

NEW KEYNESIAN LIQUIDITY TRAP AND CONVENTIONAL FISCAL STANCE: AN ESTIMATED DSGE MODEL

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Abstract. The study investigates the effect of New Keynesian liquidity trap on fiscal stance in the United States, United Kingdom and Japan economies. We developed our DSGE model in the context of an optimal and persistent interactive fiscal policy, which allows us to track the transmission channel through which shocks are distributed among real economic variables. The evidence suggests that zero lower bound mitigates the ability of monetary policy to absorb the effect of exogenous shock on the macroeconomic variables while expansionary fiscal policy was able to absorb the shock persistence transmitted from the nominal interest rate.

Keywords: *Fiscal Policy, Liquidity Trap, Bayesian, DSGE Model.*

JEL Classification: E13; E62

INTRODUCTION

The study examines the effect of the Zero Lower Bound (ZLB) rate on conventional fiscal responses within the New Keynesian DSGE model in the United States, United Kingdom and Japan. It probes whether stimulating household consumption by manipulating the real rate of interest might trigger a negative fiscal multiplier effect on the economies. We further re-evaluate the extent to which shock spread through the interest rate transmission mechanism could be absorbed by persistent fiscal responses. To cover all objectives set, we contest the earlier assumption on the interaction of sustainable increase in the interest rate within the fiscal expansion as it influences shock transmitted through the product market to the financial sector.

The significance of this study is immense as it aims at reconciling various disputes surrounding the aggregate demand policies. First, we seek to reconcile the orthodox belief that monetary policy can serve as a remedy for inflationary control within the new Keynesian framework (Azariadis, 2018; Baxter & King, 1993; Catalano & Pezzolla, 2017; Gelain, Iskrev, Lansing, & Mendicino, 2019; Patrick, Moura, & Pierrard, 2019; Reis, 2018; Vines & Wills, 2018). In particular, the New Keynesian mandates have shown that inflation persistence can act as antidote for growth recovery through output targeting (Blanchard, 2018; Christiano, Eichenbaum

& Trabandt, 2018; Cochrane, 2011; Ginters & Buss, 2015; Mankiw & Reis, 2018; Miyamoto, Nguyen & Sergeyev, 2017; Shobande, 2019). Thus, the implication of neglecting conservative monetary control for unconventional fiscal policy is a major motivation behind this study.

Second, the inability of domestic monetary policy to influence the domestic financial market, and macroeconomic predictors due to the disparity in the interest rate created by unified monetary policy and the international financial market, makes it extremely difficult to control external shocks. To the best of our knowledge, the monetary instrument that can control the shocks from the exogenous factor is absent in present literature. Thus, what we are left with is to allow the alternative fiscal policy to respond to aggregate fluctuation while shocks on the system are controlled by the monetary authority. Despite this fact, zero lower bound at a nominal interest rate still have a negative impact on the fiscal multiplier as documented by some contemporary studies (Afonso & Jalles, 2017; Ashihara & Kameda, 2018; Boubaker, Nguyen & Paltalidis, 2018; Cochrane, 2014, 2017; Diniz, 2018; Förster & Hayo, 2018; Gobbi & Grazzini, 2019; Hur & Rhee, 2019; Kataryniuk & Vallés, 2018; Lorenzoni & Werning, 2013; Protta & Grisorio, 2018; Werning, 2015). For example, a study by Cochrane (2017) has shown that there is a frictionless limit between the interest rate and fiscal multiplier. The scholar further suspects the tendency for an interest rate under rational expectation – New Keynesian framework to affect negatively the fiscal multiplier due to output variation perceived in the system (Buera & Nicolini, 2014; Cars & Lustenhouwer, 2017; Cochrane, 2005, 2011, 2014, 2017, 2018; Lorenzoni & Werning, 2013; Ramey & Zubairy, 2018; Werning, 2015).

Third, many studies that attempt to examine the relative impact of ZLB failed to account for the implication on fiscal policy. The relative few who attempted to check the policy mix reported confusing results (Barro, 1980, 1981; Barro & Gordon, 1983; Christiano, Trabandt & Walentin, 2011; Cochrane, 2005, 2017, 2018). For example, earlier studies claimed that fiscal expansionary crowd out private investment but stimulate output growth (Barro, 1980, 1981; Barro & Gordon, 1983). The study by Cochrane (2017, 2018) established that unexpected increase in the interest rate reduces aggregate demand but with a negative effect on the fiscal multiplier. Contrariwise, some studies claimed that interaction between the fiscal multiplier at ZLB was likely to be higher than expected (Ramey, 2011), while relatively few studies claimed that the fiscal multiplier at ZLB was half due to distortionary tax income (Christiano *et al.*, 2011; Drautzburg & Uhlig, 2015; Roch & Uhlig, 2018; Uhlig, 2005). Based on these discrepancies and difference in views and results, the need to further investigate the link between these variables necessitated the present study.

1. MODEL

In this section, we set up a DSGE model to interact with integrated policy mix with an effort to predict how economic uncertainties can be managed during the zero lower bound period. We follow earlier work by Boldrin, Christiano and Fisher (2001), Werning (2015), Drautzburg and Uhlig (2015), Cochrane (2017, 2018).

Consumption Sector

We considered a finite number of economic agents with consumption function stated as follows:

$$\text{Max } \sum_{t=0}^{\infty} \beta^t u(C_t, G_t), \quad (1)$$

where $0 < \beta < 1$ is the discount factor for consumption, C_t denotes household consumption and G_t denotes government consumable goods (Jiang, 2019). We then assumed that the agent utility function exhibited constant elasticity of substitution (CES) represented as follows:

$$U = \left[\phi(C_t \xi G_t)^{\rho-1/\rho} + (1 - \phi)(1 - 0)^{\rho/\rho-1} \right]^{\rho/\rho-1} \quad (2)$$

$$\text{s.t } C_t + I_t = rk_t - \tau_t^k(r_t - \delta)k_t + (1 - \tau_t^k),$$

where k_t denotes private capital, I_t is investment, r_t is return on capital, π_t denotes profit, $0 < \delta < 1$ is depreciation on capital stock, τ_t^k is tax on household capital.

