Tezukayama RIEB Discussion Paper Series No. 20

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October 2015

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**Abstract**

In this paper, we extend a new open economy macroeconomics model to a three-country framework including relocation of firms and explore the effects of government spending in each country on relative consumptions and the exchange rates. From this analysis, it is found that a government spending rise in a country always depreciates its currency, causes firms located abroad to relocate to the country and consequently decreases the country's relative consumption. In contrast, the government spending can be beneficial for neighboring countries in spite of the outflows of firms.

*JEL classification codes*: E20; E62; F20; F31; F41

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## 1. Introduction

In the "new open economy macroeconomics" (NOEM) literature, the theoretical relationship between government spending shocks and aggregate economic activity has been studied extensively (see, for example, Obstfeld and Rogoff 1995, 1996; Betts and Devereux 2000; Caselli 2001; Corsetti and Pesenti 2001; Cavallo and Ghironi 2002; Ganelli 2005; Chu 2005).[1] This literature has focused on how the macroeconomic activity of each country and the exchange rate are influenced by unanticipated fiscal shocks under monopolistic distortions and price rigidities. However, since the publication of the Obstfeld and Rogoff (1995, 1996) papers, most NOEM models have assumed that firms are immobile across countries. Although it is feasible to explore the effects of a government spending shock in this framework under the assumption of a fixed international distribution of firms, recent empirical evidence suggests that exchange rates affect the production locations of firms (see, for example, Cushman 1985, 1988; Froot and Stein 1991; Campa 1993; Klein and Rosengren 1994; Goldberg and Kolstad 1995; Blonigen 1997; Goldberg and Klein 1998; Bénassy-quéré et al 2001; Chakrabarti and Scholnick 2002; Farrell et al 2004).[2] In addition, recently, the movement of international firms aiming for higher profits has been expanding rapidly between emerging countries (for example, China, India, Brazil, etc.) and developed countries (for example, the United States, Japan, South Korea, etc.). This is because the nominal exchange rate affects the relative price of goods produced in both countries, thereby changing relative real profits across countries. It is, therefore, important to

[1] For a survey, see Lane and Ganelli (2003).

[2] For a survey of the literature examining determinants of foreign direct investment, see Blonigen (2005).

investigate the effects of a government spending shock by one country in an open economy in which the international relocation of firms matters.

In the theoretical literature on the NOEM, there has been little study of how allowing for international relocation of firms affects the macroeconomic impacts of government spending shocks. One exception is Johdo (2015), who attempts to present a new NOEM model with international relocation of firms and succeeds in showing explicitly the effects of one country's government spending on the consumption of the two countries and the exchange rate. However, because Johdo (2015) begins with the assumption of a two-country economy, he cannot consider how allowing for a third country affects the impacts of a government spending shock on international relocation and other macroeconomic variables, including consumption and the exchange rate. Recently, multinational firms have very actively invested across national borders: American, Japanese, Sweden, and France's multinational firms are increasingly making their way not only into each other's markets but also into Singapore, China, Brazil, India, and Vietnam. It is, therefore, appropriate that a multicountry model be adopted to examine how allowing for international relocation of firms affects the impacts of a government spending shock on consumption and exchange rates.

Given this motivation, this paper investigates the impacts of government spending shocks on the international distribution of firms, the exchange rate, and consumption by extending the two-country model of Johdo (2015) to a three-country model. From this analysis, we show explicitly the macroeconomic effects of government spending shocks, which lead to firm relocation among three countries, and it is found that a government spending shock in one of the three countries always depreciates its currency, causes a firm located abroad to relocate to the country and consequently decreases the country's

relative consumption in spite of the inflows of foreign firms. In contrast, it is also found that the government spending shock can be beneficial for neighboring countries in spite of the outflows of firms.

The remainder of this paper is structured as follows. Section 2 outlines the features of the model. Section 3 describes the equilibrium. In Sections 4 and 5, we examine the impacts of government spending shocks on the distribution of firms across the three countries, the nominal exchange rate, and consumption. The final section summarizes the findings and concludes.

## 2. The model

In this section, we construct a perfect-foresight, three-country model with international relocation of firms. The three countries are denoted by *A*, *B*, and *C*, respectively. For simplicity, the size of the world population is normalized to unity, and households in countries *A* and *B* inhabit the intervals [0, 1/3] and (1/3, 2/3], respectively, and those in country *C* inhabit the interval (2/3, 1]. Therefore, the shares of households in *A*, *B*, and *C* are 1/3, 1/3, and 1/3, respectively. There is monopolistic competition in the markets for goods and labor, whereas the markets for money and international bonds are perfectly competitive. On the production side, monopolistically competitive producers exist continuously in the range [0, 1], each of which produces a single differentiated product that is freely tradable. This implies that productive activity cannot be carried out in more than one location. In this model, country *A* consists of those producers in the interval $[0, m_t]$, country *B* consists of those producers in the interval $[m_t, n_t]$, and the remaining $[n_t, 1]$ producers are in country *C*, where $m_t$ and $n_t$ are

endogenous variables. Finally, we assume that firms are mobile internationally but their owners are not. Therefore, all profit flows from firms are distributed to their immobile owners according to their share of holdings.

