Tezukayama RIEB Discussion Paper Series No. 19

# Deregulation and relocation in a three country model

Wataru Johdo

Faculty of Economics, Tezukayama University

October 2015

Tezukayama University
Research Institute for Economics and Business
7-1-1 Tezukayama, Nara 631-8501, Japan

# Deregulation and relocation in a three country model

Wataru Johdo*

*Tezukayama University*

October 2015

**Abstract**

In this paper, we develop a three-country model that incorporates international relocation by imperfectly competitive firms. We explore the effects of deregulation by each country on relative consumption levels, exchange rates, and international relocation of firms. In particular, a novel feature of our model is that the international distribution of firms responds to exchange rate movements caused by deregulation shocks. From this analysis, we identify a new international transmission: the exchange rate appreciation induced by the deregulation in one of the three countries causes firms of that country to relocate to other countries, but raises the relative consumption of that country in spite of outflow of firms.

*JEL classification codes*: E6; F2; F31; F41

*Key words*: Deregulation; exchange rate; consumption; international relocation

---

* *Wataru Johdo, Department of Economics,Tezukayama University, 7-1-1, Tezukayama, Nara 631-8501, Japan*. Tel.: +81-742-48-9380; fax: +81-742-46-4994. *E-mail address*: johdo@tezukayama-u.ac.jp

## 1. Introduction

Since the subprime crisis and the 2008 collapse of the US stock market bubble, the Japanese government has coped with persistent deflation with high unemployment rates in various policies, including income tax cuts, environment-related tax cuts, and additional fiscal spending, aimed at stimulating the domestic economy. However, despite these policies, the Japanese economy has not displayed any signs of recovery. Instead, in the last few years, there has been a renewal of interest in growth-enhancing policies (or 'growth strategy') in Japan, including deregulation in the nontradable goods sector (for example, medical services, nursing services, agriculture, and airline industry). One of the principal intentions of these policies is to attract foreign firms through opening the closed domestic markets, and thereby stimulate the production side of the economy.

However, although the above implication of entry-enhancing policies is standard, little attention has been paid to the point that international firm movement can also be affected by the exchange rate. We do not believe that it is appropriate to ignore interactions between firm relocation and exchange rates when examining deregulation on national incomes and consumptions. Because there is a large body of empirical research on the relationship between exchange rates and firms' production location (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). However, in the open macroeconomics literature, there has been little study of how a deregulation by one country affects another country's consumption and the international relocation of firms through changes in nominal exchange rate.

As related studies, in the new open economy macroeconomics (NOEM) literature, the relationship between policy shocks and aggregate economic activity has been studied extensively at the theoretical level (see, for example, Obstfeld and Rogoff 1995, 2002; Lane 1997; Betts and Devereux 2000a, 2000b; Hau 2000; Bergin and Feenstra 2001; Corsetti and Pesenti 2001, 2005; Cavallo and Ghironi 2002; Devereux and Engel 2002; Kollmann 2001, 2002; Smets and Wouters 2002; Sutherland 2005a, 2005b; Senay and Sutherland 2007; Johdo 2010, 2013a, 2013b). This literature has focused on how the macroeconomic activity of each country is influenced by unanticipated monetary and real shocks in one country under monopolistic distortions and price rigidities. The benchmark model of Obstfeld and Rogoff (1995) shows that a domestic monetary expansion raises consumption of both countries by lowering the world real interest rate, which results in an increase in world consumption demand, and thereby improves foreign and domestic welfare levels. In addition, in contrast to this result from the benchmark model, much effort has been devoted to showing that expansionary monetary policy can be a 'beggar-thy-neighbor' policy by incorporating economic characteristics of the real world into the benchmark model (see, Betts and Devereux 2000a; Corsetti et al. 2000; Fender and Yip 2000; Tille 2001; Warnock (2003); Chu 2005).[1]

However, previous studies assume a fixed location of firms between countries, and show that changes in nominal exchange rates following policy shocks are the main

[1] For example, Corsetti et al. (2000) extend the benchmark model to a three-country framework that comprises two similar 'periphery' countries (denoted by A and B) and a third 'center' country, and explore the transmission effects of a monetary expansion by either of the periphery countries on its trading partners. In their analysis, they show that under complete pass-through of exchange rates to prices, when there is little substitutability between periphery and center goods, a monetary expansion in country A is a 'beggar-thy-neighbor' policy against country B.

source of the international transmission effect. Exploring the effect of policy shocks in an open economy model under the assumption of a fixed international distribution of firms is tractable. However, this assumption is restrictive, because it implies that nominal exchange rates do not affect international firm relocation. One exception is Johdo (2015), who attempts to present a NOEM model with international relocation of firms. Johdo (2015) contrasts a two-country NOEM model without international relocation with a NOEM model with international relocation, and succeeds in showing explicitly the effects of one country's deregulation 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 deregulation 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, and China's multinational firms are increasingly making their way not only into each other's markets but also into Singapore, 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 deregulation on consumption and exchange rates.

Given this motivation, this paper investigates the impacts of deregulation 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 deregulation, which lead to firm relocation among three countries.

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 deregulation on the distribution of firms across the three countries, the real exchange rate, and relative consumptions. 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. 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, there are two types of firms, tradable goods firms and non-tradable goods firms. The tradable goods firms exist continuously in the world in the [0, 1] range, and the non-tradable goods firms exist continuously in each country in the [0, 1] range. Each tradable and non-tradable goods firm uses only domestic labor as an input and produces a single differentiated product. Each firm earns positive pure profits. In particular, tradable goods firms are mobile internationally, but non-tradable goods firms are not. All profit flows are distributed to the immobile owners according to the respective holding shares. In this model, country *A* consists of those tradable goods producers in the interval [0, $m_t$], country $B$ consists of those tradable goods 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.