Investment Sector

We consider the firm level investment with the function below:

$$I_t = \left[\int_0^1 \vartheta_t^I(v)^{\psi^I} dv \right]^{1/\psi^I-1}, \quad (3)$$

where the elasticity of substitution for investment becomes $1/\psi^I - 1$ and capital accumulation becomes:

$$E_0 \sum_{t=0}^{\infty} P_t^k \left[1 + K^k/2 \left(\frac{I_t}{I_{t-1}} \right) \right] I_t - I_t \quad (4)$$

$$K_t = \sigma \frac{I_t}{I_{t-1}} + (1 - \delta)K_{t-1},$$

where $\sigma \frac{I_t}{I_{t-1}}$ denotes adjustment cost defined as follows:

$$1 - K^k/2 \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 I_t, \quad (5)$$

where K^k is adjustment cost parameters.

$$P_t^I = \left[\int_0^1 p_t^I(v)^{\psi^I/\psi^I-1} dv \right]^{\psi^I-1/\psi^I} \quad (6)$$

Price Setting Dynamics

We follow the price setting dynamic in the work by Calvo (1983), Clarida *et al.* (1998) as used by Drautzburg and Uhlig (2015), Cochrane (2018) presented as follows:

$$P_t^* - P_{t-1} = (1 - \tau\nu) \sum_{k=0}^{\infty} (\tau\nu)^k E_t[(\tilde{m}c_{t+k|t} + (P_{t+k} - P_{t-1}))], \quad (7)$$

where $\tilde{m}c_{t+k|t} = [mc_{t+k|t} - mc]$ defined as deviation of marginal cost from the steady state and mc denotes μ , where $\mu = \log \left[\frac{\tau}{1-\tau} \right]$ defined as log of desired gross mark-up (see Benchimol, 2015).

Central Bank Decision and Social Loss/Consequences

The model of social loss function that the central banks seek to minimize is presented as follows:

$$L_t^s = 1/2 E_t \sum_{i=0}^{\infty} \beta^i (\lambda y_t^2 + \pi_{t+1}^2), \quad \lambda > 0, \quad (8)$$

Where λ denotes weight on output gap of ambitious central banks, and social loss is subject to output gap and inflation dynamics.

Monetary policy reaction function by Cochrane (2017, 2018) is defined by a set of equations that signifies central bank monetary operation as follows:

$$y = \sigma(i_t - \pi_t - \rho) + e_{yt} \quad (9)$$

$$\pi_t = \pi_{t-1} + \vartheta y_t + e_{\pi t} \quad (10)$$

$$i_t = r_t + \delta_{\pi} \pi_t + \phi_y y + e_{it}, \quad (11)$$

where $\delta_{\pi} > 1$ stability threshold and $\delta_{\pi} < 1$ unstable.

We then applied the version of the New Keynesian Philip curve equation (Cochrane, 2017, 2018) by integrating equations (9), (10), (11), and we have

$$i_t = i + \sum_{j=1}^{ni} \psi_{ij} (i_{t-j} - \tilde{i}) + \sum_{j=1}^{ni} \delta_{\pi j} (\pi_{t-j} - \tilde{\pi}) + \sum_{j=1}^{ni} \phi_{yj} (\tilde{y}_{t-j}) + e_{mt}, \quad (12)$$

where e_{mt} is monetary policy shock, $\tilde{\pi}$ denotes deviation in inflation, \tilde{y} denotes long-run output.

Following Taylor's rule, we assumed equilibrium condition for an explosive or short-tempered economy where $i_t = \tilde{y} = \tilde{\pi} = 0$

$$i_t = i_t^* + \delta_{\pi j} (\pi_t - \pi_t^*) + \phi_{yj} (y_t - y_t^*). \quad (13)$$

Thus, residual combination of shocks becomes:

$$i_t = \delta_{\pi j} \pi_t^* + \phi_{y j} y_t^* + \dots x_t^* \quad (14)$$

We assumed that the central bank reaction function was based on the Taylor rule. It then follows that central bank response baseline equation is presented as:

$$R_t = (R_{t-1})^\theta \left[\pi_t^{(1+\varphi\pi)} \left(Y_t / Y_{t-1} \right)^{\theta_y} R^s \right]^{(1-\alpha)} e_t^R, \quad (14)$$

where R_t is a nominal interest rate, θ_y denotes a response rate to output and $\varphi\pi$ denotes the index inflation, R^s is an interest rate at steady state, $0 \leq \alpha \leq 1$ connected with interest rate responses to real economic variables, e_t^R is shock originating from the nominal interest rate as zero average and constant variance.

The Zero Lower Bond

Drawing from the work of Drautzburg and Uhlig (2015), Shobande (2018) and Cochrane (2018), our zero lower bond equation becomes:

$$R_{tE}^z = 1 - (ZLB_t) R_t^y + ZLB_t \widetilde{R}_{tE}^z, \quad (15)$$

where R_{tE}^z denotes a steady state of nominal return ($\epsilon > 0$), R_t^y denotes a counterfactual level of set interest rate when ZLB is obligatory.

Fiscal Policy

The government adheres to a balanced budget rule as follows:

$$g_t = T_t, \quad (16)$$

where $g_t = \sum_{t=1}^{\infty} g_t / (1+r)^t$ and $T_t = \sum_{t=1}^{\infty} T_t / (1+r)^t$, T_t denotes government lump sum tax, and g_t denotes government spending.

Therefore, government consumption is represented as follows:

$$\text{Max } E_0 \left(\sum_{t=0}^{\infty} \beta^t u \left(C_t, \frac{b_{g_{t+1}}}{R_{g_t}} \right) \right) \quad (17)$$

$$\text{s.t. } B_{t+1} - (1+r_t)B_t + \frac{M_{t+1}}{P_{t+1}} - \frac{M_t}{P_t} + \frac{b_{g_{t+1}}}{R_{g_t}} + \int T_t \theta d(z),$$

where $\int T_t \theta d(z)$ denotes total tax receipt, $b_{g_{t+1}}$ denotes government debt, R_{g_t} denotes return on government bond.