### 2.1. Households

The intertemporal objective function of representative household $x$ in country $h$ at time 0, with $h = A, B, C$, is:

$$U^h{}_0(x) = \sum_{t=0}^{\infty} \beta^t \left(\log C^h{}_t(x) + \chi \log(M^h{}_t(x)/P^h{}_t) - (\kappa/2)(\ell^{sh}{}_t(x))^2\right) \tag{1}$$

where $0 < \beta < 1$ is a constant subjective discount factor; $C^h{}_t(x)$ is the consumption index that is defined later; $M^h{}_t(x)/P^h{}_t$ is real money holdings, where $M^h{}_t(x)$ denotes nominal money balances held at the beginning of period $t + 1$, and $P^h{}_t$ is the consumption price index of country $h$; and $\ell^{sh}{}_t(x)$ is the amount of labor supplied by household $x$. At each point in time, households receive returns on risk-free nominal bonds, earn wage income by supplying labor, and receive profits from all firms equally. Therefore, a typical domestic household faces the following budget constraint:

$$E^h{}_t B^h{}_{t+1}(x) + M^h{}_t(x) = (1+ i_t)E^h{}_t B^h{}_t(x) + M^h{}_{t-1}(x) + W^h{}_t(x)\ell^{sh}{}_t(x) - P^h{}_t C^h{}_t(x) - P^h{}_t \tau^h{}_t$$

$$+ \left((E^h{}_t/E^A{}_t)\int_0^{m_t} \Pi^A_t(z)dz + (E^h{}_t/E^B{}_t)\int_{m_t}^{n_t} \Pi^B_t(z)dz + E^h{}_t \int_{n_t}^{1} \Pi^C_t(z)dz\right) \tag{2}$$

where $E^h{}_t$ denotes the nominal exchange rate, defined as country $h$'s currency per unit of country $C$'s currency (so that $E^C{}_t = 1$); $B^h{}_{t+1}(x)$ denotes the nominal bond denominated in the country $C$'s currency held by country $h$'s agent $x$ in period $t + 1$; $i_t$ denotes the

nominal yield on the bond in terms of the country $C$'s currency; $W^h_t(x)\ell^{sh}_t(x)$ is nominal labor income, where $W^h_t(x)$ denotes the nominal wage rate of labor supplied by household $x$ in period $t$; $\int_0^{m_t} \Pi_t^A(z)dz$, $\int_{m_t}^{n_t} \Pi_t^B(z)dz$, and $\int_{n_t}^{1} \Pi_t^C(z)dz$ represent the total nominal profit flows of firms located in countries $A$, $B$, and $C$, respectively; $P^h_t C^h_t(x)$ represents nominal consumption expenditure; and $\tau^h_t$ denotes real lump-sum taxes. Note that all variables in (2) are measured in per capita terms. In the government sector, we assume that government spending is purely dissipative and that it is financed by lump-sum taxes and by seigniorage revenues derived from printing the national currency. Hence, the government budget constraint in country $h$ is $G^h_t = s^h \tau^h_t + [(M^h_{t+1} - M^h_t)/P^h_t]$, where $G^h_t$ denotes the government spending in country $h$, $M^h_t$ is aggregate money supply, and $s^h$ denotes the population share of country $h$ in the world population. Countries $B$ and $C$ have an analogous government budget constraint.

Here, we assume that any monopolistically competitive firm that operates in every country employs the same production technology. In what follows, we mainly focus on the description of country $A$, because other countries are described analogously. In country $A$, firm $z \in [0, m_t]$ hires a continuum of differentiated labor inputs domestically and produces a unique product in a single location according to the CES production function:

$$y_{At}(z) = ((1/3)^{-1/\phi} \int_0^{1/3} \ell_{At}(z, x)^{(\phi-1)/\phi} dx)^{\phi/(\phi-1)} \tag{3}$$

where $y_{At}(z)$ denotes the production of firm $z$ in period $t$; $\ell_{At}(z, x)$ is the firm $z$'s input of labor from household $x$ in period $t$; and $\phi > 1$ is the elasticity of input substitution.

Given the firm's cost minimization problem, firm *z*'s optimal demand function for labor *x* is as follows:

$$\ell_{At}(z, x) = (1/3)^{-1}(W_t^A(z)/W_t^A)^{-\phi} y_{At}(z) \tag{4}$$

where $W_t^A \equiv ((1/3)^{-1} \int_0^{1/3} W_t^A(x)^{(1-\phi)} dx)^{1/(1-\phi)}$ is a price index for labor input. Similarly, the other countries' firms have an optimal demand function for labor *x* that is analogous to equation (4).

