Capital Inflows, Dutch Disease Effects, and Monetary Policy in a Small Open Economy

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Abstract

This paper studies the role of monetary policy in a small open economy that experiences Dutch disease effects as a result of capital inflows, and examines the issue of whether such a policy should seek to address these effects from a welfare perspective. I find that Dutch disease effects occur under a fixed nominal exchange rate regime. However, a monetary policy regime characterized by generalized Taylor interest rate rules featuring either the real exchange rate or the nominal exchange rate avert Dutch disease effects. Welfare results reveal that the optimal rule is a generalized Taylor rule consistent with nominal exchange rate flexibility.

1. Introduction

The documented experiences of the largest recipients of capital inflows in Asia and Latin America include high investment and consumption, gross domestic product (GDP) growth, increased current account deficits, and real exchange rate appreciation. Capital inflows have therefore been both beneficial and problematic, and thus raised serious concerns among policymakers because of their potential effects on macroeconomic stability, the competitiveness of the export sector, and the external viability of the recipient countries. The most popular policy response to capital inflows in both Latin America and Asia was sterilization, with the aim to mitigate inflationary pressures and appreciation of the real exchange rate. One aspect of capital inflow dynamics that has received little attention in the literature is its potential to induce resource reallocation, which is symptomatic of the Dutch disease. In fact, there was an expansion in nontradable output as a share of GDP and a decline in the production of manufactured goods as a share of GDP in both Argentina and the Philippines during the peak inflow period of 1990–94, the changes being more pronounced in Argentina than in the Philippines. As the above stylized fact on monetary and exchange rate policy during episodes of capital inflow suggest, addressing the resource reallocation effect and the associated impact on the prices of nontradables were not a direct focus of policy objectives. More recent years have witnessed the integration of poor developing countries into the global economy accompanied by a surge in private capital inflows into these economies. This recent wave of private capital inflows could potentially lead to the realization of the Dutch disease in poor developing countries, and therefore exposes them to policy challenges similar to those that confronted middle-income countries in the 1990s with respect to reconciling international capital mobility and domestic macroeconomic stability.

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This paper examines the question of whether Dutch disease effects in the form of contracting manufacturing sector and rising nontradable prices, caused by capital inflows, should be addressed by monetary policy. I develop a two-sector small open economy model with sticky nontradable prices to analyze the effects of an increase in capital inflow on resource reallocation and real exchange rate movement under alternative monetary policy rules, and address the fundamental issue of whether monetary policy has any desirable properties in such an economy. A fixed exchange rate regime which captures the policy stance in Latin America and Asia during episodes of capital inflows serves as the benchmark rule against which other alternatives are compared in terms of model dynamics. The alternative policy rules are formulated such that the policymaker follows a generalized Taylor rule in which deviations of nontradable price inflation, GDP, and either nominal exchange rate depreciation or real exchange rate depreciation from the steady state feed back into the interest rate. These represent the scenario where the monetary authority is not only concerned with real appreciation via the nominal exchange rate but also increasing prices of nontradables. Theoretical analyses of Dutch disease effects of capital inflow in developing economies have largely been within a partial-equilibrium framework, and have mostly been based on the dependent economy model. There is a rather limited number of studies that have examined foreign capital dynamics in small open economies within a general-equilibrium framework, none of which has analyzed the link between capital inflows and Dutch disease effects. The existing contributions to this area of research have generally studied issues relating to real exchange rate fluctuations and current account dynamics and make no reference to the Dutch disease effects of capital inflows. Examples of such studies include Serven (1995) and Agenor (1998). This paper therefore contributes to the literature by examining Dutch disease effects of an increase in capital inflows to a small open economy, with a discussion on the role and welfare effects of monetary policy.

2. The Model

The model is characterized by a small open economy and the rest of the world represented as a foreign economy. The small open economy comprises three key agents: households, firms, and a monetary authority.

Households

The small open economy is populated by a continuum of households of measure unity. The representative household enters each time period \( t \) with holdings of domestic bonds \( B_t \) denominated in units of domestic currency, foreign bonds \( B_t^* \) denominated in units of foreign currency, and shares \( x_t \) of the domestic manufacturing sector firm purchased from the previous period. I assume home currency bonds are held only domestically and that foreign currency bonds which are traded internationally are associated with adjustment costs. The household earns returns on the shares and bonds, receives profits from the nontradable sector and earns labor income. The household has preferences over a real consumption index \( C \), labor effort supplied in a competitive market \( L \), and real money balances \( M/P \), where \( M \) represents nominal money holdings and \( P \) is the consumption-based price index. The household decides on home and foreign bonds and shares to take into next period, amount of domestic manufactured good and nontradable good to consume, and labor effort to supply across sectors. The household maximizes the intertemporal utility function.
\[ U = E_t \sum_{t=0}^{\infty} \beta^t \left[ \frac{1}{1-\sigma} C_t^{-\sigma} + \frac{\chi}{1-\phi} \left( \frac{M_t}{P_t} \right)^{-\phi} \right] - \psi \frac{L_t^{1+\nu}}{1+\nu}, \]

with \( \sigma, \zeta, \chi, \nu, \psi > 0. \)