2. DATA

In this section, we highlight briefly the sources and data used. We justified the appropriateness of the United States, United Kingdom and Japan data in our study.

We showed the prior distributions and the calibrated parameters we used in our estimation. We further identified and presented different optimal and interactive fiscal policies' simulation scenarios.

We derived our estimation and simulation results using annual time-series data spanning from 1970 to 2018. The variables considered for this empiric analysis are inflation-adjusted private final consumption, chained 2010 capital formation, inflation measured by GDP implicit deflator index, the annualized interest rates (federal fund rate, bank of England base rate, bank of Japan discount rate), government expenditure and chained 2010 gross domestic product. We proxy bond spread from corporate 10-year bond treasury differential and the wages as hourly compensation index. We sourced our data from the World Bank – World Development Index (WDI), International Monetary Fund (IMF)-IFS, Federal Reserve of St. Louis (FRED), Bank of Japan (BoJ) statistics and EuroStat.

However, the log deviation data are converted to reflect the deviation from their steady-states using the HP procedures, except for the interest rate. We used these transformed data to estimate the log-linearized DSGE model as developed above using the Bayesian technique in Dynare.

We selected three big world economies (the United States, Japan and the United Kingdom) for investigating the relevance that we theoretically accorded to the fiscal policy in absorbing exogenous shocks in the ZLB economic atmosphere. These countries have practically suffered macroeconomic shocks from low interest rates, in which monetary stabilization tools failed to remedy; yet the practice of ZLB persists in these economies. In recent years, the fiscal policy adoption to remedy these crises (especially, Japan) motivated us to examine and recommend fiscal tools in stabilizing these economies from stochastic innovation.

As it were, we assume that the shocks from the several rounds of quantitative easing and lower interest policy adoption since the financial crisis can cause the conventional monetary policy to be useless. This calls for policy re-evaluation and coordination. Prašcević & Ješić (2019) have recently suggested an unconventional monetary policy to break the episodes of ZLB and its macroeconomic consequences. Interestingly, our paper derives economic implications from different levels of fiscal involvement in such an interest rate environment. Our simulation results (Panel 1–4) technically reveal the importance of a high interactive fiscal policy in the monetary policy stabilization goals in the USA, UK and Japan. This thus justifies the appropriateness of a rich dataset used for the current study.

Bayesian Estimation

The application of Bayesian technique is useful in our model estimation. We used the Bayesian tool in Dynare developed for MATLAB to estimate our DSGE model. We generated the posterior parameters for the optimal simulation scenario using the Markov Chain Monte Carlo (MCMC) – Metropolis-Hastings algorithm chain of 500 000 in length. To estimate this model, we calibrated and used prior information from existing literature.

In the end, we achieved three aims using the Bayesian estimation for our study. First, we used Bayesian inferences to obtain different sets of interactive fiscal policy in the DSGE model that minimised the societal loss function from the constraints

introduced by ZLB. The loss was captured by deviation of consumption, inflation and output from their steady states.

Second, we technically observed the speed of loss reduction (i.e., convergence of these macroeconomic variables to their steady states) after some stochastic innovations in the ZLB environment.

Third, we selected the optimal interactive fiscal policy DSGE and used the estimates to recommend policies.

To achieve our simulation objectives, we calibrated some prior parameters that were important for our study and used them to derive four simulation scenarios ($S_1 - S_4$) for forty (40) periods in length. We calibrated fiscal instruments vis-à-vis the standard monetary reaction function and monetary policy that were based exclusively on inflation targeting (IT) to derive different sets of loss responses. In the first case scenario (S_1), we allowed for one-period interactive fiscal policy with monetary policy striving to stabilise inflation and output gap. The second scenario (S_2) replicated S_1 but allowed the fiscal policy to persist up to fourth periods. In the third case scenario (S_3), we allowed the one-period fiscal policy to interact with monetary policy that targeted only inflation. The fourth case scenario (S_4) used the third scenario but we allowed the fiscal policy to persist. The calibrated output gap is the estimated policy makers' responses to output deviation from the equilibrium. This parameter is informed by the influential papers of Drautzburg and Uhlig (2015), Iwata (2009, 2013), Bhattarai and Trzeciakiewicz (2017), and Cochrane (2017, 2018). For the fiscal instruments, we estimated the share of government spending in the gross domestic products from 1970 to 2018. The average of consumption and capital tax rate for the years between 1970 and 2017 were used in the simulation scenarios. Contrary to some studies that focused on government spending, we took a broader view of fiscal policy in the stabilisation process as revealed in this work. Table 1 summarises the calibrated fiscal tools and simulation scenarios.

Table 1. Calibrated Parameters and Simulation Scenarios (S_1 – S_4)

Parameters	United States				Japan				United Kingdom			
	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4
Government-output ratio	0.30	0.30	0.30	0.30	0.35	0.35	0.35	0.35	0.40	0.40	0.40	0.40
Consumption tax	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.20	0.20	0.20	0.20
Capita tax	0.40	0.40	0.40	0.40	0.38	0.38	0.38	0.38	0.19	0.19	0.19	0.19
Mon. rule output gap	0.13	0.13	0	0	0.06	0.06	0	0	0.12	0.12	0	0

Table 2 presents the prior distribution we used in the study based on the research evidence in the existing literature. We used the prior means which had beta, normal, gamma densities, and we used inverse gamma for all the standard deviation of shocks; $w_2, b_2, \rho_2, \varphi_2, g_2, \tau_2, \psi_2$. Except for the calibrated values which we estimated, we technically relied on the study of Iwata (2013), Drautzburg and Uhlig (2015), Bhattarai and Trzeciakiewicz (2017), Nasir, Yago, Soliman and Wu, (2016), Cochrane (2017, 2018) and Jump and Levine (2019), for the prior distribution. In line with these studies, we used normal distribution for risk averseness, ρ ; monetary policy response to inflation, m_π ; and capital share, α ; and used beta distribution for

habit, h ; price indexation, I_p ; and wage indexation, I_ω ; calvo price, p ; and wage, ω ; interest rate smoothing, m_p in the monetary reaction function, persistence in wage mark-up, w_1 ; price mark-up, ρ_1 ; bond spread, b_1 ; technology, φ_1 ; government, g_1 ; tax shock, τ_1 ; and monetary policy shock, ψ_1 . We selected gamma distribution for bond spread. These prior parameters for the three economies are presented in Table 2.