### 2.1.1. Definition of consumption basket

The consumption basket of household *x* living in country *h* at period *t* is:

$$C_t^h(x) = \left[ \int_0^{m_t} c_{At}^h(z,x)^{(\theta-1)/\theta} dz + \int_{m_t}^{n_t} c_{Bt}^h(z,x)^{(\theta-1)/\theta} dz + \int_{n_t}^{1} c_{Ct}^h(z,x)^{(\theta-1)/\theta} dz \right]^{\theta/(\theta-1)} \tag{5}$$

where $\theta > 1$ is the elasticity of substitution among varieties produced within each country; and $c^h_{jt}(z, x)$ denotes consumption by household *x* located in country *h* of the good produced by firm *z* located in country *j*. From (5), the consumption-based price indexes is defined as:

$$P^h_t = \left( \int_0^{m_t} \left(P_{At}^h(z)\right)^{1-\theta} dz + \int_{m_t}^{n_t} \left(P_{Bt}^h(z)\right)^{1-\theta} dz + \int_{n_t}^{1} \left(P_{Ct}^h(z)\right)^{1-\theta} dz \right)^{1/(1-\theta)}$$

where $P^h_{jt}(z)$ is the price in country *h* of the good produced by firm *z* in country *j*, $j = A, B, C$.

### 2.1.2. Household decisions

Households maximize the consumption index $C^h_t(x)$ subject to a given level of expenditure by optimally allocating differentiated goods produced in the three countries $c^h_{jt}(z, x)$, $j = A, B, C$. From this problem, we obtain the following private demand functions:

$$c^h_{jt}(z, x) = (P^h_{jt}(z)/P^h_t)^{-\theta} C^h_t(x) \tag{6}$$

As in the NOEM literature, we assume that the government's consumption index is the same as the household sector's, given by (5). Therefore, the government's demand functions for good $j$ in the home and foreign countries are the same as those of the household sector. Summing the private and public demand functions and equating the resulting equation to the product of firm $z$ located in country $j$ yields the following market-clearing condition for any product $z$ produced in country $j$:

$$y_{jt}(z) = (P^A_{jt}(z)/P^A_t)^{-\theta}(C^A_t+G^A_t)+(P^B_{jt}(z)/P^B_t)^{-\theta}(C^B_t+G^B_t)+(P^C_{jt}(z)/P^C_t)^{-\theta}(C^C_t+G^C_t) \tag{7}$$

where $C^A_t = \int_0^{1/3} C^A_t(x)dx$, $C^B_t = \int_{1/3}^{2/3} C^B_t(x)dx$, $C^C_t = \int_{2/3}^{1} C^C_t(x)dx$, $G^A_t = \int_0^{1/3} G^A_t(x)dx$, $G^B_t = \int_{1/3}^{2/3} G^B_t(x)dx$, and $G^C_t = \int_{2/3}^{1} G^C_t(x)dx$. From the law of one price and the purchasing power parity arising from symmetric preferences, (7) is rewritten as:

$$y_{jt}(z) = (P^j_{jt}(z)/P^j_t)^{-\theta}(C^w_t + G^w_t) \tag{8}$$

where $C^w_t \equiv C^A_t + C^B_t + C^C_t$, $G^w_t \equiv G^A_t + G^B_t + G^C_t$. In the second stage, households maximize (1) subject to (2). The first-order conditions for this problem with respect to $B^h_{t+1}(x)$ and $M^h_t(x)$ can be written as:

$$C^h_{t+1}(x) = \beta C^h_t(x)(1 + i_{t+1})[(P^h_t/E^h_t)/(P^h_{t+1}/E^h_{t+1})] \quad (9)$$

$$M^h_t(x)/P^h_t = \chi C^h_t(x)[(1 + i_{t+1})E^h_{t+1}/((1 + i_{t+1})E^h_{t+1} - E^h_t)] \quad (10)$$

Equation (9) is the Euler equation for consumption, and (10) is the one for money demand.

Following Corsetti and Pesenti (2001), we introduce nominal rigidities into the model in the form of one-period wage contracts under which nominal wages in period $t$ are predetermined at the end of period $t - 1$. In the monopolistic labor market, each household provides a single variety of labor input to a continuum of domestic firms. Hence, in country $A$, the equilibrium labor-market conditions imply that $\ell_t^{sA}(x) = \int_0^{m_t} \ell_{At}(z, x)dz$, $x \in [0,1/3]$, where the left-hand side represents the amount of labor supplied by household $x$, and the right-hand side represents firms' total demand for labor $x$. By taking $W_t^A$, $P_t^A$, and $m_t$ as given, substituting $\ell_t^{sA}(x) = \int_0^{m_t} \ell_{At}(z, x)dz$ and equation (4) into the budget constraint given by (2), and maximizing the lifetime utility given by (1) with respect to the nominal wage $W_t^A(x)$, we obtain the following first-order condition for the optimal nominal wage, $W_t^A(x)$:

$$\kappa \ell_t^{sA}(x)^2 \phi (W_t^A(x)/P_t^A)^{-1} = (\phi - 1)(\ell_t^{sA}(x)/C^A_t) \quad (11)$$

The right-hand side of (11) represents the marginal consumption utility of additional labor income resulting from a decrease in the nominal wage rate. This term is positive because $\phi > 1$. The left-hand side represents the marginal disutility of an associated increase in labor effort. Hence, each monopolistically competitive household uses (11)

to set its wage rate. The labor suppliers of countries *B* and *C* have analogous optimal wage conditions.