The consumption index, a CES aggregate of the nontradable good \( C_N \) and the manufactured good \( C_T \) is given by \( C_i = [\gamma^{1/\theta} (C_{T_i})^{(\theta-1)/\theta} + (1 - \gamma)^{1/\theta} (C_{N_i})^{(\theta-1)/\theta}]^{\theta/(\theta-1)}, \) where \( \gamma \in [0, 1] \) is the share of manufactured goods in total consumption, and \( \theta > 0 \) is the intratemporal elasticity of substitution between manufactured and nontradable goods. I assume the consumption of nontradable goods is differentiated, and the consumption sub-index that aggregates individual nontradable goods is: \( C_N = \left( \int_0^1 C_N(i)^{1-\theta}di \right)^{\theta/(\theta-1)}, \) with \( \theta > 1 \) being the elasticity of substitution between individual nontradable goods. The consumer price index is \( P_t = \left[ \gamma(P_{T,t})^{1-\theta} + (1 - \gamma)(P_{N,t})^{1-\theta} \right]^{1/(1-\theta)}, \) where \( P_N = (\int_0^1 P_N(i)^{1-\theta}di)^{1/(1-\theta)} \) is the price sub-index for the nontradable sector, and \( P_T \) is the price of the manufactured good, all expressed in units of the domestic currency. The household’s budget constraint expressed in units of domestic currency is

\[
B_{t+1} + \varepsilon_t B_{t+1}^* = \frac{k}{2} (\varepsilon_t B_{t+1}^*)^2 + P_t C_t + V_t x_{t+1} + M_t + (1 + i_t)B_t + \varepsilon_t (1 + i_t^*)B_{t+1}^* + (V_t + D_t)x_t + W_t L_t + M_{t-1} + \tau_t + P\tau_t + \Pi_t,
\]

(\( k/2 \)) \( B_{t+1}^* \)^2 is a cost of adjusting foreign bond holdings relative to zero, introduced to ensure steady-state determinacy and model stationarity in response to temporary shocks, as in Turnovsky (1985). This cost can be thought of as financial intermediation costs, where the financial intermediaries are local perfectly competitive firms owned by domestic households. \( \tau_t \) is the rebate of financial intermediation fees to the household, taken as given in utility maximization, \( V_t \) is the period \( t \) price of a claim to the manufacturing firm’s entire future profit, \( D_t \) is period \( t \) dividends issued by the manufacturing sector firm, and \( i_t \) and \( i_t^* \) are the nominal interest rates on bonds denominated in home and foreign currencies, respectively, between \( t-1 \) and \( t \). \( M_{t-1} \) denotes holdings of nominal money balances entering period \( t \), and \( T_t \) is a lump-sum net real transfer. The monetary authority issues nominal money balances and rebates its seigniorage to the household, so that, in equilibrium, \( P\tau_t = M_t - M_{t-1} \). \( W_t \) is the nominal wage, \( \varepsilon_t \) is the nominal exchange rate, and \( \Pi_t \) represents profits from the nontradable sector.

The household chooses nontradable and manufactured goods to minimize expenditure conditional on consuming one unit of the consumption index. Optimal allocation of expenditure between the two goods yields standard isoelastic demands:

\[ C_{T,t} = \gamma \left( \frac{P_{T,t}}{P_t} \right)^{-\theta} C_t \quad \text{and} \quad C_{N,t} = (1 - \gamma) \left( \frac{P_{N,t}}{P_t} \right)^{-\theta} C_t. \]

The household maximizes the utility function subject to the budget constraint. The optimality conditions for domestic bonds, foreign bonds, shares, and labor supply, respectively, are as follows:

\[ C_t^{-\sigma} = \beta E_t \left[ C_{t+1}^{-\sigma}(1 + i_{t+1}) \left( \frac{P_t}{P_{t+1}} \right) \right], \]

(2)

\[ C_t^{-\sigma} \left[ \varepsilon_t + \kappa \left( \frac{\varepsilon_t B_{t+1}^*}{P_t} \right) \right] = \beta E_t \left[ C_{t+1}^{-\sigma} \left( \frac{1 + i_{t+1}^*}{P_{t+1}} \right) \right]. \]

(3)
\[ C^{-\sigma}_t V_t = \beta E_t \left[ C^{-\sigma}_{t+1}(V_{t+1} + D_{t+1}) \frac{P_{t+1}^i}{P_{t+1}} \right], \]  

(4)

\[ C^{-\sigma}_t \frac{W_t}{P_t} = \psi L_t^\iota. \]  

(5)

Equation (2) in conjunction with (3) yields uncovered interest parity;

\[
E_t \left[ C^{-\sigma}_{t+1} \left( \frac{P_{t+1}^i}{P_{t+1}} \right) \left( 1 + i_{t+1}^* - \frac{(1 + i_{t+1}^*) \left( \varepsilon_{t+1} \right)}{\varepsilon_t} \right) \right] = 0,
\]

where \( i^* \) is the foreign interest rate which is exogenously given and assumed to follow the AR(1) process: \( 1 + \eta_i = (1 + i^*)^\eta_\iota \exp \{ \varepsilon_{t+1} \}, 0 < \eta_i < 1; \varepsilon_{t+1} \sim N(0, \sigma_{t+1}). \) The consumption-based real interest rate \( r \), is defined by the Fisher parity condition:

\[ 1 + r_{t+1} = \frac{(1 + i_{t+1}^*)}{1 + \pi_{t+1}}, \]

where \( \pi_{t+1} \) is CPI inflation.\(^7\)

**Firms**

Production occurs in two sectors; a manufacturing sector and a nontradable sector.\(^8\) The manufacturing sector can be thought of as consisting of two units: an investment unit and a production unit. The investment unit solves a cost-minimization problem to determine demands for domestic and foreign investment inputs used in the production of new investment \( I \), which is required to maintain and augment the capital stock. The capital stock changes according to \( K_{t+1} = I_t + (1 - \delta)K_t \), where \( \delta \) is the depreciation rate. The adjustment cost of capital measured in terms of the manufactured good is given by \( \phi(2)([I_t/K_t] - \delta)^2K_t \), where \( \phi \) governs the size of the adjustment cost. The adjustment cost is applicable to net investment \( I_t^\iota \), which is defined as \( I_t^\iota = K_{t+1} - K_t = I_t - \delta K_t \). I assume that capital is used in the manufacturing sector only, hence the nontradable good is produced using a single input in labor. Labor is internationally immobile but can migrate instantaneously between sectors within the economy. This ensures the household faces the same nominal wage (\( W \)) in each sector. The total domestic labor supply is \( L = L_d + L_n \), where \( L_d \) is labor devoted to the manufacturing sector and \( L_n \) denotes labor in the nontradable sector. I assume a unit of manufactured good can be costlessly transformed into a unit of home investment. The manufactured good is either consumed, used for investment or exported, whereas the nontradable good is used for consumption purposes only.

