sciendo

UDK: 338.23:336.74
DOI: 10.2478/jcbtp-2019-0001

Journal of Central Banking Theory and Practice, 2019, 1, pp. 5-38
Received: 8 December 2017; accepted: 10 March 2018

Aleksandra Praščević* *, Milutin Ješić* *

* *Faculty of Economics University of Belgrade, Belgrade, Serbia*

E-mail: alja@ekof.bg.ac.rs

** *Faculty of Economics University of Belgrade, Belgrade, Serbia*

E-mail: milutinjesic@ekof.bg.ac.rs

Modeling Macroeconomic Policymakers' Interactions under Zero Lower Bound Environment: The New Keynesian Theoretical Approach

Abstract: The paper examines how the implicit coordination mechanisms between the policymakers could help in overcoming negative macroeconomic consequences which are provoked by the problem of zero lower bound (ZLB) on the nominal interest rates. For the long period of time, before the global recession started, the ZLB problem was not found to be interesting for researchers. Immediately after the crisis outbreak, more attention was put on that problem within different approaches since conventional monetary policy faced substantial limitation in overcoming business cycles. Many authors have proposed new unconventional measures in both monetary policy and fiscal policy sphere. The theoretical approaches to the ZLB problem include many different aspects. In the paper we chose to use regime switching models adjusted to simulate occasionally binding constraints in order to investigate different scenarios within the New Keynesian framework. We found that coordination between more passive monetary policymaker and more active fiscal policymaker is crucial in the ZLB environment. Central bank has to follow monetary policy rule in which both inflation stabilization and output stabilization have certain positive weight. However, credible policymaking which is supported by the relevant institutions is a necessary precondition for implicit coordination, which substantially decrease the losses occurred as a consequence of ZLB on interest rates.

Keywords: zero lower bound (ZLB), global recession, macroeconomic policymakers' interactions, New Keynesian model

JEL: C63, E17, E52, E63

1. Introduction

Varieties of substantial shocks hit the financial system and economy during the financial crisis in the USA in 2007 inducing a need for unconventional measures of monetary policy in overcoming such bad movements and economic downturns. The spillovers on the global economy required reaction of policymakers. Many of them were trapped into the zero lower bound (ZLB) environment.

In the literature, the ways for resolving this problem include two directions. In one, monetary policy is still sufficient to overcome negative consequences of the ZLB. This is usually done by introduction of some non-standard instruments. The other direction is routed by active fiscal policy. This idea has its roots in the Keynesian solution methods for problem of liquidity trap. Monetary policy is not the exclusive instrument for short-run macroeconomic stabilization any more. Fiscal policy tools became inevitable for stabilization and monetary policymakers lost their reputation as the most important authorities for successfully managing the economy. In this paper, the focus is on the second direction with special emphasis on coordination between monetary and fiscal policy in a ZLB environment. Therefore, we investigate how implicit coordination can induce activeness of fiscal policy in such environment.

We use the idea of Guerrieri & Iacoviello (2015a,b) to investigate the effects of fiscal interactive policy in the framework of standard New Keynesian model, modified to ZLB conditions. We consider a deterministic version of the model and assume finite time horizon and particular path of the shocks, with advantages in simplicity and fastness of the calculation process even if there are many state variables in the model.

In our simulation analysis, we explore four different scenarios in order to find possible effects of the interactions between fiscal and monetary policymakers within the ZLB environment. The first scenario uses standard calibration, which is similar to the original Taylor rule. In addi tion, we assume one-off government expenditure shock. The second scenario is the same as previous, but the government expenditure shock is not one-off. The third scenario has a different calibration. We assume that monetary policymaker is oriented only toward inflation gap, and output gap is not present in the monetary policy reaction function. Finally, the last scenario is different in comparison with the previous because we introduce more active fiscal policy.

The paper is divided into six parts. After the introduction, we briefly presented literature review in the second chapter. After that, we made the introduction for

the analysis of interaction between the policymakers in the ZLB environment by emphasizing the key causes and repercussions of ZLB. In the same chapter we analysed the lessons for monetary policy, fiscal policy and their coordination in this environment. In the fourth chapter, we explained the methodology and model which we employed in our analysis. In the fifth chapter we discussed the results that we had obtained from the simulation of interaction between monetary and fiscal policy in ZLB. Finally, the sixth chapter presents the conclusions.

2. Literature review

Before the global recession (or the Great Recession[1]), mainstream macroeconomic analysis[2] and general macroeconomic policy framework included the following principles (Blanchard, Dell'Ariccia, & Mauro, 2010, Mishkin, 2010, Romer, 2011).

First, monetary policy had only one target – a low and stable inflation rate (around 2 per cent), which would induce a zero output gap, according to stylized New Keynesian model with real wage rigidities (Blanchard & Gali, 2007). Inflation was viewed as exclusively monetary phenomenon where price stability had significant benefits and there was no long-run trade-off between inflation and unemployment, along with crucial role of expectations in determining inflation.

Second, just as the monetary policy should have only one target, it should hold only one instrument – policy interest rate as short-time interest rate that could be under direct control of open market operations by central bank. The Taylor principle is crucial, according to which the real interest rate should increase with higher inflation (Taylor, 1993).

Third, fiscal policy should have a limited role in short-run stabilization due to several reasons – Ricardian equivalence, superiority of monetary policy in achieving macroeconomic stability, priorities of debt stabilization in many countries, time lags in design and implementation of fiscal policy which are far more present than in the monetary policy, political motivation and pressures in designing fiscal policy which are problematic and unenviable. Instead of politically motivated fiscal policy the monetary policy could achieve more efficiency by using central bank independence and overcoming time-inconsistency problem (Barro & Gordon, 1983).

---

[1] It is similar to the name of previous period which was the "Great Moderation".

[2] Most of the pre-recession macroeconomic tenets are part of the "new neoclassical synthesis" (Goodfriend & King, 1997).

Forth, although the economists were well aware that financial frictions are important for business cycles, financial regulation as a macroeconomic policy tool has been ignored for long time. Finally, there was an important tenet of pre-recession macroeconomic framework that macroeconomic fluctuations are well under the control, due to steady decrease in cyclical fluctuations since 1980s. That was important for the conclusion that economic policy conducting has been successful, especially in the field of monetary policy strategy (i.e. "the science of monetary policy", Mishkin, 2010).

Although the monetary policy did its job good for a long time before the global recession started, with low inflation rate and low and stable output gap, there was some concern about the effects of low inflation rates on falling economy into the liquidity trap due to zero bound on nominal rate. However, the problem of ZLB on nominal interest rate seemed to be unimportant and short-lived phenomenon. In most of literature before the recession such opinion had been explained with different arguments which included mechanisms in order to overcome potential problem. Among these arguments is the claim that the only simple modification of the Taylor rule should be sufficient for the overcoming of ZLB on nominal rates during severe contractions of economic activity (Reifschneider & Williams, 2000). Similar view was provided in the paper by Gunter, Orphanides & Wieland (2004), where it was found that the consequences of the zero bound constraint are negligible for target inflation rates as low as 2 percent if the economy is subject to stochastic shocks similar in magnitude to those experienced in the USA over the 1980s and 1990s.

Inspired by the experience of the liquidity trap in Japan during 1990s when the Bank of Japan had a little space for further reduction of short-term nominal interest rates during the ongoing deflation, Eggerston and Woodford (2003) propose alternative tools including management of expectations regarding future conduct of policy or just as Krugman indicated earlier: monetary authorities should "*credibly promise to be irresponsible*, to seek a higher future price level" (Krugman, 1998, p.139). Similar was proposed by Svensson (2003) within his "Foolproof Way" as the optimal plan to escape from a liquidity trap and deflation which should include: explicit commitment of the central bank for future higher inflation, concrete actions for fulfilling the goal of higher prices in order to induce appropriate expectations, an exit strategy how to get back to normal policy.

However, the Great Recession imposed the need from monetary economists to modify their earlier analysis by requiring a total rethink about the problem of ZLB since it was far more important than they earlier realized in analysis which was based on structural models in which the ZLB episodes cannot be generated

and long sustained (Chung, Laforte, Reifschneider & Williams, 2012, Dordal-i-Carreras, Coibion, Gorodnichenko & Wieland, 2016). The global recession together with poor post-recession recovery which is often called the "age of secular stagnation" (Summers, 2014), induced a need for a new macroeconomic policy framework and the concept of liquidity trap was back in fashion, especially extensive in the New Keynesian literature (Krugman, 2014, Williamson, 2017). That necessity is connected with a change in macroeconomic thinking considering both the monetary and fiscal policy.

The new macroeconomic literature – during recession and in post-recession period, include topics of how much monetary policy was effective despite the ZLB problem, including the undertaken unconventional measures of monetary policy which were added to the traditional measures (Rudebusch, 2009, Taylor & Williams, 2009, Mishkin, 2010, Williamson, 2017), the role of expectations and possible effects of raise in inflation target during the ZLB episodes (Svensson, 2009, Coibion, Gorodnichenko & Wieland, 2012, Dordal-i-Carreras et al., 2016), effects of quantitative easing in stimulating aggregate demand (Williamson, 2016) and why monetary policy should contain an element of risk-management behaviour since nontraditional monetary tools are imperfect substitutes for conventional policy (Evans, Fisher, Gourio & Krane, 2016). The literature also explores what we have learned about the fiscal policy changes in order to be effective tool for short-run stabilization during the prolonged ZLB episodes and what are the consequences of expansionary fiscal policy (Romer, 2011).

