CAPITAL INFLOWS, DUTCH DISEASE EFFECTS, AND MONETARY POLICY

- ABSTRACT -

by

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This dissertation consists of three essays on Dutch disease effects of capital inflows in emerging market economies. In chapter one, I develop a two-sector dynamic, stochastic, general equilibrium model of a small open economy, incorporating an investment technology that utilizes both domestic and foreign capital, and show that as capital inflow increases, tradable sector output increases initially but later contracts as output of the nontradable sector expands in response to an increase in consumption of nontradables. The increase in nontradables consumption causes the relative price of nontradables to rise, thereby exerting pressure on the real exchange rate to appreciate. The
model is consistent with features of the business cycle in emerging market economies that were recipients of capital inflows.

Chapter two investigates the question of whether capital inflows cause the real exchange rate to appreciate, and whether different forms of capital inflow have variable effects on the real exchange rate. I use panel data for a group of sub-Saharan African countries to estimate a dynamic real exchange rate model specifying a set of capital inflow variables. The results reveal that increases in foreign direct investment and, especially official aid cause the real exchange rate to appreciate.

Chapter three develops a monetary version of the model in the first chapter, with monopolistic competition and sticky prices in the nontradable sector. I examine the roles and welfare implications of a set of monetary policy rules in a small open economy that is susceptible to the Dutch disease. The results show that Dutch disease effects occur under a fixed nominal exchange rate regime, mimicking the dynamics in economies that pegged the nominal exchange rate during episodes of capital inflow; whereas Taylor-type 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.
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Chapter 1

Capital Inflows, Resource Reallocation and the Real Exchange Rate in a Small Open Economy

1.1 Introduction

Economic performance in poor developing countries was disastrous during the mid-1970s and early 1980s. This called for macroeconomic stabilization and structural adjustment reforms based on initiatives of the International Monetary Fund and the World Bank. A significant occurrence over the adjustment period has been a substantial flow of foreign capital into these countries. More recent years have witnessed the integration of poor developing countries into the global economy, accompanied by a surge in private capital inflows. 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 percent of the gross domestic product (GDP) in the late 1980s to 2.8% in the late 1990s. In fact, relative to the size of their economies, poor countries now receive about the same level of FDI as middle-income countries (World
The documented experiences of the largest recipients of capital inflows in Asia and Latin America reveal positive as well as less desirable effects such as widening current account deficits, real exchange rate appreciation, high investment and consumption, and GDP growth.\(^1\) An important aspect of foreign capital dynamics that has not received much attention is the potential to induce resource reallocation, which is symptomatic of the Dutch Disease. As Figures (i) and (ii) show, there was an expansion in nontradable output as a share of GDP and a decline in the production of manufactures as a share of GDP in both Argentina and the Philippines particularly during the peak inflow period of 1990-1994, the changes being more pronounced in Argentina than in the Philippines.\(^2\) Thus this recent wave of private capital inflows could potentially lead to the realization of Dutch Disease effects in poor developing countries.\(^3\)

In this paper I develop a model of foreign capital dynamics in a small open economy. I introduce into a two-sector small open economy model, a role for an investment technology that combines home and foreign investments into new investment which is subject to installation cost. A notable feature of the set up is the integration of the real business cycle literature with the so-called Dutch Disease economics to analyze resource movements and relative price movements in a small open economy that is subject to external shocks. I examine the implication of changes in both the level and share of the foreign component

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\(^1\)The largest recipients of capital inflows include Argentina, Brazil, Chile, Colombia, Indonesia, Malaysia, Mexico, Philippines and Thailand.

\(^2\)A point to note here is 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.

\(^3\)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 scale which triggered 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.
of investment in the small open economy for the real exchange rate, resource reallocation and production across sectors. The results suggest that over the medium-run, there is a resource movement effect as labor units in the tradable sector decrease while nontradable sector labor increases, which results in a contraction of the tradable sector and expansion of the nontradable sector. The results also provide evidence for the spending effect, as rising incomes lead to an increase in demand for nontradable goods which causes the relative price of nontradables to rise thereby exerting pressure on the real exchange rate to appreciate. I should note that although the proposed model presents a set of features most of which have been used in the open economy literature, they have not been exploited in examining Dutch Disease effects in general. A novelty in this study lies in the analysis of Dutch Disease effects of capital inflows in a small open economy within a real business cycle framework.

1.1.1 Literature Review

Theoretical analyses of Dutch disease effects of foreign capital in small open economies have largely been based on the dependent economy model. Corden and Neary (1982) use the dependent economy model to show the resource movement effect and spending effect of a Hicks-neutral technological progress in a sub-sector of the tradable good sector. Marginal product of the mobile factor (labor) in the technologically improved sector rises, drawing resources out of other sectors (resource movement) which results in further adjustments in the economy. Higher real income from this sector leads to increased demand for nontradable goods and rising nontradable good prices (spending effect). This causes a further reallocation of resources toward the nontradable sector. The final outcome of such adjustments in the economy depends on which effect is dominant. They further show that an exogenous
inflow of foreign capital could be the source of such a boom in a sub-sector, giving rise to similar dynamics hence the reference to Dutch disease effects of capital inflows.

