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Deregulation in non-tradable goods sector and relocation of firms in tradable goods sector

Wataru Johdo
Tokyo Keizai University

Abstract

This study uses a new open economy macroeconomics model that incorporates cross-border relocation of firms to analyze the international spillover effects of deregulation shocks. The study shows that the deregulation shock in the non-tradable goods sector of a home country results in an appreciation of the home currency. In addition, appreciation decreases (increases) the real profits of firms in the tradable goods sector located in the home country (abroad), and then firms relocate to the foreign country. As a result, deregulation in the home country always increases (decreases) both the tradable and non-tradable consumptions in the home (foreign) country. The study also shows that higher firm mobility between two countries weakens the effects of deregulation shocks on exchange rate and relative consumption.

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Contact: Wataru Johdo - johdo@tku.ac.jp.
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1. Introduction

The relationship between demand stimulating policies and aggregate economic activity has been studied extensively in new open economy macroeconomics (NOEM) literature, e.g., the works of Obstfeld and Rogoff (1995), Betts and Devereux (2000), Hau (2000), Caselli (2001), Corsetti and Pesenti (2001), Cavallo and Ghironi (2002), Kollmann (2002), Smets and Wouters (2002), Chu (2005), Ganelli (2005), and Senay and Sutherland (2007). The literature has focused on how exchange rate and consumption of each country are influenced by unanticipated monetary and fiscal shocks under monopolistic distortions and nominal rigidities. The benchmark model of Obstfeld and Rogoff (1995) shows that, even with expenditure switching across two countries caused by exchange rate changes, a home monetary expansion raises each country's output and welfare through the first-order effect of increasing world consumption.

However, in the above literature, none of the studies consider the consumption and exchange rate effects of deregulation policies. One exception is the work of Cavelaars (2006), which studies the macroeconomic effects of deregulation policies on exchange rate and output by extending the NOEM model to include non-tradable goods sector. The literature succeeds in showing explicitly that an increase in the degree of competition in the non-tradable goods sector in a home country has international spillover effects on the foreign country via its effects on terms of trade adjustments.

Since the publication of the paper of Obstfeld and Rogoff (1995), most NOEM models including the work of Cavelaars (2006) have assumed that firms are immobile across countries, and they have shown that the short-run decrease in production of foreign tradable goods caused by the expenditure switching effect are the main sources of the international transmission mechanism. The primary focus of this study is to highlight how allowing for the international relocation of firms affects the impact of deregulation shocks on cross-country differences in consumption and exchange rate.[1]

In order to analyze the consequences of deregulation shocks in a NOEM model with international relocation of firms, this paper extends the deregulation model of Cavelaars (2006) by allowing firms in the tradable goods sector to relocate across countries after deregulation shocks in the non-tradable goods sector. This implies that our model generates an added international transmission effect of the deregulation shock that operates through the international relocation of firms in the tradable goods sector.

We conclude that a deregulation shock in the non-tradable goods sector of the home country results in a proportionate increase in both the short-run and long-run relative home consumption levels and appreciation of the home currency correspondingly. In addition, appreciation decreases (increases) the real profits of firms in the tradable goods sector located in the home country (abroad), and then some firms in the tradable goods sector relocate to the foreign country. Moreover, we show that an increase in the flexibility of relocation weakens the impact of deregulation shocks on relative consumption and exchange rate. This implies that the larger is the international mobility

[1] A large body of empirical evidence suggests that exchange rates affects the production locations and inward (or outward) foreign direct investments of firms (see, 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 & Scholnick, 2002; Farrell et al., 2004).

of firms in the tradable goods sector, the smaller is the adverse effect of relative foreign consumption by the deregulation.

2. Model

We assume a two-country (home country and foreign country) world economy. The models for the home and foreign countries are the same, and an asterisk is used to denote foreign variables. 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. Tradable goods firms are mobile internationally, but non-tradable goods firms are not. Tradable goods producers in the interval $[0, n_t]$ locate in the home country in period t, and the remaining $(n_t, 1]$ producers locate in the foreign country, where n_t is endogenous. We assume that households inhabit the interval $[0, s]$ in the home country and households inhabit the interval $(s, 1]$ in the foreign country.

