EK-131ix

The Effects of a Money-Financed Fiscal Stimulus in a Small Open Economy*

Eiji Okano† Masataka Eguchi
Nagoya City University Komazawa University

This Draft: July 2023
(First Draft: September 2021)

Abstract

We construct a small open economy model to analyze the effects of a money-financed fiscal stimulus compared with a conventional debt-financed fiscal stimulus in a liquidity trap. By developing a closed economy model, Gali[14] highlights the effectiveness of an increase in government expenditure in the debt-financed fiscal stimulus case. However, the money-financed fiscal stimulus is more effective at stabilizing output and inflation in a small open economy than in a closed economy. An increase in government expenditure in the case of the debt-financed fiscal stimulus is less effective, irrespective of nominal exchange rate pass-through, in a small open economy.

Keywords: Fiscal Stimulus, Money Financing, Debt Financing, Zero Lower Bound, Imperfect Pass-through

JEL Classification: E31, E32, E52, E62, F41

*We thank the anonymous referees for their helpful and valuable comments. Any remaining errors are our own. This research was financially supported by the Japan Society for the Promotion of Science *KAKENHI* (Grant #19K01722).

†Corresponding author. Graduate School of Economics, Nagoya City University, 1, Aza, Yamanobata, Mizuho-cho, Mizuho-ku, Nagoya-shi, Aichi, 467-8501, Japan. Tel.: +81-52-872-5721; Fax: +81-52-872-1531; Email: eiji_okano@econ.nagoya-cu.ac.jp

1 Introduction

After the global financial crisis, the policy rates in many advanced economies hit the zero lower bound (ZLB) and government debt continued to rise. In light of this situation, Gali[14], Buiter[4], and Turner[26] all presented proposals to avoid deflationary traps and provide more monetary and fiscal stimulus packages. Buiter[4] analyzes the impact of a money-financed (MF) transfer to households in a relatively general setting and emphasizes the importance of the irredeemability of money as the ultimate source of the expansionary effect of such a policy on consumption. Auerbach and Obstfeld[1] study the effects of open market operations in raising inflation and output when the economy is at the ZLB due to a temporary adverse shock. These effects depend on whether the increase in liquidity is permanent and agents expect it to be so. Gali[14], an extension of the studies by Auerbach and Obstfeld[1] and Buiter[4], proposes a theoretical framework of the MF fiscal stimulus and demonstrates its effectiveness at stabilizing both output and inflation, even in an economy becoming stuck in a liquidity trap.

We take our inspiration from them and observe that their model does not include an external sector. Gali[13] (Ch. 8) claims that extending the model to an open economy allows us to assess the extent to which opening the economy refutes some of the conclusions about monetary policy obtained for the closed economy. Following this claim, we extend the closed economy model of Gali[14] to a small open economy model in which the monetary–fiscal policy interaction affects exchange rates in addition to interest rates. Then, similar to Gali[14], we calculate the responses under the MF fiscal stimulus, conventional debt-financed (DF) fiscal stimulus, and case of *no response* under which there is no fiscal stimulus such as a tax cut or an increase in government expenditure in response to an adverse demand shock that causes the nominal interest rate to become stuck at the ZLB or in a liquidity trap. The cost of the fiscal stimulus is financed by the issuance of money and the balance of government debt in the MF fiscal stimulus case is unchanged. By contrast, the cost of the DF fiscal stimulus is financed by changing the real balance of government debt. The scenario we use for the liquidity trap is identical to that in Gali[14], where an adverse shock strikes a small open economy six periods in succession.

By simply modifying the closed economy model of Gali[14] to a small open economy model with relevant assumptions, we draw important conclusions. Our main finding is that the MF fiscal stimulus in a small open economy is more effective than in a closed economy, regardless of whether the means is a tax cut or an increase in government expenditure, in a liquidity trap. While fiscal expansions tend to increase interest rates and appreciate exchange rates, the MF fiscal stimulus alleviates the resulting problems by accommodating the fiscal expansion. Although Gali[14] emphasizes the effectiveness of government expenditure under the DF scheme in a liquidity trap, it is no longer effective in a small open economy compared with the MF scheme. Adverse demand shocks that make an economy become stuck in a liquidity trap tend to decrease domestic inflation, increase interest rates, and appreciate exchange rates. Owing to the ZLB constraint, the nominal interest rate cannot be less than zero. The MF fiscal stimulus increases consumer price index (CPI) inflation and depreciates the nominal exchange rate because of the strong incentive to obtain seigniorage, which increases money growth. Thus, the terms of trade (TOT) stabilize and the real consumption interest rate decreases. Then, output and CPI inflation recover (the relative increase in the import price applies pressure to increase the TOT and facilitates recovering output through the expenditure-switching effect). Owing to the open economy setting, the TOT is additionally involved in the determination of output; hence, the effectiveness of the MF fiscal

stimulus is higher than in a closed economy.

As mentioned, government expenditure under the *DF* scheme in a liquidity trap is no longer effective in a small open economy compared with the *MF* scheme. Under the *DF* scheme with CPI inflation targeting (CIT), the nominal exchange rate appreciates and CPI inflation severely decreases. This decrease increases government debt and tax revenue under the assumption of Ricardian fiscal policy following [14]. The government then loses its incentive to obtain seigniorage, money growth decreases, and the real consumption interest rate increases. This increase in the real consumption interest rate and a decrease in the TOT resulting from an appreciation of the nominal exchange rate decrease output. Even under the *DF* scheme with domestic inflation targeting (DIT), a decrease in the TOT resulting from an increase in government expenditure, which applies pressure to increase domestic inflation, decreases output.

Our main finding is derived in a perfect pass-through environment in which the law of one price (LOOP) is applicable. As Monacelli[22] argues, because there is a limitation in assuming perfect pass-through, we investigate our main finding in the imperfect pass-through environment. We find that while an increase in government expenditure under the *MF* fiscal stimulus is effective, an increase in government expenditure under the *DF* scheme is not, even in the imperfect pass-through environment. An increase in government expenditure applies pressure to increase domestic inflation, while the import price has nominal rigidity; hence, the TOT decreases under the *DF* scheme. Because of the TOT decreasing , a decrease in output is not effectively prevented, even if government expenditure increases under the *DF* fiscal stimulus. We consider the imperfect pass-through of the import price rather than the imperfect pass-through of the export price, which makes the export price in the units of the foreign currency sticky. If we assume the imperfect pass-through of the export price as well as the import price, owing to the sticky export price, the TOT is more sticky. Then, the decrease in output following an adverse demand shock might be alleviated and the result might change, although precise analysis is essential.

The remainder of the paper proceeds as follows. Section 2 discusses the related literature, while Section 3 shows the set of equilibrium dynamics based on the model and defines the fiscal and monetary policies we examine. Section 4 shows the effects of a fiscal stimulus in normal times when the ZLB is not available by calculating the fiscal multipliers. Section 5 considers the effects of a fiscal stimulus in a liquidity trap where there is a ZLB. Section 6 presents our conclusions.[1]

2 Related Literature

Several studies focus on the case in which an *MF* fiscal stimulus fails to stabilize the economy. Drawing on Gali[14], Tsuruga and Wake[25] analyze how an implementation lag modifies the effectiveness of an *MF* fiscal stimulus and find that it can result in a recession in normal times. In addition, in a liquidity trap, the recession deepens. English et al.[11] develop a conventional macroeconomic model and address the credibility of the central bank. They show that an *MF* fiscal stimulus is effective if communicated successfully and seen as credible by the public. However, if the public doubt the central bank's commitment to the policy, then an *MF* fiscal stimulus is ineffective.

Similar to Gali[14], this study relates to the literature on monetary policy in a New Keynesian

[1]The online appendices detail the derivation of the model, steady state, and responses in normal times and in the imperfect pass-through environment. See the corresponding author's website, https://www.econ.nagoya-cu.ac.jp/~eiji_okano/papers_e.html.

framework in the presence of a ZLB, in line with Jung et al.[19], Eggertsson and Woodford[10], Werning[27], Buiter[3], Svensson[24], Nakajima[23], and Fujiwara et al.[12]. Among these studies, Buiter[3], Svensson[24], Nakajima[23], and Fujiwara et al.[12] also assume an open economy. Buiter[3] analyzes monetary policy in a liquidity trap in a small open economy by developing a general equilibrium model without a micro foundation, while Svensson[24], Nakajima[23], and Fujiwara et al.[12] derive micro-founded models, similar to in our analysis. However, unlike our study, these authors focus only on monetary policy.

To extend the closed economy model of Gali[14] to a small open economy, we refer to Gali and Monacelli[17]. The seminal small open economy model of Gali and Monacelli[16] is precise and to simplify it without loss of generality, we refer to Gali and Monacelli[17], who aggregate individual behavior in a simplified manner.[2] An alternative way of deriving a small open economy model is by following De Paoli[9], who derives such a model by reducing a two-country model that includes home bias. However, to simplify the derivation, we follow Gali and Monacelli[17].

We also include an additional analysis of an imperfect pass-through environment by referring to the analysis of monetary policy in a small open economy with imperfect pass-through of Monacelli[22]. Corsetti et al.[6] also derive a local currency pricing model that generates incomplete pass-through. However, we follow Monacelli[22], as Corsetti et al.[6] assume a two-country economy.

3 The Model

Similar to Gali[14], we assume a representative household, sticky prices for domestic goods (i.e., Calvo pricing is applied for domestic goods), and flexible wages. Further, the government (consisting of fiscal and monetary authorities acting in a coordinated way) finances its expenditure through lump-sum taxes and issuing a riskless nominal one-period bond with a nominal interest rate and (non-interest-bearing) money. To extend the closed economy model of Gali[14], we assume an infinitesimal small open economy, complete international financial markets, the LOOP, and exports elastic to changes in the TOT, following Gali and Monacelli[17].