The existing literature on general equilibrium analysis of foreign capital dynamics in small open economies have studied issues relating to real exchange rate fluctuations and the current account without addressing Dutch disease effects of capital inflows. Examples of such studies include Serven (1995), Agenor (1998), and Gopinath (2000). Serven (1995) introduces capital good imports in a continuous time, general equilibrium, macroeconomic model. The paper examines the link between real exchange movements, capital accumulation and output. It also considers effects of fiscal policy disturbances and wealth transfers on the current account. Agenor (1998) studies the effects of a fall in world interest rates on capital flows and the real exchange rate in an optimizing framework with imperfect capital markets. Gopinath (2000) models foreign investment as the outcome of a search process which emphasizes the distinction between investment creation and destruction. The investment mechanism is embedded in a two-sector model which is used to derive the response of the economy to capital market liberalization in terms of real exchange rate movements. This paper departs from these studies by examining the macroeconomic consequences of an increase in capital inflows to a small open economy with a focus on Dutch disease effects.

The rest of the paper is organized as follows. Section 2 presents the details of the model. Section 3 discusses the solution, calibration and the results of the model. Section 4 presents the concluding remarks.
1.2 The Model

The structure is a two-sector small open economy inhabited by a continuum of identical infinitely lived households, and a foreign economy. The small open economy has two groups of agents, households and firms. The firms operate in two sectors; tradable goods sector and nontradable goods sector.

1.2.1 Households

I assume there is a continuum of households of measure unity. I will however proceed with a description of a representative household. The representative household enters each time period \( t \) with holdings of real foreign bonds \((B_t)\) and shares \((x_t)\) of the domestic tradable sector firm purchased from the previous period, all denominated in units of the tradable good. The household earns a real interest rate \((r_t)\) on bonds held from the previous period and a return \((v_t + d_t)\) on shares held from the previous period; \(v_t\) is the period \( t \) price of a claim to the tradable sector firm’s entire future profit, and \(d_t\) is period \( t \) dividends issued by the firm, all expressed in units of the tradable good. The household also earns labor income in a real wage \((w_t)\) in each period \( t \). The representative household only consumes domestically produced tradables and nontradables. The household has preferences over a real consumption index \((C)\) and labor effort \((L)\) supplied in a competitive market, and decides on bonds and shares to take into next period, amount of tradable and nontradable good to consume, and labor effort to supply across sectors. The consumption index is a composite of the nontradable good \((C_N)\) and the tradable good \((C_T)\):

\[
C_t = (C_{T,t})^\gamma (C_{N,t})^{1-\gamma},
\]
where $\gamma \in [0, 1]$ is the share of tradables in total consumption.

The consumer price index is

$$P_t = (P_{T,t})^\gamma (P_{N,t})^{1-\gamma},$$

where $P_N$ is the price of the nontradable good, and $P_T$ is the price of the tradable good, all expressed in units of the domestic currency.

The household's intertemporal utility function expressed in logarithmic form is

$$E_t \sum_{t=0}^{\infty} \beta^t \left[ \gamma \log C_{T,t} + (1-\gamma) \log C_{N,t} - \psi \frac{L_{t+1}^{1+\psi}}{1+\nu} \right].$$

The budget constraint in real terms is

$$B_{t+1} + \frac{1}{2} (B_{t+1})^2 + C_{T,t} + p_t C_{N,t} + v_t x_{t+1} \leq (1 + r_t) B_t + (v_t + d_t) x_t + w_t L_t + T_t,$$  (1.2)

where $p_t$ is the relative price of the nontradable good in terms of the tradable good, $w_t$ is the wage in units of tradable good and $\frac{1}{2} (B_{t+1})^2$ is the cost of adjusting bond holdings relative to zero. I introduce cost of adjustment for bonds to ensure steady-state determinacy and model stationarity in response to temporary shocks. This cost can be thought of as financial intermediation cost, where the financial intermediaries are local perfectly competitive firms owned by domestic households. $T_t$ is rebate of financial intermediation fees to the household. All other variables are as previously defined.