### 2.2. Firm's decision

Since the country *A*-located firm *z* hires labor domestically, given $W^A_t$, $P^A_{At}$, and $P^A_t$, $C^w_t$, $G^w_t$, $m_t$, (3), and subject to (8), the country *A*-located firm *z* faces the following profit-maximization problem:

$$\max_{P^A_{At}(z)} \Pi_{At}(z) = P^A_{At}(z) y_{At}(z) - \int_0^{1/3} W_t^A(z) \ell_{At}(z, x)\, dx = (P^A_{At}(z) - W^A_t) y_{At}(z)$$

$$\text{subject to } y_{At}(z) = (P^A_{At}(z)/P^A_t)^{-\theta}(C^w_t + G^w_t)$$

Given the above, the price mark-up is chosen according to:

$$P^A_{At}(z) = (\theta/(\theta - 1)) W^A_t \tag{12}$$

Since $W^A_t$ is given, (12) yields $P^A_{At}(z) = P^A_{At}$, $z \in [0, m_t]$. These relationships imply that each firm located in country *A* supplies the same quantity of goods. Similarly, other firms located in different country have the price mark-up that is analogous to equation (12). Denoting the maximized real profit flows of country *j*-located firms by $\Pi_{jt}(z)/P^j_t$, and substituting (8) and (12) into $\Pi_{jt}(z)$ yields:

$$\Pi_{jt}(z)/P^j_t = (1/\theta)(P^j_{jt}(z)/P^j_t)^{1-\theta}(C^w_t + G^w_t) \tag{13}$$

### 2.3. Relocation behavior

The driving force for relocation to other countries is differences in current real profits between two bounded countries.[3] In addition, following the formulation in Johdo (2015), we assume that all firms are not allowed to relocate instantaneously even if there is the profit gap. At each point in time, this adjustment mechanism for relocation between countries *A* and *B* is formulated as follows:

$$m_t - m_{t-1} = \gamma[\Pi_{At}(z)/P_t^A - \Pi_{Bt}(z)/P_t^B] = \gamma[\Pi_{At}(z)/P_t^A - (E^A{}_t/E^B{}_t)\Pi_{Bt}(z)/P_t^A] \tag{14}$$

Analogously, the adjustment mechanism for relocation between countries *B* and *C* is formulated as follows:

$$n_t - n_{t-1} = \gamma[\Pi_{Bt}(z)/P_t^B - \Pi_{Ct}(z)/P_t^C] = \gamma[\Pi_{Bt}(z)/P_t^B - E^B{}_t\,\Pi_{Ct}(z)/P_t^B] \tag{15}$$

where $\gamma$ ($0 \leq \gamma < \infty$) is a constant positive parameter that determine the degree of firm mobility between two bounded countries: a larger value of $\gamma$ implies higher firm mobility between countries. Intuitively, the parameter $\gamma$ reflects the costs falling on mobile firms in their new locations. Examples include the costs of finding appropriate plants, training the local workforce, and adapting to the local legal system. Because of these costs, firms cannot move instantaneously to a better location even if a profit gap between two countries provides the motivation.

### 2.4. Market conditions

The equilibrium condition for the integrated international bond market is given by:

[3] In the literature on multinational firms, Helpman et al. (2004) and Eckel and Egger (2009) derive the share of multinational firms endogenously by using this type of profit differential between exporting and multinational activity.

$$\int_0^{1/3} B_t^A(x)dx + \int_{1/3}^{2/3} B_t^B(x)dx + \int_{2/3}^{1} B_t^C(x)dx = 0 \tag{16}$$

This means that the net supply of bonds worldwide is zero. In addition, the money markets are assumed always to clear in all countries, so that the equilibrium conditions are given by $M^A{}_t = \int_0^{1/3} M_t^A(x)dx$ , $M^B{}_t = \int_{1/3}^{2/3} M_t^B(x)dx$ , and $M^C{}_t = \int_{2/3}^{1} M_t^C(x)dx$ , respectively.

## 3. Steady state values

In this section, we derive the solution for a symmetric steady state in which all variables are constant, initial net foreign assets are zero ($B^h{}_0 = 0$) and $G^h{}_0 = 0$, $h = A, B, C$.[4] Henceforth, we denote the steady-state values by using the subscript *ss*. In the symmetric steady state, given the Euler equation for consumption (equation (9)), the constant real interest rate is given by:

$$r_{ss} = (1 - \beta)/\beta \equiv \delta \tag{17}$$

where $\delta$ is the rate of time preference. Because symmetry, which implies $C^h{}_{ss} = C^w{}_{ss}$, holds, the steady-state international allocations of firms are:

$$m_{ss} = 1/3 \tag{18}$$

$$n_{ss} = 2/3 \tag{19}$$

The steady state output levels are:

[4] In the symmetric steady state, we drop the index value "*x*" from all variables in order to simplify notation.

$$y_{jss} = \ell^{sh}_{ss} = C^{h}_{ss} = C^{w}_{ss} = ((\phi-1)/\phi)^{1/2}((\theta-1)/\theta)^{1/2}(1/\kappa)^{1/2}, \quad j, h = A, B, C \tag{20}$$