**2.1. Household decisions**

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

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

where $0 < \beta < 1$ is a constant subjective discount factor; $C^{hT}{}_t(x)$ is the consumption of tradable good in period $t$ for household $x$ in country $h$; $C^{hN}{}_t(x)$ is the consumption of non-tradable good; and $\gamma \in (0, 1)$. The consumption indices are defined as follows:

$$C^{hT}{}_t = \left(\int_0^1 C_{jt}^{hT}(z,x)^{(\sigma-1)/\sigma} dz\right)^{\sigma/(\sigma-1)}, \quad \sigma > 1 \quad (2)$$

$$C^{hN}{}_t = \left(\int_0^1 C_t^{hN}(z,x)^{(\theta_h-1)/\theta_h} dz\right)^{\theta_h/(\theta_h-1)}, \quad \theta_h > 1 \quad (3)$$

where $\sigma$ is the elasticity of substitution between any two differentiated tradable goods, $\theta_h$ is the elasticity of substitution between any two differentiated non-tradable goods produced in country $h$, $C_{jt}^{hT}(z, x)$ is the consumption of tradable good produced by firm $z$ located in country $j$, and $C_t^{hN}(z, x)$ is the consumption of non-tradable good produced by firm $z$ located in country $h$. In particular, the non-tradable goods market approaches perfect competition as $\theta_h$ increases. Therefore, $\theta_h$ can be interpreted as a measure of the degree of competition in the non-tradable goods market. The third term in (1) is real money holdings ($M^h{}_t(x)/P^h{}_t$), 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 $h$ in period $t$. From (1), the consumption price index is defined as $P^h{}_t = \varphi(P^{hT}{}_t)^{\gamma}(P^{hN}{}_t)^{1-\gamma}$, where $\varphi \equiv \gamma^{-\gamma}(1-\gamma)^{-(1-\gamma)}$, $P^{hT}{}_t = (\int_0^1 P_{jt}^{hT}(z)^{1-\sigma}dz)^{1/(1-\sigma)}$, and $P^{hN}{}_t = (\int_0^1 P_t^{hN}(z)^{1-\theta_h}dz)^{1/(1-\theta_h)}$. $P^{hT}{}_{jt}(z)$ is the country $h$'s currency price of tradable good produced by firm $z$ located in country $j$, and $P^{hN}{}_t(z)$ is the country $h$'s currency price of non-tradable good produced by firm $z$ located in country $h$. In the fourth term in (1), $\ell^{sh}{}_t(x)$ is the amount of labor supplied by household $x$ in country $h$. 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 country $h$'s household faces the following budget constraint:

$$
\begin{aligned}
E^h{}_tB^h{}_{t+1}(x) + M^h{}_t(x) &= (1+ i_t)E^h{}_tB^h{}_t(x) + M^h{}_{t-1}(x) + W^h{}_t(x)\ell^{sh}{}_t(x) - P^{hT}{}_tC^{hT}{}_t(x) - P^{hN}{}_tC^{hN}{}_t(x) - P^{hT}{}_t\tau^h{}_t \\
&+ ((E^h{}_t/E^A{}_t)\int_0^{m_t}\Pi_t^{AT}(z)dz + (E^h{}_t/E^B{}_t)\int_{m_t}^{n_t}\Pi_t^{BT}(z)dz + E^h{}_t\int_{n_t}^{1}\Pi_t^{CT}(z)dz + (E^h{}_t/E^A{}_t)\int_0^1\Pi_t^{AN}(z)dz \\
&+ (E^h{}_t/E^B{}_t)\int_0^1\Pi_t^{BN}(z)dz + E^h{}_t\int_0^1\Pi_t^{CN}(z)dz) \qquad (4)
\end{aligned}
$$

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 $t$; $\int_0^{m_t}\Pi_t^{AT}(z)dz$, $\int_{m_t}^{n_t}\Pi_t^{BT}(z)dz$, and $\int_{n_t}^{1}\Pi_t^{CT}(z)dz$ represent the total nominal profit flows of firms in the tradable goods sector located in countries $A$, $B$, and $C$, respectively and $\int_0^1 \Pi_t^{AN}(z)dz$, $\int_0^1 \Pi_t^{BN}(z)dz$ and $\int_0^1 \Pi_t^{CN}(z)dz$ are the total nominal profit flows of firms in the non-tradable goods sector located at country $A$, $B$, and $C$, respectively; $P^{hT}{}_t C^{hT}{}_t(x)$ represents nominal consumption expenditure for the tradable goods; $P^{hN}{}_t C^{hN}{}_t$ is nominal consumption expenditure for the non-tradable goods; and $\tau^h{}_t$ denotes real lump-sum transfers from the government in period $t$. Note that all variables in (4) are measured in per capita terms. In the government sector, we assume that government spending is zero and that all seignorage revenues derived from printing the national currency are rebated to the public in the form of lump-sum transfers. Hence, the government budget constraint in country $h$ is $0 = s^h \tau^h{}_t + [(M^h{}_t - M^h{}_{t-1})/P^{hT}{}_t]$, where $M^h{}_t$ 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 the tradable (non-tradable) goods sector hires a continuum of differentiated labor inputs domestically and produces a unique product in a single location according to the CES production function, $y_{At}{}^T(z) = ((1/3)^{-1/\phi} \int_0^{1/3} \ell^T_{At}(z,x)^{(\phi-1)/\phi} dx)^{\phi/(\phi-1)}$ ($y_{At}{}^N(z) = ((1/3)^{-1/\phi} \int_0^{1/3} \ell^N_{At}(z,x)^{(\phi-1)/\phi} dx)^{\phi/(\phi-1)}$), where $y_{At}{}^T(z)$ ($y_{At}{}^N(z)$) denotes the production of firm $z$ in the tradable (non-tradable) goods sector; $\ell^T{}_{At}(z, x)$ ($\ell^N{}_{At}(z, x)$) is the tradable (non-tradable) firm $z$'s input of labor from household $x$; and $\phi > 1$ is the elasticity of input substitution. Given the firm's cost minimization problem, firm $z$'s optimal demand function for labor $x$ in sector $k$ is as follows:

$$\ell^{k}_{At}(z, x) = (1/3)^{-1}(W_t^A(z)/W_t^A)^{-\phi} y_{At}{}^{k}(z), \quad k = N, T \tag{5}$$

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 (5).