The intertemporal objective of household $i \in (0, s)$ in the home country at time t is used to maximize the following lifetime utility:

$$U^i{}_t = E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t} \left(\gamma \log C^{iT}{}_\tau + (1-\gamma)\log C^{iN}{}_\tau + \chi \log(M^i{}_\tau/P_\tau) - (\kappa/2)(\ell^{si}{}_\tau)^2\right), \quad (1)$$

where β is a constant subjective discount factor ($0 < \beta < 1$), $\ell^{si}{}_t$ is the amount of labor supplied by household i in period t, and the consumption indices are defined as follows:

$$C^{iT}{}_t = \left(\int_0^1 C_t^{iT}(j)^{(\sigma-1)/\sigma} dj\right)^{\sigma/(\sigma-1)}, \ \sigma > 1, \quad (2)$$

$$C^{iN}{}_t = \left(\int_0^1 C_t^{iN}(j)^{(\theta-1)/\theta} dj\right)^{\theta/(\theta-1)}, \ \theta > 1, \quad C^{iN*}{}_t = \left(\int_0^1 C_t^{iN*}(j)^{(\psi-1)/\psi} dj\right)^{\psi/(\psi-1)}, \ \psi > 1, \quad (3)$$

where σ is the elasticity of substitution between any two differentiated tradable goods, θ and ψ are the elasticity of substitution between any two differentiated non-tradable goods produced in the home and foreign country, respectively, $C^i_t{}^T(j)$ is the consumption of tradable good j in period t for household i, $C^i_t{}^N(j)$ ($C^{iN*}{}_t$) is the home (foreign) consumption of non-tradable good j.

The non-tradable goods market approaches perfect competition as θ increases. Therefore, the parameter θ can be interpreted as a measure of the degree of competition in the non-tradable goods market. The second term in (1) represents real money balances ($M^i{}_t/P_t$), where $M^i{}_t$ denotes nominal money balances held at the beginning of period $t + 1$, and P_t is the home country's consumption price index (CPI), which is defined as $P_t = \varphi(P^T{}_t)^\gamma(P^N{}_t)^{1-\gamma}$, where $\varphi \equiv \gamma^{-\gamma}(1-\gamma)^{-(1-\gamma)}$, $P^T{}_t = \left(\int_0^1 P_t^T(j)^{1-\sigma} dj\right)^{1/(1-\sigma)}$, $P^N{}_t = \left(\int_0^1 P_t^N(j)^{1-\theta} dj\right)^{1/(1-\theta)}$, and $P^T{}_t(j)$ ($P^N{}_t(j)$) is the home-currency price of tradable (non-tradable) good j in period t. Analogously, the foreign country's CPI is defined as $P^*{}_t = \varphi(P^{T*}{}_t)^\gamma(P^{N*}{}_t)^{1-\gamma}$, where $P_t^{T*} = \left(\int_0^1 P_t^{T*}(j)^{1-\sigma} dj\right)^{1/(1-\sigma)}$ and $P^{N*}{}_t = \left(\int_0^1 P_t^{N*}(j)^{1-\psi} dj\right)^{1/(1-\psi)}$, where $P_t^{T*}(j)$ ($P^{N*}{}_t(j)$) is the foreign-currency price of tradable (non-tradable) good j in period t. Under the law of one price, we can rewrite the corresponding price indexes to $P_t^T = (\int_0^{n_t} P_t^T(j)^{1-\sigma}dj + \int_{n_t}^1 (\varepsilon_t P_t^{T*}(j))^{1-\sigma}dj)^{1/(1-\sigma)}$ and $P_t^{T*} = (\int_0^{n_t} (P_t^T(j)/\varepsilon_t)^{1-\sigma}dj + \int_{n_t}^1 P_t^{T*}(j)^{1-\sigma}dj)^{1/(1-\sigma)}$. By ignoring the trade costs between the two countries, the law of one price holds for any tradable variety j; i.e., $P_t^T(j) = \varepsilon_t P_t^{T*}(j)$, where ε_t is the nominal exchange rate, which is defined as the home currency price per unit of foreign currency. We assume for an international risk-free real bond market, in which real bonds are denominated in the units of the composite tradable consumption good. A typical domestic household faces the following budget constraint:

$$P^T_t B^i_{t+1} + M^i_t = P^T_t(1+r_t)B^i_t + M^i_{t-1} + W^i_t \ell^{si}_t$$

$$+ \left(\int_0^{n_t} \Pi_t^T(j)dj + \int_{n_t}^1 \varepsilon_t \Pi_t^{T*}(j)dj + \int_0^1 \Pi_t^N(j)dj + \int_0^1 \varepsilon_t \Pi_t^{N*}(j)dj\right) - P^T_t C^{iT}_t - P^N_t C^{iN}_t - P^T_t \tau^i_t, \quad (4)$$

where B^i_{t+1} denotes real bonds held by home agent i in period $t + 1$, r_t denotes the real interest rate on bonds that applies between periods $t - 1$ and t, W^i_t denotes the nominal wage rate of household i in period t, $\int_0^{n_t} \Pi_t^T(j)dj$ ($\int_{n_t}^1 \varepsilon_t \Pi_t^{T*}(j)dj$) represents the total nominal profit flows of firms in the tradable goods sector located at home (abroad), and $\int_0^1 \Pi_t^N(j)dj$ ($\int_0^1 \varepsilon_t \Pi_t^{N*}(j)dj$) is the total nominal profit flows of firms in the non-tradable goods sector located at home (abroad). τ_t denotes real lump-sum transfers from the government in period t.

In the government sector, we assume that government spending is zero and 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 is $0 = \tau_t + [(M_t - M_{t-1})/P^T_t]$, where M_t is aggregate money supply and $\tau_t = \int_0^s \tau_t^i di$. The nominal interest rate i_{t+1} is defined as usual by $1 + i_{t+1} = (1 + r_{t+1})E_t(P^T_{t+1}/P^T_t)$.

In the home country, firm j in the tradable (non-tradable) goods sector domestically hires a continuum of differentiated labor inputs and produces a unique product in a single location according to the CES production function of $y^T_t(j) = (s^{-1/\phi}\int_0^s \ell_t^{diT(\phi-1)/\phi}di)^{\phi/(\phi-1)}$ ($y^N_t(j) = (s^{-1/\phi}\int_0^s \ell_t^{diN(\phi-1)/\phi}di)^{\phi/(\phi-1)}$), where $y^T_t(j)$ ($y^N_t(j)$) denotes the production of home-located firm j in the tradable goods (non-tradable goods) sector, $\ell^{diT}_t(j)$ ($\ell^{diN}_t(j)$) is firm j's input of labor from household i in period t, and $\phi > 1$ is the elasticity of input substitution. Given the home firm's cost minimization problem, firm j's optimal labor demand for household i's labor input is expressed as follows:

$$\ell_t^{dix}(j) = s^{-1}(W^i_t/W_t)^{-\phi} y_t^x(j), \quad x = N, T \quad (5)$$

where $W_t \equiv (s^{-1}\int_0^s W_t^{i\ (1-\phi)}di)^{1/(1-\phi)}$ is a price index for labor input.

In the first stage, households in the home (foreign) country maximize the consumption index of tradable goods C^{iT}_t ($C^i{}_t^{T*}$) subject to a given level of expenditure

$P_t^T C^{iT}_t = \int_0^1 P_t^T(j)\, C^{iT}_t(j)dj$ ($P_t^{T*} C^i_t{}^{T*} = \int_0^1 P_t^{T*}(j)\, C^i_t{}^{T*}(j)dj$) by optimally allocating differentiated tradable goods. This static problem yields the following demand functions for tradable good j in the home and foreign countries $C^{iT}_t(j) = (P^T_t(j)/P^T_t)^{-\sigma} C^{iT}_t$ and $C^i_t{}^{T*}(j) = (P_t^{T*}(j)/P_t^{T*})^{-\sigma} C^i_t{}^{T*}$. Aggregating the demands for tradable goods across all households worldwide and equating the resulting equation to the output of tradable good j produced in the home country, as denoted by $y_t^T(j)$, yield the following market clearing condition for any tradable product j in period t:

$$y_t^T(j) = sC^{iT}_t(j) + (1 - s)C^i_t{}^{*T}(j) = (P^T_t(j)/P^T_t)^{-\sigma} C_t^{Tw}, \tag{6}$$

where $P^T_t(j)/P^T_t = P_t^{T*}(j)/P_t^{T*}$ is from the law of one price, $sC^{iT}_t(j)$ ($(1 - s)C^i_t{}^{T*}(j)$) is aggregate home (foreign) consumption demand for tradable product j, and $C_t^{Tw} \equiv (sC^{iT}_t + (1 - s)C^i_t{}^{T*})$ is aggregate per capita world consumption. Similarly, for product j of the foreign-located firms, we obtain $y_j^{T*} = sC^{iT}_t(j) + (1 - s)C^i_t{}^{T*}(j) = (P_t^{T*}(j)/P_t^{T*})^{-\sigma} C_t^{Tw}$. Furthermore, the market clearing conditions for any non-tradable product j in period t in the home and foreign country are, respectively, as follows:

$$y_t^N(j) = sC^{iN}_t(j) = (P^N_t(j)/P^N_t)^{-\theta} sC_t^N, \tag{7}$$

$$y_t^{N*}(j) = (1 - s)C^{iN*}_t(j) = (P^{N*}_t(j)/P^{N*}_t)^{-\psi}(1 - s)C_t^{N*}. \tag{8}$$

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

$$1/C^{iT}_t = \beta E_t[(1 + r_{t+1})/C^{iT}_{t+1}], \tag{9}$$

$$\gamma/C^T_t = \chi(P^T_t/P_t)(M^i_t/P_t)^{-1} + \beta E_t[(P^T_t/P^T_{t+1})(\gamma/C^T_{t+1})], \tag{10}$$

$$C^{iN}_t = ((1-\gamma)/\gamma)(P^T_t/P^N_t)C^{iT}_t. \tag{11}$$

Here, following the work of Corsetti and Pesenti (2001), the nominal wages in period t are predetermined at time $t - 1$. In monopolistic labor markets, each household provides a single variety of labor input to a continuum of domestic firms. Hence, the equilibrium labor-market conditions in the tradable goods sector for the home and foreign countries can be expressed as $\ell^{siT}_t = \int_0^{n_t} \ell_t^{diT}(j)dj$, $i \in [0, s]$ and $\ell^{siT*}_t = \int_{n_t}^1 \ell_t^{diT*}(j)dj$, $i \in (s, 1]$, respectively. Similarly, the equilibrium labor-market conditions in the non-tradable goods sector can be expressed as $\ell^{siN}_t = \int_0^1 \ell_t^{diN}(j)dj$, $i \in [0, s]$ and $\ell^{siN*}_t = \int_0^1 \ell_t^{diN*}(j)dj$, $i \in (s, 1]$, respectively. Taking W_t, P^T_t, $y^x_t(j)$ ($x = N$, T), and n_t as a given, then by substituting $\ell^{si}_t = \int_0^{n_t} \ell_t^{diT}(j)dj + \int_0^1 \ell_t^{diN}(j)dj$ and equation (5) into the household budget constraint given by (4), and finally by maximizing the lifetime utility given by (1), with respect to W^i_t, we obtain the following optimal condition for the nominal wage:

$$\phi(W^i_t/P^T_t)^{-1} E_{t-1}[\kappa \ell^{si}_t{}^2] = (\phi - 1)E_{t-1}[(\ell^{si}_t/C^{iT}_t)]. \tag{12}$$

In monopolistic tradable and non-tradable goods markets, each firm has some monopolistic power over pricing. Considering that home-located firm j domestically hires labor, given W_t, $P^T{}_t$, $P^N{}_t$ and $C^w{}_t$, subject to equations (5) to (8), home-located firm j in each sector faces the following profit-maximization problem:

$$\max_{P_t(j)} \Pi^x{}_t(j) = P^x{}_t(j)y^x{}_t(j) - \int_0^s W_t^i \ell_t^{dix}(j)di = (P^x{}_t(j) - W_t)y^x{}_t(j), \quad x = N, T \tag{13}$$

where $\Pi^x{}_t(j)$ denotes the nominal profit of home-located firm j in sector x (= N, T) and $\int_0^s W_t^i \ell_t^{dix}(j)di$ represents total labor cost. By substituting $y^x{}_t(j)$ from equations (6) to (8) into the firm's profit $\Pi^x{}_t(j)$ ($x = N, T$) and then differentiating the resulting equation with respect to $P^x{}_t(j)$, we obtain the following price mark-ups:

$$P^T{}_t(j) = (\sigma/(\sigma - 1))W_t, \quad P^N{}_t(j) = (\theta/(\theta - 1))W_t, \quad P^{N*}{}_t(j) = (\psi/(\psi - 1))W^*{}_t. \tag{14}$$

