the lower bound and the interest rate gap increases. Compared to normal times, the policy mix is tighter because the policy interest rate should have dropped but it did not. These considerations show that the consequences of a binding lower bound on interest rates can be simulated by a setup keeping the interest rate constant when the system is affected by shocks. The considerations of these paragraphs are illustrated in the Figure 1a – 1d.

[3] Speech of the ECB President, Mario Draghi (2016) on the 6th of June 2016.

[4] The described concept is our innovation. We developed it in 2013 as a part of another project, but we did not apply it in the corresponding working paper.

F i g u r e 1a

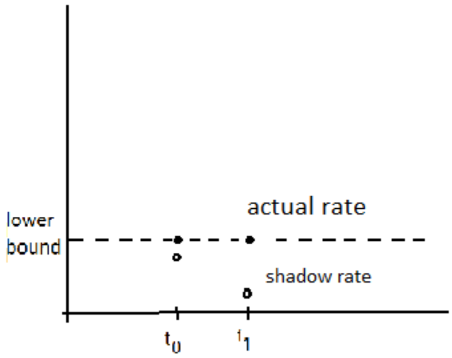
Entering the ZLB Regime



Note: Positive rate in t_0 becomes constrained in t_1, shadow rate is below the lower bound

F i g u r e 1b

Intended Monetary Loosening in ZLB Regime

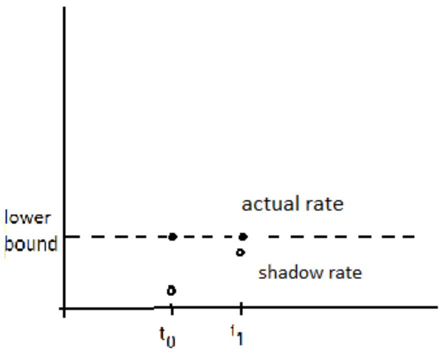


Note: Actual rate stays constant, shadow rate moves lower, interest rate gap rises.

Source: Own sketches.

F i g u r e 1c

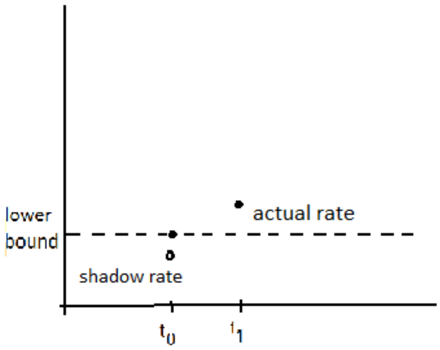
Intended Monetary Tightening in ZLB regime



Note: True rate stays constant, shadow rate moves towards the lower bound, rate gap drops.

F i g u r e 1d

Exiting the ZLB Regime Due to a Larger Positive Interest Rate Shock



Note: If the rate shock is larger than the interest rate gap,the actual rate > ZLB, the gap vanishes.

Source: Own sketches.

From a computational point of view, the situation in Figure 1b will require a positive compensating shock to keep the actual rate constant during intended monetary loosening, whereas the situation in Figure 1c will require a negative compensating shock in order to offset the intended monetary tightening.

Our analysis consists of comparing two scenarios:

i) simulating a spending shock in normal times, i.e. increased government spending, where the interest rate can move freely and

ii) simulating a shock in a ZLB environment, i.e. a shock to the interest rate in unison with a shock to government spending, while preventing the interest rate from reacting to increased government spending and keeping it at the level before the government spending shock.

The latter simulation is done numerically in two steps. First a positive transitory shock to government spending is introduced and the reaction of the system in normal times is computed. Then, one period after another, the induced changes in the interest rate are offset by a shock in the interest rate with sign opposing the reaction of interest rate to increased spending. This shock is updated in each period, so that the total reaction to the two shocks remains exactly zero for all lags. The linearity of VARs and their moving average representation is crucial for the correctness of this approach. The exact procedure of accumulating the compensated shock is elaborated in Part 5.

For the case, where the presence of a binding lower bound means loosening policy, the size of the compensating shock is on the one hand proportional to the increase in fiscal multiplier in the ZLB relative to normal times. However, a large interest rate gap is required for the ZLB staying binding, if the compensating shock is large. Thus, the high absolute value of this shock means higher efficiency of fiscal policy, but a decreased probability of fully exploiting this efficiency. If the compensating shock in the interest rate is too large relative to the interest rate gap (Figure 1d), the interest rate gap will be totally eliminated and the lower bound will cease to be binding. The resulting multiplier in this situation will be between the values of the multiplier in normal times and those under a fully binding ZLB.