3.1 Equilibrium Dynamics

We approximate the equilibrium around the steady state in which inflation is zero as follows (ignoring the ZLB constraint at this point):

International Risk-sharing Condition

$$\hat{\xi}_t = -(1-\nu)\, s_t + \hat{\xi}^*_t - \zeta_t, \tag{1}$$

Market-clearing Condition

$$\hat{y}_t = \nu\,(2-\nu)\, s_t + (1-\nu)\,\hat{c}_t + \nu \hat{y}^*_t + \hat{g}_t, \tag{2}$$

Consumption Euler Equation

$$\hat{\xi}_t = \hat{\xi}_{t+1} + \left(\hat{i}_t - \pi_{t+1} - \hat{\rho}_t\right), \tag{3}$$

[2] Their study analyzes the effectiveness of wage rigidity in a currency union.

Marginal Utility of Consumption

$$\hat{\xi}_t = -\sigma \hat{c}_t + \upsilon \hat{l}_t, \tag{4}$$

First-order Necessary Condition for Firms

$$\pi_{H,t} = \beta \pi_{H,t+1} - \kappa \hat{\mu}_t, \tag{5}$$

Price Markup Gap

$$\hat{\mu}_t = \hat{\xi}_t - \frac{\alpha + \varphi}{1 - \alpha} \hat{y}_t - \nu s_t, \tag{6}$$

Money Demand Schedule

$$\hat{l}_t = \hat{c}_t - \eta \hat{i}_t, \tag{7}$$

The Logarithmic First Differential of the Definition of the Real Money Balance

$$\hat{l}_{t-1} = \hat{l}_t + \pi_t - \Delta m_t, \tag{8}$$

Consolidated Government Budget Constraint

$$\hat{b}_t = (1 + \rho) \hat{b}_{t-1} + (1 + \rho) b \hat{i}_{t-1} - (1 + \rho) b \pi_t + \hat{g}_t - \widehat{tr}_t - \chi \Delta m_t, \tag{9}$$

A Combination of the Logarithmic First Differential of the Definition of the CPI and TOT

$$\pi_t = \pi_{H,t} + \nu \left(s_t - s_{t-1} \right), \tag{10}$$

Definition of the Trade Balance

$$\widehat{nx}_t = \hat{y}_t - \nu s_t - \hat{c}_t - \hat{g}_t, \tag{11}$$

Definition of the TOT

$$s_t = e_t + p_t^* - p_{H,t}, \tag{12}$$

Definition of Domestic Inflation

$$\pi_{H,t} = p_{H,t} - p_{H,t-1}, \tag{13}$$

Definition of Import Inflation

$$\pi_{F,t} = p_{F,t} - p_{F,t-1}, \tag{14}$$

A Combination of the (Logarithmic) Definition of the TOT with the (Logarithmic) Definition of Domestic and Import Inflation

$$\pi_{F,t} = s_t - s_{t-1} + \pi_{H,t}, \tag{15}$$

with $\kappa \equiv \frac{(1-\theta\beta)(1-\theta)\Theta}{\theta}$, $\Theta \equiv \frac{1-\alpha}{(1-\alpha)+\alpha\epsilon}$, $\varphi \equiv \frac{V_{nn} N}{V_n}$, $\upsilon \equiv \frac{U_{cl} L}{U_c}$, $\sigma \equiv -\frac{U_{cc} C}{U_c}$, where $\beta \equiv \frac{1}{1+\rho} \in (0,1)$ denotes the subjective discount factor, ρ denotes the rate of time preference, $\nu \in [0,1]$ denotes openness, $\mu \equiv \log\left(\frac{\epsilon}{\epsilon - 1}\right)$ denotes the constant (desired) price markup, $\eta \equiv \frac{\epsilon_{lc}}{\rho}$ with $\epsilon_{lc} \equiv \frac{1}{\sigma_l + \upsilon}$ and $\sigma_l \equiv \frac{U_{ll} L}{U_l}$ denotes the elasticity of substitution between consumption and real balances, $\chi \equiv \frac{L}{Y}$ is

Table 1: Notation of the Variables

Variable	Definition	Description
Y_t		Output
$\hat{y}_t$	$\log\left(\frac{Y_t}{Y}\right)$	
C_t		Consumption
$\hat{c}_t$	$\log\left(\frac{C_t}{C}\right)$	
Z_t		The Exogenous Preference Shifter
$\hat{\rho}_t$	$-\log\left(\frac{Z_{t+1}}{Z_t}\right)$	The Demand Shock
$P_{H,t}$		The Domestic Price
$p_{H,t}$	$\log P_{H,t}$	
$P_{F,t}$		The Import Price in Units of the Domestic Currency
$p_{F,t}$	$\log P_{F,t}$	
$\mathcal{S}_t$	$\frac{P_{F,t}}{P_{H,t}}$	The TOT
s_t	$\log\mathcal{S}_t$	
G_t		Government Expenditure
$\hat{g}_t$	$\frac{G_t}{Y}$	
$U_{c,t}$		The Marginal Utility of Consumption
ξ_t	$\log\left(\frac{U_{c,t}}{U_c}\right)$	
P_t	$P_{H,t}^{1-\nu}P_{F,t}^{\nu}$	The CPI
Π_t	$\frac{P_t}{P_{t-1}}$	(Gross) CPI inflation
π_t	$\log\Pi_t$	
i_t		The Nominal Interest Rate
$\hat{i}_t$	$\log\left(\frac{1+i_t}{1+\rho}\right)$	
M_t		(Non-interest-bearing) Money
m_t	$\log M_t$	
L_t	$\frac{M_t}{P_t}$	Real Money Balance
$\hat{l}_t$	$\log\left(\frac{L_t}{L}\right)$	
B_t		Nominal Risk-less One-period Gov. Debt in the Small Open Economy
$\hat{b}_t$	$\frac{\mathcal{B}_t-\mathcal{B}}{Y}$	
$\mathcal{B}_t$	$\frac{B_t}{P_t}$	Real Government Debt
TR_t		Lump-sum Taxes
$\widehat{tr}_t$	$\frac{TR_t-TR}{Y}$	
NX_t		Net Exports
$\widehat{nx}_t$	$\log\left[\left(\frac{NX_t}{P_{H,t}}\right)/Y\right]$	
Z_t^*		The Preference Shifter in the Foreign Country
ζ_t	$-\log\left(\frac{Z_t^*}{Z_t}\right)$	
Y_t^*		Output in the Foreign Country
$\hat{y}_t^*$	$\log\left(\frac{Y_t^*}{Y^*}\right)$	
$U_{c,t}^*$		The Marginal Utility of Consumption in the Foreign Country
ξ_t^*	$\log\left(\frac{U_{c,t}^*}{U_c^*}\right)$	
P_t^*		The Price in the Foreign Country
p_t^*	$\log P_t^*$	
$\mathcal{E}_t$		The Nominal Exchange Rate (The Price of the Foreign Currency in Units of the Dom. Currency)
e_t	$\log\mathcal{E}_t$	
$\Pi_{H,t}$	$\frac{P_{H,t}}{P_{H,t-1}}$	(Gross) Domestic Inflation

Table 1: Notation of the Variables (cont.)

Variable	Definition	Description
$\pi_{H,t}$	$\log\Pi_{H,t}$	
$\Pi_{F,t}$	$\frac{P_{F,t}}{P_{F,t-1}}$	(Gross) Import Inflation
$\pi_{F,t}$	$\log\Pi_{F,t}$	
MC_t^n		The Nominal Marginal Cost
MC_t	$\frac{MC_t^n}{P_{H,t}}$	The Real Marginal Cost
μ_t	$-\log MC_t$	The Logarithmic Average Markup
$\hat{\mu}_t$	$\mu_t - \mu$	The Price Markup Gap

Note: Variables without a time script are the steady-state values of those variables.

the inverse income velocity of money, $b \equiv \frac{\mathcal{B}}{Y}$ denotes the steady-state share of government debt to output, and Δ is the difference operator. We assume $Z_t^* = 1$ and $Z_{t+1} = Z_t^{\varrho}$ with $\varrho = 0$. Thus, $\hat{\rho}_t = \log Z_t = \zeta_t$. The presentation of the model and notation closely parallel the model of Gali[14]. Table 1 presents the notation of the variables.

Eqs. (1) to (7), (9), and (11) to (14) are derived by log-linearizing the international risk-sharing condition, market-clearing condition, Euler equation, marginal utility of consumption, first-order necessary condition for firms, definition of the marginal cost, money demand schedule, consolidated government budget constraint, definition of the trade balance, definition of the TOT, definition of domestic inflation, and definition of import inflation. Although Eqs. (12) to (15) play no essential role in deciding the dynamic paths, they are necessary to calculate the nominal exchange rate and import inflation. We use a logarithmic definition of the LOOP $p_{F,t} = e_t + p_{F,t}^*$ to derive Eq. (12). Plugging this into Eq. (12), Eq. (12) becomes $s_t = p_{F,t} - p_{H,t}$.

Our log-linearized model inherits the features of the small open economy of Gali and Monacelli[16], whose model consists of not only the New Keynesian IS and Philips curves, but also the international risk-sharing condition. In addition, the market-clearing condition and average markup include the TOT. Then, both consumption and output are affected by changes in the TOT. Thus, in contrast to Gali[14], not only the real consumption interest rate, but also the TOT is involved in monetary–fiscal policy interactions.