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

$$C^{hk}{}_{jt}(z, x) = (P^{hk}{}_{jt}(z)/P^{hk}{}_t)^{-\theta_h} C^{hk}{}_t(x), \quad j = A, B, C, \quad k = N, T \tag{6}$$

Summing the above 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 $j$, $j = A, B, C$:

$$y^T{}_{jt}(z) = (P^{AT}{}_{jt}(z)/P^{AT}{}_t)^{-\theta h} C^{AT}{}_t + (P^{BT}{}_{jt}(z)/P^{BT}{}_t)^{-\theta h} C^{BT}{}_t + (P^{CT}{}_{jt}(z)/P^{CT}{}_t)^{-\theta h} C^{CT}{}_t \tag{7}$$

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

$$y^T_{jt}(z) = (P^{jT}_{jt}(z)/P^{jT}_t)^{-\theta_h} C^{Tw}_t, \quad j = A, B, C \tag{8}$$

where $C^{Tw}_t \equiv C^{AT}_t + C^{BT}_t + C^{CT}_t$. Furthermore, the market clearing conditions for any non-tradable product $z$ in period $t$ in each country are, respectively, as follows:

$$y_{jt}{}^N(z) = s_j C^{jN}_t(z) = (P^{jN}_t(z)/P^{jN}_t)^{-\theta_h} s_j C_t^{jN}, \quad j = A, B, C \tag{9}$$

In the second stage, households maximize (1) subject to (4). The first-order conditions for this problem with respect to $B^h_{t+1}(x)$, $M^h_t(x)$ and $C^{hN}_t(x)$ can be written as:

$$C^h_{t+1}(x) = \beta C^h_t(x)(1 + i_{t+1})[(P^{hT}_t/E^h_t)/(P^{hT}_{t+1}/E^h_{t+1})] \tag{10}$$

$$M^h_t(x)/P^{hT}_t = \chi C^h_t(x)[(1 + i_{t+1})E^h_{t+1}/((1 + i_{t+1})E^h_{t+1} - E^h_t)] \tag{11}$$

$$C^{hN}_t(x) = ((1-\gamma)/\gamma)(P^{hT}_t/P^{hN}_t)C^{hT}_t(x) \tag{12}$$

where $i_{t+1}$ is the nominal interest rate for country $C$'s currency loans between periods $t$ and $t + 1$, defined as usual by $1 + i_{t+1} = (P^C_{t+1}/P^C_t)(1 + r_{t+1})$, and where $r_{t+1}$ denotes the real interest rate. Equation (10) is the Euler equation for consumption, (11) is the one for money demand, and (12) is the optimal condition for allocation between tradable and non-tradable goods.

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 in the tradable goods sector imply that $\ell_t^{sAT}(x) = \int_0^{m_t} \ell^T_{At}(z, x)dz$, $x \in [0,1/3]$, where the left-hand side represents the amount of labor supplied by household *x*, and the right-hand side represents tradable goods firms' total demand for labor *x*. Similarly, the equilibrium labor-market condition of the non-tradable goods sector in country *A* implies that $\ell_t^{sAN}(x) = \int_0^1 \ell_{At}^N(z,x)dz$, $x \in [0,1/3]$. By taking $W_t^A$, $P_t^{AT}$, and $m_t$ as given, substituting $\ell_t^{sA}(x) = \int_0^{m_t} \ell_{At}^T(z,x)dz + \int_0^1 \ell_{At}^N(z,x)dz$ and equation (5) into the budget constraint given by (4), 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, $W_t^A(x)$:

$$\kappa \ell_t^{sA}(x)^2 \phi (W_t^A(x)/P_t^{AT})^{-1} = (\phi - 1)(\ell_t^{sA}(x)/C_t^A) \tag{13}$$

The right-hand side of (13) 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 (13) 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 $P^A{}_t$, $m_t$, and subject to (8) and (9), the country *A*-located firm *z* faces the following profit-maximization problem:

$$\max_{P_{At}^{Ak}(z)} \Pi^{Ak}{}_{At}(z) = P^{Ak}{}_{At}(z) y^k{}_{At}(z) - \int_0^{1/3} W_t^A(z) \ell_{At}^k(z,x)\,dx = (P^{Ak}{}_{At}(z) - W^A{}_t) y^k{}_{At}(z), \quad k = N, T$$

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

$$P^{AT}{}_{At}(z) = (\sigma/(\sigma - 1))W^{A}{}_{t}, \quad P^{AN}{}_{t}(z) = (\theta_h/(\theta_h - 1))W^{A}{}_{t} \tag{14}$$

Since $W^{A}{}_{t}$ is given, (14) yields $P^{AT}{}_{At}(z) = P^{AT}{}_{At}$, $z\in[0, m_t]$. These relationships imply that each tradable goods firm located in country $A$ supplies the same quantity of goods. Similarly, other firms located in other countries have the price mark-up that is analogous to equation (14). Similarly, from (14), the price mark-ups for any non-tradable product $z$ in period $t$ in the home country are identical $P^{AN}{}_{At}(z) = P^{AN}{}_{At}$, $z\in[0, 1]$. Denoting the maximized real profit flows of country $j$-located tradable goods firms by $\Pi^{k}{}_{jt}(z)/P^{jT}{}_{t}$, and substituting (8) and (14) into $\Pi_j$ yields:

$$\Pi^{T}{}_{jt}(z)/P^{jT}{}_{t} = (1/\sigma)(P^{jT}{}_{jt}(z)/P^{jT}{}_{t})^{1-\sigma}C^{Tw}{}_{t}, \quad j = A,B,C \tag{15}$$

Similarly, the real profit flows of country $j$-located firms in the non-tradable goods sector, $\Pi^{N}{}_{jt}(z)/P^{jT}{}_{t}$, is as follows:

$$\Pi^{N}{}_{jt}(z)/P^{jT}{}_{t} = (1/\theta_h)(P^{jN}{}_{t}(z)/P^{jN}{}_{t})^{1-\theta_h}(P^{jN}{}_{t}/P^{jT}{}_{t})s_j C_{jt}{}^{N} \tag{16}$$

## 2.3. Relocation behavior of tradable goods firms

The driving force for relocation to other countries is differences in current real profits of tradable goods firms between two bounded countries.[2] Following the formulation in Johdo (2015), we assume that all tradable goods firms are not allowed to relocate

[2] 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.

instantaneously even if there is the profit gap. At each point in time, the adjustment mechanism for relocation between countries *A* and *B* is formulated as follows:

$$m_t - m_{t-1} = \eta[\Pi^T_{At}(z)/P_t^{AT} - \Pi^T_{Bt}(z)/P_t^{BT}] = \eta[\Pi^T_{At}(z)/P_t^{AT} - (E^A_t/E^B_t)\Pi^T_{Bt}(z)/P_t^{AT}] \quad (17)$$