The fiscal policy became an important issue not only for overcoming recession but also during the post-recession period. Therefore, extensive literature focuses on fiscal multipliers measurement in order to calculate effects of fiscal stimulus (Cogan, Cwik, Taylor & Wieland, 2010, Cwik & Wieland, 2010, Auerbach & Gorodnichenko, 2011, 2012, Coenen et al., 2012), but also the effects that could be expected of potential austerity measures which were taken in some economies due to public finance problems (Jaksic & Jesic, 2016). Therefore, effectiveness of alternative fiscal policy approaches in stabilizing economies (countercyclical fiscal policy), including the issue of how long fiscal activism should be implemented, together with the problem of double-dip recession that austerity measures could induce was in the focus of macroeconomics.

However, after the recession ended, some tenets of pre-recession framework could still hold and disputes still exists whether the monetary policy during the recession was after all effective, taking into account that despite the fact that the initial shocks from financial crisis were far more substantial than those which induced the Great Depression, the fall in economic activity was less severe.

That could be the result of aggressive and, after all, suitable monetary policy response (Mishkin, 2010), together with changes in fiscal policy. Although the New Keynesian models are in many aspects similar to neoclassical models with emphasizing crowding out effects of private consumption, many of them recently confirmed in theory that government spending shocks can have large multipliers in circumstances of ZLB on nominal interest rates (Woodford, 2010, Christiano, Eichenbaum and Rebelo, 2011).

3. Zero lower bound on interest rates: causes and repercussions

The Great Recession, as the most dramatic worldwide economic contraction since the Great Depression in 1930s, brought the problem of zero lower bound (ZLB) on nominal interest rate as one of the most important causes for ineffectiveness of monetary policy in managing economic recovery. That problem also induced a new role for fiscal policy as it has become the key instrument to be used in overcoming the recession pressures, as well as during the post-recession period of long-term stagnation. However, fiscal policy was constrained by high debt/GDP ratios in many countries due to huge discretionary fiscal stimulus during the recession. Therefore, the unconventional policy instruments, both in monetary and fiscal policy, had to be undertaken in order to overcome the ZLB problem with interest rates.

The legacy of the global recession concerns lessons that macroeconomists learned about fiscal and monetary policy since the recession ruined some of the most important foundations of macroeconomic policymaking. The central place among them takes the problem of ZLB on nominal interest rates which became central to the behaviour of macroeconomy instead of being a minor issue (Romer, 2011, Mishkin, 2010), as it was before the recession started – during the "Great Moderation" in the most advanced economies[3]. That problem contributed to abandoning monetary policy as the exclusive instrument for short-run macroeconomic stabilization. Instead of monetary policy, fiscal policy tools became inevitable for stabilization.

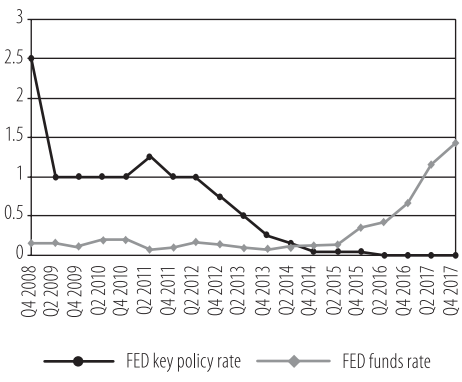
As we already mentioned, before the global recession started, there was almost consensus between monetary economists that the ZLB could happen only temporarily and not so sharply. Conventional monetary policy in the pre-recession period was based on "flexible inflation targeting" according to the theory of op-

[3] The period started in early 1980s characterized by low inflation, low variability of inflation, as well as by declining output volatility.

timal monetary policy –central bank sets its policy instruments (a short-term interest rate) to maximize the objective function subject to the constraints. The theory and corresponding model included: 1) the central bank's objective function which includes minimizing deviations of inflation from its optimal rate and minimizing deviations of real economic activity from its natural rate level; 2) constraints which include that there is no long-run trade-off between unemployment and inflation in the world of rational expectations with transmission of monetary policy to the economy through the real interest rate so the real interest rates have to rise in order to stabilize inflation (just as in the Taylor's rule); 3) use of a linear quadratic (LQ) framework – the equations describing the dynamic behaviour of the economy are *linear* (a basic feature of DSGE models), and the objective function specifying the goals of policy is *quadratic* (Mishkin, 2010, p. 14).

Although the monetary policy could be more flexible than fiscal policy, it appeared to be ineffective in situation when the economies were suffered from the shocks which were far larger than anyone could expect. As response to the collapse in global aggregate demand central banks cut their nominal rates to close to zero. That happened with the FED that lowered the federal funds rate closely to zero and has kept it there from December 2008 until December 2015 (during that period the target rate remained at 0.00–0.25%). Similar policy could be found with the ECB policy in the euro area which had even more complicated institutional constraints connected with explicit commitment of the ECB to price stability (figure 1). That was the reason why the ECB had less potential for implementing unconventional monetary measures. European policymakers, especially fiscal authorities all around the euro area, faced with the problem of incompleteness of the economic union in the field of fiscal policy together with the public finance problems and a sovereign debt crisis in many European countries. Besides the central banks in developed countries, central banks in emerging economies, including the SEE countries, were gradually reducing the interest rate and also took specific measures aimed at supporting the recovery (Krstevska, 2015, p. 44).

Graph 1: Policy rates in the USA and the euro area



Source: *ECB https://sdw.ecb.europa.eu/browseTable.do?node=9691107*

FED *https://fred.stlouisfed.org*

Although the cyclical fluctuations are unavoidable way of the market economies functioning, the challenge of the ZLB problem which policymakers were facing for too long, as a result of the massive contraction shock from the financial crisis, did not fit to any earlier macroeconomic experience. The only comparison could be with experience of Japanese liquidity trap during the 1990s. Therefore the concept of the liquidity trap which was established by John Maynard Keynes during 1930s (Keynes, (1987 [1936])) has been revitalized. However, the nature of these two problems is different, including their causes, characteristics, and ways for overcoming.

3.1. Lessons for monetary policy – expansionary and innovative approaches

Before the Great Recession started, flexible inflation targeting in which the monetary policy focused on minimizing inflation and output gaps was loudly proclaimed. However, possible solutions for the ZLB problem include some unconventional elements which could be summarized as following (Mishkin, 2010, Williamson, 2017):

a. raising the central bank's inflation target;
b. quantitative easing (QE) with expansion of central banks' balance sheets and large-scale asset purchases of both government securities and private assets;
c. negative nominal interest rates;
d. liquidity provision when central banks expanded lending to both banks and other financial institutions;
e. helicopter money;
f. management of expectations by commitment of the central banks of keeping their policy rate at very low levels for a long period of time.

When the recession started, the U.S. monetary authorities (Federal Open Market Committee - FOMC) immediately exploited the usual monetary policy response – a reduction of the federal funds rate to its lower bound of zero. According to the policy rate rule that was guideline for federal rate settings (the so-called Taylor's rule) for two decades before the recession started, the rate should be related to movements of the inflation rate and unemployment rates[4]. The FED's actual

[4] It was recommended to lower the funds rate by 1.3 percentage points if core inflation falls by one percentage point and by almost two percentage points if the unemployment rate rises by one percentage point.

policy followed that rule with only few and small exceptions (in the mid-1990s and mid-2000s). That could be found also for the episode of monetary policy when the recession started in 2007 and when the FED lowered the rate by over than 5%. However, the rate has been stuck to zero bound and further decrease that will follow the Taylor's rule would need that the rate has to be reduced to –5% by the end of 2009. But since the rate couldn't be so reduced to become negative, *the monetary policy funds rate shortfall* appeared to be important problem that had to be neutralized by other unconventional monetary measures (Rudebusch, 2009). That situation in USA lasted for long eight years, during which several questions were opened in order to overcome the problem of inefficiency of the monetary policy.

First question related to the optimal inflation rate. Since the nominal rate could not be reduced sufficiently to stimulate the economy, the mechanism which will use the real interest rate should be exploited more extensively and that could be done by increasing an optimal inflation rate up to 4% (Blanchard et al., 2010). Yet, such increasing of the optimal inflation rate could be too costly for the whole economy since increased inflation rate could induce negative effects on business and household decisions whenever it rises above 3% (Mishkin, 2010, p. 33)[5]. Due to temporarily destabilizing long-term inflation expectations could lose their anchor (Issing, 2011). Also, macroeconomic stability with rising inflation targeting could be taken into question since commitment strategies of central banks could be seen not time-consistent any more[6]. That is why, although the higher inflation could have well-known benefits during the recession periods, previous level of targeted inflation rate (up to 2%) has been still valid during and after the recession.

Second question is related to the effects of the fall in real interest rates which could be found for decades before the recession started and which could be connected with financial frictions that started the financial crisis. Decrease of the real interest rates which started in the pre-recession period, due to several reasons did not have only positive consequences on fostering economic activities, but also negative in the form of emerging financial bubbles which induced the financial crisis in 2007. According to Krugman the US real interest rates averaged over peak-to-peak business cycles dropped from 5% in the 1980s, to 2% in the 1990s, and to just 1% in the 2000s, after the Lehman collapse and recession

[5] Economic records from 1970s in the USA and other industrialized countries leading to what is known as "The Great Inflation" period.

[6] Over the last decades, central banks have made up to 2-percent inflation target credible, securing price stability.

started the real rates have averaged about -1%. Similar decline could be found in the euro-zone (Krugman, 2014, p. 63).