The modeling innovation here involves a specification under which an investment unit combines home and foreign investment inputs to produce investment, where the price of foreign investment is considered exogenous and is represented as a stochastic process. In effect, capital inflow is captured by an increase in foreign investment in response to a negative shock to the price of foreign investment.\(^9\)

**Manufacturing sector** Investment Unit: I assume that the investment unit uses a constant-returns-to-scale technology that combines home investment \( (I_{Ht}) \) and foreign
investment \( (I_F) \) to produce investment \( (I) \) required to maintain and accumulate capital.\(^{10}\) The equation describing the technology is

\[
I_t = \left[ \mu^{1/\rho} (I_{Ht})^{(\rho - 1)/\rho} + (1 - \mu) \right]^{1/(1 - \rho)},
\]

where \( \rho > 0 \), and \( 0 < \mu \leq 1 \). \( \mu \) is the share of investment expenditure on home investment, and \( \rho \) is the elasticity of substitution between home and foreign investment. Associated with this investment technology is a mini-

imized unit-cost function denoted \( P_P \), the replacement cost of capital expressed as

\[
P_{t,t} = \left[ \mu (P_{T,t})^{1-\rho} + (1 - \mu) (P_{F,t})^{1-\rho} \right]^{1/(1 - \rho)},
\]

where \( P_{F,t} \) is the price of foreign investment in units of domestic currency and \( P_{F,t} \) is the price of foreign investment in units of domestic currency. I assume the law of one price holds so that \( P_{F,t} = \varepsilon_t P_{F,t} \), where \( P_{F,t} \) is the foreign currency price of foreign investment, which is exogenous and follows the stochastic process: \( P_{F,t+1} = \left( P_{F,t} \right)^{\eta_{pf}} \exp \{ \varepsilon_{pf,t+1} \} \), \( 0 < \eta_{pf} < 1 \); \( \varepsilon_{pf} \sim N(0, \sigma_{pf}) \).

For any given rate of investment, the unit’s minimization problem is as follows:

\[
\min_{\{I_H, I_F\}} P_{T,t} I_{H,t} + P_{T,t} I_{F,t} \quad \text{s.t.} \quad \left[ \mu^{\rho}(I_{H,t})^{1 - \rho} + (1 - \mu) P_{F,t}^{\rho - 1} \right]^{1/(1 - \rho)} = I_t.
\]

The optimization yields demands for foreign and home investment, respectively, as

\[
I_{F,t} = (1 - \mu) \left( \frac{P_{F,t}}{P_{T,t}} \right)^{-\rho} I_t,
\]

\[
I_{H,t} = \mu \left( \frac{P_{T,t}}{P_{F,t}} \right)^{-\rho} I_t.
\]

**Production Unit:** The production unit produces a manufactured good \( (Y_T) \) according to the following constant-returns-to-scale technology:

\[
Y_{T,t} = \exp \{ a_t \} K_t^{1 - \alpha_t}, \quad 0 < \alpha_t < 1,
\]

where \( a_t \) is a sector-specific productivity shock which follows an AR(1) process given by \( a_{t+1} = \eta_{a} a_t + \varepsilon_{a,t+1} \), \( 0 < \eta_{a} < 1 \); \( \varepsilon_{a} \sim N(0, \sigma_{a}) \). The unit maximizes the present discounted value of dividends:

\[
E_t \sum_{s=t}^{\infty} \Lambda^{-s} \left[ P_{T,t} Y_{T,s} - W_t L_{T,s} \left( I_s + \frac{\phi}{2} \left( I_s - \delta \right)^2 K_s \right) \right],
\]

subject to \( K_{t+1} = I_t + (1 - \delta) K_t \). The set of efficiency conditions for the choice variables \( K_{t+1}, I_t \), and \( L_{T,t} \), respectively, are

\[
E_t \Lambda_{t+1} \left( \alpha P_{T,t+1} \frac{Y_{T,t+1}}{K_{t+1}} - P_{t,t+1} \left[ \frac{\phi}{2} \left( I_{t+1} - \delta \right)^2 - \phi \left( I_{t+1} - \delta \right) I_{t+1} \right] \right)
\]

\[
+ Q_{t+1}(1 - \delta) = Q_t,
\]

\[
P_{t,t} \left( 1 + \phi \left( I_t - \delta \right) \right) = Q_t,
\]

\[
(1 - \alpha) \frac{Y_{T,t}}{L_{T,t}} = \frac{W_t}{P_{T,t}}.
\]
Equation (8) is an investment Euler equation which describes the evolution of \( Q_t \), and equation (9) determines the investment rate as a function of Tobin’s \( q \), which in this case is \( Q_t/P_{t,t} \), i.e. the ratio of the shadow price of capital to the price of investment. I assume that in steady state there are no adjustment costs, so that \( Q_t/P_{t,t} = 1 \) and \( \delta = I/K \). Using the definition of net investment, equation (9) can be rewritten as

\[
\frac{I_t^*}{K_t} = \frac{1}{\phi} \left( \frac{Q_t}{P_{t,t}} - 1 \right),
\]

which shows that there is no change in the capital stock when the shadow value of a unit of capital (\( Q_t \)) equals its replacement cost, i.e. the price of new uninstalled capital (\( P_{t,t} \)).

Equation (10) describes demand for labor.

**Nontradable sector** I assume there is a continuum of monopolistically competitive firms of measure unity in this sector, each producing output with the production function \( Y_{N,t}(i) = \exp[z_t]L_{N,t}(i) \), where \( z_t \) is a stochastic productivity parameter for the nontradable sector following the \( AR(1) \) process: \( z_{t+1} = \eta_t z_t + \epsilon_{t+1} \), \( 0 < \eta_t < 1; \epsilon_t \sim N(0, \sigma_z) \). Firms demand labor in a perfectly competitive fashion, taking the wage and level of output as given. The static efficiency condition for labor demand is:

\[
mc = \frac{Y_{N,t}(i)}{L_{N,t}(i)} = \frac{W_t}{P_{N,t}},
\]

(11)

where \( mc = MC/P_N \) is the real marginal cost, the inverse of which is the markup, which is common across firms.