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

$$n_t - n_{t-1} = \eta[\Pi^T_{Bt}(z)/P_t^{BT} - \Pi^T_{Ct}(z)/P_t^{CT}] = \eta[\Pi^T_{Bt}(z)/P_t^{BT} - E^B_t\Pi^T_{Ct}(z)/P_t^{BT}] \quad (18)$$

where $\eta$ ($0 \leq \eta < \infty$) is a constant positive parameter that determine the degree of firm mobility between two bounded countries: a larger value of $\eta$ implies higher firm mobility between countries. Intuitively, the parameter $\eta$ 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:

$$\int_0^{1/3} B_t^A(x)dx + \int_{1/3}^{2/3} B_t^B(x)dx + \int_{2/3}^{1} B_t^C(x)dx = 0 \quad (19)$$

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 $\theta_{h0} = \theta$, $h = A, B, C$ (detailed derivations given in Appendix A).[3] Henceforth, we denote the steady-state values by using the subscript *ss*. In the symmetric steady state, in which all variables are constant in all countries, given the Euler equation for consumption (equation (10)), the constant real interest rate is given by:

$$r_{ss} = (1 - \beta)/\beta \equiv \delta \tag{20}$$

where $\delta$ is the rate of time preference. Because symmetry, which implies $C^{hT}{}_{ss} = C^{wT}{}_{ss}$ and $C^{AN}{}_{ss} = C^{BN}{}_{ss} = C^{CN}{}_{ss}$ hold, the steady-state international allocations of firms are:

$$m_{ss} = 1/3 \tag{21}$$

$$n_{ss} = 2/3 \tag{22}$$

The steady state labor, output and consumption levels of each country $h$, $h = A, B, C$, are

$$\ell^{sh}{}_{ss} = ((\phi-1)/\phi)^{1/2}((\sigma-1)/\sigma)^{1/2}(\gamma/\kappa)^{1/2}[1+((\gamma-1)/\gamma)(\sigma/(\sigma-1))((\theta-1)/\theta)]^{1/2} \tag{23}$$

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

$$y_{hss}{}^{T} = C^{hT}{}_{ss} = C^{Tw}{}_{ss} = ((\phi-1)/\phi)^{1/2}((\sigma-1)/\sigma)^{1/2}(\gamma/\kappa)^{1/2}[1+((\gamma-1)/\gamma)(\sigma/(\sigma-1))((\theta-1)/\theta)]^{-1/2} \tag{24}$$

$$y_{hss}{}^{N} = s_h C^{hN}{}_{ss} =$$

$$(1/2)((\phi-1)/\phi)^{1/2}((\sigma-1)/\sigma)^{1/2}(\gamma/\kappa)^{1/2}[1+((\gamma-1)/\gamma)(\sigma/(\sigma-1))((\theta-1)/\theta)]^{-1/2}((\gamma-1)/\gamma)(\sigma/(\sigma-1))((\theta-1)/\theta) \tag{25}$$

The steady-state levels of real profit flows of country $h$-located tradable and non-tradable firms are:

$$\Pi^{T}{}_{hss}(z)/P_{ss}{}^{hT} =$$

$$(1/\sigma)((\phi-1)/\phi)^{1/2}((\sigma-1)/\sigma)^{1/2}(\gamma/\kappa)^{1/2}[1+((\gamma-1)/\gamma)(\sigma/(\sigma-1))((\theta-1)/\theta)]^{-1/2} \tag{26}$$

$$\Pi^{N}{}_{hss}(z)/P_{ss}{}^{hT} =$$

$$(1/2\theta)((\phi-1)/\phi)^{1/2}((\sigma-1)/\sigma)^{1/2}(\gamma/\kappa)^{1/2}((\gamma-1)/\gamma)[1+((\gamma-1)/\gamma)(\sigma/(\sigma-1))((\theta-1)/\theta)]^{-1/2} \tag{27}$$

## 4. A log-linearized analysis

In this model, as in Cavelaars (2006), we also interpret the elasticity of substitution between any two differentiated non-tradable goods produced in country $h$ as an instrument of deregulation in country $h$, $h = A, B, C$. To examine the macroeconomic effects of an unanticipated permanent deregulation shock ($d\theta_h > 0$), we solve a log-linear approximation of the system around the initial, zero-shock steady state with $B^{h}{}_{ss,0} = 0$, $h = A, B, C$, and $\theta_{h0} = \theta$ 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 $\hat{W}^j = \hat{P}_j^{jT}(z) = \hat{P}^{jT}(z) = 0$, $j =$ *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 B for the derivation of short- run and long-run deregulation effects).

By log-linearizing equations (17) and (18) around the symmetric steady state and setting $\hat{P}_j^{jT}(z) = \hat{P}^{jT}(z) = 0$, $j$ = *A*, *B*, *C*, we obtain the following log-linearized expression for the international distribution of firms:

$$\hat{m} = 3\eta\theta_1\left(\hat{E}^A - \hat{E}^B\right) \tag{28}$$

$$\hat{n} = (3/2)\eta\theta_1\hat{E}^B \tag{29}$$

Equation (28) 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 tradable goods firms located in country *B* towards the country *A*.[4] Intuitively, with fixed nominal wages, which cause nominal

[4] This result is consistent with the evidence found in the empirical literature on the relationship between exchange rates and FDI (e.g., 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, and Bolling et al, 2007).

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 tradable goods through the 'expenditure-switching effect'; i.e., $\hat{y}^{AT} - \hat{y}^{BT} = \theta\left(\hat{E}^A - \hat{E}^B\right)$.[5] This increases the relative profits of country *A*-located tradable goods firms, and consequently, tradable goods firms located in country *B* relocate to the country *A*. Equation (28) also shows that nominal exchange rate changes have greater effects the greater is the flexibility of relocation (the larger is η). By contrast, when relocation costs are high (η = 0), nominal exchange rate changes have a negligible effect on the relocation of tradable goods firms. The intuition behind the impact of $E^B$ in equation (29) on *n* can be explained analogously.

## 5. Deregulation

Now, we consider the effects of an unanticipated permanent deregulation shock in the non-tradable goods sector in each country.

### 5.1. The case of $\hat{\theta}_A = \overline{\theta}_A > 0, \hat{\theta}_B = \overline{\theta}_B = \hat{\theta}_C = \overline{\theta}_C = 0$

[5] 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'.