Although low nominal and real interest rates could stimulate economic activity which did not happened sufficiently during and after the Great Recession, they could also undermine financial stability. That could lead to dichotomy between the monetary and financial stability policy which was present in the macroeconomic models and practice even before the recession started. The unconventional monetary policy measures which were applied during the recession to stabilize output around its natural rate level in the short run made that problem of dichotomy even more important (Mishkin, 2010).

The third question is related to the role that expectations could have in overcoming the ZLB problem. Increase in targeted inflation rate can also help to prevent inflationary expectations from falling down to too low a level, inducing more recessionary pressures. Expectations could be very important for overcoming the ZLB problem, just as it was suggested in the literature before the recession started (Eggerston & Woodford, 2003, Svensson 2003, Krugman 1998). Expectations have a decisive role, both in explanation of economic downturns and in shaping the long-run interest rate. Theoretically, the management of expectations can stimulate aggregate demand when the policy rate is stuck at the ZLB by using commitment that short term interest rates will be low for a substantial period of time. That will help lower long-term interest rates and also raise inflation expectations, thereby reducing the real interest rate.

The final question is connected to issue of how to create the exit strategy for central banks after long-run unconventional monetary policy conducting which could have obstructive effects on the ability of monetary policy to manage the economy in the future. The problem is far more important if we take into account that low nominal and real interest rates during long period undermine financial stability by increasing risk-taking behaviour of investors and promoting irresponsible lending by commercial banks. The details on non-conventional measures and its repercussions can be found in Kyriazis, N.A. (2017), Bastidon, C., Gilles, P. & Huchet, N. (2016) and Jakl, J. (2017).

3.2. The revival of fiscal policy

The policymakers` reactions to the global recession were in a Keynesian manner, in order to ensure that painful recession will not turn into deep economic depression. After decades during which most of mainstream economists had completely abandoned faith in economic policy activism, Keynesian expansion-

ary policies were reborn. That is particularly correct for extensive fiscal stimulus which was undertaken immediately when the financial shock occurred and when the policymakers understood that severity of the shock overwhelmed the potency of conventional monetary policy to stabilize the economy. Soon after that the "pragmatic Keynesians" revitalized the concept of fiscal policy stimulation as the key way for overcoming severe recessions. Just as the Keynes originally suggested monetary authorities were first to react to the recession, but when these measures had been exhausted the policymakers should turn to the fiscal policy.[7]

The massive fiscal interventions were required due to large contraction shocks that followed the financial crisis, making huge fall in global aggregate demand. And just as the theory suggested even before the Great Recession started, massive financial crisis is often followed by very slow economic growth during which economies face with public finance problems with bad budgetary positions of the governments. All of these make fiscal policy conducting even more complicated, but vital for fostering economic activity and preserving the level of aggregate demand.

However, if we go back to the lessons we have learned about the fiscal policy during the global recession they consist of several important issues. First, the recession highlighted limits of the stabilization policies which were based exclusively on monetary policy, as more flexible than fiscal policy. Yet, implementation of substantial discretionary fiscal stimulus during the recession was needed in almost every economy, including advanced economies (USA, EU, and Japan), economies with emerging markets and developing economies. Most of the governments had to abandon its fiscal rules, and not rely on automatic stabilizers, whose effectiveness is adequate during minor contractions in economic activity, but do not help in the fight against strong economic recession.

The IMF recommended huge discretionary fiscal stimulus for all economies whose financial systems could sustain it. The fiscal expansion had to be extensive enough to compensate for decrease in private demand and able to last long given uncertain duration of the recession. It also had to be sufficiently diversified because impacts of the specific fiscal measures could not be estimated in advance (Spilimbergo, Symansky, Blancard & Cottarelli, 2008). Such fiscal expansion had to be sustainable in the medium term, but also capable to eliminate possible negative effects on behavioural response of consumers and companies (crowding-out effects not only in the short run, but even more important in the long run due to

[7] Keynes was primarily a monetary economist and he claimed to use the fiscal policy intervention as supplement to monetary policy, and whenever the monetary policy became ineffective.

the debt accumulation) and whether the crowding-in effect of private spending and investments could be expected once the cuts in government spending replace the fiscal stimulus during the fiscal consolidation. In that context it is very important to estimate how long the ZLB problem is going to exist since expansionary government spending shocks are less likely to crowd out private consumption or investments during that period.

Second, the fiscal policy appeared to be more effective than it was proved to be before the global recession. For these reasons the composition of the fiscal stimulus was very important. The stimulus has to focus not only on consumers - households, but also directly on companies, since they were facing a severe reduction in demand for their products, and uncertainty about future economic trends. Therefore, fiscal stimulus was related to tax cuts, increased government spending, or a combination thereof. However, according to the practice the main fiscal measure refers to increase of government expenditures mainly for infrastructure projects and programmes connected to the industrial policy implementation, which has been back on the agenda of policymakers.

By turning policymakers to different fiscal tools, a need to calculate the short-run effects of certain fiscal policy measures emerged extensively. Policymakers should know the size of fiscal multipliers in order to create effective composition of fiscal stimulus. The effects of fiscal measures which were taken are primarily measured through their influence on job creation, as well as on their impact on reduction of amplitude of cyclical contractions (in the form of falling GDP).[8] It is important to measure effects on several macroeconomic aggregates, not just on GDP.

However, the fiscal multipliers measurements are highly regime dependent, meaning that they depend greatly on the monetary regime which is used. In that context, a kind of coordination between fiscal and monetary policy could be of special interest, as well as the issue of which of these two instruments should be used as a leader in economic policymaking (fiscal or monetary policy). The fiscal multipliers also depend on the state of the economy – effects of fiscal stimulus vary over the business cycle, as well as on the different fiscal instruments which are used in fiscal stimulus package. According to the old-Keynesian models, an

[8] Some studies estimated that effects of the U.S. fiscal stimulus packages were in the creation of 3.3 million (Romer & Bernstein, 2009) to 3.7 million jobs (Zandi & Blinder, 2010) until the end of 2010, and according to the estimates of the Council of Economic Advisers, they affected the U.S. GDP growth by 2%-3% in the second and third quarters of 2009, and the growth of employment by 600,000 to 1.1 million jobs in the third quarter of 2009 (Gravelle, Hungerford & Labonte, 2009).

increase in government spending rather than increases in transfers or tax rebates boosts total spending (and total GDP) more than one for one. That is a mechanism of traditional Keynesian multiplier effect.

Yet, the problem of fiscal multipliers measurement is even more complex, since multipliers also depend on expectations of future economic movements and future policymakers` measures, made both by consumers and business sector, as well as on the share of non-Ricardian households in the economy[9]. It is also important to consider if the monetary policy could not be used by national policymakers due to the existence of a monetary union, which also makes the measurement of fiscal multipliers even more complicated.

According to massive empirical research and literature following results can be summarized. First, fiscal policy is considerably more effective in recessions than in expansions with considerably larger multipliers during downturns than during the booms, or average economic circumstances. Thus, the multiplier of government spending increases by 0.6 to 0.8 units during recession. These effects are even more important in circumstances of the ZLB problem (Wieland, 2011). Second, multipliers of disaggregate spending variables behave differently in relation to aggregate fiscal policy shocks. Therefore, fiscal transfers during the recession became most effective which was not the case during average economic circumstances. On the other hand, tax changes do not show such regime dependence in their impacts. Third, spending multipliers exceed tax multipliers during the recession even more than during normal times (Acocella, Di Bartolomeo & Hallet, 2016, p. 166).

An extensive empirical research of fiscal multipliers measurement during the global recession and in the post-recession period provide conclusions according to which the fiscal policy roles and objectives are far more complex than before the great recession started. The medium and long-run objectives of fiscal policy in terms of providing sustainability of public services and social equity, as well as in achieving sustainable public finance in the long run (low public debt and budget deficit), that had been exclusively important for a long time before the global recession, were replaced with short-term stabilization goals. Yet, these changes did not last long enough and austerity measures were introduced in

[9] Abandonment of fiscal policy effectiveness among mainstream macroeconomists before the global recession had been largely based on the Ricardian Equivalence Hypothesis (Barro, 1974). If there is a large share of non-Ricardian households, just as it occurred in the euro area, then the fiscal policy measures have large Keynesian effects – effects on the real GDP growth up to 1.6 percentage points of discretionary fiscal expansion during the Great Recession (Coenen et al. 2012).

many economies, especially in European economies. These measures had some counterproductive effects on growth, employment and public deficit. Success in the austerity measures implementation included achievement in avoiding another recession to start, and economies stayed far away from their full-employment and prosperity[10]. However, these effects were easy to predict in the context of Keynesian doctrine according to which the policymakers have responsibility to provide employment to everyone. So, just as Joseph Stiglitz mentioned: "Yes, we were all Keynesians – but all too briefly".

Therefore, in order to describe poor economic situation in advanced economies during the post-recession period, Larry Summers reintroduced the term and concept of "secular stagnation" which was invented in 1938 by a famous American Keynesian economist – Alvin Hansen, who was worried if there would be sufficient investment demand to sustain future economic growth in the USA, since the U.S. economy faced a crisis of underinvestment and deficient aggregate demand. Therefore, he strongly recommended fiscal stimulus (Hansen, 1939), claiming that fiscal policy is vital for maintaining the aggregate demand at the level which corresponds to the full-employment equilibrium in specific circumstances of the U.S. economy during late 1930s which can be compared in many elements with the recent post-recession situation of weak recovery and shortages in the global aggregate demand.