The updating process yields the two scenarios in terms of dependent variables of the VARs in a form somewhat resembling impulse-response functions. Alternative paths of output and government spending are computed from these scenarios together with the cumulative multipliers. As the government spending used in multipliers contains both shocks and the endogenous reaction of government spending to own shock, we find it more appropriate to evaluate the impact of the fiscal stimulus in cumulative terms.

3. Policy Coordination and Size of the Multiplier in ZLB

The reaction of the monetary policy to fiscal shock is crucial for the change of the fiscal multiplier. Figure 2a and 2b illustrate the reaction of the system to temporary positive unit fiscal shock lasting four quarters.[5] Muscatelli, Tirelli and Trecroci (2002) estimate SVARs for several important economies and find that in the United States, the interest rate falls after fiscal shock, whereas it rises for

Germany. We obtain the same results for the US,[6] as shown in Figure 2b.[7] This means that the monetary policy is aligned with fiscal policy. They are simultaneously expansive or restrictive since they are complementary. On the contrary, the estimate for the Euro area (Figure 2a) shows that the interest rates rise after fiscal expansion, the monetary policy thus works against fiscal, the policies are substitutes.

Figure 2a

Reaction of Interest Rate to Government Spending

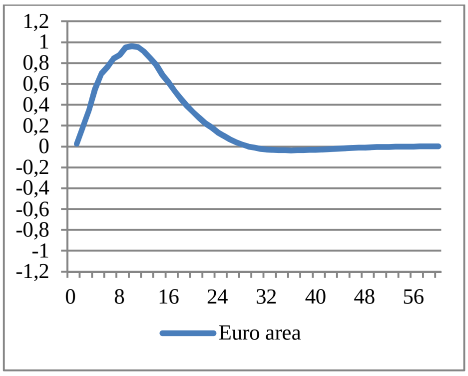
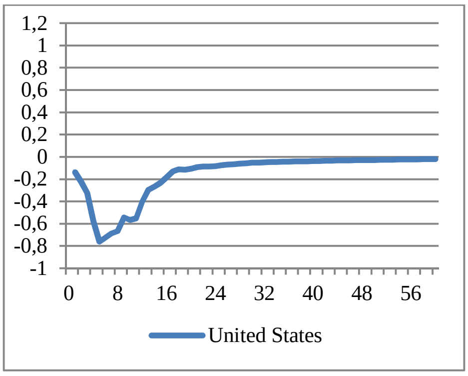


Figure 2b

Reaction of the Interest Rate to Government Spending



Note: The horizontal axis depicts quarters.

Source: Own computations.

As shown by Buti, Roeger and in't Veld (2001), the reason for this may be the different nature of external shocks the economy is facing. In the framework of a simple supply and demand model, negative demand shock is associated with output and prices falling at the same time, while the negative supply shock leads to falling output and increasing prices. If the fiscal policy reacts predominantly to the output and monetary policy predominantly to inflation, then demand shocks lead to complementary policies, whereas supply shock leads to policies substituting each other.

Different signs of impulse-response functions may arise because the United States faces predominantly demand shocks (for example negative shocks to private consumption and investment resulting from one-off events), whereas the

[5] The reactions are from the technical point of view moving sums of impulse-response functions. They smooth out the short run fluctuations of iRFs resulting from uneven seasonal adjustment. In order to get plausible results, we need a well-behaved output gap that rises with government spending and decreases with the policy interest rate. Although we do not use it directly, we also expect the interest rate to rise in response to the output gap. We consider these assumptions as standard and rejected all model versions violating them.

[6] The situation at the end of the year 2016 and beginning of 2017, when the Fed signaled that it could increase rates in response to expected fiscal expansion, is not yet in our sample period.

[7] The underlying model is presented later.

Euro area faces predominantly supply shocks (for example wage pressures). Alternative explanation rests upon the different mandates of the Fed and the ECB. Whereas the Fed with a dual mandate may help the fiscal authorities to alleviate recessions, the ECB, focused solely on inflation, may anticipate inflationary pressures after a fiscal expansion.[8]

With respect to considerations in the section 2, these impulse-response functions lead to an increase of the fiscal multiplier in the ZLB for the Euro area, as the policy mix becomes looser in the ZLB (compared to normal times) and its decrease for the United States, as the policy mix becomes (paradoxically) more restrictive.

The reaction function of fiscal policy to monetary policy is of lesser importance, because the response is very small relative to the exogenous shocks to government spending and because the size of fiscal shock is recomputed per unit in the fiscal multiplier.