3.2 Fiscal and Monetary Policies

3.2.1 Government Budget Constraint and Financing Regime

As in Gali[14], we assume the following simple (Ricardian) tax rule throughout the analysis:

$$\widehat{tr}_t = \psi_b \hat{b}_{t-1} + \hat{\varsigma}_t, \tag{16}$$

which shows that tax variations have two components. The first is $\psi_b \hat{b}_{t-1}$, which is endogenous and varies in response to deviations in the debt ratio from its long-run target, where $\psi_b > \rho$ is a tax adjustment parameter that guarantees that $\lim_{k\to\infty} \mathrm{E}_t\left(b_{t+k}\right) = 0$ (i.e., the debt ratio converges to its long-run target). The other is $\hat{\varsigma}_t$, which is independent of the debt ratio and represents the exogenous component of the tax rule.[3]

[3]Accordingly, the government's transversality condition $\lim_{k\to\infty} \Lambda_{t,t+k} \mathcal{B}_{t+k} = 0$ is satisfied for any price path as long as the discount factor $\Lambda_{t,t+k}$ converges to zero as $k \to \infty$, which is the case in all the experiments considered

3.2.2 Experiments

Following Gali[14], we analyze two stylized fiscal interventions announced in period zero and implemented from that period onward. The first intervention consists of an exogenous tax cut as $\hat{\varsigma}_t = -\delta^t < 0$, for $t = 0, 1, 2, ...$, where $\delta \in [0, 1)$ measures the persistence of the exogenous fiscal stimulus. Symmetrically, the second takes the form of an exogenous increase in government expenditure as $\hat{g}_t = \delta^t > 0$, for $t = 0, 1, 2, ...$ In both cases, we normalize the size of the stimulus to correspond to 1% of steady-state output in period zero.

Similar to Gali[14], we analyze the effects of each type of fiscal intervention under the *MF* and *DF* schemes. We define the *MF* scheme, which is our focus, as the one in which seigniorage is adjusted every period to keep real debt $\mathcal{B}_t$ unchanged. Plugging $\hat{b}_t = 0$ into Eq. (9), we have

$$\Delta m_t = \frac{1}{\chi}\left[\hat{g}_t - \hat{\varsigma}_t + (1+\rho)\, b\left(\hat{i}_{t-1} - \pi_t\right)\right], \tag{17}$$

for $t = 0, 1, 2, ...$, where we use Eq. (16). The previous assumptions, combined with Eq. (16), imply that under the *MF* regime, the government does not need to adjust taxes as a result of an increase in government expenditure, either in the short or in the long run, relative to their initial level. Alternatively, in the case of a tax cut, taxes decrease temporarily by δ^t. In other words, under the *MF* regime, the government does not need to raise taxes or debt in response to the fiscal interventions considered here. In both cases, monetary policy must give up control of the nominal interest rate and instead adjust the money supply to meet the government's financing needs.

Under the *DF* scheme, the fiscal authority issues debt to finance the fiscal stimulus, eventually adjusting the path of taxes to attain the long-run debt target $\mathcal{B}$, as the tax rule in Eq. (16) implies. We assume that the monetary authority pursues an independent price stability mandate. For concreteness, we assume that if feasible, it conducts policy; hence,

$$\pi_{H,t} = 0, \tag{18}$$

$$\pi_t = 0, \tag{19}$$

for all t.[4] Either DIT (see Eq. (18)) or CIT (see Eq. (19)) is applicable under the *DF* scheme. The money supply and thus seigniorage then adjust endogenously to bring about the interest rate required to stabilize prices, as well as the regime generally assumed in the New Keynesian literature on the effects of fiscal policy.

3.3 Calibration

Our parameterization is consistent with that of Gali[14], except for the parameters specific to an open economy, namely, openness ν (Table 2).[5] [6] We set this parameter following Monacelli[22].

below. We assume the previous property, often referred to as Ricardian (or passive) fiscal policy (e.g., Leeper[21]), as in standard specifications of the New Keynesian model, and must be combined with active monetary policy (as implicitly assumed below) to guarantee a local unique equilibrium.

[4] A class of the Taylor rule in Corsetti et al.[8] and others can represent the *DF* scheme instead of Eq. (19), although we adopt Eq. (18) or (19) to adhere to Gali's[14] setting.

[5] Gali[14] does not clarify the value of relative risk aversion σ. We infer that Gali[14] might set the value to 1, similar to Monacelli[22], because the responses of our macroeconomic variables in a closed economy resemble those in Gali[14]. Accordingly, we set the value to 1, following Monacelli[22], to generate more convenient results.

[6] If there is capital accumulation, α can be regarded as the capital share of output. However, there is no capital accumulation in the model and we term α as the index of decreasing returns to labor, as in Table 2, following Gali and Monacelli[17].

Table 2: Parameterization

Parameter	Description	Value	Source
σ	Relative Risk Aversion	1	Monacelli[22]
ν	Openness	0.4	
β	Discount Factor	0.995	Gali[14]
φ	Curvature of Labor Disutility	5	
α	Index of Decreasing Returns to Labor	0.25	
ϵ	Elasticity of Substitution among Goods	9	
θ	Calvo Index of Price Rigidities	$\frac{3}{4}$	
χ	Steady-state Inverse Velocity	$\frac{1}{3}$	
η	Semi-elasticity of Money Demand	7	
υ	Separability of Real Balances	0	
ψ_b	Tax Adjustment	0.02	
b	Target Debt Ratio	2.4	
δ	Persistence	0.5	

Both our implied assumptions of perfect substitution between domestic and import goods and our benchmark parameterization of relative risk aversion attain balanced trade; that is, $\widehat{nx}_t = 0$ for all t as long as the demand shock $\hat{\rho}_t$ does not hit the economy.

4 The Effects of the Fiscal Stimulus in Normal Times

4.1 Sensitivity Analysis

We now discuss the sensitivity of some of the above qualitative findings in terms of the effectiveness of fiscal policies. We focus on the parameter measuring the degree of openness ν, a feature of small open economies not present in closed economies, instead of focusing on the degree of price stickiness θ and persistence of the shock δ, as Gali[14] does. Focusing on openness is important to understand how the assumption of a small open economy affects the effectiveness of a fiscal stimulus.

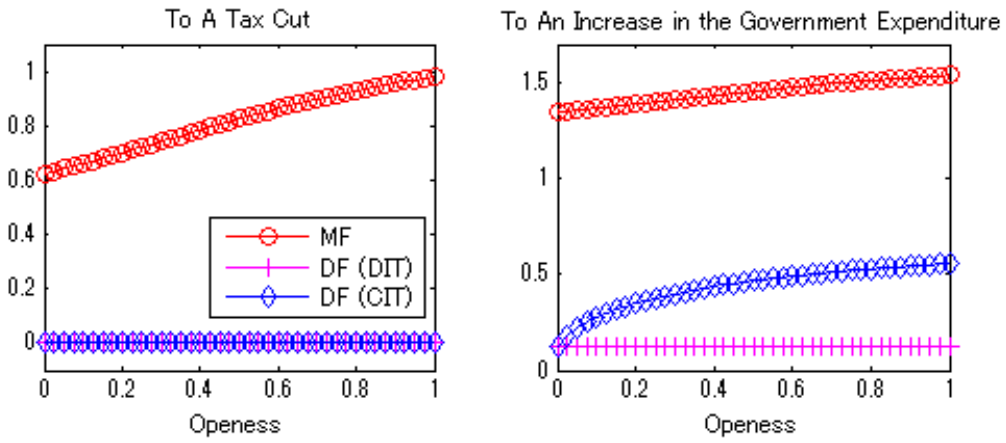
Following Gali[14], we define the cumulative output multiplier $(1-\delta)\sum_{t=0}^{\infty}\hat{y}_t$. Figure 1 depicts the cumulative output multipliers for a tax cut and an increase in government expenditure as a function of openness ν. The multipliers are on the vertical axis, while the level of openness is on the horizontal axis. The red line with circles, magenta line with pluses, and blue line with diamonds are the multipliers under the *MF* fiscal stimulus, *DF* fiscal stimulus scheme with DIT, and *DF* fiscal stimulus scheme with CIT, respectively. Panel 1 depicts the fiscal multipliers to a tax cut, while Panel 2 plots these for an increase in government expenditure. On the left of each figure, openness is zero (i.e., $\nu = 0$); that is, the multipliers shown on the extreme left correspond to those in a closed economy, as Gali[14] assumes.

4.1.1 Fiscal Multipliers and a Tax Cut

We first discuss the multipliers for a tax cut as a function of openness ν. The multipliers are zero regardless of the changes in ν under the *DF* scheme (Panel 1, Figure 1). Ricardian equivalence holds and there are no fiscal effects in the first instance.

By contrast, under the *MF* scheme, the multipliers strongly increase with a tax cut as ν increases (Panel 1, Figure 1). A tax cut (and an increase in government expenditure) increases

Figure 1: Fiscal Multipliers: The Role of Openness



domestic inflation through a decrease in the average markup, and CPI inflation increases. This increase in CPI inflation implies that the CPI shifts upward in the long run. Because purchasing power parity (PPP) holds in the long run, the nominal exchange rate depreciates in the long run. This depreciation leads to increases in import inflation and the import price. As the definition of the (logarithmic) CPI $p_t = (1-\nu)\, p_{H,t} + \nu p_{F,t}$ suggests, as openness increases, the share of the import price increases and the CPI rises. That is, the greater openness, the higher the CPI and the more depreciated the nominal exchange rate because of PPP in the long run. Because depreciation in the nominal exchange rate increases the TOT, the TOT increases with openness.

This increase in the TOT accompanies a (relative) increase in domestic output. Combining Eqs. (1) and (2) yields

$$s_t = (\hat{y}_t - \hat{y}_t^*) - \hat{g}_t - (1-\nu)\,\zeta_t, \tag{20}$$

where $\sigma = 1$. Eq. (20) shows that a (relative) increase in domestic output accompanies an increase in the TOT due to the expenditure-switching effect, together with the effect of the increase in consumption through the risk-sharing transfer of resources (see Eq. (1)). Thus, the more open the economy, the higher its output because of the greater increase in the TOT. The multiplier continues to increase with openness ν.

4.1.2 Fiscal Multipliers for an Increase in Government Expenditure

Similar to the multipliers for a tax cut under the *MF* scheme, the multipliers for an increase in government expenditure under the *MF* scheme increase with openness ν (Panel 2, Figure 1). The reason is that the TOT increases as openness ν increases, as described in Section 4.1.1.