In accordance with the concept of secular stagnation, the following claims could be important for macroeconomic conditions during the post-recession period (Teulings & Baldwin, 2014, p. 2):

g. Negative real interest rates are needed to equate saving and investment with full employment.
h. It is much harder to achieve full employment with low inflation and a zero lower bound (ZLB) on policy interest rates.
i. The old macroeconomic toolkit is inadequate.

The economic strategy which had been applied during the recession as combination of expansive monetary policy (deep cuts in interest rates and monetary quantitative easing) and expansive fiscal policy (rising public spending and cutting taxes) was successful since the second Great Depression did not happened. However, in many economies governments returned to a more orthodox approach

[10] The EU economies witnessed the double-dip recession and some of them even a triple-dip recession. In 2013, almost 27 million Europeans were unemployed and similar situation happened in the U.S. with a huge number of half-time employed workers who would like to find full-time job, but unsuccessfully.

in policymaking just as the recession ended, no matter how weak the recovery was. Such approach included a mix of expansive monetary policy and tight fiscal policy (cutting government spending and raising taxes) in order to solve the public finance problems and to avoid new recession. However, that policy mix was not sufficient to ensure lasting and strong economic recovery. Instead, more aggressive use of fiscal policy, just as Hansen suggested for circumstances during the late 1930s (during the age of secular stagnation) should have been included. Finally, policymakers have to have in mind that fiscal policy objective is not price stability but fiscal policy measures like tax increase or public consumption increase that can directly influence price stability (Fabris, 2018, p. 7).

3.3. The interactions between macroeconomic policymakers in the ZLB environment

The key aspect of view on the broader picture of ZLB repercussions is the revival of the coordination paradigm. It is worth emphasizing that coordination between the policymakers can be understood in different ways. The mechanisms used for coordination of actions of the policymakers can be roughly divided into two categories: institutional and operational ones. The interactions between the creators of monetary and fiscal policy are common on day-to-day basis, but sometimes more important are informal rules of conduct, which have their origins in the institutions. These institutions represent the rules of the game. Therefore, in that context, the implicit coordination is very important and influences the outcome of the game, irrespectively of the presence of the formal interactions between the policymakers.

From the theoretical point of view, institutional mechanisms of coordination are more oriented towards analysing the problem of interactions between monetary and fiscal policymakers by the concept of game theory. On the other side, operational mechanisms are more visible. They are used for the implementation of the previously made decisions about the policy making, and for the observation of conduct of the counterparty in the process. Therefore, they have a valuable role in the creation of expectations and policy reaction functions.

Under the ZLB constraint some monetary policymaker's actions induce the interaction with the fiscal policymaker on the operational level. Some unconventional measures of monetary policy are based on the government securities. Also, the low level or even zero level of nominal interest rates has negative influence on the demand for government securities. Attractiveness of securities can substantially decrease in the period of ZLB constraint. In many countries the monetary

policymaker is responsible for maintaining financial stability. In the case of low interest rates, the investors behave riskier in order to make targeted earnings. In these situations, there is a broad manoeuvre space for coordination between monetary and fiscal policy with the purpose of maintaining financial stability. Finally, in small open economies there is a need for operational coordination between monetary and fiscal policy to address the problem of exchange rate movements. This is especially emphasized in the conditions of high public debt and ZLB because the conflict between monetary and fiscal policy can be revived.

On the other side, institutional mechanisms of coordination are extremely important for resolving the problems which arise as consequences of ZLB. Institutional mechanisms are grounded on the institutions. Good institutions help to overcome the negative effects of ZLB, by employing formal and informal (implicit) mechanisms of coordination. Inclusive formal institutions provide the procedures to decrease the negative effects and spillovers. This is achieved by rare or even without any formal interaction between the policymakers. Contrary, weak institutions provide the outcomes that are extremely sensitive to the shocks, which could make the cooperation between the policymakers impossible to sustain. The main consequence is that macroeconomic stability is more vulnerable to shocks, especially because of ineffectiveness of some policy instruments in the ZLB environment.

Finally, we want to emphasize the importance of implicit coordination in the presence of ZLB. In the process of policymaking, each policymaker forms expectations of the behaviour of the other one, and they try to guess the correct policy reaction function of the counterparty. In the presence of ZLB, the fiscal policymaker observes approximately the policy reaction function of the monetary policymaker and *vice versa*. Fiscal policymaker is aware of more passive monetary policy in the ZLB environment as a response to the fiscal expansion. The behaviour of central bank in the ZLB conditions makes broad manoeuvre space for fiscal policymaker, which actions are not constrained by the response of the monetary policymaker. In addition, output gap is the variable in which the fiscal policymaker is usually interested. Based on the above-mentioned facts, the fiscal and monetary policymakers implicitly coordinate their actions in those conditions.

The central role in such environment is placed on the fiscal policymaker, which has to reduce the negative consequences imposed by ZLB on welfare function because the hands of the monetary policymaker are tied. This is the case which we analyse in the next chapters. When ZLB stops binding, monetary policymaker credibly follows the standard Taylor rule, and fiscal policymaker again observes

that its actions can be at least partially neutralized by monetary policy tightening. Therefore, by the mechanism of implicit coordination, fiscal policymaker adjusts its instruments with respect to the current (normal) conditions. According to Woodford (2010, p. 41.) in normal times when the ZLB is not binding, there are many reasons for leaving output-gap stabilization largely to monetary policy. This implies that fiscal policy has the goal to satisfy the principle of efficient composition of aggregate expenditure.

4. Methodology, theoretical model and simulation scenarios

4.1. Underline methodology

The problem of ZLB on interest rates can be analysed in different frameworks. One very popular framework in recent times employs the regime switching models with purpose of occasionally binding constraints modelling. More precisely, the switches between the reference regimes can be exogenous or endogenous. However, endogenous switches characterize our problem. Therefore, there are two different paths in order to find the solution for these models. One option is very popular and relatively new – the projection method. This method is used because the standard perturbation method cannot be used when regime switches are endogenous. The problem with the projection method is that computer software is very slow in the process of finding a solution in cases where there are many equations and variables in the model. In addition, it is more technically sophisticated in comparison with the perturbation method.

One easy way to deal with the abovementioned problems related to occasionally binding constraints is developed by Guerrieri & Iacoviello in their 2015 paper "OccBin: A Toolkit for Solving Dynamic Models with Occasionally Binding Constraints Easily". The idea can be summarized in as follows. First, we have to assume in which period the constraint is binding. When we find the path of the endogenous variables, we check whether it is consistent with the initial guess of the periods while the constraint is binding. If it is consistent, that is the end, if not, we have to make another guess, and again follow the iterative procedure. The main advantage of this method for dealing with occasionally binding constraints is that it is much faster than other methods because it delivers a solution easily, almost irrespectively of the number of the state variables, and it is simpler. However, this simplicity does not affect the accuracy of the results under the reasonable calibrations of the model, which is shown in the main paper of Guerrieri & Iacoviello (2015a, p. 36) and Separate Appendix (2015b, p. 2). The main

disadvantage is that the method disregards the possibility that economy could be pushed in the ZLB environment in the future, i.e. the economy is shifted to ZLB completely unexpectedly and it is assumed that it will not be in that position ever again.

Our motive was to analyse the interaction between macroeconomic policymakers in the environment of ZLB, which is occasionally a binding constraint. In addition, we wanted to analyse the performances of different monetary policy rule specifications and the effectiveness of the fiscal policy in the environment of ZLB on interest rates. We use the idea of Guerrieri & Iacoviello (2015a,b) to investigate these effects, but in the framework of standard New Keynesian model, modified to analyse this kind of environment. We considered a deterministic version of the model and assume finite time horizon and particular path of the shocks.

Fernandez-Villaverde, Gordon, Guerron-Quintana & Rubio-Ramirez (2012, p. 23) show that shocks that have the power to push the economy to zero lower bound are discount rate and productivity shocks. Contrary, fiscal and monetary shocks are neutralized by monetary policy rule, and it is hard to shift the economy to that environment by introducing these kinds of shocks. Although they show that shocks that indirectly influence the preferences of the agents are the most effective to simulate economy shift to the ZLB environment, we decided to do that directly by introducing the preference shock.

4.2. Baseline theoretical model

Model block consists of the standard New Keynesian equations[11] yet modified to simulate deterministic environment because of the above-mentioned reasons. In addition, the model block incorporates monetary policy rule, which has the form dependent on the immanent environment (Zero lower bound binding or not). Market clearing condition in comparison with simple New Keynesian framework is augmented with government expenditure shocks in order to observe the interactions between monetary and fiscal policymakers.

Dynamic IS equation (Euler equation) is stated as follows:

$$c_t = -\frac{1}{\sigma}\left(i_t - \pi_{t+1} - \rho\right) + c_{t+1} - u_t \tag{1}$$

The New Keynesian Phillips curve is presented in a following way:

[11] Equations are modified version of those presented in Galí (2015), p. 63.

$$\pi_t = \beta\pi_{t+1} + \kappa y_t \tag{2}$$

Monetary policy rule is defined as a variation of the Taylor rule:

$$i_t = \begin{cases} 0, & \rho + \phi_\pi \pi_t + \phi_y y_t \leq 0 \\ \rho + \phi_1 \pi_t + \phi_2 y_t, & \text{otherwise} \end{cases} \tag{3}$$

Market clearing condition is determined in a following way:

$$y_t = c_t + g_t \tag{4}$$

In the previous equations, c, π, y, g, i, and *u* are defined as consumption, inflation, output (since the economy is operating under deterministic environment, this variable can be thought as "output gap" defined as the difference between output and steady state value of the output), government expenditure, interest rate and preference shock, respectively. Parameter's calibration is done according to Galí (2015, p. 67), which is standard to the New Keynesian theory literature.