Moreover, W_t is a given; thus, from (14), all home-located firms in the tradable good sector charge the same price. Subsequently, we define the above identical prices as $P^T{}_t(j) = P^T{}_t(h)$, $j\in[0, n]$. Similarly, the price mark-ups for any non-tradable are defined as $P^N{}_t(j) = P^N{}_t(h)$, $j\in[0, 1]$. The price mark-ups of foreign-located firms are also defined as $P_t^{x*}(j) = P_t^{x*}(f)$, $x = N$, T. By substituting (6) and (14) into the real profit flows of home- and foreign-located firms in the tradable goods sector (i.e., $\Pi^T{}_t(h)/P^T{}_t$ and $\Pi_t(f)^{T*}/P_t^{T*}$, respectively), we obtain

$$\Pi^T{}_t(h)/P^T{}_t = (1/\sigma)(P^T{}_t(h)/P^T{}_t)^{1-\sigma}C^{Tw}{}_t, \quad \Pi^T{}_t(f)^*/P_t^{T*} = (1/\sigma)(P_t^{T*}(f)/P_t^{T*})^{1-\sigma}C^{Tw}{}_t. \tag{15}$$

Similarly, the real profit flows of home- and foreign-located firms in the non-tradable goods sector (i.e., $\Pi^N{}_t(h)/P^T{}_t$ and $\Pi_t(f)^{N*}/P_t^{T*}$, respectively) are as follows:

$$\Pi^N{}_t(h)/P^T{}_t = (1/\theta)(P^N{}_t(h)/P^N{}_t)^{1-\theta}(P^N{}_t/P^T{}_t)sC_t^N{}_t, \tag{16}$$

$$\Pi^N{}_t(f)^*/P_t^{T*} = (1/\psi)(P_t^{N*}(f)/P_t^{N*})^{1-\psi}(P^{N*}{}_t/P^{T*}{}_t)(1 - s)C_t^{N*}. \tag{17}$$

In this model, the driving force of relocation to other countries is the difference in current real profits between home- and foreign-located tradable goods firms. Following the formulation of Johdo (2015, 2019), the above adjustment mechanism for relocation at time t is formulated as follows[2]:

$$n_t - n_{t-1} = \eta[\Pi^T{}_t(h)/P^T{}_t - \Pi^T{}_t(f)^*/P^T{}_t{}^*] = \eta[\Pi^T{}_t(h)/P^T{}_t - \varepsilon_t\Pi^T{}_t(f)^*/P^T{}_t], \tag{18}$$

where $\Pi^T{}_t(f)^*/P^T{}_t{}^*$ can be expressed as $\varepsilon_t\Pi^T{}_t(f)^*/P^T{}_t$ by using purchasing power parity (i.e., $P_t^T = \varepsilon_t P_t^{T*}$) and η ($0 \leq \eta < \infty$) is a constant positive parameter used to determine the degree of firm mobility between the two countries. A larger value of η implies higher firm mobility between two countries.

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[2] Equation (18) shows that all firms are not allowed to relocate instantaneously even if there is the profit gap. Han et al. (2014) gave a clearer reasoning why not all firms move all together, rather only some of the firms can relocate and the other can not. I thank a referee for directing me to this literature.

The equilibrium condition for the integrated international real bond market is given by $\int_0^s B_{t+1}^i di + \int_s^1 B_{t+1}^{*i} di = 0$. Money markets are given by $M_t = \int_0^s M_t^i di$ and $M^*{}_t = \int_s^1 M_t^{*i} di$.

3. Analysis of Unilateral Deregulation

The macroeconomic effects of unanticipated unilateral deregulation shocks in the non-tradable goods markets ($d\theta > 0$, $d\psi = 0$) need to be examined.[3] As in the work of Cavelaars (2006), we interpret the elasticity of substitution between any two differentiated non-tradable goods (θ) as an instrument of deregulation. Thus, we solve a log-linear approximation of the system around the initial zero-shock steady state with $B_{ss,0} = 0$ and $\theta_0 = \psi_0$, as described in Appendix. Following the work of Obstfeld and Rogoff (1995, 1996), for any variable X, we use $\hat{X}$ to denote "short-run" percentage deviations from the initial steady-state value and $\overline{X}$ to denote "long-run" percentage deviations from the initial steady-state value.