In this subsection, we focus on the impacts of a permanent deregulation shock in country *A*: $\hat{\theta}_A = \overline{\theta}_A > 0$. In this case, the closed-form solutions for the key variables are as follows:

$$\hat{E}^A - \hat{E}^B = \left[ \frac{\alpha_2 d\theta_2 - \alpha_1 d\theta_1}{(\alpha_2)^2 - (\alpha_1)^2} \right] < 0 \tag{30a}$$

$$\hat{E}^B = \left[ \frac{\alpha_2 d\theta_1 - \alpha_1 d\theta_2}{(\alpha_2)^2 - (\alpha_1)^2} \right] < 0 \tag{30b}$$

$$\hat{m} = 3\eta\theta_1 \left[ \frac{\alpha_2 d\theta_2 - \alpha_1 d\theta_1}{(\alpha_2)^2 - (\alpha_1)^2} \right] < 0 \tag{31a}$$

$$\hat{n} = (3\eta/2)\theta_1 \left[ \frac{\alpha_2 d\theta_1 - \alpha_1 d\theta_2}{(\alpha_2)^2 - (\alpha_1)^2} \right] < 0 \tag{31b}$$

$$\hat{C}^{AN} - \hat{C}^{BN} = (\theta - 1)^{-1} \hat{\theta}_A > 0 \tag{32}$$

$$\hat{C}^{AN} - \hat{C}^{CN} = (\theta - 1)^{-1} \hat{\theta}_A > 0 \tag{33}$$

$$\hat{C}^{AT} - \hat{C}^{BT} = \overline{C}^{AT} - \overline{C}^{BT} = -\left(\hat{E}^A - \hat{E}^B\right) > 0 \tag{34}$$

$$\hat{C}^{BT} - \hat{C}^{CT} = \overline{C}^{BT} - \overline{C}^{CT} = -\hat{E}^B > 0 \tag{35}$$

$$\hat{C}^{AT} - \hat{C}^{CT} = \overline{C}^{AT} - \overline{C}^{CT} = -\left(\hat{E}^A - \hat{E}^B\right) - \hat{E}^B > 0 \tag{36}$$

where

$$d\theta_1 = -\frac{2\theta_2\delta^{-1}}{\theta - 1} \left[ \frac{2 + 6\eta\theta_1 + \sigma}{(2 + 6\eta\theta_1 + \sigma)^2 - 9\eta^2\theta_1^2} \right] \overline{\theta}_A - (1 - \gamma)\left(\frac{1}{\theta}\right)\overline{\theta}_A < 0 \tag{37}$$

$$d\theta_2 = -\frac{\delta^{-1}}{\theta-1}\left[\frac{6\eta\theta_1\theta_2}{(2+6\eta\theta_1+\sigma)^2-9\eta^2\theta_1^2}\right]\overline{\theta}_A < 0 \tag{38}$$

$$\alpha_1 = \delta^{-1}\left\{1+2\theta_2\left[\frac{(6\eta\theta_1+\sigma)(2+6\eta\theta_1+\sigma)-9\eta^2\theta_1^2}{(2+6\eta\theta_1+\sigma)^2-9\eta^2\theta_1^2}\right]-\theta_2\right\}-\theta_2+6\gamma\left(\frac{\sigma-1}{\sigma}\right)\eta\theta_1+\gamma\left(\frac{\sigma-1}{\sigma}\right)\sigma+1>0 \tag{39}$$

$$\alpha_2 = -\left\{\delta^{-1}\left[\frac{12\eta\theta_1\theta_2}{(2+6\eta\theta_1+\sigma)^2-9\eta^2\theta_1^2}\right]+3\eta\theta_1\gamma\left(\frac{\sigma-1}{\sigma}\right)\right\}<0 \tag{40}$$

$$\theta_1 = \gamma^{1/2}\tilde{\phi}^{1/2}\tilde{\sigma}^{3/2}\tilde{\kappa}^{1/2}\left(1+\tilde{\gamma}\tilde{\sigma}^{-1}\tilde{\theta}\right)^{-1/2} \tag{41}$$

$$\theta_2 = 1+\tilde{\sigma}\gamma\left(1+\tilde{\gamma}\tilde{\sigma}^{-1}\tilde{\theta}\right) \tag{42}$$

and $\tilde{\gamma} = (1-\gamma)/\gamma$, $\tilde{\delta} \equiv (1+\delta)/\delta$, $\tilde{\theta} \equiv (\theta-1)/\theta$, and $\tilde{\phi} \equiv (\phi-1)/\phi$. Equations (30a) and (30b) indicate that an increase in the degree of competition in the non-tradable goods sector in country *A* ($\overline{\theta}_A = \hat{\theta}_A > 0$) leads to exchange rate appreciation in $E^A - E^B$ and $E^B$. Equation (31a) shows that an increase in the degree of competition in the non-tradable goods sector in country *A* causes country *A*'s firms to relocate to country *B*. Equation (31b) shows that the deregulation in country *A* causes country *B*'s firms to relocate to country *C*. Equations (32) and (33) show that the short-run relative non-tradable consumption levels of country *A* rise when there is an unanticipated deregulation in country *A*. Equations (34) and (36) show that the short-run relative tradable consumption levels of country *A* rise when there is an unanticipated deregulation in country *A*. Equations (35) shows that the short-run relative tradable consumption levels of country *B* to country *C* rises when there is an unanticipated deregulation in country *A*.

The above results can be explained intuitively as follows. An unanticipated deregulation in country *A* leads to an instantaneous decline of good prices in the non-tradable good sector of that country because of the fall in the price mark-ups of the non-tradable goods sector. The decrease of the non-tradable price index then raises the relative non-tradable consumptions in the country *A* (see equation (32)). This then leads to an increase in labor demand of the non-tradable goods sector in the country *A*, which in turn raises labor income in the country *A*. As a result, the increase in labor income in the country *A* increases the relative tradable and non-tradable consumptions in the country *A*. Because of this mechanism, the country *A* currency must appreciate to restore equilibrium in the market for real balances ($\hat{E}^{A} < 0$, see equations (30a), (34) and (36)). This is because the real money demand for liquidity services is increasing in aggregate consumption. In addition, the appreciation decreases relative country *A*'s tradable goods production through the expenditure-switching effect; i.e., $\hat{y}^{AT} - \hat{y}^{BT} = \sigma\left(\hat{E}^{A} - \hat{E}^{B}\right)$. This decreases the relative profits of country *A*-located tradable goods firms, and consequently, country *A* located tradable goods firms relocate to the country *B* ($\hat{m} < 0$, see equation (31a)). Hereafter, we shall call this the 'relocation effect'. This relocation then increases labor demand in country *B*, which in turn raises labor income in country *B*. As a result, country B households increase consumption, which requires an appreciation of country *B*'s currency to restore money market equilibrium. Therefore, the deregulation in country *A* raises the real price of country *B*'s goods relative to country *C*'s goods because of the appreciation of country *B*'s currency ($\hat{E}^{B} < 0$, see equation (30b)), which causes world demand to switch from country *B*'s goods to country *C*'s goods. This demand shift increases the relative profits of firms located in country *C*, which causes firms located in country *B* to relocate to country *C* ($\hat{n} < 0$, see equation (31b)). In sum, a permanent deregulation shock in country *A* always benefits country *A* in terms of relative consumption level not only to country *B*, but also to country *C*.