Regardless of openness, the multipliers are identical in a closed economy, namely, $\nu = 0$, under the *DF* fiscal stimulus scheme with DIT. Plugging Eqs. (1), (4), (6), (18), and (20) into Eq. (5) and assuming $\sigma = 1$ yield

$$\hat{y}_t = -\frac{(1-\alpha)\,\nu}{1+\varphi}\zeta_t + \frac{1-\alpha}{1+\varphi}\hat{g}_t,$$

which implies that output under the *DF* fiscal stimulus scheme with DIT is unaffected by openness ν and depends on government expenditure, as long as ζ_t does not shift the logarithmic international

risk-sharing condition (Eq. (1)). Thus, the multipliers are identical in a closed economy (Panel 2, Figure 1). This result is consistent with Gali and Monacelli's[15] finding that the equilibrium dynamics in a small open economy are isomorphic to those in a closed economy under DIT. As Gali and Monacelli[16] discuss, the nominal exchange rate moves one-for-one with the TOT, given that domestic prices are fully stabilized under DIT, as Eq. (12) implies.[7] Thus, under DIT, the dynamics of output, domestic inflation, and so forth in a small open economy are identical to those in a closed economy.[8]

With an increase in government expenditure under the *DF* scheme with CIT, import inflation must decrease through an appreciation of the nominal exchange rate to offset the pressure to increase CPI inflation stemming from the increase in domestic inflation brought about by an increase in government expenditure. As openness increases, the share of domestic inflation in CPI inflation decreases and the pressure to increase CPI inflation brought about by the increase in domestic inflation is alleviated. Thus, as openness increases, the pressure to decrease import inflation must be alleviated. That is, a decrease in the TOT must be alleviated as openness increases. As uncovered interest parity implies, the TOT relates negatively to current nominal interest rates.[9] Thus, an increase in the nominal interest rate, which is identical to the real consumption interest rate under the *DF* fiscal stimulus scheme with CIT, reduces as openness increases, such that the decrease in consumption from openness is alleviated. In other words, the crowding out of consumption is alleviated as openness increases and the multipliers thus increase with openness (Panel 2, Figure 1).

Finally, we indicate that the sensitivity analysis does not regard the costs of using monetary financing frequently, such as higher steady-state inflation and possibly higher risk premiums, volatile capital flows, and exchange rate volatility. When implementing the *MF* fiscal stimulus, we have to regard those costs.

5 The Effects of the Fiscal Stimulus in a Liquidity Trap

This section explores the effectiveness of the *MF* fiscal stimulus at stabilizing the economy in the face of a temporary adverse demand shock by comparing it with the effectiveness of the *DF* fiscal stimulus, similar to Gali[14]. We assume that the adverse demand shock is sufficiently large to prevent the central bank from fully stabilizing output and inflation given the ZLB constraint on the nominal interest rate.

Similar to Gali[14], the ZLB constraint takes the form $\hat{i}_t \geq \log\beta$ and the experiment assumes that $\hat{\rho}_t = -\gamma < \log\beta$ for $t = 0, 1, 2, ...T$ and $\hat{\rho}_t = 0$ for $t = T+1, T+2, ...$ This describes a temporary adverse demand shock that takes the natural interest rate into negative territory up to period T. After period T, the shock vanishes. We assume $\gamma = -0.01$ and $T = 5$. The shock is assumed to be fully unanticipated, but once realized, the trajectory of $\{\hat{\rho}_t\}$ and corresponding policy responses are known with certainty.

The ZLB constraint can be incorporated formally into the set of equilibrium conditions above

[7] By plugging $p_{H,t} = 0$ into Eq. (12), we have $e_t = s_t$, where we ignore p_t^*.

[8] Suppose a decrease in the nominal interest rate. In a small open economy, this decrease increases consumption and increases the TOT through a depreciation of the nominal interest rate. Similarly, in a closed economy, it increases consumption. In both economies, this decrease increases output identically because the nominal exchange rate moves one-for-one with the TOT under DIT.

[9] Uncovered interest parity implies that the nominal exchange rate appreciates as the nominal interest rate increases. Then, the TOT decreases if the other variables remain unchanged.

by replacing Eq. (7) with a complementary slackness condition:

$$\left(\hat{i}_t - \log\beta\right)\left(\hat{l}_t - \hat{c}_t + \eta\hat{i}_t\right) = 0,$$

for all t, where

$$\hat{l}_t \geq \hat{c}_t - \eta\hat{i}_t, \tag{21}$$

represents demand for real money balances.

In addition to the previous changes, under the *DF* fiscal stimulus and *no response* benchmark, Eqs. (18) and (19) must be replaced with

$$\left(\hat{i}_t - \log\beta\right)\pi_{H,t} = 0, \tag{22}$$

$$\left(\hat{i}_t - \log\beta\right)\pi_t = 0, \tag{23}$$

for all t, together with Eqs. (18) and (19), which are DIT and CIT, respectively. This is applicable for the period in which the ZLB constraint on the nominal interest rate is unavailable. By contrast, in the *MF* fiscal stimulus case, Eq. (17) determines the money supply for all t. If the nominal interest rate is positive, Eq. (21) holds with equality (but with inequality once the nominal interest rate reaches the ZLB and the real money balances overshoot their satiation level). Thus, given $\beta = 0.995$, the experiment considered corresponds to an unanticipated fall in the natural interest rate to –2% (in annual terms) for six quarters and a subsequent revision back to the initial value of 2% (in annual terms).

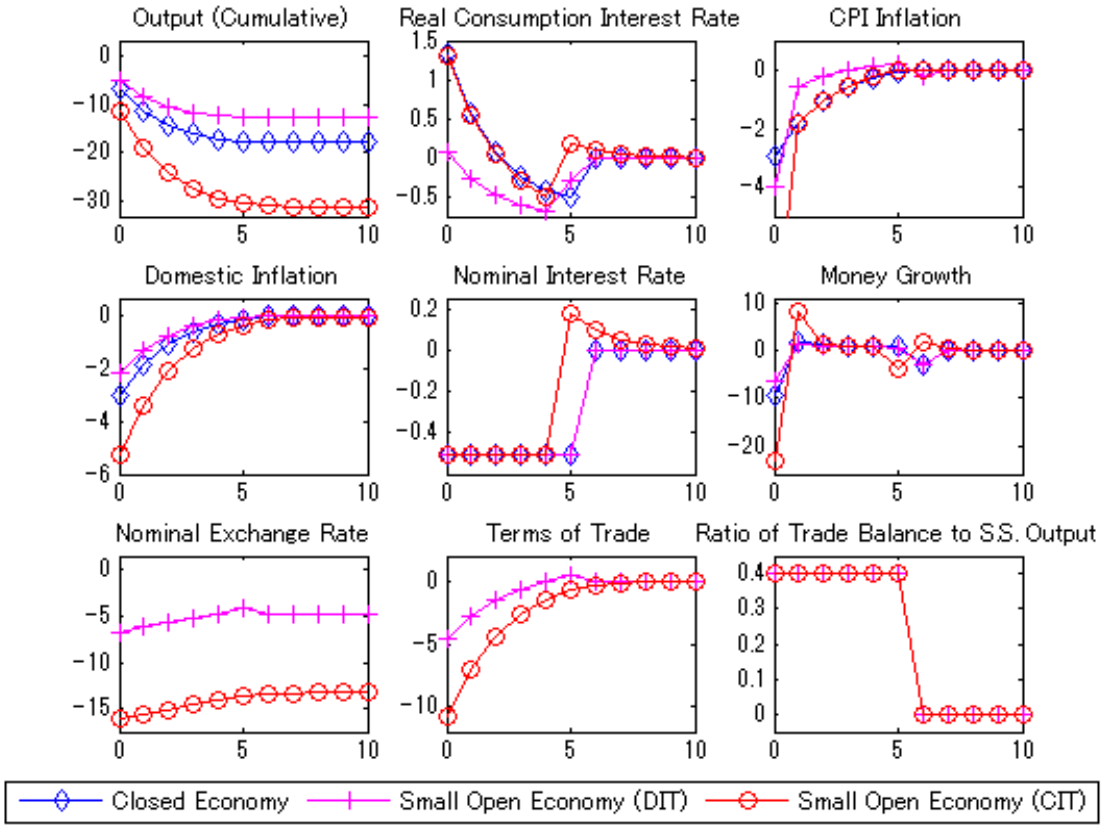
Figures 2 to 6 depict the responses in the case of *no response* to a tax cut under the *MF* scheme, an increase in government expenditure under the *MF* scheme, a tax cut under the *DF* scheme, and an increase in government expenditure under the *DF* scheme, respectively. In these figures, the blue line with diamonds shows the responses in a closed economy (i.e., $\nu = 0$), while the red line with circles and magenta line with pluses show the responses in a small open economy with CIT and DIT, respectively. In a small open economy, $\nu = 0.4$ (our benchmark parameterization). In the case of *no response* to the shock (i.e., $\hat{g}_t = \hat{\varsigma}_t = 0$, for $t = 1, 2, 3\ldots$), monetary policy is described by Eqs. (18) and (22) in DIT, and Eqs. (19) and (23) in CIT as the benchmark. The scenario for the tax cut is that a 1% tax cut lasts for the duration of the adverse shock ($\hat{\varsigma}_t = -0.01$, for $t = 0, 1, \ldots, 5$) in the *MF* and *DF* fiscal stimulus cases, similar to Gali[14]. The scenario for the increase in government expenditure is a 1% increase in the steady-state ratio to output in response to the adverse demand shock that lasts for the duration of the adverse shock ($\hat{g}_t = 0.01$, for $t = 0, 1, \ldots, 5$) in the *MF* and *DF* fiscal stimulus cases, again similar to Gali[14].

5.1 *No Response*

We start by considering the case of *no response* in which there is no fiscal stimulus to the adverse demand shock as the benchmark. First, we discuss the responses with DIT. As mentioned, Gali and Monacelli[15] show that the equilibrium dynamics in a small open economy are isomorphic to those in a closed economy under DIT. However, in our small open economy model, changes in $\hat{\rho}_t$ change ζ_t, which shifts the international risk-sharing condition (Eq. (1)) (recall that $\hat{\rho}_t = \zeta_t$). Thus, the adverse demand shock raises the marginal utility of consumption above that in the foreign country and increases the trade balance, even if we assume perfect substitution between

domestic and foreign goods and $\sigma = 1$ (Panel 9, Figure 2).[10] Plugging Eqs. (1) and (2) into Eq. (11) yields $\widehat{nx}_t = -\nu\zeta_t$, which implies that the adverse demand shock makes the trade balance positive.