**Price Setting:** Firms in the nontradable sector are allowed to set prices according to a stochastic time-dependent rule as in Calvo (1983) and Yun (1996). In each period a firm faces a constant probability \((1 - \varphi)\) of changing its price independent of past history. Letting \( \varphi \) be the probability that the price set at time \( t \) still holds at time \( t + k \), a firm that has the opportunity to reset its price will choose \( P_{N,t}(i) \) to maximize

\[
E_t \sum_{k=0}^{\infty} (\beta \varphi)^k \Lambda_{t+k} Y_{N,t+k}(i) MC_{t+k} Y_{N,t+k}(i) \]

subject to \( Y_{N,t+k}(i) \leq (P_{N,t}(i)/P_{N,t})^{\delta} C_{N,t+k} \), where \( \Lambda_{t+k} \) is the marginal utility-based discount factor. The optimal pricing condition is:

\[
\tilde{P}_{N,t}(i) = \frac{\varphi}{1 - \varphi} \sum_{k=0}^{\infty} \beta^k \varphi^k \Lambda_{t+k} Y_{N,t+k}(i) MC_{t+k} Y_{N,t+k}(i),
\]

(12)

where \( \tilde{P}_{N,t}(i) \) represents the newly set price for a firm that adjusts its price in period \( t \). Equation (12) is a dynamic markup equation by which nontradable good firms forecast future demand and marginal costs in setting the price. Standard aggregation results imply that the price of the nontradable good evolves according to the rule

\[
P_{N,t} = \left[ \varphi P_{N,t-1}^{1-\varphi} + (1 - \varphi) \tilde{P}_{N,t}^{1-\varphi} \right]^{1/\beta}.
\]

(13)

A combination of the log-linearized versions of (12) and (13) yields the familiar forward-looking Phillips curve:

\[
\hat{\pi}_{N,t} = \beta E_t \hat{\pi}_{N,t+1} + \frac{(1 - \varphi)(1 - \beta \varphi)}{\varphi} \hat{mc}_t,
\]

(14)
where \( \hat{mc} \) represents the log deviation of real marginal cost from its steady-state level. Equation (14) is analogous to the standard forward-looking equation in dynamic neo-Keynesian models except that in this case both marginal cost and inflation are specific to the nontradable sector.

**The Foreign Economy**

I assume the foreign economy produces a tradable good \((Y^F_t)\) and nontradable good \((Y^N_t)\), with prices \(P^F_t\) and \(P^N_t\), respectively, in units of foreign currency. The small open economy takes these variables as exogenously given. Furthermore, given that the home economy exports part of its tradable output, I assume demand for exports is given by \(X_t = e_t^* GDP^*_F\); \( \omega > 0 \), where \(X_t\) is units of manufactured good exported, \(e_t\) is the real exchange rate, and \(GDP^*_F\) is aggregate output in the foreign economy.

**Terms of Trade, Real Exchange Rate, and Current Account**

The terms of trade, \(S_{PT}^t = P^T_t/P^F_t\), is defined as the price of imports relative to the price of exports, and the real exchange rate, \(e_t = \varepsilon_t P^*_F/ P_t\), is defined as the ratio of the price of foreign consumption basket to the domestic one, where \(P^*_F\) is the foreign consumer price index in units of foreign currency, and is assumed to be a composite of tradable and nontradable prices.\(^{12}\) The current account equation for the domestic economy is given by \(CA_t = e_t^* B_t^* + P^*_F X_t - P^F_t I_{t,F}^t\).

**Monetary Policy Rules**

I examine the dynamics of the model under three alternative monetary policy regimes. The monetary authority uses the nominal interest rate as the policy instrument. The benchmark rule labeled “FER rule” delivers a fixed exchange rate regime and is given by

\[
(1 + i_{t+1}) = \left( 1 + i^*_t \right) \left( \frac{\varepsilon_t}{\bar{\varepsilon}} \right)^{\omega_\varepsilon},
\]

where \(\omega_\varepsilon > 0\), and \(\varepsilon_t = \bar{\varepsilon}\) for all \(t\). Under this policy rule, the monetary authority pegs the nominal exchange rate at a target level \(\bar{\varepsilon}\) in all periods by varying the nominal interest rate in reaction to movements in the foreign interest rate and deviation of the nominal exchange rate from the target, taking into account the adjustment cost of foreign bonds.\(^{13}\) The alternative policy rules are formulated so that the policymaker follows a generalized Taylor rule in which deviations of nontradables inflation, GDP, nominal exchange rate depreciation, and real exchange rate depreciation from their respective steady-state levels feed back on the interest rate.\(^{14}\) The general form of the equation describing the policy rules is:

\[
(1 + i_{t+1}) = (1 + r^{ss})(1 + \pi^N_{t,F})^{\omega_{N,F}} \left( \frac{gdp_t}{gdp^{ss}} \right)^{\omega_{gdp}} \left( \frac{\varepsilon_t}{\varepsilon_{t-1}} \right)^{\omega_\varepsilon} \left( \frac{e_t}{e_{t-1}} \right)^{\omega_e},
\]

where \(\omega_{N,F} > 1\), \(\omega_{gdp} > 0\), \(\omega_\varepsilon \geq 0\), and \(\omega_e \geq 0\), are the reaction coefficients on nontradable good price inflation, GDP, nominal exchange rate depreciation, and real exchange rate depreciation, respectively.
depreciation, respectively, and $\rho^*$ and $gdp^*$ are the steady-state real interest rate and GDP, respectively. The first alternative rule, “NER rule,” is given by equation (16) with $\omega_e = 0$, and the second alternative, the “RER rule,” is given by the same equation with $\omega_e = 0$.