### 5.2. The case of $\hat{\theta}_B = \overline{\theta}_B > 0, \hat{\theta}_A = \overline{\theta}_A = \hat{\theta}_C = \overline{\theta}_C = 0$

In this subsection, we focus on the impacts of a permanent deregulation shock in country *B*: $\hat{\theta}_B = \overline{\theta}_B > 0$. In this case, the closed-form solutions for the key variables are as follows:

$$\hat{E}^A - \hat{E}^B = \left[\frac{\alpha_2 d\theta_2 - \alpha_1 d\theta_1}{(\alpha_2)^2 - (\alpha_1)^2}\right] > 0 \qquad (43a)$$

$$\hat{E}^B = \left[\frac{\alpha_2 d\theta_1 - \alpha_1 d\theta_2}{(\alpha_2)^2 - (\alpha_1)^2}\right] < 0 \qquad (43b)$$

$$\hat{m} = 3\eta\theta_1\left[\frac{\alpha_2 d\theta_2 - \alpha_1 d\theta_1}{(\alpha_2)^2 - (\alpha_1)^2}\right] > 0 \qquad (44a)$$

$$\hat{n} = (3\eta/2)\theta_1\left[\frac{\alpha_2 d\theta_1 - \alpha_1 d\theta_2}{(\alpha_2)^2 - (\alpha_1)^2}\right] < 0 \qquad (44b)$$

$$\hat{C}^{AN} - \hat{C}^{BN} = -(\theta - 1)^{-1}\hat{\theta}_B < 0 \qquad (45)$$

$$\hat{C}^{BN} - \hat{C}^{CN} = (\theta - 1)^{-1}\hat{\theta}_B > 0 \qquad (46)$$

$$\hat{C}^{AT} - \hat{C}^{BT} = \overline{C}^{AT} - \overline{C}^{BT} = -\left(\hat{E}^A - \hat{E}^B\right) < 0 \qquad (47)$$

$$\hat{C}^{BT} - \hat{C}^{CT} = \overline{C}^{BT} - \overline{C}^{CT} = -\hat{E}^{B} > 0 \tag{48}$$

$$\hat{C}^{AT} - \hat{C}^{CT} = \overline{C}^{AT} - \overline{C}^{CT} = 0 \tag{49}$$

where

$$d\theta_1 = \frac{2\theta_2\delta^{-1}}{\theta - 1}\left[\frac{2 + 6\eta\theta_1 + \sigma}{(2 + 6\eta\theta_1 + \sigma)^2 - 9\eta^2\theta_1^2}\right]\overline{\theta}_B + \left(\frac{1-\gamma}{\theta}\right)\overline{\theta}_B > 0 \tag{50}$$

$$d\theta_2 = -\left(\frac{2\theta_2\delta^{-1}}{\theta - 1}\right)\left[\frac{2 + 6\eta\theta_1 + \sigma}{(2 + 6\eta\theta_1 + \sigma)^2 - 9\eta^2\theta_1^2}\right]\overline{\theta}_B - \left(\frac{1-\gamma}{\theta}\right)\overline{\theta}_B < 0 \tag{51}$$

The above results can be explained intuitively as follows. First, the instantaneous fall in the price mark-ups of the non-tradable goods sector in country *B* leads to the decrease of the non-tradable price subindex, which then raises the relative non-tradable consumptions in country *B* (see equations (45) and (46)). This then leads to an increase in labor demand of the non-tradable goods sector in the country *B*, which in turn raises labor income in the country *B*. As a result, the increase in labor income in the country *B* increases the relative tradable and non-tradable consumptions in the country *B*. Because of this mechanism, the country *B* currency must appreciate to restore equilibrium in the market for real balances ($\hat{E}^{B} < 0$, see equations (43a), (43b), (47) and (48)). Under a given $E^A$, this then leads to a rise in the real price of country *B*'s goods relative to both country *A*'s and country *C*'s goods because of the appreciation of country *B*'s currency, which causes world demand to switch from country *B*'s goods to both country *A*'s and country *C*'s goods (the expenditure-switching effect). These demand shifts increase the relative profits of firms located in countries *A* and *C*, which causes firms located in country *B* to relocate to countries *A* and *C* ($\hat{m} > 0$ and $\hat{n} < 0$, see equations (44a) and

(44b)). In sum, a permanent monetary shock in country *B* always benefits country *B* in terms of relative consumption level not only to country *A*, but also to country *C*.

**5.3. The case of** $\hat{\theta}_C = \overline{\theta}_C > 0, \hat{\theta}_A = \overline{\theta}_A = \hat{\theta}_B = \overline{\theta}_B = 0$

In this subsection, we focus on the impacts of a permanent deregulation shock in country *C*: $\hat{\theta}_C = \overline{\theta}_C > 0$. In this case, the closed-form solutions for the key variables are as follows:

$$\hat{E}^A - \hat{E}^B = \left[\frac{\alpha_2 d\theta_2 - \alpha_1 d\theta_1}{(\alpha_2)^2 - (\alpha_1)^2}\right] > 0 \tag{52a}$$

$$\hat{E}^B = \left[\frac{\alpha_2 d\theta_1 - \alpha_1 d\theta_2}{(\alpha_2)^2 - (\alpha_1)^2}\right] > 0 \tag{52b}$$

$$\hat{m} = 3\eta\theta_1\left[\frac{\alpha_2 d\theta_2 - \alpha_1 d\theta_1}{(\alpha_2)^2 - (\alpha_1)^2}\right] > 0 \tag{53a}$$

$$\hat{n} = (3\eta/2)\theta_1\left[\frac{\alpha_2 d\theta_1 - \alpha_1 d\theta_2}{(\alpha_2)^2 - (\alpha_1)^2}\right] > 0 \tag{53b}$$