Figure 2: Responses in the Case of *No Response* in a Liquidity Trap



Owing to the fluctuation in the trade balance, the dynamics in a small open economy are not necessarily identical to those in a closed economy. The adverse demand shock decreases domestic inflation, and CPI inflation decreases (Panels 3 and 4, Figure 2). This decrease in CPI inflation is larger than that in a closed economy because it includes import inflation, which has no nominal rigidity. However, it decreases the TOT by appreciating the nominal exchange rate because of PPP in the long run, and output decreases (Panels 1, 7, and 8, Figure 2). Here, the nominal exchange rate appreciates, whereas the nominal interest rate decreases and becomes stuck at the ZLB (Panel 5, Figure 2). The magnitude of the shock is sufficiently large to decrease the CPI. Because of PPP in the long run, the nominal exchange rate appreciates, whereas the decrease in the nominal interest rate applies pressure to depreciate.[11]

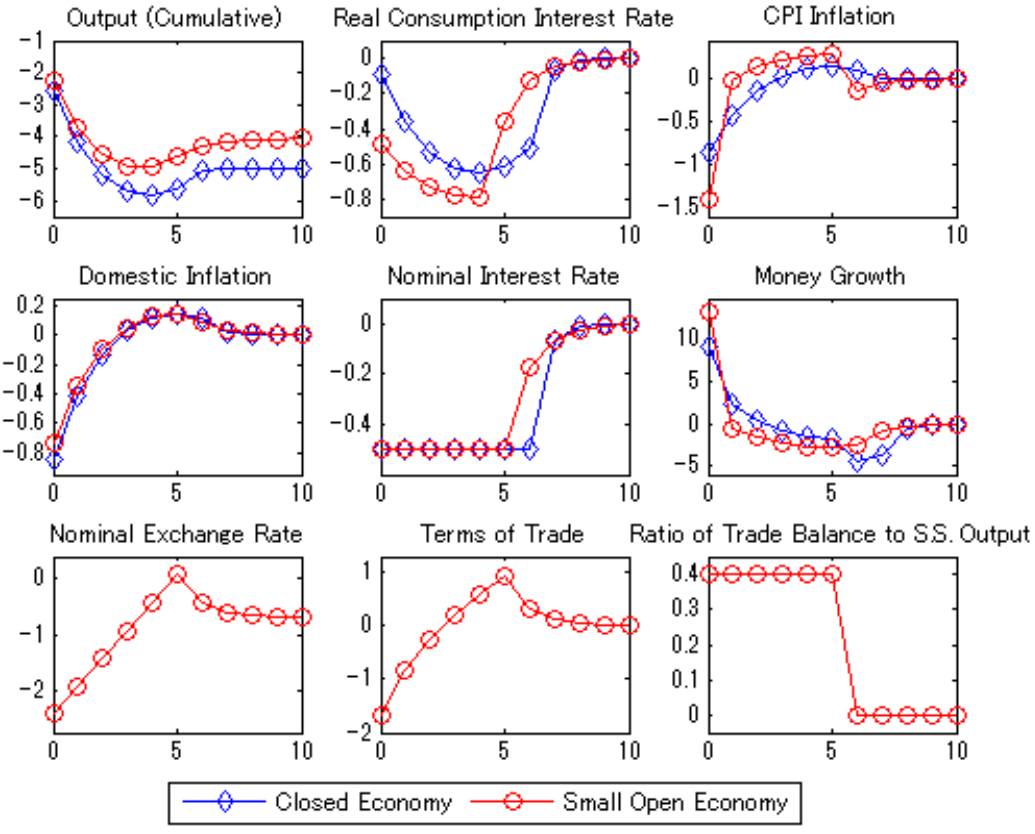
[10] Under this assumption, if no exogenous shock changes the trade balance directly, balanced trade is attained. A 1% increase in the import price raises demand for domestic goods by 1%. However, this increase in demand for domestic goods is canceled out by the increase in the import price; hence, the trade balance is unchanged (see Gali and Monacelli[16] for the details)

[11] Similar to us, Cook and Devereux[5] show exchange rate appreciation in the liquidity trap, which depends on the magnitude of the adverse demand shock; as the shock weakens, appreciation is alleviated. In our model, under

On the one hand, the recovery of CPI inflation is faster than that in a closed economy (Panel 3, Figure 2). Thus, the real consumption interest rate in a small open economy is lower than that in a closed economy (Panel 2, Figure 2). This lower real consumption interest rate overcomes the pressure to decrease consumption and helps make the decrease in output somewhat smaller than that in a closed economy.

Next, we discuss the responses in a small open economy with CIT. The fall in domestic inflation is larger than that with DIT because domestic inflation is not the target to stabilize (Panel 4, Figure 2). This decrease applies higher pressure to the nominal exchange rate to appreciate than with DIT, although the nominal interest rate decreases and becomes stuck at the ZLB (Panels 5 and 7, Figure 2). This appreciation of the nominal exchange rate decreases import inflation and the TOT decreases (Panel 8, Figure 2). This serves to decrease domestic inflation again because it also decreases consumption and output and increases the average markup. Thus, the pressure to decrease domestic inflation is more severe in a small open economy than in a closed economy and the resulting fall in CPI inflation is correspondingly more severe (Panel 3, Figure 2).

Figure 3: Dynamic Effects of a Tax Cut under the *MF* Fiscal Stimulus in a Liquidity Trap

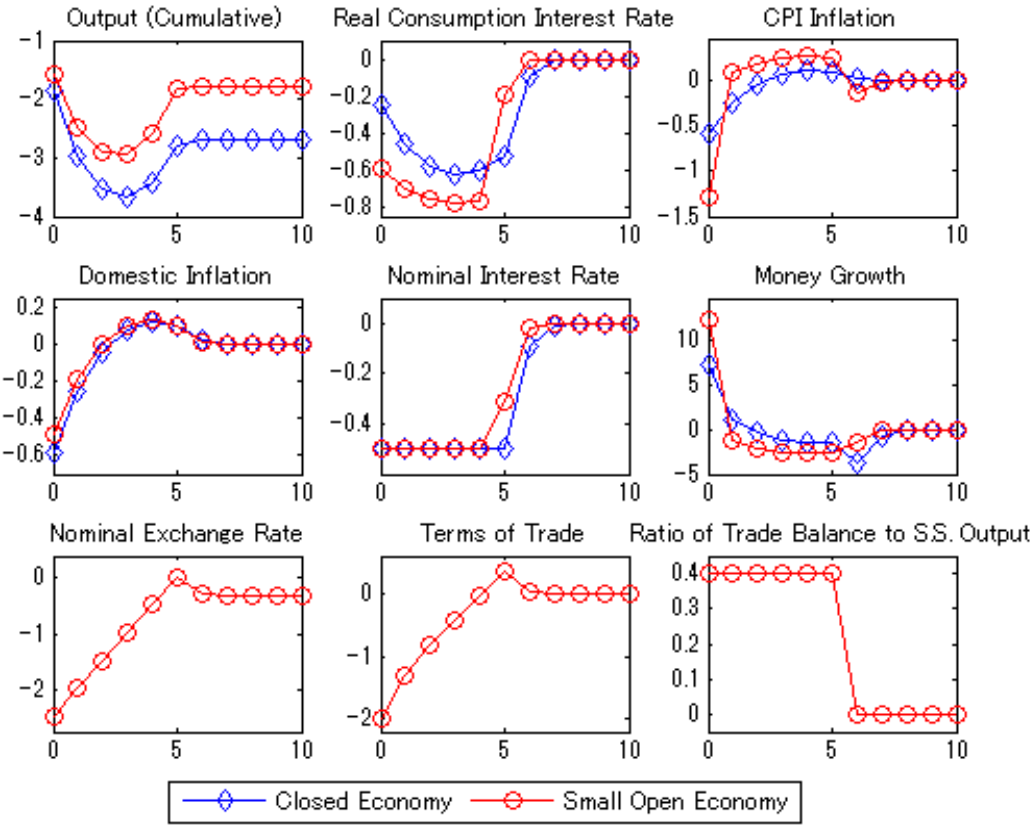


This severe decrease in CPI inflation amplifies the burden of redeeming government debt. Thus,

DIT, for the benchmark, $\gamma = -0.0075$, and -0.005, the exchange rate appreciates by approximately 4.71%, 1.91%, and 0%, respectively, in the long run. Under CIT, for the benchmark, $\gamma = -0.0075$, and -0.005, it appreciates by approximately 13.24%, 6.89%, and 0.19%, respectively, in the long run.

government debt is higher than in a closed economy. Given our simple tax rule, Eq. (16), the larger balance of real government debt raises tax revenue in a small open economy. This higher tax revenue completes the fiscal consolidation in period four. Seigniorage is no longer necessary and money growth decreases. Then, the nominal interest rate increases in period five when the adverse demand shock is still striking (Panel 5, Figure 2). This increase and overshooting of the nominal interest rate increases the real consumption interest rate; hence, the recovery in consumption is weaker than that in a closed economy. As a result, the recovery of output is delayed and decrease in (cumulative) output in a small open economy is 1.77 times larger than that in a closed economy (Panel 1, Figure 2).