Table 2. Prior Distribution

Parameters		Prior						
			United States		Japan		United Kingdom	
		Density	Mean	Std.	Mean	Std.	Mean	Std.
Habit	h	Beta	0.85	0.02	0.70	0.01	0.71	0.02
Risk averseness	ρ	Normal	1.17	0.02	1.13	0.06	0.95	0.02
Index price	I_p	Beta	0.28	0.07	0.15	0.03	0.32	0.09
Index wage	I_ω	Beta	0.41	0.08	0.35	0.05	0.38	0.14
Calvo price	p	Beta	0.81	0.03	0.79	0.05	0.78	0.05
Calvo wage	ω	Beta	0.83	0.03	0.73	0.04	0.56	0.05
Mon.rule Inflation	m_π	Normal	1.63	0.18	1.97	0.14	1.60	0.24
Mon.rule output gap	m_y	–	<i>sim.</i>	<i>sim.</i>	<i>sim.</i>	<i>sim.</i>	<i>sim.</i>	<i>sim.</i>
Interest smoothening	m_p	Beta	0.92	0.02	0.80	0.04	0.74	0.02
Capital share	α	Normal	0.24	0.01	0.15	0.01	0.25	0.03
Bond spread	δ	Gamma	0.47	0.04	0.36	0.02	0.33	0.01
AR (1) wage mark -up	w_1	Beta	0.97	0.01	0.94	0.02	0.96	0.01
AR (1) bond spread	b_1	Beta	0.91	0.02	0.67	0.01	0.93	0.02
AR (1) price mark- up	ρ_1	Beta	0.91	0.05	0.72	0.06	0.89	0.04
AR (1) technology	φ_1	Beta	0.95	0.01	0.89	0.04	0.93	0.01
AR (1) government	g_1	Beta	0.98.	0.01	0.92	0.01	0.97	0.01
AR (1) tax shock	τ_1	Beta	0.98	0.01	0.96	0.01	0.98	0.01
AR (1) monetary policy	ψ_1	Beta	0.22	0.05	0.13	0.02	0.15	0.02
Std. Dev wage mark -up	w_2	Inv Gam.	0.23	0.02	0.26	0.05	0.29	0.02
Std. Dev. bond spread	b_2	Inv Gam.	0.08	0	0.05	0.01	0.06	0.01
Std. Dev. price mark-up	ρ_2	Inv Gam.	0.32	0.02	0.16	0.01	0.46	0.05
Std. Dev. technology	φ_2	Inv Gam.	0.47	0.02	0.57	0.07	0.43	0.02
Std. Dev. government	g_2	Inv Gam.	0.36	0.02	0.38	0.04	0.67	0.07
Std. Dev. tax shock	τ_2	Inv Gam.	1.44	0.08	1.32	0.05	1.61	0.12
Std. Dev. monetary rule	ψ_2	Inv Gam.	0.22	0.05	0.13	0.02	0.18	0.06

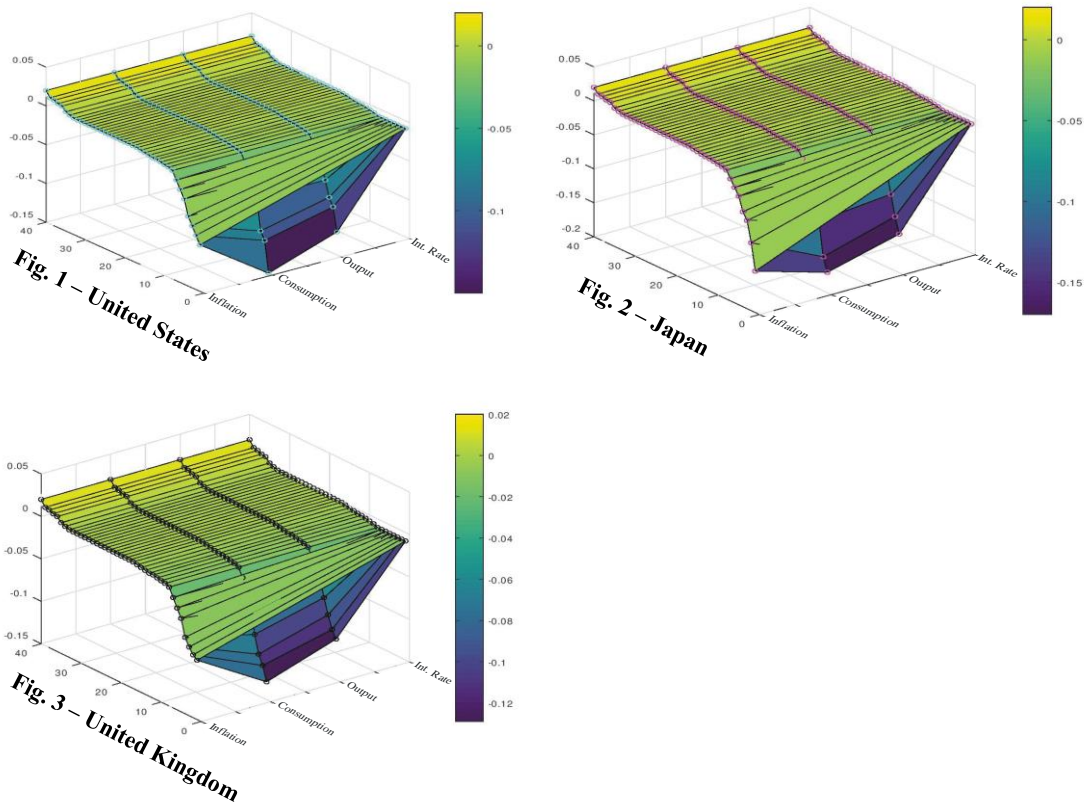
3. RESULTS

Panels 1–4 depict the three-dimensional graphical illustrations of the dynamic responses of output, inflation and consumptions to the stochastic innovations in our model within the framework of zero lower bound interest rate. We calculated and observed the differential in the magnitudes of the losses to the central banks based on the deviation of these macroeconomic predictors from their equilibrium after stochastic shocks hit the economies. The size of the disequilibrium/loss is depicted on the Y-axis, the convergence periods is displayed on the X-axis and the economic predictors are captured on the Z-axis. From our estimations, we find the following:

Panel 1 (Figs. 1–3) reveals the deviation of the macroeconomic variables from the steady states in a conventional monetary policy that strive to stabilise the output gap and inflation with minimal fiscal policy intervention. We found that the US

consumption, inflation and output deviated from the steady states by 15 %, 9 % and 12 %, respectively, as initial responses to shocks in the ZLB environment and subsequently converged to the equilibrium after some periods. The Japanese macroeconomic variables, which initially responded by 17 %, 13.9 % and 14.3 %, dropped while the UK recorded losses of 12.9 %, 8 % and 10.2 % to macroeconomic predictors from shocks. The magnitude of these losses justifies the monetary policy impotency to absorb the exogenous shocks when fiscal involvement is negligible. We observed that the conventional monetary policy was incapacitated by the presence of the ZLB and central banks' struggle to minimise the manifestation of the shocks on these macroeconomic predictors.

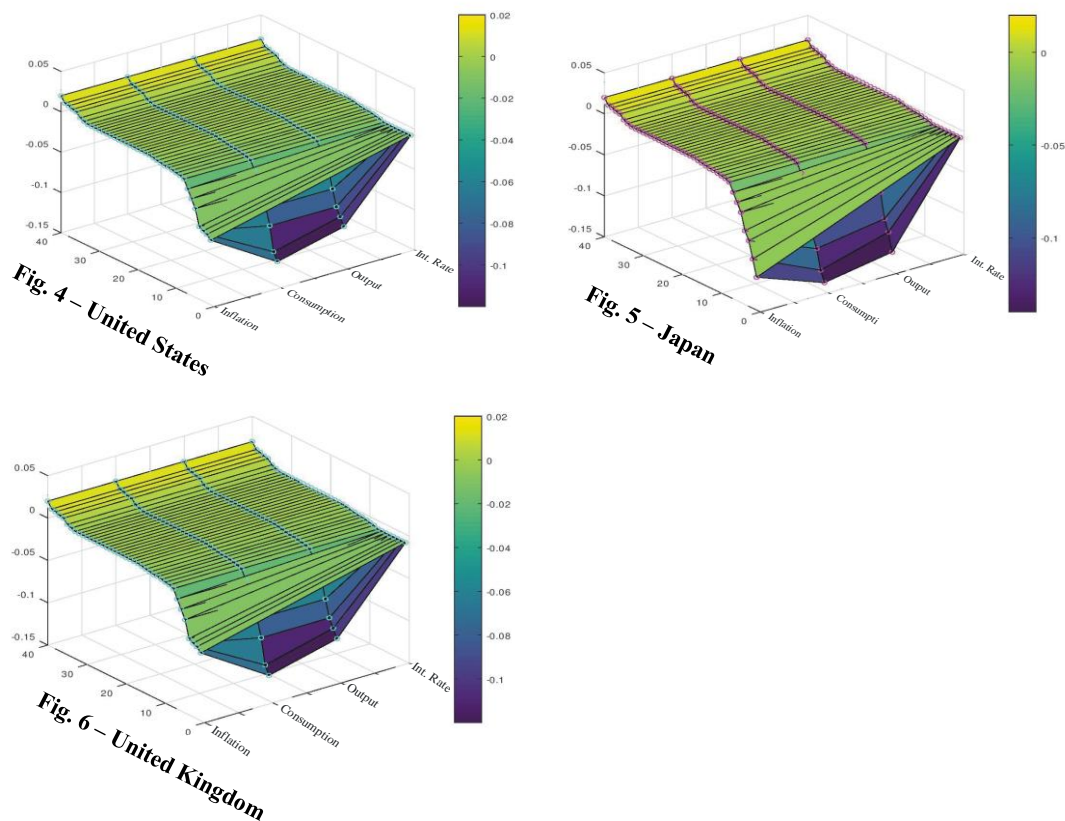
Panel 1. Standard Monetary and Low Fiscal Policy Interaction



Panel 2 (Figs. 4–6) presents the result of a persistent fiscal policy in the central bank stabilisation objective such that monetary rule responds to both inflation and output gap. In this simulation scenario, the fiscal policy interacts with monetary policy for four periods. Thus, we observed that the dynamic responses of the macroeconomic predictors to the stochastic innovation in the model varied from the first simulation scenario. The US economy records initial deviations of 12 %, 7.74 % and 10.86 % from steady states; Japan shows 14 %, 11 % and 12.6 %, while the UK estimates show 10.5 %, 7 % and 8.3 % deviation from the equilibrium. By allowing the fiscal policy to persist in the stabilisation goal, the Federal Reserve was capable

of reducing losses by 20 %, 14 % and 9.5 %; BOK by 17.64 %, 20.86 % and 11.88 %; BOE by 18.6 %, 12.5 % and 19.41 % on consumption, inflation and output relative to the first case scenario. Although the previous findings (see Adam, 2011; Bhattarai, Trzeciakiewicz & 2017; Blanchard, 2018; Blanchard, Erceg & Lindé, 2015; Catalano & Pezzolla, 2017; Christiano, Eichenbaum & Trabandt, 2016; Falagiarda & Saia, 2017; Farmer, Khramov & Nicolò, 2015; Gelain *et al.*, 2019; Gerke *et al.*, 2013; Ginters & Buss, 2015; Miyamoto *et al.*, 2017; Nakamichi, 2012; Patrick *et al.*, 2019; Ramey & Zubairy, 2018; Reis, 2018; Woodford, 2007) vary across the multiplier effects of fiscal activities in the ZLB economic atmosphere, our findings support the fiscal policy potency in minimising shock effects on the macroeconomic predictors in the ZLB environment in the USA, Japan and the UK. This finding reverberates the report by Schabert and Bredemeier (2015).