4. The Underlying Models for the United States and the Euro Area

Our analysis is based on reduced form VARs that are then identified by Cholesky decomposition. The vector of dependent variables consists of (i) interest rate, (ii) the quarterly growth rate of government spending[9] and (iii) the change of the output gap between quarters.[10] The choice of the exogenous vector follows Muscatelli, Tirelli and Trecroci (2002). The output gap is derived from log GDP and HP filtered using a smoothing parameter λ = 1 600. Data from national

[8] We have estimated several versions of analogous model for Slovakia as well, but we do not report it, because none was satisfactory. They had in common that the monetary policy was offsetting the fiscal shocks and the multiplier was greater in the ZLB environment (as in the Euro area).

[9] For the US, government spending is defined as government consumption and gross investments. For the Euro area such series has been available only since 2002. Therefore, we use government consumption as a proxy for government spending. We have tested the two series for the Euro area and found the paths of growth rates are to a great degree similar. There are somewhat larger short-term swings present in the series with investments; however the two series pass the tests of equality. We have carried out two versions of the one-sample Kolmogorov-Smirnov test against theoretical distribution, testing whether the difference of growth rates of government spending without and with investment is normal. We did it with an estimated mean and mean equal to zero. Neither of these tests were significant at the 5% level. Thus, we concluded that the difference of the two series is just noise and the series with more observations can be used.

[10] The series from national accounts are clearly integrated of order 1 and a transformation into stationary series is needed in order to get a stable model. We used differenced output gap instead of differenced output, because we assume that the used variables do not affect the potential output. We assume the interest rate to be stationary (regardless of statistical properties of the series in finite samples), because it is quasi a growth rate and, contrary to a random walk, has a lower bound. If all series were I(1), we could try to estimate a VECM model, capturing long run relations between the endogenous variables.The interest rate is stationary and used without differencing in our model, so that a VECM model is out of question in our case.

accounts is seasonally adjusted. For interest rates, we use the ECB policy rate (main refinancing operations, end of quarter) for the euro area and Fed Funds rate for the United States. We work with six period lag structure in the VARs.[11] The ordering in Cholesky decomposition follows Blanchard and Perotti (2002), i.e. government spending, output gap and interest rate for both the United States and for the Euro area. Although, automatic stabilizers are much more important in the Euro area and therefore, as shown in Dolls, Fuest and Peichl (2009),[12] output could have been ordered before government spending we follow the same ordering of both economies as it is standard in the most of literature. We used the sample 1970Q4 – 2015Q4 for the United States and 2001Q1 – 2015Q4 for the Euro area. The structural impulse-response functions of the identified VARs, reduced form residuals and the matrices for the transformation of reduced form residuals into structural shocks are used in further computations.

We assumed that fiscal and monetary policy does not affect potential output. This means that both policies are used for management of aggregate demand only. If potential output is affected, our results should be interpreted as the lower bound for the multiplier since if the policies affect potential output, they affect it in the same direction as output gap.

The information set (vector of endogenous variables) could be widened in more ways. Debt could be related to the size of the multiplier (Nickel and Tudyka, 2013), but it is the non-linear function of other variables in the model and its impact on output depends upon institutional settings. The fiscal policy in the US is less constrained by debt than the policy in the Euro area, even if the debt-to-output is higher in the US. This is the case because the debt is issued centrally in the US in domestic currency, whereas it is issued by member states in a currency they do not control immediately in the Euro area. Inflation was not included, as it is not in the focus of this paper and the impact of fiscal policy on

[11] The lag length was chosen so that the reduced form residuals are without lower order serial correlation or seasonality. For the US, the lag exclusion test for the sixth lag rejected the null hypothesis and residuals from VARs of lower order were clearly serially correlated. The tests were less clear for the Euro area, but residuals from a VAR with four lags still contained seasonality. Since the assumption about residuals being white noise is crucial for the consistency of the estimates, we decided in favor of a higher number of lags, ignoring the lag length criteria, which indicated lower numbers of lags. The problems with the serial correlation could be caused by seasonal adjustment, which changed the dynamic structure of the time series, but that problem is beyond the scope of this paper (we downloaded the series seasonally adjusted). Another justification for higher lag order is the fact that, according to overviews by Batini, Eyraud and Weber (2014) and Padoan (2009), multipliers tend to have a ∩-shaped path with a peak in the second year after the fiscal impulse and using more lags is more likely to fit this pattern.

[12] Dolls, Fuest and Peichl (2009) show that the welfare system in the Euro area offsets 21% of unemployment shock versus 7% in the US. If this difference was significant and the unemployment benefits started in the same quarter as the downturn that caused them, output could be ordered before government spending for the Euro area.

inflation is only indirect (through output gap). Including inflation in the model would necessitate assumptions about monetary policy being offsetting to fiscal policy (otherwise some impulse-response functions would have incorrect signs) and do not want to assume this.