3. Solution and Calibration

I obtain a numerical solution for the model by taking log-linear approximations of the equilibrium conditions and employing the method of undetermined coefficients. I calibrate the model at quarterly frequency with the following choices of parameter values that are roughly consistent with features of the economic environment of a representative developing economy. The parameter values are given in Table 1. In accordance with the real business cycle (RBC) literature, I set the household discount factor $\beta = 0.99$, so that the annual real interest rate is 4%. The share of capital in manufactured good production is $\alpha = 0.33$, which is also standard in the small open economy literature. The depreciation rate $\delta$, is set to 0.05 and the inverse of elasticity of labor supply, $\nu = 0.83$, following Kose and Riezman (1999). In line with the literature on the stationarity properties of small open economy models, I set $\kappa$, the rate at which the marginal adjustment cost of bond holdings changes, to 0.01. The elasticity of substitution between tradable and nontradable consumption is set to 1.4, an estimate for developing countries in Ostry and Reinhart (1992). The parameter associated with the disutility of labor supply $\psi$, is set to 1, the share of manufactured good in the consumption basket is set to $\gamma = 0.45$, the inverse of the intertemporal elasticity of substitution in consumption $\sigma = 2$, and the parameter associated with the adjustment cost of capital, $\phi = 3$, all following Devereux et al. (2006). I follow the standard in the literature on Calvo-style pricing behavior, and set the probability of price non-adjustment $\theta = 0.75$, which implies on average price adjustment occurs every four quarters. I set the share of home investment in the production of investment, $\mu = 0.5$, and the elasticity of substitution between home and foreign investment $\rho = 1.5$. For the monetary policy

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
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<tbody>
<tr>
<td>$\beta$</td>
<td>0.99</td>
<td>Household’s discount factor</td>
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<tr>
<td>$\gamma$</td>
<td>0.45</td>
<td>Share of manufactured good</td>
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<tr>
<td>$\kappa$</td>
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<td>Coefficient on adjustment cost for bond holding</td>
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<tr>
<td>$\psi$</td>
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<td>Coefficient on labor in utility</td>
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<tr>
<td>$\rho$</td>
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<td>Elasticity of substitution between home and foreign investment</td>
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<tr>
<td>$\nu$</td>
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<td>Inverse of elasticity of labor supply</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.33</td>
<td>Share of capital in manufacturing sector</td>
</tr>
<tr>
<td>$\phi$</td>
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<td>Capital adjustment cost parameter</td>
</tr>
<tr>
<td>$\mu$</td>
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<td>Share of home investment</td>
</tr>
<tr>
<td>$\delta$</td>
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<td>Rate of capital depreciation</td>
</tr>
<tr>
<td>$\sigma$</td>
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<td>Inverse of elasticity of substitution in consumption</td>
</tr>
<tr>
<td>$\phi$</td>
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<td>Probability of price non-adjustment</td>
</tr>
<tr>
<td>$\theta$</td>
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<td>Elasticity of substitution between tradable and nontradable good</td>
</tr>
<tr>
<td>$\sigma_{pf}$</td>
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<td>Standard deviation of foreign price shock</td>
</tr>
<tr>
<td>$\sigma_{f}$</td>
<td>0.0032</td>
<td>Standard deviation of foreign interest rate shock</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>0.007</td>
<td>Standard deviation of innovation (Manufacturing)</td>
</tr>
<tr>
<td>$\sigma_z$</td>
<td>0.0035</td>
<td>Standard deviation of innovation (Nontradable)</td>
</tr>
</tbody>
</table>
parameters, I set $\omega_{V_s} = 1.5$ and $\omega_{p} = 0.5$ as in the familiar Taylor rule. I set $\omega_k = 0.45$ when monetary policy is described by the RER rule and $\omega_k = 0$ otherwise. For the NER rule, $\omega_k$ is set to 0.2, and equal to 0 otherwise. With respect to the standard deviations of innovations, I assume that of the manufacturing sector, $\sigma_e = 0.007$, and for the nontradable sector, $\sigma_e = 0.0035$, following the RBC literature. I also assume the standard deviation of innovation to the foreign interest rate and price of foreign investment to be $\sigma_i = 0.0032$ and $\sigma_{pf} = 0.005$, respectively. The degree of persistence for all exogenous stochastic processes is set to 0.95.

4. Model Dynamics

I analyze impulse responses of selected variables to a 1% negative shock to the price of foreign investment. First, I highlight the transmission mechanism following an increase in capital inflow in response to the shock within a flexible price setting and then follow up with analysis of the dynamics within the set-up with nominal rigidity under different monetary policy rule specifications. The objective is to draw implications of the model with respect to the Dutch disease, with a focus on the behavior key variables. Figure 1 shows impulse response functions of selected variables under flexible prices and the FER rule, Figure 2 compares impulse responses under the NER rule and FER rule, and

Figure 1. Impulse Response Functions—Flexible Prices (squares), FER (circles)
Flexible Price Setting

Figure 1 compares impulse response functions from a flexible price setting with those from a sticky-price setting under the FER rule. In a flexible price setting with no role for monetary policy, an increase in foreign capital into the manufacturing sector in response to a decrease in the price of foreign investment leads to an increase in the capital stock which causes an increase in demand for labor in that sector. The marginal product and hence the real wage go up, drawing labor resources into the manufacturing sector (resource movement effect). This results in further adjustments in the economy as higher incomes from the booming manufacturing sector leads to increased demand for nontradable goods, raising nontradable good prices (spending effect), which implies a real exchange rate appreciation. The higher demand for nontradable goods causes a further reallocation of resources towards expanding nontradable output. Thus manufacturing sector labor declines whilst nontradable sector labor rises.
Sticky Price Set-Up under Alternative Policy Rules