We assume that slope of the New Keynesian Phillips curve is determined as follows:

$$\kappa = \frac{(1-\theta)(1-\beta\theta)}{\theta} \frac{1-\alpha}{1-\alpha+\alpha\varepsilon} \left(\sigma + \frac{\varphi+\alpha}{1-\alpha} \right) \tag{5}$$

Table 1: Parameter calibration

Parameter symbol	Parameter meaning	Calibrated value
β	Discount factor	0.99
ρ	Steady state interest rate	-log(β)
σ	Curvature of the utility consumption	1
φ	Inverse Frisch elasticity of labour supply	5
α	Parameter in production function	1/4
ε	Demand elasticity	9
θ	Index of price stickiness	3/4
κ	Slope of the New Keynesian Phillips curve	0.17
ϕ_1	Coefficient of the response of monetary policymaker to inflation gap	1.5
ϕ_2	Coefficient of the response of monetary policymaker to output gap	Dependent on the simulation scenario

Source: Calibration according to Galí (2015), p. 67.

4.3. Simulation scenarios

We assume four different simulation scenarios of the same theoretical model, which make it possible to analyse the effects of interactions between monetary and fiscal policymakers in different environments. Common to all simulation scenarios is that we assume 30 periods (quarters) of simulation length. In addition, we assume that preference shock is calibrated to 0.025 in the first period with high persistence of 0.8. In every simulation model, we assume that coefficient ϕ_1 is 1.5.[12]

Table 2: Simulation scenarios

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
ϕ_2	0.125	0.125	0	0
g	g(1)=0.02	g(1,2,3)=0.02	g(1)=0.02	g(1,2,3)=0.02

Source: Authors' assumptions

The reason why we decided to simulate these four different scenarios is that we want to investigate what are the effects of the interactions of fiscal and monetary policymakers in the ZLB environment. These effects are observed after the preference shock hit the economy, so it is common to all models. In the all scenarios described above, the fiscal policy is active, but the difference is what the extent of that activeness is. Therefore, these simulations can be compared with the benchmark model when the economy is hit by the preference shock, which put it in the ZLB environment, and fiscal policy is inactive in that situation. In addition, the difference between the simulation scenarios is calibration of parameters in the monetary policy rule and the frequency of the government expenditure shocks.

The first scenario uses standard calibration, which is similar to the original Taylor rule. In addition, we assume one-off government expenditure shock in the first period. We can call this scenario "Standard simulation". The second scenario is the same as previous, but the government expenditure shock is not one-off, rather permanent in the first three periods. This scenario can be called "Standard simulation with highly interactive fiscal policy". The third scenario has a different calibration. We assume that monetary policymaker is oriented only toward inflation gap, and output gap is not present in the monetary policy reaction function. This kind of model is very common in related literature, especially those that analyse strict inflation targeting approach. We can call this scenario "Strict

[12] The coefficients in the monetary policy rule are assumed to satisfy the following determinacy condition (Galí 2015, p. 106); $\kappa(\phi_1 - 1) + (1-\beta)\phi_2 > 0$.

inflation-averse monetary policymaker simulation". Finally, the last scenario is different in comparison with the previous ones because we introduce a more active fiscal policy in the first three periods. It can be called "Strict inflation-averse monetary maker simulation with highly interactive fiscal policy".

In order to compare the simulated effects of the model, we applied the simple welfare criterion in the form of loss function. We use the form that is common in the literature. The overall loss for society is calculated as a sum of discounted period losses. Period losses are calculated under assumption that society equally weights the inflation stabilization and output stabilization.

$$\text{Loss} = \frac{1}{2}\sum_{t=1}^{30}\beta^{t}(\pi_t^2 - y_t^2) \tag{6}$$

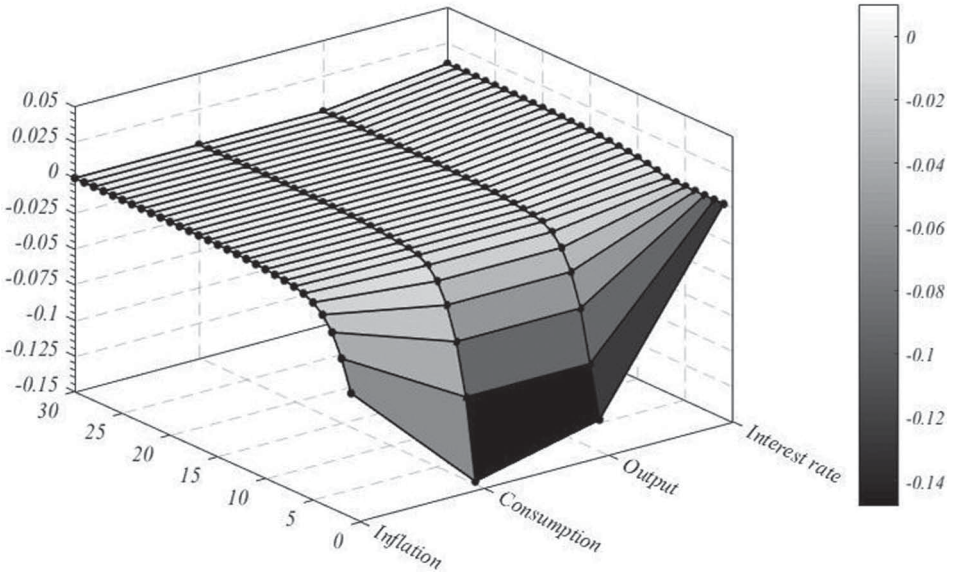
5. Discussion of the results

The results of the simulations scenarios are depicted in the following graphs. The response of the four variables on the preference and fiscal shocks can be seen. These variables are inflation, consumption, output and interest rate. We calculated the paths of these variables in the environment of ZLB, which is the consequence of the preference shock and the monetary policy rule modified to catch this kind of environment conditions.

5.1. "Standard simulation"

"Standard simulation" is based on the assumption of conventional monetary policy rule, where central bank puts some positive but not infinite weight on inflation stabilization. Therefore, the output stabilization is of central bank interest, too. This is the most common calibration specification in the literature because it is grounded on the basis of the original Taylor rule. In addition, the flexible inflation targeting literature emphasizes that, in practice, central banks which adopt inflation targeting monetary strategy are flexible targeters rather than strict inflation targeters. On the other side, we assume low interactiveness of fiscal policy, with a supporting role to monetary policy only in the first period. Although we introduced the fiscal policy to the "game" that does not change the fact that monetary policymaker is in charge of the stabilization of the economy.

Graph 2: Variables' responses in the "Standard simulation"



Source: Authors' calculations

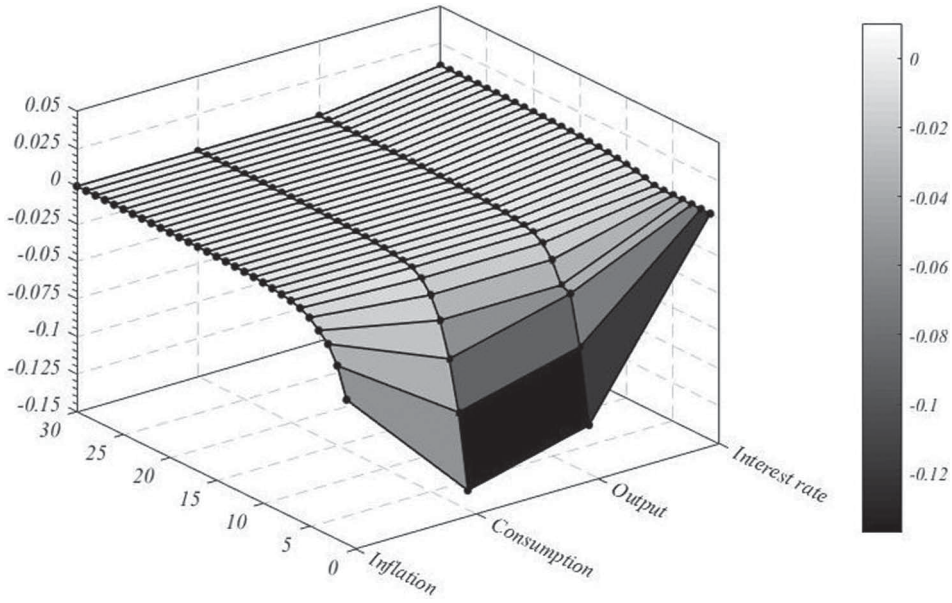
As expected, the results of this "miss-coordination" between monetary and fiscal policy are high decreases in relevant variables. The first period losses are highest due to inflation decreases of 6.27 percentage points from the steady state, consumption of 14.80, and output of 12.80. The ZLB on interest rates imposes the constraint, since from the first period the economy is in such environment which implies the interest rate stuck on the zero. If the economy can operate as the constraint is not binding then the losses would be much smaller. Our result indirectly shows how the impotence of the monetary policy under constraint is being materialized, i.e. the deepness of the ZLB effects. As the time goes on, the losses are smaller because the variables converge to their steady state levels and the economy departures from the ZLB environment. The presented losses are lower compared to the situation where there is no fiscal intervention (see Appendix).

5.2. "Standard simulation with highly interactive fiscal policy"

The second scenario has the baseline model specification and calibration the same as they were in the previous. Monetary policy rule is specified as standard Taylor type. The difference emerges from the nature of the fiscal policy, which is more interactive in this scenario. The government expenditure shock is not one-

off, contrary; there are multiple shocks that occur in the first three periods. We decided to simulate this scenario because we had a motive to investigate is fiscal policy supporting tool to monetary policy in the ZLB environment.