Controlling for the ZLB during the Great Financial Crisis by excluding the ZLB regime is not feasible for the euro area because of insufficient history of the series. For the US however, the subsequent robustness check with the sample shortened until 2008Q4 leads to no significant changes in multipliers and their relations. Another option would be to use shadow rates instead, but these are unobservable and subject to great uncertainty. Estimating them would definitely go beyond the scope of this paper.

5. Details of the Computation of Compensating Shocks and Multipliers

The dependent vectors of the VARs consist of interest rate, growth rate of government spending and change of output gap. They are identified with Cholesky decomposition. After the estimation, the structural impulse responses, the residual and the transforming matrices are retrieved for each model. The transformation matrices can be made lower triangular by rearranging rows and columns. If e_t is the vector of reduced form residuals, u_t is the vector of structural shocks and R is the transformation matrix, $e_t = Tu_t$. The reduced form residuals were arranged into the matrix e and the matrices of structural shocks u_0 are computed as $u_0' = R^{-1}e'$. With C_j being the structural impulse responses, the endogenous series are replicated with the (truncated) AR representation

$$y^f = \sum_{j=0}^{T} C_j u_{0,t-j} \text{ or } y_f = C(L)u_0'$$

The fiscal expansion shocks are defined as a matrix Δu containing zeros apart from the first four values in the second column that are set to unity. The changed endogenous series were computed with AR representation

$$y_n = C(L)(u_0 + \Delta u)'$$

The reactions are computed as

$$difk = y_n - y_f$$

In further computations, *diff_r* denotes the reaction of interest rates to fiscal expansion and *d_r_r* (a scalar) denotes the reaction of the interest rate to own shock (from C_j) for the first period. For the computation of reactions in ZLB (with shocks both to government spending and interest rate we make iterations for $t_0 = 0$ to $T - 1$ (T being the number of observations):

In the iterations, we decrease the values in the first column of the matrix of additional shocks Δu in rows $t_0 + 1$ to T by dif_r_{t0+1}/d_r_r if $diff\_r$ is positive (or increase them, if $diff\_r$ is negative) while leaving the second column increased as indicated above. We compute

$$y_i = C\left(L\right)\left(u_0 + \Delta u\right)' \text{ a } diff\_i = y_i - y_f$$

We update $diff\_r$ as a value of $diff\_i$ corresponding to interest rates and go to next t_0. After the last iteration, we mark the $y_i = y_c$ and $diff\_i = diffc$. These are the reactions presented in Figures 3 and 4 as the values for ZLB. The shocks to government spending and interest rates from Figures 2a and 2b are given in the final version of Δu (the column for output gap containing zeros only was omitted in Figures 2a and 2b).

Finally, we compute the alternative paths for output and government spending for the fiscal expansion in normal times and in the ZLB (denoted in the following formula with the subscript h denoting either possibility) and compute the cumulative multiplier for lag j as

$$M_{h,j} = \frac{\sum_{t=1}^{j}(Y_{h,t} - Y_t)}{\sum_{t=1}^{j}(G_{h,t} - G_t)}$$

6. Results for the United States and the Euro Area

We begin our presentation of the results by presenting shocks. As the VAR models use differences for integrated variables, transitory shock to differences means a permanent shock to levels. In order to eliminate the short run fluctuations, we define the shock to government spending as a unit increase for four quarters. The results for a normal situation are therefore the four-period moving sum of the structural impulse-response functions.

The dotted lines are compensating shocks to interest rate, keeping the interest rate at the level before the fiscal shock. The difference between the Euro area and US is visible at first sight. While the shock is negative and thus expansionary for the Euro area (the monetary policy is looser in the ZLB regime than in normal times during fiscal expansion), it is mostly positive and tightening for the United States (where it is tighter than in normal times). The case of the Euro area corresponds to Figure 1c, whereas the case of the United States corresponds to

Figure 1b. This is the consequence of the different signs of the impulse response functions of interest rates to government spending shock discussed in the Part 3. The results for a normal situation (solid line in Figures 4 and 5) correspond to reactions to government spending shocks only; the results for the ZLB regime (dashed line) correspond to reactions to both shocks. Absolute values of compensating shocks depend on the reaction of the interest rate to spending shock and on the reaction of the interest rate to own shock in the first period (as shown in Part 5). Since the latter factor is much larger for the US than for the Euro area, the resulting compensating shock to the interest rate for the US is much smaller in magnitude than the shock in the Euro area.