As Figure 1 shows, in a sticky price set-up with monetary policy designed to follow the FER rule, a fall in the price of foreign investment causes a decline in the unit cost of investment and an increase in the foreign component of investment. The capital stock declines in response to the shock, however. This is because although the unit cost of investment falls, the shadow value of capital decreases as well and by a greater percentage implying a decline in investment. The greater decline in the shadow value of capital is accounted for by the fact that the expected marginal return on investment, which also depends on the expected discounted marginal revenue product of capital and the future value of capital, declines on impact of the shock. The fall in investment results in a decline in the capital stock and consequently a contraction in output of manufactures. Although there is a decline in the output of manufactures, the decline in the cost of investment generates an increase in dividends which goes to finance an increase in consumption of both manufactures and nontradables. The greater increase in nontradables consumption increases demand for nontradable sector labor while manufacturing sector labor falls. The increase in demand for nontradable labor results in a rise in real marginal cost, which implies rising nontradable price inflation. The real exchange rate thus appreciates because of the increase in nontradable price inflation.

Figure 3. Impulse Response Functions—NER (squares), RER (circles)
As Figure 2 depicts, under the NER rule, the shock induces an increase in foreign investment as well as gross investment. Investment increases because the ratio of the shadow value of capital to the unit cost of investment increases. The capital stock rises as a result, leading to an expansion in the output of manufactures. Consumption of both manufactures and nontradables decline as investment increases upon impact of the shock. Consumption of both goods recovers in the following period but the recovery in nontradables consumption is contained such that it remains below the steady-state level. The manufacturing sector therefore does not lose labor units to the nontradable sector. Nontradable price inflation also falls initially as a result and rises thereafter. The real exchange rate depreciates in the period of the impact partly because of the decline in nontradable price inflation. The real exchange rate, however, reverts towards the steady-state level as the nontradable price inflation increases and the nominal exchange rate appreciates. Figure 3 shows that when monetary policy is given by the RER rule, the dynamics are essentially the same as under the NER rule.

The results suggest that an increase in foreign capital induces Dutch disease effects under the FER rule but not when monetary policy follows the NER rule or the RER rule. Under the FER rule, the shock leads to a decline in investment such that an increase in foreign investment does not translate into an increase in the capital stock. However, there is an increase in nontradables consumption which leads to positive nontradable good price inflation and real exchange rate appreciation. Thus both resource movement effect and spending effect are observed. Under the NER and RER rules, there is no resource movement effect since the nontradable sector does not attract manufacturing sector labor units. This is explained by the observation that the recovery in nontradables consumption after an initial decline in response to the shock never exceeds the steady-state level which ensures nontradable sector inflation remains below or at the steady-state level.

The Role of Nontradable Price Rigidity and Monetary Policy

The introduction of price rigidity and monetary policy alters the dynamics realized in a flexible price setting. The pricing behavior ensures that not all nontradable good firms are able to adjust prices in each period, therefore positive inflation would occur only if the firms adjusting prices choose prices that on average exceed the aggregate price level in the previous period. Moreover, monetary policy as given by the NER and the RER rules are such that any increases in the nontradable price inflation feed back into the interest rate which in turn has implications for consumption and investment decisions. A Taylor-type policy rule that targets the exchange rate limits the extent to which nontradable good prices rise, thereby effectively controlling demand for nontradables. This eliminates the spending effect and prevents the loss of labor by the manufacturing sector to the nontradable sector observed in a flexible price setting.

5. A Quantitative Assessment of the Model

I assess the quantitative performance of the model by drawing comparisons with quantitative features of the business cycle in two emerging market economies that were recipients of foreign capital in the early 1990s. Since emerging market economies generally resorted to fixed nominal exchange rate regimes in the face of capital inflows, I use the properties of the model under the FER rule for this purpose. I focus on the model’s prediction with respect to the volatility of key macroeconomic variables and
the contemporaneous correlation of each of the variables with aggregate output (GDP). Table 2 shows business cycle statistics for Argentina and the Philippines, and theoretical moments from the model.

Table 2. Standard Deviations and Relative Standard Deviations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Argentina</th>
<th>Philippines</th>
<th>FER</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>0.04</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Consumption</td>
<td>0.05</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Investment</td>
<td>0.09</td>
<td>0.08</td>
<td>0.01</td>
</tr>
<tr>
<td>Consumption/GDP</td>
<td>1.38</td>
<td>0.88</td>
<td>0.84</td>
</tr>
<tr>
<td>Investment/GDP</td>
<td>2.53</td>
<td>6.29</td>
<td>0.58</td>
</tr>
<tr>
<td>Real Exchange Rate</td>
<td>0.21</td>
<td>0.06</td>
<td>0.15</td>
</tr>
<tr>
<td>Manufactures</td>
<td>0.59</td>
<td>0.29</td>
<td>0.03</td>
</tr>
<tr>
<td>Current Account</td>
<td>1.04</td>
<td>7.84</td>
<td>4.45</td>
</tr>
</tbody>
</table>

Contemporaneous Correlation with GDP

<table>
<thead>
<tr>
<th></th>
<th>Argentina</th>
<th>Philippines</th>
<th>FER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption</td>
<td>0.90</td>
<td>0.55</td>
<td>0.86</td>
</tr>
<tr>
<td>Investment</td>
<td>0.96</td>
<td>0.62</td>
<td>0.80</td>
</tr>
<tr>
<td>Manufactures</td>
<td>0.66</td>
<td>0.78</td>
<td>0.62</td>
</tr>
<tr>
<td>Real Exchange Rate</td>
<td>-0.40</td>
<td>0.60</td>
<td>0.39</td>
</tr>
<tr>
<td>Current Account</td>
<td>-0.78</td>
<td>-0.50</td>
<td>-0.20</td>
</tr>
</tbody>
</table>

Notes: Sample moments for Argentina and the Philippines are calculated using data with a sample length from 1993Q1 to 2003Q1. The data come from combined sources, i.e. IFS online, website of Ministry of Economy and Production-Argentina, and data used by Aguiar and Gopinath (2007). All series are logged (except current account) and filtered using an HP filter with a smoothing parameter of 1600. Theoretical moments are also HP-filtered and are calculated based on parameter values reported in Table 1.