Figure 4: Dynamic Effects of an Increase in Government Expenditure under the *MF* Fiscal Stimulus in a Liquidity Trap



5.2 *MF* Fiscal Stimulus

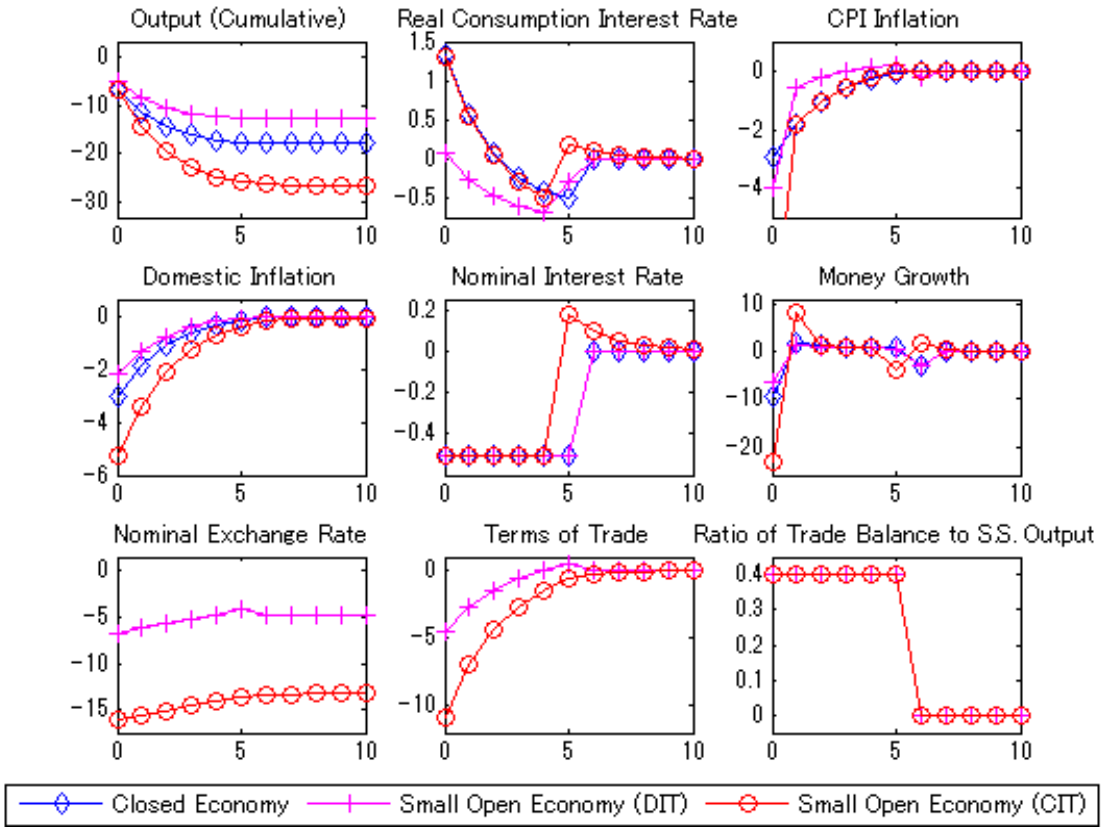
5.2.1 Response To a Tax Cut

A tax cut under the *MF* scheme in a small open economy stabilizes output and inflation and is more effective than that in a closed economy (Panels 1, 3, and 4, Figure 3). The decrease in CPI inflation immediately after the adverse demand shock strikes is larger than that in a closed economy. This larger decrease in CPI inflation deprives revenue from the inflation tax; hence,

together with financing a tax cut, the government has a strong incentive to obtain seigniorage. Thus, the increase in money growth is larger than that in a closed economy (Panel 6, Figure 3).

This higher money growth alleviates the decline in consumption through the lower real consumption interest rate; hence, the decrease in domestic inflation is alleviated and recovery in CPI inflation is faster (Panels 2, 3, and 4, Figure 3). This faster recovery in CPI inflation helps alleviate the appreciation of the nominal exchange rate compared with the case of *no response* (Panel 7, Figures 2 and 3). An appreciation of the nominal exchange rate is then alleviated; hence, the decrease in the TOT is alleviated compared with the case of *no response* (Panel 8, Figures 2 and 3). Then, the recovery in output is more vigorous and decrease in (cumulative) output is smaller (Panel 1, Figure 3). Thus, the *MF* fiscal stimulus is more effective in a small open economy than in a closed economy.

Figure 5: Dynamic Effects of a Tax Cut under the *DF* Scheme in a Liquidity Trap



In addition, this result—that the effect of monetary easing under the ZLB in a small open economy is stronger than that in a closed economy—is consistent with the result in Section 4.3.1 that the higher openness, the higher the fiscal multipliers in the *MF* scheme.

5.2.2 Response To an Increase in Government Expenditure

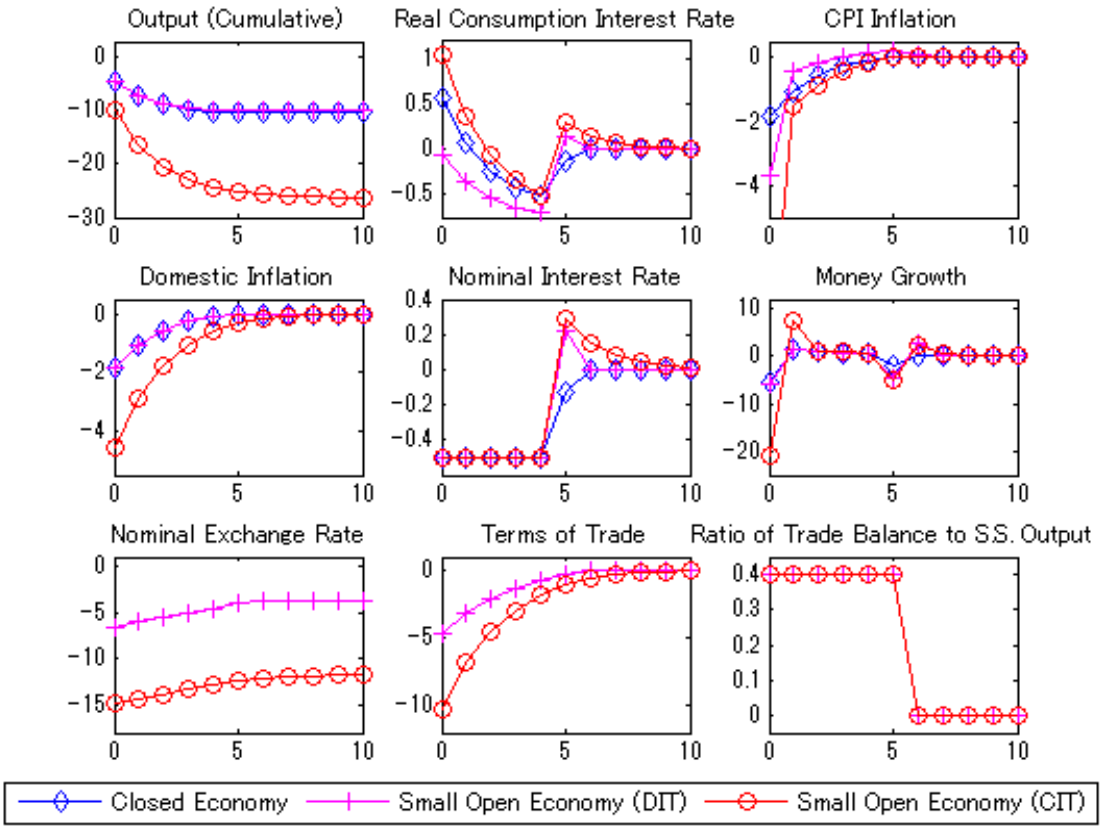
An increase in government expenditure is more effective at stabilizing output than in a closed economy, similar to a tax cut in a small open economy (Panel 1, Figure 4). Money growth is hiked more than in a closed economy (Panel 6, Figure 4). Thus, the fall in the real consumption interest rate is larger than that in a closed economy, as for a tax cut (Panel 2, Figure 4). The faster recovery in CPI inflation helps alleviate the decrease in the TOT through the alleviated appreciation of the nominal exchange rate (Panels 3, 7, and 8 in Figure 4).

5.3 *DF* Fiscal Stimulus

5.3.1 Response To a Tax Cut

The responses to a tax cut under the *DF* scheme are identical to those in the case of *no response*, except for taxes, real government debt, and the fiscal surplus with inflation tax (i.e., the blue line with diamonds, magenta line with pluses, and red line with circles in Figure 2 are identical to those in Figure 5). Ricardian equivalence is attained and there are no effects on any other variables.

Figure 6: Dynamic Effects of an Increase in Government Expenditure under the *DF* Scheme in a Liquidity Trap

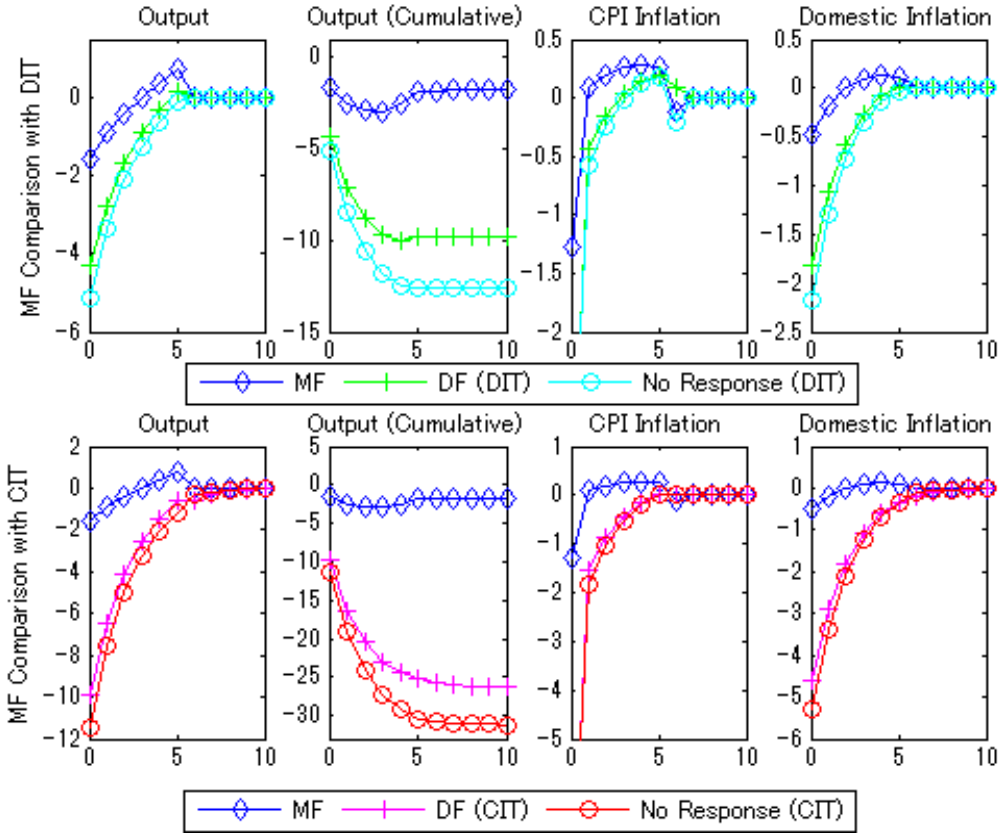


5.3.2 Response To an Increase in Government Expenditure

Unlike the *MF* fiscal stimulus, an increase in government expenditure under the *DF* scheme in a small open economy is ineffective at stabilizing output and inflation (Figure 6). This is due to a decrease in the TOT and strong effects of the *MF* fiscal stimulus. Gali[14] suggests that the increase in government expenditure under the *DF* scheme impacts output and inflation markedly and that their responses are similar to those for an increase in government expenditure under the *MF* scheme. Thus, our finding of an increase in government expenditure under the *DF* scheme is different from his.