Figure 3a
Additional Structural Shocks, Euro Area

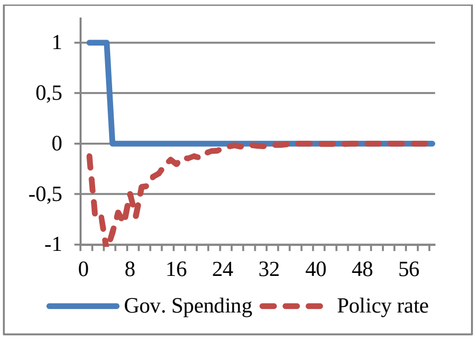
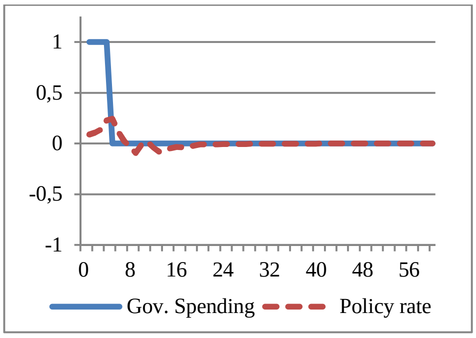


Figure 3b
Additional Structural Shocks, United States



Note: The horizontal axis depicts quarters.
Source: Own computations.

Reactions of the models to these shocks are shown in the next four Figures:

Figure 4a
Additional Changes in Government Spending, Euro Area

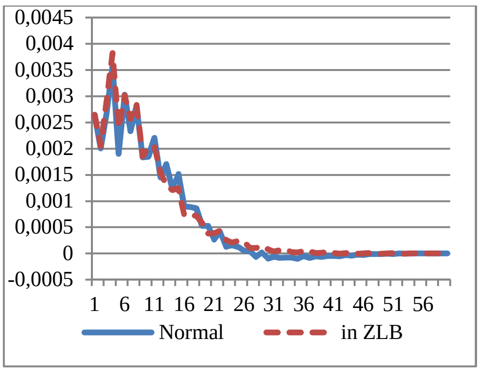
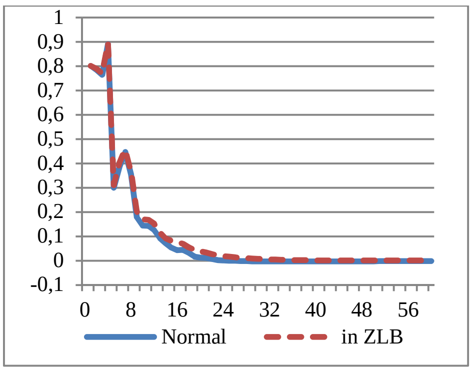


Figure 4b
Additional Changes in Government Spending, United States



Note: The horizontal axis depicts quarters.
Source: Own computations.

It is evident from the Figures 4a and 4b that the government spending has a considerable inertia and once there is an exogenous temporary increase, government spending keeps increasing endogenously for some quarters on. For example, infrastructure projects last several quarters or years and if a project is started, it is going to continue in subsequent periods. For this reason we present cumulative multipliers only, as we find a shock in a single quarter inseparable from its endogenous echo within the logic of our VAR models. It is evident as well that government spending reacts very weakly to changes in policy interest rates in both economies.

Figure 5a
Additional Changes in Output, Euro Area

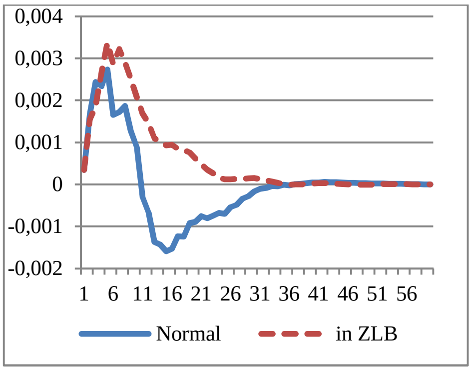
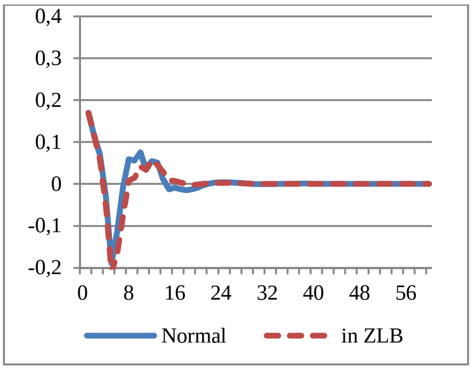


Figure 5b
Additional Changes in Output, United States



Note: The horizontal axis depicts quarters.
Source: Own computations.