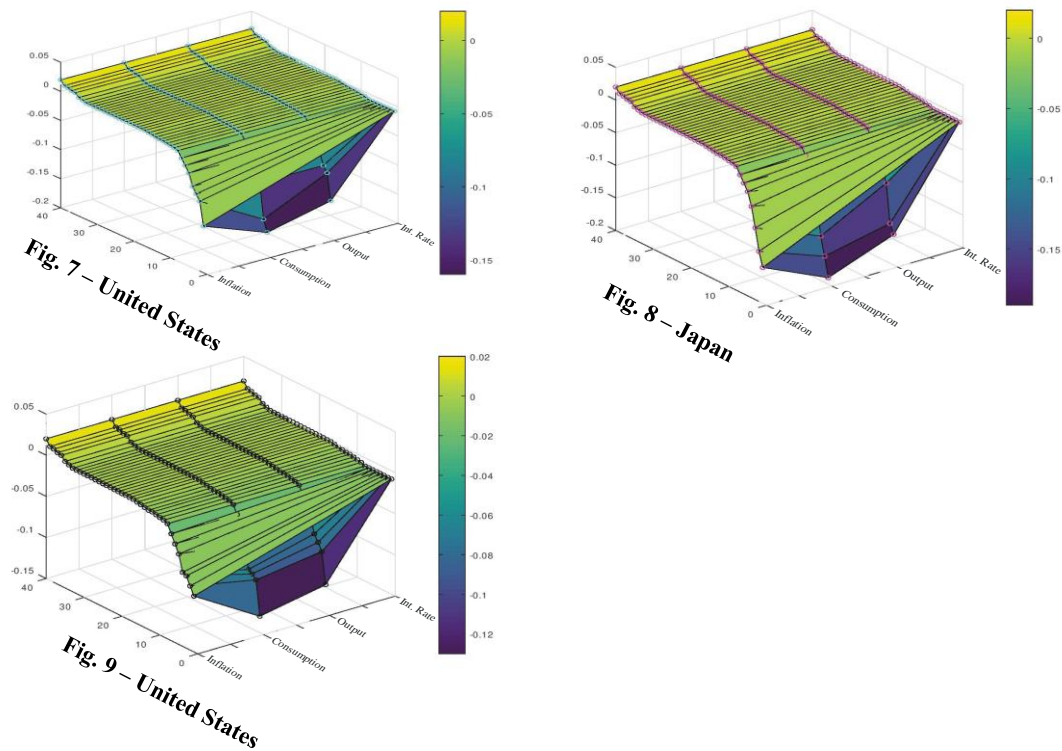
Panel 2. Standard Monetary and Persistent Fiscal Policy Interaction



Panel 3 (Figures 7–9) simulates the one-time fiscal policy interaction with an exclusive inflation targeting monetary policy. In this case scenario, monetary reaction function responds only to inflationary pressure in their stabilization goal by allowing one-time fiscal policy response to address shock effects on macroeconomic predictors. We presumed that this scenario would worsen the shock effects on consumption, output and possibly inflation. Since output gap exerted pressure on

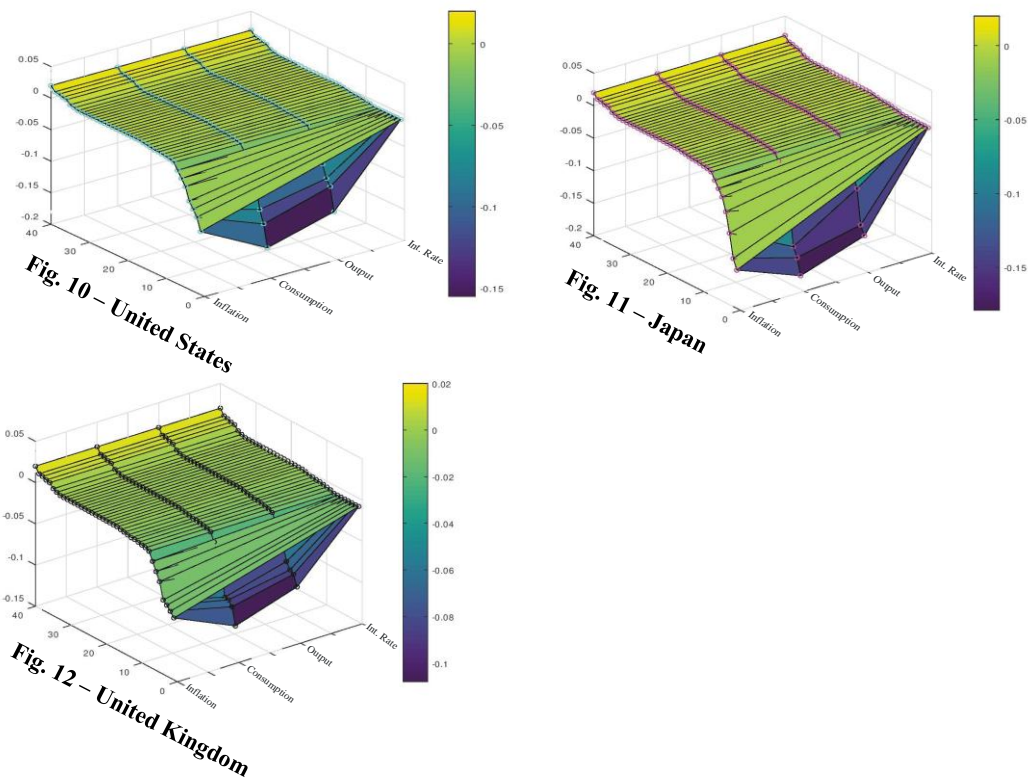
inflation, the capacity of weak monetary policy, without fiscal support, to control the inflationary pressure might further be enfeebled. Our simulation confirmed that this scenario produced worse results relative to the above simulation results. The US data showed 16 %, 12 % and 13.5 % consumption, inflation and output from the initial deviation from the equilibrium shocks. The Japanese estimation result recorded 19 %, 14.5 % and 15.3 % initial deviations and UK estimates showed 13 %, 8.2 % and 11.5 % initial deviations of these macroeconomic predictors. This result implies that interacting fiscal policy with this monetary strategy is inefficient in any ZLB environment.