The table shows the standard deviations for consumption, investment, GDP, real exchange rate, manufactures production, current account, and the relative standard deviations of consumption to GDP, and investment to GDP. The model matches the observed volatility in consumption and GDP in the Philippines, which turns out to be lower but not very different from the volatility in these two variables in Argentina. It underpredicts the volatility in investment and manufactures production vis-à-vis the observed volatility in the two emerging market economies. The predicted volatility of the current account is greater than observed in Argentina but lower than observed in the Philippines, and is about equal to the mean volatility for the two countries. The same is true for volatility of the real exchange rate; the model’s predicted value being lower than Argentina’s and higher than in the Philippines but approximately equal to the average volatility for the two countries. In terms of the relative standard deviations, the model predicts a volatility of consumption relative to GDP less than the observed volatility in Argentina, but close to that in the Philippines. However, it predicts a smaller volatility of investment relative to GDP than observed in both economies.

The table also presents the contemporaneous correlation of each variable with aggregate output. The model does well in matching the consumption–GDP correlation, producing a coefficient that lies between the observed values for Argentina and the Philippines. The same holds for the investment–GDP correlation, with the correlation coefficient being equal to the average value for the two countries. The real exchange rate–GDP correlation produced by the model is smaller but bears the same positive sign as in the Philippines. The observed coefficient for Argentina is negative. The predicted correlation coefficient between the current account and GDP bears the correct sign.
but is lower than the estimates for the two countries. The model also underpredicts the correlation between manufactures production and GDP observed in the reference economies. Generally, the model does quite well quantitatively, producing moments that are roughly consistent with empirically observed counterparts in Argentina and the Philippines.

6. Welfare Analysis

The dynamics of the model show that, under sticky nontradable prices, a nominal exchange rate peg is crucial to the occurrence of the Dutch disease, hence such a policy rule may be a bad choice for an economy that seeks to avoid that. Similarly, mimicking flexible prices would not be good either in that respect. However, the question still remains as to whether it is desirable for monetary policy to mitigate or prevent Dutch disease effects. I investigate this issue by analyzing the welfare consequences of the dynamics generated by capital inflow under different monetary policy rules in terms of the utility of the representative household. I compare the welfare effects of an optimal generalized Taylor rule to that under a fixed nominal exchange rate rule and a rule that mimics flexible prices. The welfare criterion used is the expectation of the second-order Taylor expansion of the household’s utility function around the steady state given by

$$W_t = \frac{C_t^{1-\sigma}}{1-\sigma} \left[ \psi \frac{L_t^{1+\nu}}{1+\nu} + \overline{C}^{1-\sigma} E(\hat{C}_t) - \psi \overline{L}^{1+\nu} E(\hat{L}_t) - \frac{\sigma}{2} \overline{C}^{1-\sigma} E(\hat{C}_t^2) - \frac{\psi \sigma}{2} \overline{L}^{1+\nu} E(\hat{L}_t^2) \right],$$

where $\overline{C}$ and $\overline{L}$ are steady-state values of consumption and labor, respectively, and variables with a “hat” notation denote percentage deviations from the steady state.

For the optimal rule, I assume the monetary authority chooses the reaction coefficients in the policy rule to maximize the welfare function, and that it can commit to such rules. I allow for a more general specification of the interest rate rule for this class of rules given by

$$1 + i_{t+1} = (1 + i_t)^{\omega_i} (1 + r^{\ast}) (1 + \pi_{N,t})^{\omega_{\pi_N}} \left[ \frac{gdp_t}{gdp^{\ast}} \right]^{\omega_{gdp}} \left( \frac{\epsilon_t}{\epsilon_{t-1}} \right)^{\omega_{\epsilon}} \left( \frac{\epsilon_t}{\epsilon_{t-1}} \right)^{\omega_{\epsilon}},$$

where $\omega_i \geq 0$ is the degree of interest rate smoothing; all other variables are as previously defined.

The optimal reaction parameters are as follows: $\omega_i = 0.75$, $\omega_{\pi_N} = 2.8282$, $\omega_{gdp} = 0$, $\omega_{\epsilon} = 0$, $\omega_{\epsilon} = 0.05$. Thus, the optimal generalized Taylor rule is characterized by a strong reaction to nontradable inflation, a significant degree of interest rate smoothing, and nominal exchange rate flexibility. I evaluate the welfare criterion under this rule and obtain a value of $-1.9714$. The welfare losses under the FER rule and under a policy rule that mimics flexible prices are $-2.95$ and $-2.30$, respectively. The dominant policy rule therefore is an optimal generalized Taylor rule. Figure 4 shows impulse response functions illustrating the dynamics under the optimal rule. In essence, with the choice of the optimal reaction coefficients, the policymaker prevents Dutch disease effects by containing the recovery in nontradables consumption after the initial decline, ensuring there is no reallocation of labor resources away from the manufacturing sector. The results suggest that, under the optimal rule, the monetary authority makes the household better off by allowing the nominal exchange rate to respond to movements in international prices following exogenous shocks. Intuitively, consumption and employment do not respond optimally to exogenous shocks in the presence of price rigidities. Movements in the nominal exchange rate are therefore necessary to induce
optimal movements in international relative prices. In turn, this results in responses of the household’s consumption and labor supply that deliver higher welfare than under the FER rule. It should be noted, however, that these responses do not coincide with those under flexible prices, as welfare is higher under the optimal rule than under flexible prices. Thus by being less aggressive in responding to nontradables inflation relative to the rule that mimics flexible prices, the monetary authority allows the household to choose combinations of nontradables and manufactures that ensure minimal variability in the consumption index, thereby improving welfare.