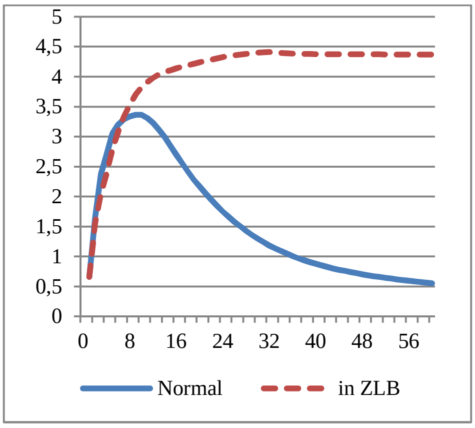
Different signs of compensating shocks to the policy rates make for a differentiated response of output. Whereas for the Euro area, the initial additional increase is later compensated by a drop, in the zero lower bound environment the increase is higher and there is no drop. This is the manifestation of the phenomena discussed in the section 3. (We always assume that the interest rate gap is big enough to stay non-zero for all values of compensating shock, so that the ZLB stays binding. The reactions thus shall be interpreted as upper bounds.) For the United States the paths in both scenarios are more similar. However, it can be seen that, when the differences are the largest, the curve for binding ZLB is under the curve for normal times. This difference is the result of additional tightening in fiscal expansion in the ZLB, as foreshadowed by positive compensating shock for that lag for the US.[13] Multipliers are computed by transforming the

[13] Reactions of interest rates were computed as well, but they are omitted for space reasons. Their reaction to government spending only was in fact moving sums of impulse-response functions if Figu re 1a and 1b and their reaction to both shocks were zero as this was the assumption of our computation.

aforementioned additional changes back into level and computing cumulative multipliers. They are shown in Figures 5a and 5b.

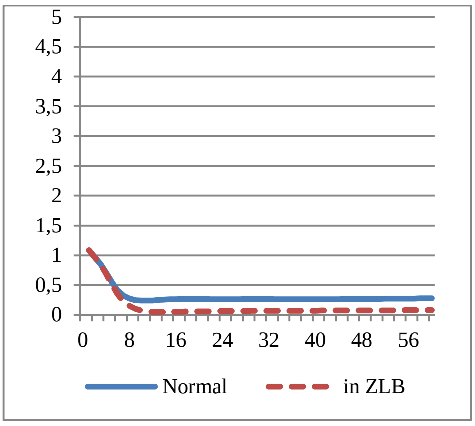
F i g u r e 6a

Fiscal multipliers, Euro area



F i g u r e 6b

Fiscal multipliers, United States



Note: The horizontal axis depicts quarters.
Source: Own computations.

For the Euro area, the multiplier first rises above unity in both situations, but then the paths diverge: while it decreases below unity in normal times, it rises further and converges to a high value in the presence of the zero lower bound. The absolute size of the multiplier in normal times is consistent with the reasoning of Paul Krugman cited by Müller, Hettig and Mueller (2015): the multiplier for a coordinated Euro area effort is much higher than the multipliers for single member countries. This is rationalized by spillovers of significant part of fiscal stimulus in a given member country to another member countries via foreign trade.[14] The effect of the negative compensating shock (which represents additional loosening of monetary policy during fiscal expansion) is quite large. In the United States, the multiplier starts at a value around unity and drops in normal times to a very low level and, if the lower bound on interest rates is binding, practically towards zero. The difference between this result and the conclusions of some earlier studies is caused by the fact that a structure inducing monetary policy to offset the fiscal expansion is imposed in the DSGE model, whereas the VARs we are using are completely agnostic and "let the data speak" in this regard.

One might argue that a different composition of government spending (see Footnote 2) might influence the absolute values of the multipliers. However, this is unlikely, as meta-analysis by Gechert, Hallett and Rannenberg (2015) implies

[14] This reasoning is given in a New York Times blog post „The economic consequences of Herr Steinbrueck" from December 11, 2008 by P. Krugman.

that multipliers of public investment tend to be higher than those of consumption, contrary to our calculations. The different sample could be another factor causing differences in computed multipliers as well. This sample difference means that the multipliers are likely to be greater for the Euro area, where a greater part of the observations corresponds to the global financial crisis, than for the United States, where GFC corresponds to smaller part of the sample. Our multipliers are indeed greater for the Euro area, but the offsetting shocks do not depend on the position of output gap, so that the change in multipliers due to ZLB is in our framework independent of possible change of multipliers due to recession.