Panel 3. Exclusive Inflation Targeting Monetary and Low Fiscal Policy Interaction



Panel 4 (Figs. 7–9) replicates the simulation procedure for the third panel but allowed the fiscal policy to persist. We observed improvement in the losses to consumption, inflation and output for solely inflation targeting monetary policy, which allowed for persistent interactive fiscal policy in the stabilisation strategy. The consumption, inflation and output initial losses to shock effect dropped to 15.5 %, 10 % and 12.7 % in the USA and showed percentage improvement of 3.13 %, 16.67 % and 5.9 % relative to the third simulation scenario. The Japanese result recorded 17.9 %, 14.1 % and 14.7 % initial deviations and improved by 5.78 %, 2.7 % and 3.9 % relative to the third simulation. The UK estimates revealed 10.8 %, 7.5 % and 8.4 % initial deviations and improved by 16.9 %, 8.5 % and 27 % relative to the third simulation scenario.

Panel 4. Exclusive Inflation Targeting and Persistent Fiscal Interaction



Our estimation supported the theory. First, we observed an optimal result when a comprehensive monetary policy was coordinated with a persistent interactive fiscal policy to achieve the stabilisation goals. Relatively, this (S_2) produced the lowest losses to all the macroeconomic predictors in the zero lower bound environment during and after the shocks. Second, we observed that monetary policy rule that responded to both output and inflation improved the losses. Third, we noted that the contractionary fiscal policy tools such as high taxes-imposed constraints on the fiscal policy to fully mitigate losses from exogenous shocks. Thus, we present the posterior results for the optimal simulation in the section below.

Posterior Distribution

Table 3 presents the posterior estimates for the optimal model. In this section, we compare and discuss the posterior means for the parameters across three economies.

Table 3. Posterior Estimation of the Optimal Calibrated Scenario (S_2):
High Fiscal Policy Involvement

Parameters		Prior						
			United States		Japan		United Kingdom	
		Density	Mean	Std.	Mean	Std.	Mean	Std.
Habit	h	Beta	0.92	0.01	0.67	0.05	0.79	0.01
Risk averseness	ρ	Normal	1.25	0.03	1.12	0.09	0.99	0.01
Index price	I_p	Beta	0.30	0.05	0.23	0.01	0.37	0.05
Index wage	I_w	Beta	0.43	0.05	0.36	0.03	0.56	0.08
Calvo price	p	Beta	0.87	0.02	0.81	0.04	0.95	0.02
Calvo wage	ω	Beta	0.88	0.01	0.75	0.04	0.60	0.03
Mon.rule inflation	m_π	Normal	1.34	0.15	1.21	0.08	1.23	0.07
Mon.rule output gap	m_y	–	–	–	–	–	–	–
Interest smoothening	m_p	Beta	0.94	0.01	0.86	0.02	0.79	0.03
Capital share	α	Normal	0.25	0.01	0.18	0.01	0.34	0.02
Bond spread	δ	Gamma	0.42	0.06	0.24	0.02	0.19	0.01
AR(1) wage mark -up	w_1	Beta	0.84	0.01	0.93	0.01	0.75	0.01
AR(1) bond spread	b_1	Beta	0.86	0.02	0.49	0.01	0.82	0.01
AR(1) price mark- up	ρ_1	Beta	0.79	0.07	0.82	0.04	0.73	0.02
AR(1) technology	φ_1	Beta	0.86	0.04	0.76	0.02	0.89	0.01
AR(1) government	g_1	Beta	0.95	0.03	0.93	0.01	0.94	0.01
AR(1) tax shock	τ_1	Beta	0.89	0.03	0.91	0.01	0.91	0.01
AR(1) monetary policy	ψ_1	Beta	0.19	0.01	0.12	0.02	0.11	0.02
Std. Dev. wage mark -up	w_2	Inv Gam.	0.16	0.04	0.23	0.02	0.18	0.01
Std. Dev. bond spread	b_2	Inv Gam.	0.07	0.01	0.01	0.01	0.03	0.01
Std. Dev. price mark-up	ρ_2	Inv Gam.	0.25	0.08	0.12	0.01	0.32	0.03
Std. Dev. technology	φ_2	Inv Gam.	0.42	0.13	0.34	0.03	0.35	0.02
Std. Dev. government	g_2	Inv Gam.	0.34	0.01	0.56	0.02	0.54	0.05
Std. Dev. tax shock	τ_2	Inv Gam.	1.21	0.02	1.26	0.02	1.43	0.08
Std. Dev. monetary rule	ψ_2	Inv Gam.	0.16	0.04	0.09	0.02	0.08	0.02

Source: Researchers (2019).