$$\hat{C}^{BN} - \hat{C}^{CN} = -(\theta - 1)^{-1}\hat{\theta}_C < 0 \tag{54}$$

$$\hat{C}^{AN} - \hat{C}^{CN} = -(\theta - 1)^{-1}\hat{\theta}_C < 0 \tag{55}$$

$$\hat{C}^{AT} - \hat{C}^{BT} = \overline{C}^{AT} - \overline{C}^{BT} = -\left(\hat{E}^A - \hat{E}^B\right) < 0 \tag{56}$$

$$\hat{C}^{BT} - \hat{C}^{CT} = \overline{C}^{BT} - \overline{C}^{CT} = -\hat{E}^B < 0 \tag{57}$$

$$\hat{C}^{AT} - \hat{C}^{CT} = \overline{C}^{AT} - \overline{C}^{CT} = -\left(\hat{E}^{A} - \hat{E}^{B}\right) - \hat{E}^{B} < 0 \tag{58}$$

where

$$d\theta_1 = \frac{2\theta_2\delta^{-1}}{\theta - 1}\left[\frac{3\eta\theta_1}{(2 + 6\eta\theta_1 + \sigma)^2 - 9\eta^2\theta_1^2}\right]\overline{\theta}_C > 0 \tag{59}$$

$$d\theta_2 = \left(\frac{2\theta_2\delta^{-1}}{\theta - 1}\right)\left[\frac{2 + 6\eta\theta_1 + \sigma}{(2 + 6\eta\theta_1 + \sigma)^2 - 9\eta^2\theta_1^2}\right]\overline{\theta}_C + \left(\frac{1-\gamma}{\theta}\right)\overline{\theta}_C > 0 \tag{60}$$

The above results can be explained intuitively as follows. An unanticipated deregulation in country *C* leads to an instantaneous decline of good prices in the non-tradable good sector of that country because of the fall in the price mark-ups of the non-tradable goods sector. The decrease of the non-tradable price index then raises the relative non-tradable consumptions in the country *C* (see equations (54) and (55)). This then leads to an increase in labor demand in the country *C*, which in turn raises labor income in the country *C*. As a result, the increase in labor income in the country *C* increases the relative tradable and non-tradable consumptions in the country *C*. Because of this mechanism, the country *C* currency must appreciate to restore equilibrium in the market for real balances ($\hat{E}^{A} = \hat{E}^{B} > 0$, see equations (52b), (57) and (58)). However, in this stage, country *A*'s currency relative to *B*'s remains unchanged because $\hat{E}^{A} - \hat{E}^{B} = 0$. Therefore, at this stage, the deregulation in country *C* raises the real price of country *C*'s goods relative to only country *B*'s goods because of the appreciation of country *C*'s currency, which causes world demand to switch from country *C*'s goods to country *B*'s goods (the expenditure-switching effect). This demand shift decreases the relative profits of firms located in country *C*, which causes firms located in country *C* to relocate to country *B* ($\hat{n} > 0$, see equation (53b)). The relocation then raises the labor income of country *B*, which raises the relative consumption of country *B* (see equation (56)). Because of the relocation effect, country *B*'s currency must appreciate to restore equilibrium in the market for real balances. Therefore, the deregulation in country *C* raises the real price of country *B*'s goods relative to country *A*'s goods because of the appreciation of country *B*'s currency (see equation (52a)), which causes world demand to switch from country *B*'s goods to country *A*'s goods. This demand shift increases the relative profits of firms located in country *A*, which causes firms located in country *B* to relocate to country *A* ($\hat{m} > 0$, see equation (53)). In sum, a permanent deregulation shock in country *C* always benefits country *C* in terms of relative consumption level not only to country *B*, but also to country *A*.

## 6. Conclusion

In this paper we have provided a generalization of the model of Johdo (2015) that allows for relocation of firms among three countries. We have used this generalized model to consider the question of how allowing for international relocation of firms affects the responses of both consumption and exchange rates to deregulation shocks. From this analysis, we succeeded in showing explicitly the effects of deregulation policy shocks, which lead to firm relocation among three countries, and it was found that when relocation matters, a permanent deregulation shock in one of the three countries always benefits that country in terms of relative consumption in spite of outflow 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).[6] Also of interest is extending the model to account for trade impediments such as tariffs and transport costs as in Fender and Yip (2000).[7] Further, the consideration of the effects of deregulation under a fixed exchange rate system in our model is noteworthy. These issues remain for future research.

---

[6] 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.

[7] 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).

## References

Bénassy-quéré, A., Fontagné, L. and Lahréche-révil, A. (2001). 'Exchange-rate strategies in the competition for attracting foreign direct investment', *Journal of the Japanese and International Economies*, 15, pp. 178–198.

Bergin, P.R. and Feenstra, R.C. (2001). 'Pricing-to-market, staggered contracts, and real exchange rate persistence', *Journal of International Economics*, 54, pp. 333–359.

Betts, C. and Devereux, M. (2000a). 'Exchange rate dynamics in a model of pricing-to-market', *Journal of International Economics*, 50, pp. 215–244.

Betts, C. and Devereux, M. (2000b). 'International monetary policy coordination and competitive depreciation: A reevaluation', *Journal of Money, Credit, and Banking* 32, pp.722–745.

Blonigen, B.A. (1997). 'Tariff-jumping antidumping duties', *Journal of International Economics*, 57, pp. 31–50.

Blonigen, B.A. (2002). 'Tariff-jumping antidumping duties', *Journal of International Economics*, 57, pp. 31–50.

Bolling, C., Shane, M. and Roe, T. (2007). 'Exchange rates and U.S. foreign direct investment in the global processed food industry', *Agricultural and Resource Economics Review*, 36, pp. 230–238.

Brainard, L.S. (1997). 'An empirical assessment of the proximity-concentration trade-off between multinational sales and trade', *American Economic Review*, 87, pp. 520–544.

Campa, J.M. (1993). 'Entry by foreign firms in the united states under exchange rate uncertainty', *Review of Economics and statics*, 75, pp.614–622.

Cavallo, M. and Ghironi, F. (2002). ‘Net foreign assets and the exchange rate: Redux revised’, *Journal of Monetary Economics*, 49, pp. 1057−1097.

Cavelaars, P. (2006). ‘Output and price effects of enhancing services sector competition in a large open economy’, *European Economic Review*, 50, pp. 1131−1149.