The presented change in multipliers should be understood as an upper bound. First because the economy could transit from a zero lower bound regime to a normal regime, if there is a large negative compensating shock. Second because the central bank can use other tools (for example unconventional monetary policy) if the ZLB is binding, so that the impact of these tools substitutes for the impact of interest rates. In the case of the US, computations show how inefficient the fiscal policy in the US would be without the support of QE and other forms of unconventional monetary policy. In these circumstances, the multipliers in the ZLB would be closer to their normal values than indicated in the presented Figures 6a and 6b, but the sign of the changes may stay the same, depending on the reaction function of the central bank to fiscal expansion.

Conclusion

A binding (zero) lower bound of interest rates materially affects the efficiency of economic policy tools. It has been known for decades that fiscal policy is efficient in these circumstances. Recent studies based on DSGE models mostly confirm this result with some caveats. The purpose of this study was twofold: to relax the need for imposing strict structure to the model, (as DSGE models do) and to quantify the fiscal multiplier in ZLB regime. As the results depend on the sign of a specific impulse-response function of the VAR models, we are able to put the size of the multiplier in relation to the character of fiscal-monetary interactions We develop a way of constructing special shocks to interest rates that compensate their reactions to fiscal expansion and hold the interest rates constant, mimicking their behavior, when the lower bound is binding. We apply the shocks to moving average representations of structural VARs. With this approach, we also eliminated the need of non-constant parameters or discrete variables in our VARs. We apply the methodology was applied to the Euro area (on aggregate level) and to the United States. VAR models, in which we inserted the fiscal shocks and the compensating shocks, allow interest rates to rise (offsetting monetary policy) or drop (aligned with monetary policy) in response to fiscal expansion in normal times, contrary to DSGE models.

The fiscal multiplier in the ZLB then rises relative to normal times, if the monetary policy is offsetting in normal times and drops if it is aligned in nor mal times. For the Euro area, where the policy rates offset the fiscal expansion (e.g. they rise), the long run multiplier rises from below unity in a normal situation to above two in a ZLB. This result is analogous with that of Christiano, Eichenbaum and Rebello (2011). We find, similarly to Erceg and Linde (2010) that the multiplier decreases, if the fiscal expansion is large, as the economy is forced out of ZLB regime. For the United States, where the monetary policy is more aligned with fiscal policy (interest rates drop in response to fiscal expansion), the long run multiplier drops from 0.2 in normal times to zero in a ZLB because the character of fiscal-monetary interaction is different than in the euro area. This result, however, does not account for unconventional monetary policy that could be a substitute for interest rate movements.

References

ALBERTINI, J. – POIRIER, A. – ROULLEAU-PASDELOUP, J. (2014): The Composition of Government Spending and the Multiplier at the Zero Lower Bound. [SFB 649 Discussion Paper.] Berlin: Humboldt Universität.

ALTIG, D. et al. (2011): Firm-Specific Capital, Nominal Rigidities and the Business Cycle. Review of Economic Dynamics, Elsevier for the Society for Economic Dynamics, *14*, No. 2, pp. 225 – 247.

BATINI, N. – EYRAUD, L. – WEBER, A. (2014): A Simple Method to Compute Fiscal Multipliers. [IMF Working Paper, WP/14/93.] Washington, DC: International Monetary Fund.

BLANCHARD, O. – PEROTTI, R. (2002): An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output. The Quarterly Journal of Economics, *117*, No. 4, pp. 1329 – 1368.

BLINDER, A. S. (1982): Issues in the Coordination Of Monetary and Fiscal Policy. [Working Paper, No. 982.] Cambridge: NBER.

BUTI, M. – ROEGER, W. – in't VELD (2001): Stabilising Output and Inflation in the EMU: Policy Conflicts and Cooperation under the Stability Pact. Journal of Common Market Studies, *39*, No. 5, pp. 801 – 828.

BILBIIE, F. O. – MONACELLI, T. – PEROTTI, R. (2014): Is Government Spending at the Zero Lower Bound Desirable? [Working Paper.] Cambridge: NBER.

COENEN, G. et al. (2012): Effects of Fiscal Stimulus in Structural Models. American Economic Journal: Macroeconomics, *4*, No. 1, pp. 22 – 68.

DeLONG, B. – SUMMERS, L. H. (2012): Fiscal Policy in a Depressed Economy. Brookings Papers on Economic Activity, *43*, No. 1, pp. 233 – 297.

DOLLS, M. – FUEST, C. – PEICHL, A. (2009): Automatic Stabilizers and Economic Crisis: US vs. Europe. [Discussion Paper, No. 4310.] Bonn: IZA.

DRAGHI, M. (2016): On the Importance of Policy Alignment to Fulfil Our Economic Potential. 5th Annual Tommaso Padoa-Schioppa Lecture by Mario Draghi, President of the ECB, at the Brussels Economic Forum 2016, Brussels, 9 June 2016. Available at: <https://www.ecb.europa.eu/press/key/date/2016/html/sp160609.en.html>.