Graph 3: Variables' responses in the "Standard simulation with highly interactive fiscal policy"



Source: Authors' calculations

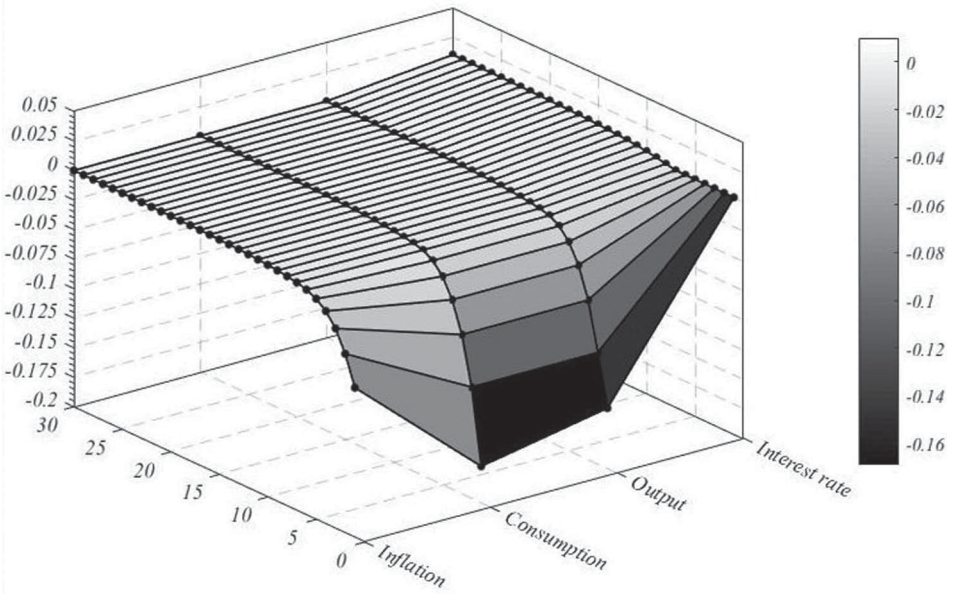
The results are depicted in the previous graph. Although decreases in relevant variables are high, they are smaller than in the previous scenario. The first period losses are highest as expected, since the inflation decreases by 5.36 percentage points from the steady state, consumption by 13.73 and output by 11.73. The presented losses are much lower in comparison with fiscal intervention (see Appendix). The main cause for this improvement in the variables responses can be found in the introduction of multiple fiscal policy shocks.

5.3. "Strict inflation-averse monetary policymaker simulation"

The third scenario has a slightly different calibration. We wanted to investigate what are the consequences of the framework where monetary policymaker is oriented only towards inflation gap, and output gap is not build in the monetary policy reaction function. New monetary policy frameworks have been developing

over the past decades. One of them is inflation targeting. This monetary strategy can be developed in two ways, and theoretical papers divide the approaches into two categories: strict inflation targeting and flexible inflation targeting. This kind of scenario is common in related literature, especially those that analyse the strict inflation targeting approach. In addition, in some papers the authors proposed that monetary policy rules have a better effectiveness if they are focused only on inflation stabilization (Galí, 2001, p. 13). These reasons were interesting for us to make these two additional following calibration scenarios.

Graph 4: Variables' responses in the "Strict inflation-averse monetary policymaker simulation"



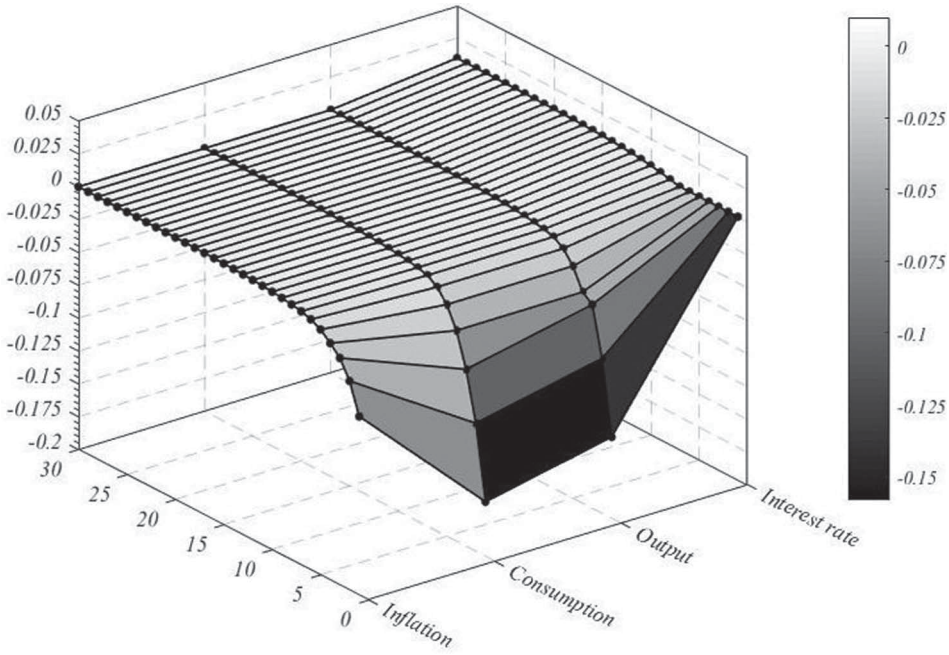
Source: Authors' calculations

The single oriented monetary policy leaves consequences on the variable responses. The decreases in the variables are the highest in comparison with the other scenarios. If the society is concerned about output stabilization then this scenario can produce high losses. In the first period, gaps are the highest since inflation decreases by 7.32 percentage points from the steady state, consumption by 16.90 and output by 14.90. The presence of one-off fiscal shock reduces the effects of the ZLB in comparison with the fully absent fiscal policy (see Appendix). Besides that, this scenario produces by far the worst effects.

5.4. "Strict inflation-averse monetary policymaker simulation with highly interactive fiscal policy"

Finally, the last scenario is different in comparison with the previous because we introduce the more active fiscal policy in the first three periods, similar to what we did in differentiating between the first two scenarios. Again, the monetary policy rule is focused on inflation stabilization and output stabilization is not at all in the scope of the monetary policymaker interest.

Graph 5: Variables' responses in the "Strict inflation-averse monetary policymaker simulation with highly interactive fiscal policy"



Source: Authors' calculations

The strict inflation-averse monetary policy effects on the relevant variables in our model can be partially mitigated by more active fiscal policy. The high losses are relieved by more intensive expansionary fiscal policy, which has an influence on the output and consumption. In the first period, inflation decreases by 6.41 percentage points from the steady state, consumption by 15.82 and output by 13.82. The presence of multiple fiscal shocks reduces the effects of the ZLB in comparison with the fully absent fiscal policy (see Appendix).

5.5. The comparative analysis of the scenarios and general conclusions

The first results depicted in the previous graphs clearly prove the necessity of coordination between monetary and fiscal policy makers in the conditions of ZLB on interest rates. In order to make comparative assessment of the simulation scenarios, we will present the key quantitative indicators of each scenario in the following table.

Table 3: Simulation scenarios comparative analysis

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Number of periods when Zero lower bound is binding	6	6	7	7
Society loss before the fiscal shock(s)	0.0209	0.0209	0.0277	0.0277
Society loss after the fiscal shock(s)	0.0180	0.0131	0.0243	0.0185

Note: Society losses are calculated according to equation No. 6.
Source: Authors' calculations

The results support our expectation that the second scenario gives the best results. The results can be basis for the answers on some crucial questions. First, what has to be in the focus of the monetary policymaker? Second, what is the role of fiscal policy in the conditions of ZLB and what would be possible effects of a discoordination between monetary and fiscal policy?

As can be seen, the better results give the scenario simulations where central bank follows a standard monetary policy rule of the Taylor type. In our opinion, the focus of monetary policymaker has to be on both, inflation stabilization and output stabilization. The preference shock that imposes constraint on the monetary policy in the form of ZLB on interest rates has a more durable influence on the economy, under simpler monetary policy rule, because in the first two scenarios where central bank follows monetary policy rule of Taylor type the ZLB stops binding in the 6th period, while on the other two cases where the focus is only on the inflation stabilization the ZLB stops binding in the 7th period. In addition, society losses are lower in the first two cases than in the second two cases. The effects of the preference shocks that are strong enough to put the economy into ZLB environment are more harmful if the output stabilization is not in the interest of the central bank. Of course, that policy of the central bank that tends to stabilize output is effective only in the short run, i.e. in the long run this variable is not affected by the monetary policy. Based on all of the above, we think that a better solution for the society is that central bank follows monetary policy

rule in which the both, inflation stabilization and output stabilization, have some positive weight.

The second important conclusion is that active fiscal policy in the conditions of ZLB environment can be very effective in decreasing the losses that emerge, because of preference shocks. The necessary duration for monetary policy to stabilize the economy is higher in the framework of fully absent fiscal policy than in the opposite case. The society losses are drastically lower when the fiscal policy is active, especially when the interactiveness of fiscal policy is high, because the responses of the relevant variables converge to the steady state values much faster. According to Woodford (2010, p. 34.) in that situation, it can be desirable to use government expenditures to fill the output gap at least partially, even at the price of distorting to some extent the composition of expenditures. From the abovementioned reasons, the indirect conclusion can be made that coordination between monetary and fiscal policy is *conditio sine qua non* in the environment of ZLB on interest rates. The temporarily impotence of the monetary policy can be mitigated by active fiscal policy which has the role to support the economy in that period.