Our estimation revealed that households possessed fair habits in the consumption function h 's being 0.92, 0.67 and 0.79 for the USA, Japan and the UK, respectively, which were close to the results found in Bhattarai & Trzeciakiewicz (2017), Drautzburg & Uhlig (2015), Nasir *et al.* (2016). The risk averseness ρ s was estimated 1.25, 1.12 and 0.95. It was evaluated within the neighbourhoods of 1.17 by Drautzburg and Uhlig (2015) for the US data, 1.13 obtained by Iwata (2013) for the Japanese data, and 0.95 obtained by Bhattarai and Trzeciakiewicz (2017) for the UK data. The calvo sticky wage, ω 's was 0.88, 0.75 and 0.60, which indicated that wage adjustment occurred approximately every fourth quarter in the USA, third quarter in Japan and the UK. The calvo sticky price parameters; p 's were 0.87, 0.81 and 0.95, which indicated that prices were marked up at approximately one year in the three economies, respectively. The interest rate smoothing estimates; m_p were 0.94, 0.86 and 0.79; They were around the estimated interest rate persistence; 0.92 was obtained

by Drautzburg and Uhlig (2015), 0.80 – by Iwata (2013) and 0.74 –by Bhattarai and Trzeciakiewicz (2017). The estimated monetary response to inflation m_π was 1.34, 1.21 and 1.23; this evidence showed a gradual weakness in the monetary policy control on inflation. We assumed that the ability of monetary policy could have been worse in the absence of a persistent interactive fiscal policy. Also, from the shocks to fiscal policy, our estimation demonstrates that shocks to government spending persisted than the tax shocks while monetary policy was at minimum across the economies.

Variance Decomposition

Table 4 summarises the variance decomposition we derived from the estimation. According to these estimates, shocks to fiscal policy and bond spread are the major drivers of the variations in the macroeconomic variables, while the mark-ups contribute less variations to these predictors in the United States. In Japan, the causes of variations are distributed across several shocks, but the result demonstrates lower effects from monetary policy and bond spread. We observed counter effects in the fiscal policy shocks in the United Kingdom That is, we observed positive shock from the expansionary government spending and a negative tax shock on consumption, output and inflation. The shock to mark-ups also relatively contributes to the variation in these macroeconomic predictors in the UK.

Table 4. Variance Decom. of the Optimal Calibrated Scenario (S₂):
High Fiscal Policy Involvement

Shocks	Inflation			Consumption			Output		
	US	Japan	UK	US	Japan	UK	US	Japan	UK
Wage mark-up	4.02	17.34	11.07	8.03	15.93	14.3	4.58	13.25	9.13
Price mark-up	7.5	16.03	13.9	6.63	19.83	9.34	4.04	16.84	12.01
Technology	11.03	17.72	9.02	18.02	16.6	7.08	14.2	14.53	8.5
Government	20.61	19.03	23.09	24.89	20.61	20.02	19.08	21.7	26.6
Bond spread	20.23	5.03	6.01	19.45	6.32	8.60	20.02	9.29	10.21
Tax	20.59	15.05	30.03	9.01	12.97	36.8	29.01	15.8	35.02
Monetary rule	10.02	9.8	6.88	12.97	7.74	3.86	10.07	8.59	5.52
% Sum	100	100	100	100	100	100	100	100	100

US- United States, UK- United Kingdom

Source: Researchers (2019).

Table 5. Initial Macroeconomic Loss from Shocks

Scenario	United States		
	Inflation	Consumption	Output
S ₁	9 %	15 %	12 %
S ₂	7.74 %	12 %	10.86 %
S ₃	12 %	16 %	13.5 %
S ₄	10 %	15.5 %	12.7 %

Source: Researchers (2019).

4. CONCLUDING REMARKS

The goal of the study was to describe the ability of the fiscal policy to absorb exogenous shocks from the nominal interest rate within the new Keynesian DSGE model in the USA, UK and Japan economies. Our theoretical intuition and empirical strategy followed the New Keynesian DSGE model proposed by Lorenzoni and Werning (2013), Werning (2015) and Cochrane (2017, 2018). Contrary to earlier studies, the findings of our simulations were robust to a number of checks. First, our simulation results suggested that the nominal interest rate limited the ability of monetary policy to respond to macroeconomic turbulence, particularly, when the economies had bias to preserve the interest rate at a lower bound period. Surprisingly, the results indicated that the fiscal expansionary stance acted as a shock absorber by compelling the macroeconomic predictors back to their initial equilibrium. However, fiscal discipline must be embraced to sustain this stability strategy. Contrariwise, we found shocks being transmitted from the contractionary fiscal policy with consequence on the economies that had bias to stimulate aggregate demand.

Comparably, specific country evidences showed mixed results. This was expected since these economies had different macroeconomic dynamics as well as varied policy prospect. For instance, in the United States, we observed bubble persistence in the interest rate, which helped manage irregular inflation, even though the monetary policy was inactive during the period observed. However, complementary expansionary fiscal stance and unconventional monetary approach were observed from our results.

In the United Kingdom, our estimated model showed an unevenly spread from two major sources, which was beyond the purview of the monetary policy control. First, we observed shock from the tax system practice on consumption and investment, which contrasted aggregate demand components. Second, the shocks from the nominal interest rate continued to drop the rate of investment. However, the UK economy continued to survive this paraded shock due to the active fiscal expansionary stance. Nevertheless, serious erosion in tax practice hampered the ability of agents' responses to aggregate demand as the economy continued to be exposed to exogenous shock. The UK tax system utilises a combination of income, capital and consumption in its tax base, which formed the overall tax objectives. The present taxes are inefficient and ineffective with adverse effects on consumption and output. The aftermath effect was observed in the unstable investment. This served as a signal to investors to postpone or delay investment and led to slower economic growth.

In Japan, the expansionary fiscal persistent stance continued to act as a stabilising mechanism to the economy. Specifically, the Japanese economy enjoyed an increase in consumption with exception of the perceived crowding-out private investment in some relative quarter during the zero lower bound rate period. While fiscal policy remained active, monetary policy struggled to normalize the macroeconomic turmoil in the economy. Thus, the present policy mix adopted in the Japanese economy needed to adopt the unconventional monetary policy to complement the current fiscal response that was found to be effective for managing the economy.

This research thus supported the findings of Bhattarai & Trzeciakiewicz (2017), Buera & Nicolini (2014), Cochrane (2017, 2018), Lorenzoni & Werning (2013), Miyamoto et al. (2017), Werning (2015) who had earlier advocated the need for the use of the fiscal policy to manage macroeconomic imbalance.

Finally, additional studies can complement this existing effort by investigating the role of global predictor during the zero lower bound period when the economies bias towards the adoption of persistence fiscal policy as a strategy for correcting macroeconomics imbalance.

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