Under the *DF* scheme with DIT, while CPI inflation decreases, the recovery of CPI inflation is very fast and this completes the fiscal consolidation faster (Panel 3, Figure 6). Then, money growth decreases; hence, the nominal interest rate is hiked and it overshoots (Panels 5 and 6, Figure 6). However, the real consumption interest rate is lower than that in a closed economy owing to the faster recovery in CPI inflation (Panel 2, Figure 6). On the one hand, while the increase in government expenditure applies pressure to increase output, it likewise applies pressure to increase domestic inflation; hence, the TOT decreases more in the case of *no response* with DIT (Panel 8, Figures 2 and 6). Owing to the higher decrease in the TOT, (cumulative) output decreases (Panel 1, Figure 6).

Figure 7: Dynamic Effects of an Increase in Government Expenditure in a Liquidity Trap: Comparison of the *MF* Scheme, *DF* Scheme, and Case of *No Response* in a Small Open Economy



Under the *DF* scheme with CIT, CPI decreases severely and the nominal exchange rate appreciates (Panels 3 and 7, Figure 6). This severe decrease in CPI inflation, which amplifies the burden of redeeming government debt, increases tax revenue. Money growth decreases, and then the nominal interest rate is hiked and it overshoots (Panels 5 and 6, Figure 6). The real consumption interest rate increases (Panel 2, Figure 6). Thus, the recovery of consumption is delayed. The severe appreciation of the nominal exchange rate also decreases the TOT significantly (Panel 8, Figure 6), which decreases output (Panel 1, Figure 6).

To compare the effectiveness of an increase in government expenditure with that in the *no response* case, the panels in the first row in Figure 7 (as well as Figure 8) compare the responses under the *MF* scheme, the*DF* scheme with DIT, and the case of *no response* with DIT, while the panels in the second row compare the responses under the *MF* scheme, the *DF* scheme with CIT, and the case of *no response* with CIT in a small open economy with openness ν set to 0.4. In Figure 7 (as well as Figure 8), the blue line with diamonds is the response under the *MF* scheme, green line with pluses is the response under the *DF* scheme with DIT, cyan line with circles is the response in the case of *no response* with DIT, magenta line with pluses is the response under the *DF* scheme with CIT, and red line with circles is the response in the case of *no response* with CIT. The green and magenta lines with pluses in each panel are closer to the red and cyan lines with circles in each panel (Figure 7). Thus, an increase in government expenditure under the *DF* scheme is ineffective in a small open economy. Clearly, our finding differs from that of Gali[14].

Finally, we refer to the responses on the trade balance in a small open economy, where the ratio of the trade balance to steady-state output is positive when the adverse demand shock strikes (Panel 9, Figure 6). The reverse side of the trade balance is the capital account balance excluded from interest income, namely, $\widehat{nx}_t = \widehat{nfa}_t - (1+\rho)\,\widehat{nfa}_{t-1}$, where $\widehat{nfa}_t$ denotes the ratio of net foreign assets to steady-state output. Thus, a positive trade balance implies that net foreign assets increase when the adverse demand shock strikes. To finance government expenditure, the balance of government debt increases and ratio of the deviation of real government debt from its steady-state value to steady-state output reaches approximately 12.17–28.97% in a small open economy after the adverse demand shock strikes. This positive trade balance implies that those government bonds are completely held by households and that households also purchase foreign assets. Therefore, the small open economy is a creditor nation, rather than a debtor nation, although huge government debt is issued, especially under the *DF* scheme.

5.4 Additional Analysis: The Effects of an Increase in Government Expenditure in a Liquidity Trap with Imperfect Pass-through

Monacelli[22] argues that there is a limitation to assuming perfect pass-through.[12] Thus, in this section, imperfect pass-through is introduced instead of perfect pass-through, as assumed in the previous sections.[13] Then, following Monacelli[22], we introduce retailers with pricing-to-market behavior to generate an imperfect pass-through environment. This allows us to consider whether an increase in government expenditure under the *DF* scheme, which is viewed as effective in a liquidity trap by Gali[14], is also effective in an imperfect pass-through environment.

[12]There are two well-established empirical facts: the overwhelming failure of the LOOP for tradables and more rapid exchange rate pass-through on wholesale import prices. See Monacelli[22].

[13]Many empirical facts deny our assumption in an open economy setting. See Monacelli[22], Corsetti et al.[6], Corsetti et al.[7], Corsetti et al.[8], Gopinath et al.[18], Benigno[2], and Kirchnera and Rieth[20] for more details.

5.4.1 The Model and Equilibrium Dynamics in an Imperfect Pass-through Environment

To generate an imperfect pass-through environment, we introduce retailers selling import goods in a monopolistic competitive market in a small open economy following Calvo pricing. Different from Monacelli[22], we assume that they maximize their profits in units of the foreign currency as foreigners. Let $\Psi_t \equiv \frac{\mathcal{E}_t P_t^*}{P_{F,t}}$ denote the LOOP gap. Because of those retailers, $\Psi_t = 1$, namely, the LOOP, for all t is no longer applicable and an imperfect pass-through environment results. The definition of the TOT holds independently of the degree of pass-through (i.e., $\mathcal{S}_t \equiv \frac{P_{F,t}}{P_{H,t}}$ is still applicable). Owing to this assumption, PPP applies in the long run.

Eqs. (1), (2), (12), and (15) are no longer available as the equilibrium dynamics in an imperfect pass-through environment in which the LOOP (i.e., $\Psi_t = 1$ for all t) is not applicable. These equations are replaced by

International Risk-sharing Condition

$$\hat{\xi}_t = -\psi_t - (1-\nu)\, s_t + \hat{\xi}_t^* - \zeta_t, \tag{24}$$

Market-clearing Condition

$$\hat{y}_t = \nu\,(2-\nu)\, s_t + (1-\nu)\,\hat{c}_t + \nu\psi_t + \nu\hat{y}_t^* + \hat{g}_t, \tag{25}$$

The First-Order Necessary Condition for Firms

$$\pi_{F,t} = \beta\pi_{F,t+1} + \kappa_F\psi_t - \frac{1-\theta_F}{\theta_F}\,(e_{t+1} - e_t)\,, \tag{26}$$

Definition of the TOT

$$s_t = e_t + p_t^* - \psi_t - p_{H,t}, \tag{27}$$

respectively, with $\kappa_F \equiv \frac{(1-\theta_F)(1-\theta_F\beta)}{\theta_F}$ and $\psi_t \equiv \log\Psi_t$ where θ_F denotes the Calvo index of price rigidities for import goods. In addition,

The Nominal Exchange Rate and the LOOP Gap

$$e_t = \psi_t + p_{F,t} - p_t^*, \tag{28}$$

is necessary to calculate the (logarithmic) LOOP gap. Therefore, the equilibrium dynamics in an imperfect pass-through environment consist of Eqs. (3) to (11), (13), (14), and (24) to (28).

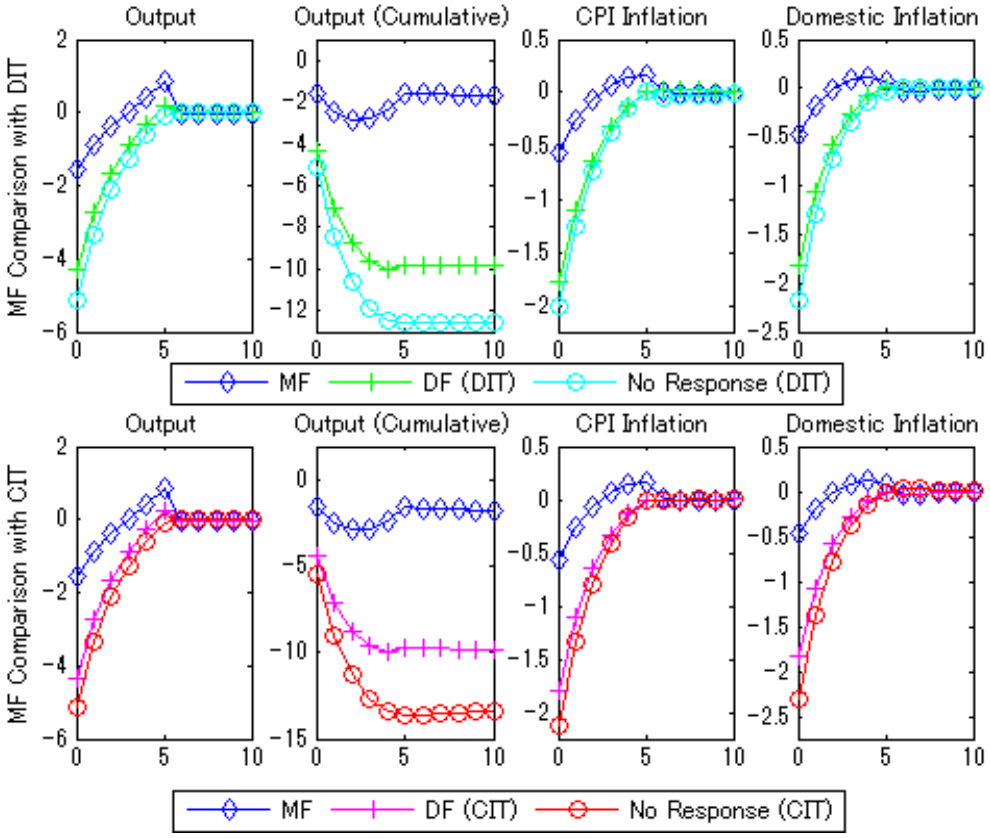
5.4.2 The Effects of an Increase in Government Expenditure in a Liquidity Trap with Imperfect Pass-through

In Figure 8, the panels in the first row show the responses under the *MF* scheme, *DF* scheme with DIT, and *no response* with DIT, while the panels in the second row show the responses under the *MF* scheme, *DF* scheme with CIT, and *no response* with CIT in a small open economy with openness ν set to 0.4. Further, the Calvo index of price rigidities for import goods θ_F to 0.75. We calculate only the responses to an increase in government expenditure for the sake of brevity.