EGGERTSON, G. (2010): What Fiscal Policy Is Effective at Zero Interest Rates? In: ACEMOGLU, D. and WOODFORD, M. (eds): NBER Macroeconomics Annual 2010. Vol. 25. Chicago: University of Chicago Press.

EGGERTSON, G. – KRUGMAN P. (2010): Debt, Deleveraging, and the Liquidity Trap: A Fisher-Minsky-Koo Approach. [Mimeo.] Princeton, NJ: Princeton University.

ERCEG, C. J. – LINDE, J. (2010): Is there a Fiscal Free Lunch in a Liquidity Trap? [International Finance Discussion Papers 1003.] Washington, DC: Board of Governors of the Federal Reserve System.

FARHI, E. – WERNING, I. (2016): Fiscal Multipliers: Liquidity Traps and Currency Unions. Handbook of Macroeconomics, *2*, 2016, pp. 2417 – 2492.

FELDERER, B. – HOMBURG, S. (1992): Macroeconomics and New Macroeconomics. 2nd Edition. Berlin: Springer Verlag.

GECHERT, S. – HALLETT, A. H. – RANNENBERG, A. (2015): Fiscal Multipliers in Downturns and the Effects of Eurozone Consolidation. [CEPR Policy Insight, No. 79.] London: CEPR.

CHRISTIANO, L. – EICHENBAUM, M. – REBELO, S. (2011): When Is the Government Spending Multiplier Large? Journal of Political Economy, *119*, No. 1, pp. 78 – 121.

KILPONEN, J. et al. (2015): Comparing Fiscal Multipliers across Models and Countries in Europe. [Working Paper.] Frankfurt am Main: European Central Bank.

LAURENS, B. – de la PIEDRA, E. G. (1998): Coordination of Fiscal and Monetary Policies. [IMF Working Paper, WP/98/25.] Washington, DC: International Monetary Fund.

McMANUS, R. – GULCIN OZKAN, F. – TRZECIAKIEWICZ, D. (2014): Self-defeating Austerity at the Zero Lower Bound. [Discussion Papers in Economics.] York: University of York.

MEINUSCH, A. – TILLMANN, P. (2016): The Macroeconomic Impact of Unconventional Monetary Policy Shocks. Journal of Macroeconomics, *47*, No. A, pp. 58 – 67.

MICHAELIS, H. – WATZKA, S. (2017): Are there Differences in the Effectiveness of Quantitative Easing at the Zero-lower-bound in Japan over Time? [CESifo Working Paper Series 4901.] Munich: CESifo Group.

MÜLLER, G. J. – HETTIG, T. – MUELLER, G. (2015): Fiscal Policy Coordination in Currency Unions (at the zero lower bound). In: Beiträge zur Jahrestagung des Vereins für Socialpolitik 2015: Ökonomische Entwicklung – Theorie und Politik – Session: Common Currencies. Muenster: German Economic Association.

MUSCATELLI, V. A. – TIRELLI, P. – TRECROCI, C. (2002): Monetary and Fiscal Policy Interactions over The Cycle: Some Empirical Evidence. Munich: CESIFO.

NAKAJIMA, J. (2011): Monetary Policy Transmission under Zero Interest Rates: An Extended Time-varying Parameter Vector Autoregression Approach. The B. E. Journal of Macroeconomics, *11*, No. 1, pp. 1 – 24.

NICKEL, C. – TUDYKA, A. (2013): Fiscal Stimulus in Times of High Debt, Reconsidering Multipliers and Twin Deficits. [ECB Working Paper, No. 1513.] Frankfurt am Main: European Central Bank.

OLIVIER, Ch. – TAKANGMO, M. (2014): Government Spending Multipliers and the Zero Lower Bound in an Open Economy. [Scientific Series.] Montreal: CIRANO.

PADOAN, P. C. (2009): Fiscal Policy in the Crisis: Impact, Sustainability, and Long-Term Implications. [ADBI Working Paper Series, No. 178.] Tokyo: Asian Development Bank Institute.

WARMEDINGER, T. – CHECHERITA-WESTPHAL, C. – HERNÁNDEZ de COS, P. (2015): Fiscal Multipliers and Beyond. [Occasional Paper.] Frankfurt am Main: European Central Bank.

WOODFORD, M. (2011): Simple Analytics of the Government Expenditure Multiplier. American Economic Journal: Macroeconomics, *3*, No. 1, pp. 1 – 35.

ZEMAN, J. (2016): Fiscal Multipliers in Slovak Economy. [Working Paper.] Bratislava: National bank of Slovakia.