By log linearizing equation (18) around the symmetric steady state and by setting $\hat{W} = \hat{W}^* = 0$, we obtain the following log-linearized expression for the international distribution of firms:

$$\hat{n} = 2\eta(\gamma/\kappa)^{1/2}((\phi-1)/\phi)^{1/2}((\sigma-1)/\sigma)^{3/2}[1+((\gamma-1)/\gamma)(\sigma/(\sigma-1))((\theta-1)/\theta)]^{-1/2}\hat{\varepsilon}. \quad (19)$$

Equation (19) shows that exchange rate depreciation induces the global relocation of firms toward the home country. Intuitively, with fixed nominal wages, which cause nominal product prices to be sticky because of the mark-up pricing by monopolistic product suppliers (i.e., $\hat{W} = \hat{W}^* = \hat{P}^T(h) = \hat{P}^{*T}(f) = \hat{P}^N(h) = \hat{P}^{*N}(f) = 0$), depreciation increases relative home tradable goods production through the expenditure-switching effect, i.e., $\hat{y}^T(h) - \hat{y}^{*T}(f) = \sigma\hat{\varepsilon}$. This phenomenon increases the relative profits of home-located tradable goods firms, and consequently, other tradable goods firms relocate to the home country.[4] Also, equation (19) shows that for a much larger η any given changes in nominal exchange rates have much more prominent effects on the relocation of firms.

In order to show the macroeconomic effects of deregulation policy shocks of the home country, we then consider the impacts of an unanticipated permanent increase in θ in period 1. This means $\overline{\theta} = \hat{\theta} > 0$. In particular, we analyse the influence of the deregulation shock on the following key variables: exchange rate, international relocation of firms, and relative consumptions of tradable and non-tradable goods. The closed-form solutions for the key variables are as follows:

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[3] Because of the symmetry of the model, a foreign deregulation shock is treated analogously, i.e., $d\psi > 0$, $d\theta = 0$.

[4] A large empirical literature (e.g., Cushman 1988; Caves 1989; Froot and Stein 1991; Campa 1993; Klein and Rosengren 1994; Blonigen 1997; Goldberg and Klein 1998; Baek and Okawa 2001; Bénassy-quéré et al 2001; Chakrabarti and Scholnick 2002; Bolling et al 2007; Udomkerdmongkol et al 2009) find support for the relationship between exchange rates and foreign direct investments.

$$\hat{\varepsilon} = -\frac{1}{\eta_1}\left\{\delta^{-1}\left(\frac{2\theta_2}{\theta-1}\right)(2+4\eta\theta_1+\sigma)^{-1}\overline{\theta}+\left(\frac{1-\gamma}{\theta}\right)\hat{\theta}\right\}<0\,, \tag{20}$$

$$\hat{n} = -\frac{2\eta\theta_1}{\eta_1}\left\{\delta^{-1}\left(\frac{2\theta_2}{\theta-1}\right)(2+4\eta\theta_1+\sigma)^{-1}\overline{\theta}+\left(\frac{1-\gamma}{\theta}\right)\hat{\theta}\right\}<0\,, \tag{21}$$

$$\hat{C}^N-\hat{C}^{N*}=\left(\frac{1}{\theta-1}\right)\hat{\theta}>0, \quad \overline{C}^N-\overline{C}^{N*}$$

$$=\frac{1}{\eta_1}\left[\frac{4\eta\theta_1+\sigma}{2+4\eta\theta_1+\sigma}\right]\left\{\delta^{-1}\left(\frac{2\theta_2}{\theta-1}\right)(2+4\eta\theta_1+\sigma)^{-1}\overline{\theta}+\left(\frac{1-\gamma}{\theta}\right)\hat{\theta}\right\}+\left[\frac{1+4\eta\theta_1+\sigma}{2+4\eta\theta_1+\sigma}\right](\theta-1)^{-1}\overline{\theta}>0\,, \tag{22}$$

$$\hat{C}^T-\hat{C}^{T*}=\overline{C}^T-\overline{C}^{T*}=\frac{1}{\eta_1}\left\{\delta^{-1}\left(\frac{2\theta_2}{\theta-1}\right)(2+4\eta\theta_1+\sigma)^{-1}\overline{\theta}+\left(\frac{1-\gamma}{\theta}\right)\hat{\theta}\right\}>0, \tag{23}$$

$$\eta_1=\delta^{-1}\left[1+2\theta_2\left(\frac{4\eta\theta_1+\sigma}{2+4\eta\theta_1+\sigma}\right)-\theta_2\right]+4\gamma\tilde{\sigma}\eta\theta_1+\gamma(\sigma-1)-\theta_2+1>0\,,$$