Equation (20) shows that not only do all firms worldwide produce the same amount of output, it also shows that all households worldwide consume this output and supply the labor required to produce this output. Substituting $C^{w}_{ss}$ from equation (20) into equation (13) yields the following steady-state levels of real profit flows of country *j*-located firms, which are equal:

$$\Pi_{jss}/P^{j}_{ss} = (1/\theta)((\phi-1)/\phi)^{1/2}((\theta-1)/\theta)^{1/2}(1/\kappa)^{1/2}, \quad j = A, B, C \tag{21}$$

## 4. A log-linearized analysis

To examine the macroeconomic effects of an unanticipated permanent government spending shock, we solve a log-linear approximation of the system around the initial, zero-shock steady state with $B^{h}_{ss,0} = 0$, $h = A, B, C$, as derived in the previous section. For any variable *X*, we use $\hat{X}$ to denote short-run percentage deviations from the initial steady-state value, i.e., $\hat{X} = dX_1 / X_{ss,0}$, where $X_{ss,0}$ is the initial, zero-shock steady-state value, and subscript 1 denotes the period in which the shock takes place. These short-run percentage deviations are consistent with the length of nominal wage contracts. Thus, nominal wages and goods prices can be determined as $\hat{W}^{j} = \hat{P}^{j}_{j}(z) = 0$, $j = A, B, C$, in the short-run log-linearized equations. In addition, we use $\overline{X}$ to denote long-run percentage deviations from the initial steady-state value, i.e., $\overline{X} = dX_2 / X_{ss,0} = dX_{ss} / X_{ss,0}$, which is consistent with flexible nominal wages. Note

that $X_2 = X_{ss}$ because the new steady state is reached at period 2 (see Appendix for the derivation of short-run and long-run fiscal policy effects).

By log-linearizing equations (14) and (15) around the symmetric steady state and setting $\hat{W}^j = \hat{P}_j^j(z) = 0$, $j = A, B, C$, we obtain the following log-linearized expression for the international distribution of firms:

$$\hat{m} = 3\gamma((\phi-1)/\phi)^{1/2}((\theta-1)/\theta)^{3/2}(1/\kappa)^{1/2}\left(\hat{E}^A - \hat{E}^B\right) \tag{22}$$

$$\hat{n} = (3/2)\gamma((\phi-1)/\phi)^{1/2}((\theta-1)/\theta)^{3/2}(1/\kappa)^{1/2}\hat{E}^B \tag{23}$$

Equation (22) shows that under a given $E^B$, an exchange rate depreciation of country $A$'s currency ($\hat{E}^A - \hat{E}^B > 0$) induces relocation of firms located in country $B$ towards the country $A$.[5] Intuitively, with fixed nominal wages, which cause nominal product prices to be sticky because of mark-up pricing by monopolistic product suppliers, the depreciation in country $A$'s currency increases relative production of country $A$'s goods through the 'expenditure-switching effect'; i.e., $\hat{y}^A - \hat{y}^B = \theta\left(\hat{E}^A - \hat{E}^B\right)$.[6] This increases the relative profits of country $A$-located firms, and consequently, firms located in country $B$ relocate to the country $A$. Equation (22) also shows that nominal exchange rate changes have greater effects the greater is the flexibility of relocation (the larger is

[5] This result is consistent with the evidence found in the empirical literature on the relationship between exchange rates and foreign direct investments (see, for example, Cushman 1988; Caves 1989; Froot and Stein 1991; Campa 1993; Klein and Rosengren 1994; Blonigen 1997; Goldberg and Klein 1998; Bénassy-quéré et al 2001; Chakrabarti and Scholnick 2002; Kiyota and Urata 2004; Bolling et al 2007).

[6] The expenditure-switching effect arises intuitively because exchange rate depreciation causes a decrease in the relative real price of country $A$'s goods for households in all countries so that world consumption demand switches toward country $A$'s goods. Corsetti et al (2005) also define this as 'competitive effect'.

γ). By contrast, when relocation costs are high (γ = 0), nominal exchange rate changes have a negligible effect on the relocation of firms. The intuition behind the impact of $E^B$ in equation (23) on the international relocation of firms between countries *B* and *C* can be explained analogously.

## 5. Government spending shocks

Now, we consider the effects of an unanticipated permanent government spending shock in each country.

### 5.1. The case of $\hat{G}^A = \overline{G}^A > 0, \hat{G}^B = \overline{G}^B = \hat{G}^C = \overline{G}^C = 0$

In this subsection, we focus on the impacts of a permanent government spending shock in country *A*. In this case, the closed-form solutions for the six key variables are as follows:

$$\hat{E}^A - \hat{E}^B = -\tilde{\tilde{\delta}}\left(\frac{\alpha_1}{(\alpha_2)^2 - (\alpha_1)^2}\right)\hat{G}^A > 0 \tag{24}$$

$$\hat{E}^B = \tilde{\tilde{\delta}}\left(\frac{\alpha_2}{(\alpha_2)^2 - (\alpha_1)^2}\right)\hat{G}^A > 0 \tag{25}$$

$$\hat{m} = -3\gamma\theta_1\tilde{\tilde{\delta}}\left(\frac{\alpha_1}{(\alpha_2)^2 - (\alpha_1)^2}\right)\hat{G}^A > 0 \tag{26}$$

$$\hat{n} = (3\gamma/2)\theta_1\tilde{\tilde{\delta}}\left(\frac{\alpha_2}{(\alpha_2)^2 - (\alpha_1)^2}\right)\hat{G}^A > 0 \tag{27}$$