An increase in government expenditure under the *DF* scheme is ineffective, irrespective of whether DIT or CIT, even in the imperfect pass-through environment, while it is effective under

the *MF* scheme. The green and magenta lines with pluses are closer to the cyan and red lines with circles (Figure 8). Even in an imperfect pass-through environment, under the *MF* scheme, the government depends on seigniorage to finance an increase in government expenditure and money growth increases; hence, the real consumption interest rate decreases. Although the TOT decreases due to the sticky import price and increase in government expenditure, which applies pressure to increase domestic prices, the recovery in output and inflation is strong because of the low real consumption real interest rate (Panels 1 and 2, Figure 8).

Figure 8: Dynamic Effects of an Increase in Government Expenditure in an Imperfect Pass-through Environment in a Liquidity Trap: Comparison of the *MF* Scheme, *DF* Scheme, and Case of *No Response* in a Small Open Economy



Owing to the sticky import price, the CPI is also sticky. Under the *DF* scheme with DIT, the decrease in the TOT is alleviated compared with in the perfect pass-through environment. However, owing to sticky CPI, the pace of the recovery of CPI inflation is slower; hence, the real consumption interest rate is higher than in the perfect pass-through environment. Thus, the response of output is the same as in the perfect pass-through environment and its recovery is weak (Panels 1 and 2, Figures 7 and 8). Under the *DF* fiscal stimulus scheme with CIT, while the TOT severely decreases in the perfect pass-through environment, this decrease is alleviated because of sticky CPI. However, even in the imperfect pass-through environment, the TOT decreases because of the increase in government expenditure, which applies pressure to increase domestic prices.

Thus, the recovery in output is weak, which is different from under the *MF* fiscal stimulus (Panels 5 and 6, Figure 8). Thus, the *DF* fiscal stimulus is less effective than the *MF* fiscal stimulus, irrespective of whether DIT or CIT, even in the imperfect pass-through environment.

Here, we only consider the imperfect pass-through of the import price and not the imperfect pass-through of the export price, which makes the export price in units of the foreign currency sticky. If we assume the imperfect pass-through of the export price as well as the import price, owing to the sticky export price, the TOT is more sticky. The decrease in output following an adverse demand shock might then be alleviated and effects of an increase in government expenditure under the *DF* fiscal stimulus might be stronger, although precise analysis is essential.

6 Conclusion

Gali[14] proposes a theoretical framework of an *MF* fiscal stimulus and demonstrates its effectiveness at stabilizing both output and inflation, even in an economy becoming stuck in a liquidity trap. We extend the closed economy model of Gali[14] to a small open economy model in which the monetary–fiscal policy interaction affects exchange rates in addition to interest rates. Then, similar to Gali[14], we analyze the effects of an *MF* fiscal stimulus compared with those resulting from a conventional *DF* fiscal stimulus with and without the ZLB on the nominal interest rate in a small open economy.

In a liquidity trap, the *MF* fiscal stimulus is more effective at stabilizing both output and inflation than in a closed economy. The *MF* fiscal stimulus increases CPI inflation and depreciates the nominal exchange rate through an increase in money growth. Thus, the TOT stabilizes and real consumption interest rate decreases. Owing to the open economy setting, the TOT is additionally involved in the determination of output; hence, the effectiveness of the *MF* fiscal stimulus is higher than in a closed economy. The increase in government expenditure under the *DF* scheme is less effective, irrespective of nominal exchange rate pass-through, although its effectiveness is highlighted by Gali[14] assuming a closed economy.

References

[1] Auerbach, Alan J. and Maurice Obstfeld (2005), "The Case for Open-market Purchases in a Liquidity Trap," *American Economic Review*, 95, 110–137.

[2] Benigno, Pierpaolo (2009), "Price Stability with Imperfect Financial Integration," *Journal of Money, Credit and Banking*, 41, 121–149.

[3] Buiter, Willem H. (2001), "The Liquidity Trap in an Open Economy," *CEPR Discussion Papers*, No. 2923.

[4] Buiter, Willem H. (2014), "The Simple Analytics of Helicopter Money: Why It Works–Always," *Economics, The Open-access, Open-assessment E-Journal*, 8, 1–51.

[5] Cook, David and Michael B. Devereux (2016), "Exchange Rate Flexibility under the Zero Lower Bound," *Journal of International Economics*, 101, 52–69.

[6] Corsetti, Giancarlo, Luca Dedola, and Sylvain Leduc (2007), "Optimal Monetary Policy and the Sources of Local-Currency Price Stability," in *International Dimensions of Monetary Policy*, University of Chicago Press, Chicago, IL.

[7] Corsetti, Giancarlo, Andre Meier, and Gernot J. Muller (2012), "Fiscal Stimulus with Spending Reversals," *Review of Economics and Statistics*, 94, 878–895.

[8] Corsetti, Giancarlo, Keith Kuester, and Gernot J. Muller (2013), "Floats, Pegs and the Transmission of Fiscal Policy," in Cespedes and Gali (ed.), *Fiscal Policy and Macroeconomic Performance*, Ch. 7.

[9] De Paoli, Bianca (2009), "Monetary Policy and Welfare in a Small Open Economy," *Journal of International Economics*, 77, 11–22.

[10] Eggertsson, Gauti and Michael Woodford (2003), "Zero Bound on Interest Rates and Optimal Monetary Policy," *Brookings Papers on Economic Activity*, 1, 139–233.

[11] English, William B., Christopher J. Erceg, and David Lopez-Salido (2017), "Money Financed Fiscal Programs: A Cautionary Tale," *Finance and Economics Discussion Series*, 2017-060. Washington: Board of Governors of the Federal Reserve System.

[12] Fujiwara, Ippei, Tomoyuki Nakajima, Nao Sudo, and Yuki Teranishi (2013), "Global Liquidity Trap," *Journal of Monetary Economics*, 60, 936–949.

[13] Gali, Jordi (2015), "Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework and Its Applications (Second Eds.)," Princeton, NJ, USA: *Princeton University Press.*

[14] Gali, Jordi (2020), "The Effects of a Money-financed Fiscal Stimulus," *Journal of Monetary Economics*, 115, 1–19.

[15] Gali, Jordi and Tommaso Monacelli (2002), "Monetary Policy and Exchange Rate Volatility in a Small Open Economy," *NBER Working Paper*, No. 8905.

[16] Gali, Jordi and Tommaso Monacelli (2005), "Monetary Policy and Exchange Rate Volatility in a Small Open Economy," *Review of Economic Studies*, 72, 707–734.

[17] Gali, Jordi and Tommaso Monacelli (2016), "Understanding the Gains from Wage Flexibility: The Exchange Rate Connection," *American Economic Review*, 106, 3829–3868.

[18] Gopinath, Gita Gopinath, Emine Boz, Camila Casas, Federico J. Diez, Pierre-Olivier Gourinchas, and Mikkel Plagborg-Moller (2020), "Dominant Currency Paradigm," *American Economic Review*, 110, 677–719.

[19] Jung, Taehun, Yuki Teranishi, and Tsutomu Watanabe (2005), "Optimal Monetary Policy at the Zero-Interest-Rate Bound," *Journal of Money, Credit and Banking*, 37, 813–835.

[20] Kirchnera, Markus and Malte Rieth (2021), "Sovereign Default Risk, Macroeconomic Fluctuations and Monetary-Fiscal Stabilization," *DIW Berlin Discussion Papers*, No. 1966.

[21] Leeper, Eric M. (1991), "Equilibria under 'Active' and 'Passive' Monetary and Fiscal Policies," *Journal of Monetary Economics*, 27, 129–147.

[22] Monacelli, Tommaso (2005), "Monetary Policy in a Low Pass-Through Environment," *Journal of Money, Credit and Banking*, 37, 1047–1066.

[23] Nakajima, Tomoyuki (2008), "Liquidity Trap and Optimal Monetary Policy in Open Economies," *Journal of the Japanese and International Economies*, 22, 1–33.

[24] Svensson, Lars E. O. (2004), "The Magic of the Exchange Rate: Optimal Escape from a Liquidity Trap in Small and Large Open Economies," Mimeo.

[25] Tsuruga, Takayuki and Shota Wake (2019), "Money-financed Fiscal Stimulus: The Effects of Implementation Lag," *CAMA Working Paper*, 12/2019. Center for Applied Macroeconomic Analysis, Crawford School of Public Policy, Australian National University.

[26] Turner, Adair (2015), "The Case for Monetary Finance. An Essentially Political Issue," presented at the 16th Jacques Polak Annual Research Conference, the International Monetary Fund, November 5–6, 2015.

[27] Werning, Ivan (2011), "Managing a Liquidity Trap: Monetary and Fiscal Policy," *NBER Working Paper* No. 17344.