$$\theta_1=\gamma^{1/2}\tilde{\phi}^{1/2}\tilde{\sigma}^{3/2}\tilde{\kappa}^{1/2}\left(1+\tilde{\gamma}\tilde{\sigma}^{-1}\tilde{\theta}\right)^{-1/2}>0,\ \ \theta_2=\tilde{\sigma}\gamma\left(1+\tilde{\gamma}\tilde{\sigma}^{-1}\tilde{\theta}\right)<1,$$

where $\tilde{\gamma}=(1-\gamma)/\gamma$, $\tilde{\theta}=(\theta-1)/\theta$, $\tilde{\phi}=(\phi-1)/\phi$, and $\tilde{\sigma}=(\sigma-1)/\sigma$, $\tilde{\kappa}=1/\kappa$. Equation (20) indicates that an increase in the degree of competition in the home non-tradable goods sector ($\overline{\theta}=\hat{\theta}>0$) leads to appreciation of its currency ($\hat{\varepsilon}<0$). Equation (21) indicates that an increase in the degree of competition in the non-tradable goods sector leads to the relocation of some firms from the home to the foreign countries. Equations (22) show that the relative non-tradable consumption levels of the home country increase in the short-run and long-run when there is an increase in the degree of competition in the non-tradable goods sector. Equation (23) shows that the relative tradable consumption levels of the home country increase in short-run and long-run when there is an increase in the degree of competition in the non-tradable goods sector.

Equation (22) and (23) also show that an increase in the flexibility of relocation (the larger is η) weakens the effect of deregulation on relative home consumptions of tradable and non-tradable goods. Intuitively, as the relocation of firms becomes much more flexible (η increases), a greater relative decrease in labor income in the home country is achieved, because more tradable goods firms relocate to the foreign country, and therefore, the increase in the relative consumptions of tradable and non-tradable goods are smaller. Furthermore, equation (20) shows that the larger is the value of η, the smaller is the response of exchange rate to the deregulation shock.

4. Conclusion

The main findings of our analysis are as follows: i) a deregulation shock in the home country always increases tradable consumption as well as non-tradable consumption in the home country in the relative terms, ii) an increase in the degree of competition in the home country's non-tradable sector leads to an appreciation of the home currency, and iii) appreciation then decreases the relative real profits of firms located in the home country, and consequently, firms relocate to the foreign country.

Appendix

Symmetric Steady State

The solutions for a symmetric steady state are derived. In the steady state, all exogenous variables are constant, the initial net foreign assets are zero ($B_0 = 0$), and $\theta_0 = \psi_0$ and $s = s^* = 1/2$. The superscript i and the index j are omitted because households and firms make the same equilibrium choices within and between countries. Then, we denote the steady-state values by using the subscript ss. Because symmetry, which implies $C^T{}_{ss} = C^{T*}{}_{ss} = C^{Tw}{}_{ss}$ and $C^N{}_{ss} = C^{N*}{}_{ss}$ hold, the steady-state allocation of firms in the tradable sector is $n_{ss} = 1/2$. The steady state labor, output and consumption levels are as follows:

$$\ell^s{}_{ss} = \ell^{s*}{}_{ss} = ((\phi-1)/\phi)^{1/2}((\sigma-1)/\sigma)^{1/2}(\gamma/\kappa)^{1/2}[1+((\gamma-1)/\gamma)(\sigma/(\sigma-1))((\theta-1)/\theta)]^{1/2},$$

$$y_{ss}{}^T = y_{ss}{}^{T*} = C^T{}_{ss} = C^{T*}{}_{ss} = C^{Tw}{}_{ss}$$

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

$$y_{ss}{}^N = y_{ss}{}^{N*} = sC^N{}_{ss} = (1-s)C^{N*}{}_{ss}$$

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

The steady-state levels of real profit for home- and foreign-located firms in the tradable and non-tradable goods sectors are as follows:

$$\Pi_{ss}{}^T(h)/P_{ss}{}^T = \Pi_{ss}(f)^{T*}/P_{ss}{}^{T*}$$

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

$$\Pi^N{}_{ss}(h)/P_{ss}{}^T = \Pi^N{}_{ss}(f)^*/P_{ss}{}^{T*}$$

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

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