$$\hat{C}^A - \hat{C}^B = \tilde{\delta}\left(\frac{\alpha_1}{(\alpha_2)^2 - (\alpha_1)^2}\right)\hat{G}^A < 0 \tag{28}$$

$$\hat{C}^A - \hat{C}^C = \tilde{\delta}\left(\frac{\alpha_1 - \alpha_2}{(\alpha_2)^2 - (\alpha_1)^2}\right)\hat{G}^A < 0 \tag{29}$$

where

$$\alpha_1 = \tilde{\delta}\left\{1 + 2\tilde{\theta}\left[\frac{(6\gamma\theta_1 + \theta)(1 + 6\gamma\theta_1 + \theta) - 9\gamma^2\theta_1^2}{(1 + 6\gamma\theta_1 + \theta)^2 - 9\gamma^2\theta_1^2}\right] - \tilde{\theta}\right\} + 1 + 6\gamma\tilde{\theta}\theta_1 + \tilde{\theta}(\theta - 1) > 0 \tag{30}$$

$$\alpha_2 = -\left\{\delta^{-1}\left[\frac{6\gamma\theta_1\tilde{\theta}}{(1 + 6\gamma\theta_1 + \theta)^2 - 9\gamma^2\theta_1^2}\right] + 3\gamma\tilde{\theta}\theta_1\right\} < 0 \tag{31}$$

$$\theta_1 = ((\phi - 1)/\phi)^{1/2}((\theta - 1)/\theta)^{3/2}(1/\kappa)^{1/2} > 0 \tag{32}$$

$$\tilde{\delta} \equiv (1 + \delta)/\delta, \quad \tilde{\theta} \equiv (\theta - 1)/\theta, \quad \tilde{\phi} \equiv (\phi - 1)/\phi$$

Equations (24) and (25) indicate that an unanticipated government spending shock in country *A* leads to exchange rate depreciation in $E^A - E^B$ and $E^B$, respectively. Equation (26) shows that an unanticipated government spending shock in country *A* causes country *B* firms to relocate to country *A*. Equation (27) shows that an unanticipated government spending shock in country *A* causes country *C* firms to relocate to country *B*. Equations (28) and (29) show that the relative consumption levels of country *A* decrease when there is an unanticipated government spending shock in country *A*.

The above results can be explained intuitively as follows. First, a rise in government spending in country *A* results in crowding-out of country *A* consumption, because

country *A*'s government-spending rise does not increase country *A*'s output sufficiently to offset the rise in taxes. Hereafter, we shall call this the 'crowding-out effect'. Under a given $E^B$, the reduction in country *A*'s consumption then leads to a depreciation of its currency ($\hat{E}^A - \hat{E}^B > 0$, see equation (24)). This happens because, given that the demand for real money balances is increasing with consumption, country *A*'s currency must depreciate and decrease the supply of real money balances in country *A* to restore money market equilibrium. Furthermore, the exchange rate depreciation causes consumption switching as world consumption demand shifts toward country *A*'s goods because of the fall in the relative price of country *A*'s goods. This in turn causes country *B*'s firms to relocate to country *A* because of the increase in relative profits of firms located in country *A* ($\hat{m} > 0$, see equation (26)). This relocation then increases labor demand in country *A* and decreases labor demand in country *B*, which in turn raises the labor income of country *A* and decreases the labor income of country *B*. Hereafter, we shall call this the '*AB* relocation effect'. As a result, the consumption increases in country *A* while the consumption decreases in country *B*. Thus, $\hat{C}^A - \hat{C}^B$ is determined by the two conflicting mechanisms of the crowding-out effect and the *AB* relocation effect. However, from equation (28), such a government spending rise unambiguously leads to a decrease (rise) in the relative consumption of country *A* (*B*), $\hat{C}^A - \hat{C}^B < 0$.

In addition, from the decrease in the consumption of country *B* through the *AB* relocation effect, country *B*'s currency must depreciate and decrease the supply of real money balances in country *B* to restore money market equilibrium ($\hat{E}^B > 0$, see equation (25)). This in turn causes country *C*'s firms to relocate to country *B* because of the increase in the relative profits of firms located in country *B* ($\hat{n} > 0$, see equation

(27)). This relocation then increases labor demand in country *B* and decreases labor demand in country *C*, which in turn raises labor income in country *B* and decreases labor income in country *C*. Hereafter, we shall call this the '*BC* relocation effect'. As a result, the consumption increases in country *B* while the consumption decreases in country *C*. Therefore, $\hat{C}^A - \hat{C}^C$ is determined by the three conflicting mechanisms of the crowding-out effect, the *AB* relocation effect, and the *BC* relocation effect. However, from equation (29), such a government spending rise unambiguously leads to a decrease (rise) in the relative consumption of country *A* (*C*), $\hat{C}^A - \hat{C}^C < 0$.

In sum, a permanent government spending shock in country *A* is detrimental to country *A* in terms of the relative consumption level. In other words, a permanent government spending shock in country *A* always benefits not only country *B* but also country *C* in terms of relative consumption.