Caves, R. (1989). ‘Exchange-rate movements and foreign direct investment in the United States’, in *The Internationalization of U.S. Markets*, pp.199−228, Audretsch, D.B. and Claudon, M.P., eds, New York University Press.

Chakrabarti, R. and Scholnick, B. (2002). ‘Exchange rate expectations and foreign direct investment flows’, *Weltwirtschaftliches Archiv*, 138, pp. 1−21.

Chu, H. (2005). ‘Welfare and public: The role of internationalized production’, *Economic Inquiry*, 43, pp. 542−557.

Corsetti, G., Pesenti, P., Roubini, N. and Tille, C. (2000). ‘Competitive devaluations: toward a welfare-based approach’, *Journal of International Economics*, 51, pp. 217−241.

Corsetti, G. and Pesenti, P. (2001). ‘Welfare and macroeconomic interdependence’, *Quarterly Journal of Economics*, 116, pp. 421−444.

Corsetti, G. and Pesenti, P. (2005). ‘International dimensions of optimal monetary policy’, *Journal of Monetary Economics*, 52, pp. 281−305.

Corsetti, G., Martin, P. and Pesenti, P. (2005). ‘Productivity, terms of trade, and the ‘home market effect’’, *Journal of International Economics*, 73, pp. 99−127.

Cushman, D.O. (1985). ‘Real exchange rate risk, expectations, and the level of foreign direct investment’, *Review of Economics and Statistics*, 67, pp. 297−308.

Cushman, D.O. (1988). ‘Exchange rate uncertainty and foreign direct investment in the United Statess’, *Weltwirtschaftliches Archiv*, 124, pp. 322–336.

Devereux, M. and Engel, C. (2002). ‘Exchange rate pass-through, exchange rate volatility, and exchange rate disconnect’, *Journal of Monetary Economics*, 49, pp. 913–940.

Eckel, C. and Egger, H. (2009). ‘Wage bargaining and multinational firms’, *Journal of International Economics*, 77, pp. 206–214.

Farrell, R., Gaston, N. and Sturm, J.M. (2004). ‘Determinants of Japan’s foreign direct investment: An industry and country panel study, 1984–1998’, *Journal of the Japanese and International Economies*, 18, pp. 161–182.

Fender, J. and Yip, C.K. (2000). ‘Tariffs and exchange rate dynamics redux’, *Journal of International Money and Finance*, 19, pp. 633–655.

Froot, K.A. and Stein, J.C. (1991). ‘Exchange rates and foreign direct investment: an imperfect capital markets approach’, *Quarterly Journal of Economics*, 106, pp. 1191–1217.

Goldberg, L. and Klein, M. (1998). ‘Foreign direct investment, trade, and real exchange rate linkages in developing countries’, in Glick, R., eds., *Managing Capital Flows and Exchange rates: Perspectives from the Pacific Basin*, pp. 73–100. Cambridge, UK: Cambridge University Press.

Goldberg, L. and Kolstad, C. (1995). ‘Foreign Direct Investment, Exchange rate variability and Demand Uncertainty’, *International Economic Review*, 36, pp. 855–873.

Hau, H. (2000). ‘Exchange rate determination: The role of factor price rigidities and nontradeables’, *Journal of International Economics,* 50, pp. 421–447.

Helpman, E., Melitz, M.J. and Yeaple, S.R. (2004). ‘Exports versus FDI’, *American Economic Review,* 94, pp. 300–316.

Johdo, W. (2010). ‘The effects of monetary policy under habit persistence: A two-country analysis’, *Journal of International and Global Economic Studies,* 2, pp. 1–14.

Johdo, W. (2013a). ‘Does monetary expansion improve welfare under habit formation?’, *Economics Bulletin,* 33, pp. 1959–1968.

Johdo, W. (2013b). ‘Consumption tax, nontraded goods and welfare’, *Theoretical Economics Letters*, 3, pp. 262–266.

Johdo, W. (2015). ‘The macroeconomic effects of a deregulation policy under international firm mobility’, *Tezukayama RIEB Discussion Paper Series* 18.

Kiyota, K. and Urata, S. (2004). ‘Excahnge rate, exchange rate volatility and foreign direct investment’, *The World Economy,* 1501–1536.

Klein, M.W. and Rosengren, E.S. (1994). ‘The real exchange rate and foreign direct investment in the United States: relative wealth vs. relative wage effects’, *Journal of International Economics,* 36, pp. 373–389.

Kollmann, R. (2001). ‘Explaining international comovements of output and asset returns: The role of money and nominal rigidities’, *Journal of Economic Dynamics and Control,* 25, pp. 1547–1583.

Kollmann, R. (2002). ‘Monetary policy rules in the open economy: effects on welfare and business cycles’, *Journal of Monetary Economics,* 49, pp. 989–1015.

Lane, P.R. (1997). ‘Inflation in open economies’, *Journal of International Economics*, 42, pp. 327–347.

Obstfeld, M. and Rogoff, K. (1995). ‘Exchange rate dynamics redux’, *Journal of Political Economy*, 103, pp. 624–660.

Obstfeld, M. and Rogoff, K. (2002). ‘Global implications of self-oriented national monetary rules’, *Quarterly Journal of Economics*, 117, pp. 503–535.

Russ, K.N. (2007). ‘The endogeneity of the exchange rate as a determinant of FDI: A model of entry and multinational firms’, *Journal of International Economics*, 71, pp. 344–372.

Senay, O. and Sutherland, A. (2007). ‘Foreign money shocks and the welfare performance of alternative monetary policy regimes’, *Scandinavian Journal of Economics*, 109, pp. 245–266.

Smets, F. and Wouters, R. (2002). ‘Openness, Imperfect exchange rate pass-through and monetary policy’, *Journal of Monetary Economics*, 49, pp. 947–981.

Sutherland, A. (2005a). ‘Cost-push shocks and monetary policy in open economies’, *Oxford Economic Papers*, 57, pp. 1–33.

Sutherland, A. (2005b). ‘Incomplete pass-through and the welfare effects of exchange rate variability’, *Journal of International Economics*, 65, pp. 375–399.

Tille, C. (2001). ‘The role of consumption substitutability in the international transmission of monetary shocks’, *Journal of International Economics*, 53, pp. 421–444.

Warnock, F.E. (2003). 'Exchange rate dynamics and the welfare effects of monetary policy in a two-country model with home-product bias', *Journal of International Money and Finance*, 22, pp. 343–363.