7. Conclusions

This paper examines the effects of an increase in capital inflow with respect to intersectoral resource reallocation and real exchange rate movement under alternative monetary policy rules. I also analyze welfare effects of the different monetary policy rules during an episode of capital inflow to ascertain the desirability of preventing Dutch disease effects. The results show that an increase in capital inflow induces Dutch disease effects when monetary policy is designed to keep the nominal exchange rate fixed. On the other hand, when monetary policy follows a Taylor-type interest rate rule,
where the nominal interest rate reacts to movements in either the nominal exchange rate depreciation or the real exchange rate depreciation in addition to deviations of nontradable price inflation and aggregate output from the steady-state level, neither a contraction of the manufacturing sector nor an expansion of the nontradable sector is observed, hence no Dutch disease effects occur under these rules.

Welfare results reveal that a generalized Taylor rule, under which the reaction coefficients are optimally chosen by the policymaker to maximize welfare of the household, outperforms a fixed nominal exchange rate regime and a policy rule that mimics flexible prices. Dutch disease effects do not occur under this rule, and therefore the results suggest that addressing Dutch disease effects via such a rule in a representative economy is desirable.

Appendix

Figure A1. Argentina

Figure A2. Philippines

Notes: Figures A1 and A2 are based on data from World Development Indicators 2002. Manufacturing is as defined in the database; Nontradables represent services as defined in the database.
References


Notes

1. The recipients include Argentina, Brazil, Chile, Colombia, Indonesia, Malaysia, Mexico, Philippines, and Thailand.


3. The term “Dutch disease” was originally used to describe the difficulties faced by manufacturing in the Netherlands following the development of natural gas on a large enough scale to trigger a major appreciation of the real exchange rate. It has since been used to refer to any situation in which a natural resource boom, or large foreign aid or capital inflows, cause real appreciation that jeopardizes the prospects of manufacturing (Williamson, 1995).

4. See Figures A1 and A2 in the Appendix. Although the decline in the share of manufacturing output in the Philippines is slight, the expansion in the nontradable sector together with evidence provided in other studies (e.g. Corbo and Hernandez, 1996) are indicative of the presence of...
Dutch disease effects. It should also be noted that of the total amount of capital inflow received, the mean value of FDI as a percentage of GDP for the period 1990–2000 was 2.7 and 1.8 for Argentina and the Philippines, respectively, which could be one reason for the differences in sectoral activities across the countries.

5. Net private capital inflows increased from about US$50 billion a year over the period 1987–89 to over US$150 billion a year during 1995–97. Foreign direct investment (FDI) flows to poor developing countries rose from 0.4% of gross domestic product (GDP) in the late 1980s to 2.8% in the late 1990s, which puts them at par with middle-income countries relative to the size of their economies (World Bank, 2002).

6. The assumption that the household does not consume any foreign good is a simplifying one. It by no means has any bearing on the degree of openness of the small open economy as investment requires imported capital.

7. The household also decides on the amount of money to hold, but the money demand relation is ignored. This is because monetary policy regimes will focus on the nominal interest rate as the policy instrument, in which case money demand only pins down the nominal money stock. See Woodford (2003) for details.

8. Typically, a model of the Dutch disease has a tradable sector that consists of two subsectors and a nontradable sector. In this set-up, adding a second tradable sector under the assumption that it produces using labor only and that the output is dedicated to exports does not change the results.

9. An exogenous decline in the price of foreign investment could be interpreted more broadly as an exogenous reduction in taxes that result in a decline in the domestic effective price of foreign investment.

10. It has been documented that FDI flows to emerging market economies have financed increases in investment with a high imported capital content (see Montiel and Reinhart, 1999). Therefore, by this assumption, an increase in the import content of investment could be rationalized as an increase in FDI inflow.

11. The specification for the value of the production unit is derived from equation (4):

\[ V_t = E_t \sum_{s=t}^{\infty} \beta^{t-s} \left( \frac{C_t}{C_s} \right)^{\sigma} D_s, \]

where \( \beta^{s-t} (C_t/C_s)^{\sigma} = \Lambda_s \) for \( s = t, t + 1, t + 2, \ldots \) is the stochastic discount factor; and

\[ D_s = P_{t,s} Y_{t,s} - P_{t,s} \left( I_t + \phi \left( \frac{I_t}{K_t} - \delta \right)^2 K_t \right) - W_t L_{t,s} \]

is dividends.

12. As in McCallum and Nelson (1998), I assume that the domestic economy’s exports form an insignificant fraction of foreigners’ consumption and therefore has a negligible weight in the foreign price index.

13. Benigno et al. (2007) show that such a rule ensures determinacy of the exchange rate.

14. Aggregate output (GDP) in the model is defined as the value of output of all sectors.

15. It is noteworthy that the observed impulse response of the price of investment is identical across the various specifications of the model because it is predominantly being driven by the exogenous price of foreign capital.

16. There are differences in views about the desirability of resisting a real appreciation following capital inflow. One view is that such an inflow permits a country to enjoy a larger real income, which it can take in any combination of consumption and investment that it prefers. The other view is that the damage to the tradable goods industries caused by the real appreciation can harm the country’s prospects for development, given that those industries tend to be the key to long-term growth, although the theory behind this has never been very satisfactorily developed. Nevertheless, it remains a strongly held view (Williamson, 1995).

17. This representation of the welfare criterion is an alternative to the one that features a quadratic term of inflation, which uses the model’s Phillips curve to replace terms in the utility function involving consumption (and hence output in equilibrium) with terms involving inflation and the output gap; see Woodford (2003) for details. Since the Phillips curve in this set-up applies

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only to the nontradable sector, it is more convenient to use this representation. It should also be noted that I follow the literature and assume that real money balances do not affect welfare of the representative household.

18. Such rules are optimal for the given class of rules under consideration. Solution for optimal policies is obtained using numerical methods.

19. I introduce interest rate smoothing to accommodate other possible representations in this class of rules.

20. A policy rule that mimics flexible prices can be achieved by aggressively reacting to nontradable inflation.