An accommodative monetary policy, which does not react to fiscal activeness, gives strength to the fiscal effects on the relevant variables. Of course, these fiscal effects in normal conditions are the highest when central bank is strict inflation-averse and output stabilization is not in its focus. However, in the ZLB conditions, this advantage disappears and the standard monetary policy rule gives the best outcomes. This again proves that coordination between macroeconomic policymakers is necessary for the policy effectiveness, and that outcomes in one sphere are highly dependent on measures in the other.

6. Conclusion

The response of macroeconomic policymakers during the global recession included measures of monetary and fiscal policy, known as countercyclical measures, with the goal to ensure two main objectives: to maintain financial system stability and to stimulate aggregate demand, as well as economic activity. The global recession, together with poor post-recession recovery, induced a need for a new macroeconomic policy framework and the concepts of liquidity trap and ZLB were brought back in fashion, especially in the New Keynesian literature. Possible solutions for the ZLB problem include some unconventional elements, especially in the sphere of monetary policy. However, many authors have claimed that the problem cannot be resolved only by monetary policy. Fiscal policy is

more effective in those conditions. Our goal was to analyse the interaction between macroeconomic policymakers in the environment of ZLB, which is occasionally a binding constraint.

The key element for the view on the broader picture of ZLB repercussions is the revival of the coordination paradigm. Under ZLB constraint some monetary policymaker's actions induce the interaction with the fiscal policymaker on the operational level. On the other side, institutional mechanisms of coordination are extremely important for resolving the problems which arise as consequences of ZLB.

We employed the methodology of regime switching models, where switch is endogenous. Simulation of the four different scenarios has shown that the best solution for the society is that central bank follows monetary policy rule in which both inflation stabilization and output stabilization have some positive weight, and where fiscal policy routed by mechanisms of coordination is more active. Therefore, contrary to the conventional paradigm where fiscal policy does not have appropriate instruments for stabilization of the economy, the conclusion is different in the ZLB framework. The economy is suffering losses because of ZLB conditions, but interactive fiscal policy can decrease these losses. This is possible because of the non-responsiveness of the central bank. When ZLB stops binding, the normal conditions imply normal reaction of the monetary policy in accordance with the standard Taylor rule, so credible monetary policy supported by a good institution is sufficient for implicit coordination. Fiscal policymaker fulfils its role in the ZLB environment, but in normal conditions monetary policy is in charge of stabilization of the economy, and every action of the fiscal authority which is not consistent with that will be penalized by monetary policy reaction implied by the Taylor rule.

7. References

1. Acocella, N., Di Bartolomeo, G. & Hallet, H.A. (2016). *Macroeconomic Paradigms and Economic Policy*. Cambridge: Cambridge University Press.
2. Auerbach, A. J. & Gorodnichenko, Y. (2011). Fiscal Multipliers in Recession and Expansion Cambridge, MA: National Bureau of Economic Research. NBER Working Paper 17447.
3. Auerbach, A. J. & Gorodnichenko, Y. (2012). Measuring the Output Responses to Fiscal Policy. *American Economic Journal: Economic Policy*, *4*(2), 1–27.
4. Barro, R.J. (1974). Are Government Bonds Net Wealth? *Journal of Political Economy*, *82*(6), 1095–1117.
5. Barro, R.J. & Gordon, D.B. (1983). Rules, Discretion, and Reputation in a Model of Monetary Policy. *Journal of Monetary Economics*, *12*, 101-121.
6. Bastidon, C., Gilles, P. & Huchet, N. (2016). The ECB, Between Conservatism and Pragmatism. *Journal of Central Banking Theory and Practice, 1,* 25-52. doi: 10.1515/jcbtp-2016-0002
7. Blanchard, O., & Galí, J. (2007). Real Wage Rigidities and the New Keynesian Model. *Journal of Money, Credit, and Banking*, *39*(1), Supplement, 36–65.
8. Blanchard, O., Dell'Ariccia, G. & Mauro, P. (2010). *Rethinking Macroeconomic Policy*, Washington D.C.: International Monetary Fund. IMF Staff Position Note SPN/10/03.
9. Christiano, L., Eichenbaum, M. & Rebelo, S. (2011). When is the Government Spending Multiplier Large? *Journal of Political Economy*, *119*(1), 78-121.
10. Chung, H., Laforte, J.P., Reifschneider, D. & Williams, J.C. (2012). Have We Underestimated the Likelihood and Severity of Zero Lower Bound Events? *Journal of Money, Credit and Banking*, Blackwell Publishing, *44*(2), 47-82. doi: 10.1111/j.1538-4616.2011.00478.x
11. Coenen, G., Erceg, C. J., Freedman, C., Furceri, D., Kumhof, M., Lalonde, R., Laxton, D., Lindé, J., Mourougane, A., Muir, D., Mursula, S., de Resende, C., Roberts, J., Roeger, W., Snudden, S., Trabandt, M. & in't Veld, J. (2012). Effects of Fiscal Stimulus in Structural Models. *American Economic Journal: Macroeconomics*, 4(1), 22-68.
12. Cogan, J. F., Cwik, T., Taylor, J. B. & Wieland, V. (2010). New Keynesian Versus Old Keynesian Government Spending Multipliers. *Journal of Economic Dynamics and Control*, *34*, 281–295.
13. Coibion, O., Gorodnichenko, Y. & Wieland, J. (2012). The Optimal Inflation Rate in New Keynesian Models: Should Central Banks Raise Their Inflation Targets in Light of the Zero Lower Bound? *Review of Economic Studies*,

Oxford University Press, *79*(4), 1371-1406. doi: 10.1093/restud/rds013
14. Cwik, T. & Wieland, V. (2010). Keynesian Government Spending Multipliers and Spillovers in the Euro Area. Frankfurt am Main: European Central Bank. ECB Working Paper 1267.
15. Dordal-i-Carreras, M., Coibion, O., Gorodnichenko, Y. & Wieland, J. (2016). *Infrequent but Long-Lived Zero-Bound Episodes and the Optimal Rate of Inflation*. Cambridge, MA: National Bureau of Economic Research. NBER Working Papers Series 22510).
16. Eggertsson, G. & Woodford, M. (2003). The Zero Bound on Interest Rates and Optimal Monetary Policy. *Brookings Papers on Economic Activity, 1*, 139–233.
17. Evans, C., Fisher, J., Gourio, F. & Krane, S. (2016). Risk Management for Monetary Policy Near the Zero Lower Bound. *Brookings Papers on Economic Activity*, *1*, 141-219.
18. Fabris, N. (2018). Challenges for Modern Monetary Policy. *Journal of Central Banking Theory and Practice, 2,* 5-24. doi: 10.2478/jcbtp-2018-0010
19. Fernandez-Villaverde, J., Gordon, G., Guerron-Quintana, P. & Rubio-Ramirez, J. (2012). *Nonlinear Adventures at the Zero Lower Bound*. Cambridge, MA: National Bureau of Economic Research. NBER Working Paper Series 18058.
20. Galí, J. (2001). *Targeting Inflation in an Economy with Staggered Price Setting.* Santiago: Central Bank of Chile. Central Bank of Chile Working Paper 123.
21. Galí, J. (2015). *Monetary Policy, Inflation and Business Cycle: An Introduction to the New Keynesian Framework and Its Application*. Second Edition, Princeton, USA: Princeton University Press.
22. Goodfriend, M. & King, R.G. (1997). The New Neoclassical Synthesis and the Role of Monetary Policy. In B.S. Bernanke and J.J. Rotemberg, (Eds.), *NBER Macroeconomics Annual* (231-83). Cambridge, MA.: MIT Press.
23. Gravelle, J. G., Hungerford, T. L. & Labonte, M. (2009). Economic Stimulus: Issues and Policies, CRS Report for Congress, 7-5700, R40104.
24. Guerrieri, L. & Iacoviello, M. (2015a). OccBin: A Toolkit for Solving Dynamic Models with Occasionally Binding Constraints Easily. *Journal of Monetary Economics*, *70*, 22-38. doi: 10.1016/j.jmoneco.2014.08.005
25. Guerrieri, L. & Iacoviello, M. (2015b). Appendix for Online Publication: OccBin: A Toolkit for Solving Dynamic Models with Occasionally Binding Constraints Easily. *Journal of Monetary Economics*, *70*, 11-16. doi: 10.1016/j.jmoneco.2014.08.005
26. Gunter, G., Orphanides, A. & Wieland, V. (2004). Price Stability and Monetary Policy Effectiveness When Nominal Interest Rates are Bounded at Zero. *The B.E. Journal of Macroeconomics, 4*(1), 1-25.