### 5.2. The case of $\hat{G}^B = \overline{G}^B > 0, \hat{G}^A = \overline{G}^A = \hat{G}^C = \overline{G}^C = 0$

In this subsection, we focus on the impacts of a permanent government spending shock in country *B*. In this case, the closed-form solutions for the six key variables are as follows:

$$\hat{E}^A - \hat{E}^B = \tilde{\delta}\left(\frac{\alpha_1 + \alpha_2}{(\alpha_2)^2 - (\alpha_1)^2}\right)\hat{G}^B < 0 \tag{33}$$

$$\hat{E}^B = -\tilde{\delta}\left(\frac{\alpha_1 + \alpha_2}{(\alpha_2)^2 - (\alpha_1)^2}\right)\hat{G}^B > 0 \tag{34}$$

$$\hat{m} = 3\gamma\theta_1\tilde{\delta}\left(\frac{\alpha_1+\alpha_2}{(\alpha_2)^2-(\alpha_1)^2}\right)\hat{G}^B < 0 \tag{35}$$

$$\hat{n} = -(3\gamma/2)\theta_1\tilde{\delta}\left(\frac{\alpha_1+\alpha_2}{(\alpha_2)^2-(\alpha_1)^2}\right)\hat{G}^B > 0 \tag{36}$$

$$\hat{C}^A - \hat{C}^B = -\tilde{\delta}\left(\frac{\alpha_1+\alpha_2}{(\alpha_2)^2-(\alpha_1)^2}\right)\hat{G}^B > 0 \tag{37}$$

$$\hat{C}^B - \hat{C}^C = \tilde{\delta}\left(\frac{\alpha_1+\alpha_2}{(\alpha_2)^2-(\alpha_1)^2}\right)\hat{G}^B < 0 \tag{38}$$

The above results can be explained intuitively as follows. First, a rise in the government spending in country *B* results in the crowding out of country *B*'s consumption, because country *B*'s government spending rise does not increase country *B*'s output sufficiently to offset the rise in taxes (the crowding-out effect). Under a given $E^A$, the decrease in the consumption of country *B* then leads to exchange rate depreciation of country *B*'s currency ($\hat{E}^A - \hat{E}^B < 0$, $\hat{E}^B > 0$, see equations (33) and (34)). Furthermore, the exchange rate depreciation causes consumption switching as world consumption demand shifts toward country *B*'s goods because of the fall in the relative price of country *B*'s goods. This in turn causes firms located in countries *A* and *C* to relocate to country *B* because of the increase in the relative profits of firms located in country *B* ($\hat{m} < 0$, $\hat{n} > 0$, see equations (35) and (36)). This relocation increases labor demand in country *B* and decreases labor demand in countries *A* and *C*, which in turn raises labor income in country *B* and decreases labor income in countries *A* and *C*. As a result, the relocation increases the consumption in country *B*, while it decreases the

consumption in countries *A* and *C*. Thus, the government spending effect on $\hat{C}^A - \hat{C}^B$ is determined by the three conflicting mechanisms of the crowding-out effect, the *AB* relocation effect, and the *BC* relocation effect. However, from equation (37), such a government spending rise unambiguously leads to a rise (decrease) in the relative consumption of country *A* (*B*), $\hat{C}^A - \hat{C}^B > 0$.

Similarly, the impact of an increase in government spending in country *B* on $\hat{C}^B - \hat{C}^C$ is ambiguous. This is because the impact of an increase in government spending is also determined by three conflicting mechanisms: the crowding-out effect, the *AB* relocation effect, and the *BC* relocation effect. However, from (38), such a government spending rise unambiguously leads to a decrease (rise) in the relative consumption of country *B* (*C*), $\hat{C}^B - \hat{C}^C < 0$.

In sum, a permanent government spending rise in country *B* is detrimental to country *B* in terms of the relative consumption level. In other words, a permanent government spending rise in country *B* always benefits country *A* but also country *C* in terms of relative consumption level.

### 5.3. The case of $\hat{G}^C = \overline{G}^C > 0, \hat{G}^A = \overline{G}^A = \hat{G}^B = \overline{G}^B = 0$

In this subsection, we focus on the impacts of a permanent government spending shock in country *C*. In this case, the closed-form solutions for the six key variables are as follows:

$$\hat{E}^A - \hat{E}^B = -\tilde{\delta}\left(\frac{\alpha_2}{(\alpha_2)^2 - (\alpha_1)^2}\right)\hat{G}^C < 0 \tag{39}$$

$$\hat{E}^B = \tilde{\tilde{\delta}}\left(\frac{\alpha_1}{(\alpha_2)^2 - (\alpha_1)^2}\right)\hat{G}^C < 0 \tag{40}$$

$$\hat{m} = -3\gamma\theta_1\tilde{\tilde{\delta}}\left(\frac{\alpha_2}{(\alpha_2)^2 - (\alpha_1)^2}\right)\hat{G}^C < 0 \tag{41}$$

$$\hat{n} = (3\gamma/2)\theta_1\tilde{\tilde{\delta}}\left(\frac{\alpha_1}{(\alpha_2)^2 - (\alpha_1)^2}\right)\hat{G}^C < 0 \tag{42}$$

$$\hat{C}^B - \hat{C}^C = -\tilde{\tilde{\delta}}\left(\frac{\alpha_1}{(\alpha_2)^2 - (\alpha_1)^2}\right)\hat{G}^C > 0 \tag{43}$$

$$\hat{C}^A - \hat{C}^C = \tilde{\tilde{\delta}}\left(\frac{\alpha_2 - \alpha_1}{(\alpha_2)^2 - (\alpha_1)^2}\right)\hat{G}^C > 0 \tag{44}$$

The above results can be explained intuitively as follows. First, a rise in government spending in country *C* results in the crowding out of country *C*'s consumption, because country *C*'s government spending rise does not increase country *C*'s output sufficiently to offset the rise in taxes (the crowding-out effect). The decrease in the consumption of country *C* through the crowding-out effect then leads to exchange rate depreciation of its currency ($\hat{E}^A = \hat{E}^B < 0$, see equation (40)). However, at this stage, country *A*'s currency relative to *B*'s remains unchanged, because $\hat{E}^A - \hat{E}^B = 0$. Furthermore, the exchange rate depreciation causes consumption switching as world consumption demand shifts toward country *C*'s goods because of the fall in the relative price of country *C*'s goods. This in turn causes country *B*'s firms to relocate to country *C* because of the increase in the relative profits of firms located in country *C* ($\hat{n} < 0$, see equation (42)). This relocation increases labor demand in country *C* and decreases labor

demand in country *B*, which in turn increases labor income in country *C* and decreases labor income in country *B* (the *BC* relocation effect). As a result, the relocation increases the consumption in country *C* and decreases that of country *B*. Thus, $\hat{C}^B - \hat{C}^C$ is determined by the two conflicting mechanisms of the 'crowding-out effect' and the *BC* relocation effect. However, from equation (43), such a government spending rise unambiguously leads to a rise (decrease) in the relative consumption of country *B* (*C*), $\hat{C}^B - \hat{C}^C > 0$.

Furthermore, as discussed in the definition of the *BC* relocation effect, the rise in country *C*'s government spending also decreases country *B*'s consumption through firm relocation from country *B* to country *C*. From this result, country *B*'s currency must depreciate to restore equilibrium in the market for real balances. This depreciation of country *B*'s currency weakens the initial appreciation of its currency, and consequently the change in country *A*'s currency relative to *B*'s is negative ($\hat{E}^A - \hat{E}^B < 0$, see equation (39)). Furthermore, this leads to reduction of the real prices of country *B*'s goods relative to country *A*'s goods, which causes world demand to switch from country *A*'s goods to country *B*'s goods. These demand shifts increase the relative profits of firms located in country *B*, which cause firms located in country *A* to relocate to country *B* ($\hat{m} < 0$, see equation (41)). This relocation increases labor demand in country *B* and decreases labor demand in country *A*, which in turn increases labor income in country *B* and decreases labor income in country *A* (the *AB* relocation effect). As a result, the relocation decreases the consumption in country *A*. Thus, $\hat{C}^A - \hat{C}^C$ is determined by the three conflicting mechanisms of the 'crowding-out effect', the *AB* relocation effect, and the *BC* relocation effect. However, from equation (44), such a government spending

rise unambiguously leads to a rise (decrease) in the relative consumption of country *A* (*C*), $\hat{C}^A - \hat{C}^C > 0$. This is because the decrease in $\hat{C}^A - \hat{C}^C$ through the *AB* and *BC* relocation effects is dominated by the country *C*'s consumption reduction through the crowding-out effect.

In sum, a permanent government spending shock in country *C* is detrimental to country *C* in terms of the relative consumption revel. In other words, a permanent government spending shock in country *C* always benefits not only country *A* but also country *B* in terms of relative consumption.

## 6. Conclusion

In this paper we considered the question of how allowing for international relocation of firms among three countries affects the impacts of government spending shocks on relative consumption and exchange rates. From this analysis, we showed explicitly the macroeconomic effects of government spending shocks that lead to firm relocation among three countries, and it was found that a government spending shock in one of the three countries always depreciates its currency and decreases its relative consumption levels, while it can be beneficial for the neighboring countries in spite of the outflows of firms.

However, the model developed here is rather simple in a number of respects. This suggests many directions for future research. First, this paper may yield results that are more interesting if the current model is modified to include sunk costs, as in Russ

(2007).[7] Also of interest is extending the model to account for trade impediments such as tariffs and transport costs as in Fender and Yip (2000).[8] Further, the consideration of the effects of other fiscal policy (for example, consumption tax) in our model is noteworthy[9]. These issues remain for future research.

[7] Campa (1993) finds the negative effect of sunk costs (e.g., investment in advertising and media promotion) on industry entry into the US during the 1980s. Brainard (1997) also finds that overseas production by multinationals decreases with the fixed costs of production.

[8] Empirical evidence shows that higher tariff has an important effect on foreign direct investment of firms based in developed countries (see Brainard, 1997, and Blonigen, 2002).

[9] Johdo (2013) studies the welfare effects of a consumption tax rise based on the two-sector small open economy model of Obstfeld and Rogoff (1995), but do not allow for the endogenous determination of the distribution of firms.

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