27. Hansen, A. (1939). Economic Progress and Declining Population Growth, *The American Economic Review*, *29*, 1–15.
28. Issing, O. (2011). Lessons for Monetary Policy: What Should the Consensus Be? Washington D.C.: International Monetary Fund. IMF Working Paper WP/11/97.
29. Jakl, J. (2017). Impact of Quantitative Easing on Purchased Asset Yields, its Persistency and Overlap. *Journal of Central Banking Theory and Practice, 2,* 77-99. doi: 10.1515/jcbtp-2017-0014
30. Jaksic, M. & Jesic, M. (2016). Budget Constraint Fulfilment in Some EU Candidate Countries. *Montenegrin Journal of Economics*, 12 (2), 101-115.
31. Keynes, J. M. (1936 [1987]). *Opća teorija zaposlenosti, kamate i novca*, Zagreb: Cekade.
32. Krstevska, A. (2015), Monetary Policy Objectives During the Crisis: An Overview of Selected Southeast European Countries. *Journal of Central Banking Theory and Practice, 1,* 35-46. doi: 10.1515/jcbtp-2015-0003
33. Krugman, P. (1998). It's Baaack: Japan's Slump and the Return of the Liquidity Trap. *Brookings Papers on Economic Activity*, *29*(2), 137-206.
34. Krugman, P. (2014). Four observations on secular stagnation. In C. Teulings and R. Baldwin (Eds.), *Secular Stagnation: Facts, Causes, and Cures* (61-68). London: CEPR Press.
35. Kyriazis, N.A. (2017). Eurozone Debt Monetization and Helicopter Money Drops: How Viable can this be? *Journal of Central Banking Theory and Practice, 3,* 5-15. doi: 10.1515/jcbtp-2017-0018
36. Mishkin, F.S. (2010). Monetary Policy Strategy: Lessons from the Crisis. Prepared for the ECB Central Banking Conference, "Monetary Policy Revisited: Lessons from the Crisis" Frankfurt, November 18-19, 2010. https://www0.gsb.columbia.edu/faculty/fmishkin/papers/10ecb.pdf
37. Reifschneider, David L., & Williams, J.C. (2000). Three Lessons for Monetary Policy in a Low-Inflation Era. *Journal of Money, Credit, and Banking*, *32*(part 2), 936–966.
38. Romer, C. & Bernstein, J. (2009). The Job Impact of the American Recovery and Reinvestment Plan. January 9, 2009. Retrieved from: https://www.economy.com/mark-zandi/documents/The_Job_Impact_of_the_American_Recovery_and_Reinvestment_Plan.pdf
39. Romer, D. (2011). What Have We Learned about Fiscal Policy from the Crisis? IMF Conference on Macro and Growth Policies in the Wake of the Crisis, Retrieved from: https://www.imf.org/external/np/seminars/eng/2011/res/pdf/DR3presentation.pdf
40. Rudebusch, G.D. (2009). The Fed's Monetary Policy Response to the Current Crisis. *Federal Reserve Bank of San Francisco Economic Letter*, 2009-17(May).

41. Spilimbergo, A, Symansky, S., Blancard, O. & Cottarelli, C. (2008). *Fiscal Policy for the Crisis.* Washington D.C.: International Monetary Fund. IMF Staff Position Note SPN/08/01.
42. Summers, L. (2014). U.S. Economic Prospects: Secular Stagnation, Hysteresis, and the Zero Lower Bound. *Business Economics*, *49*(2), 65-73. doi: 10.1057/be.2014.13.
43. Svensson, L.O. (2003). Escaping from a Liquidity Trap and Deflation: The Foolproof Way and Others. *Journal of Economic Perspectives*, *17*(4), 145–166. doi: 10.1257/089533003772034934
44. Svensson, L.O. (2009). Flexible Inflation Targeting—Lessons from the Financial Crisis. *Amsterdam: The Netherlands Bank*, September 21. Retrieved from: https://www.bis.org/review/r090923d.pdf
45. Taylor, J.B. (1993). Discretion versus Policy Rules in Practice. *Carnegie-Rochester Conference Series on Public Policy*, *39*(December), 195-214.
46. Taylor, J.B. & Williams, J. (2009). A Black Swan in the Money Market. *American Economic Journal: Macroeconomics*, *1*(1), 58-83.
47. Teulings, C. & Baldwin, R. (2014). Introduction (in *Secular Stagnation: Facts, Causes, and Cures*), CEPR Press, London.
48. Wieland, J. (2011). Fiscal Multipliers in the Liquidity Trap: International Theory and Evidence. manuscript. Retrieved from: https://ideas.repec.org/p/red/sed010/717.html
49. Williamson, S. (2016). Scarce Collateral, the Term Premium, and Quantitative Easing. *Journal of Economic Theory*, *164*(C), 136-165. doi: 10.1016/j.jet.2015.07.010
50. Williamson, S. (2017). *Low Real Interest Rates and the Zero Lower Bound* (Working Paper 2017-010A), St. Louis: Federal Reserve Bank of St. Louis, Retrieved from: https://doi.org/10.20955/wp.2017.010
51. Woodford, M. (2010). Simple Analytics of the Government Expenditure Multiplier. Prepared for the session "*Fiscal Stabilization Policy*" at the meetings of the Allied Social Science Associations, Atlanta, Georgia, January 3-5, 2010. Retrieved from: http://www.columbia.edu/~mw2230/G_ASSA.pdf
52. Zandi, M. & Blinder, A. (2010). *How the Great Recession Was Brought to an End.* Retrieved from: https://www.economy.com/mark-zandi/documents/End-of-Great-Recession.pdf
53. ECB https://sdw.ecb.europa.eu/browseTable.do?node=9691107
54. FED https://fred.stlouisfed.org

Appendix

In the Appendix we present the effects of the preference shock on the path of the four relevant variables, i.e. the impotence of monetary policy in the ZLB environment. The following table shows two situations which are different with respect to two alternative calibrations of parameters in the monetary policy rule. The left part corresponds with the "Standard simulation" and "Standard simulation with highly interactive fiscal policy" before the introduction of fiscal shocks. The right part is related to the "Strict inflation-averse monetary policymaker simulation" and "Strict inflation-averse monetary policymaker simulation with highly interactive fiscal policy", again before the introduction of fiscal shocks. The unpleasant response of the observed variables is significant in both cases, but the more adverse effects are inherent to the second type of calibration since the output gap volatility is not directly observed by the central bank which is strict inflation-averse. The discounted overall society loss is 0.0209 for the first two scenarios, and 0.0277 for the last two scenarios.

Table A1: Responses of relevant variables to the preference shock

	Standard monetary policy rule				Strict inflation-averse central bank			
period	Inflation	Consumption	Output	Interest rate	Inflation	Consumption	Output	Interest rate
1	-0.0661	-0.1480	-0.1480	0.0000	-0.0766	-0.1690	-0.1690	0.0000
2	-0.0413	-0.0918	-0.0918	0.0000	-0.0483	-0.1057	-0.1057	0.0000
3	-0.0260	-0.0559	-0.0559	0.0000	-0.0306	-0.0651	-0.0651	0.0000
4	-0.0166	-0.0333	-0.0333	0.0000	-0.0198	-0.0394	-0.0394	0.0000
5	-0.0111	-0.0195	-0.0195	0.0000	-0.0132	-0.0235	-0.0235	0.0000
6	-0.0079	-0.0114	-0.0114	0.0000	-0.0093	-0.0140	-0.0140	0.0000
7	-0.0060	-0.0073	-0.0073	0.0002	-0.0070	-0.0088	-0.0088	0.0000
8	-0.0048	-0.0058	-0.0058	0.0022	-0.0055	-0.0068	-0.0068	0.0017
9	-0.0038	-0.0047	-0.0047	0.0037	-0.0044	-0.0054	-0.0054	0.0034
10	-0.0031	-0.0037	-0.0037	0.0050	-0.0036	-0.0043	-0.0043	0.0047
11	-0.0024	-0.0030	-0.0030	0.0060	-0.0028	-0.0035	-0.0035	0.0058
12	-0.0020	-0.0024	-0.0024	0.0068	-0.0023	-0.0028	-0.0028	0.0066
13	-0.0016	-0.0019	-0.0019	0.0075	-0.0018	-0.0022	-0.0022	0.0073
14	-0.0013	-0.0015	-0.0015	0.0080	-0.0015	-0.0018	-0.0018	0.0079
15	-0.0010	-0.0012	-0.0012	0.0084	-0.0012	-0.0014	-0.0014	0.0083
16	-0.0008	-0.0010	-0.0010	0.0087	-0.0009	-0.0011	-0.0011	0.0086
17	-0.0006	-0.0008	-0.0008	0.0090	-0.0008	-0.0009	-0.0009	0.0089
18	-0.0005	-0.0006	-0.0006	0.0092	-0.0006	-0.0007	-0.0007	0.0091
19	-0.0004	-0.0005	-0.0005	0.0094	-0.0005	-0.0006	-0.0006	0.0093
20	-0.0003	-0.0004	-0.0004	0.0095	-0.0004	-0.0005	-0.0005	0.0095
21	-0.0003	-0.0003	-0.0003	0.0096	-0.0003	-0.0004	-0.0004	0.0096
22	-0.0002	-0.0003	-0.0003	0.0097	-0.0002	-0.0003	-0.0003	0.0097
23	-0.0002	-0.0002	-0.0002	0.0098	-0.0002	-0.0003	-0.0003	0.0098
24	-0.0001	-0.0002	-0.0002	0.0098	-0.0001	-0.0002	-0.0002	0.0098
25	-0.0001	-0.0002	-0.0002	0.0099	-0.0001	-0.0002	-0.0002	0.0099
26	-0.0001	-0.0001	-0.0001	0.0099	-0.0001	-0.0002	-0.0002	0.0099
27	0.0000	-0.0001	-0.0001	0.0100	-0.0001	-0.0001	-0.0001	0.0100
28	0.0000	-0.0001	-0.0001	0.0100	0.0000	-0.0001	-0.0001	0.0100
29	0.0000	-0.0001	-0.0001	0.0100	0.0000	-0.0001	-0.0001	0.0100
30	0.0000	0.0000	0.0000	0.0100	0.0000	0.0000	0.0000	0.0100

Source: Authors' calculations