The representative household maximizes the intertemporal utility (1.1) subject to the budget constraint (1.2). The first-order conditions are:
\[
\frac{\gamma}{C_{T,t}} (1 + \kappa(B_{t+1})) = \beta E_t \left[ (1 + r_{t+1}) \frac{\gamma}{C_{T,t+1}} \right],
\]  
(1.3)

\[
\frac{\gamma}{C_{T,t}} v_t = \beta E_t \left[ (v_{t+1} + d_{t+1}) \frac{\gamma}{C_{T,t+1}} \right],
\]  
(1.4)

\[
\frac{\gamma}{C_{T,t}} = \frac{1}{p_t} \frac{1 - \gamma}{C_{N,t}},
\]  
(1.5)

\[
\psi L_t' = \frac{\gamma}{C_{T,t}} w_t.
\]  
(1.6)

Condition (1.3) implies that the marginal utility of a unit of tradable good forgone at time \( t \) as a result of purchasing a unit of foreign bonds must equal the expected discounted marginal utility of a unit of that good at time \( t + 1 \). Condition (1.4) implies the same for holding shares. Equation (1.5) shows that the marginal utility of consuming a unit of the tradable good must be equal to the marginal utility of consuming a unit of the nontradable good measured in terms of the tradable good. Equation (1.6) shows that the ratio of marginal disutility from supplying a unit of labor effort to the marginal utility of consumption must equal the real wage.

Asset prices may be derived by rewriting equations (1.3) and (1.4) respectively as follows.

\[
\frac{1}{1 + r_{t+1}} = E_t \left[ \beta \frac{C_{T,t}}{C_{T,t+1}} \frac{1}{1 + \kappa(B_{t+1})} \right],
\]  
(1.7)

\[
v_t = E_t \left[ \beta \frac{C_{T,t}}{C_{T,t+1}} (v_{t+1} + d_{t+1}) \right].
\]  
(1.8)
The two asset price equations above imply a no-arbitrage condition

\[
E_t \left[ (1 + r_{t+1}) \frac{1}{C_{T,t+1}} \frac{1}{1 + \kappa(B_{t+1})} \right] = E_t \left[ \frac{1}{C_{T,t+1}} \frac{(v_{t+1} + d_{t+1})}{v_t} \right].
\] (1.9)

In the absence of uncertainty and adjustment cost of bond holding, equation (1.9) boils down to the standard no-arbitrage condition

\[
1 + r_{t+1} = \frac{v_{t+1} + d_{t+1}}{v_t},
\] (1.10)

which makes the representative household indifferent on the margin between returns on foreign bonds and domestic shares.

### 1.2.2 Firms

Production occurs in the tradable and nontradable sectors. The tradable 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, whereas the level of total investment is determined by the production unit. Investment decision is subject to adjustment costs and hence implies a forward-looking behavior. Factor demands are determined in a perfectly competitive fashion in each sector. The tradable sector firm uses a constant returns to scale technology in capital and labor to produce a single tradable good. I assume that capital is used in the tradable sector only, hence the nontradable good is produced using a single input in labor.\(^4\) The

\(^4\)This assumption is made for the sake of simplicity. This makes possible the generation of a capital-inflow-induced boom in one sector in order to capture the Dutch disease phenomenon.
tradable sector firm must invest to maintain and augment the stock of capital. To account for foreign capital in the domestic economy, I further assume there is a constant returns to scale technology that combines domestic and foreign investment to produce investment \((I)\). The capital stock \((K)\) changes according to

\[
K_{t+1} = I_t + (1 - \delta)K_t,
\]

where \(\delta\) is the depreciation rate. The installation cost of capital, measured in terms of the tradable good, is given by

\[
\frac{\phi}{2} \left( \frac{I_t}{K_t} - \delta \right)^2 K_t,
\]

where \(\phi\) governs the size of the installation cost. The installation cost is applicable only to net investment \(I^n_t\), which is defined as

\[
I^n_t = K_{t+1} - K_t = I_t - \delta K_t.
\]

Labor is internationally immobile but can migrate instantaneously between sectors within the economy. This ensures the household faces the same wage \(w\) in each sector. The total domestic labor supply is

\[
L = L_T + L_N,
\]

where \(L_T\) is labor devoted to the tradable sector and \(L_N\) denotes labor in the nontradable sector. I assume a unit of tradable good can be transformed into a unit of home investment.
without incurring any costs. Therefore the tradable good is either consumed, used for investment, or exported. The nontradable good is used for consumption purposes only. Both the tradable and nontradable goods are supplied in a perfectly competitive domestic market. The currency price of the tradable good is determined on the world market.

 Tradable Sector

**Investment Unit** The investment unit uses a constant returns to scale technology that combines domestic investment \( I_H \) and foreign investment \( I_F \) to produce investment \( I \).\(^5\) The equation describing the technology is

\[
I = \left[ \mu^\frac{1}{\rho} (I_H)_{\rho}^{\frac{\rho-1}{\rho}} + (1 - \mu) \frac{1}{\rho} (I_F)_{\rho}^{\frac{\rho-1}{\rho}} \right]_{\rho}^{\frac{\rho}{\rho-1}}, \tag{1.11}
\]

where \( \rho > 0 \), and \( 0 < \mu < 1 \). Associated with this investment technology is a minimized unit-cost function denoted \( P_I \), the replacement cost of capital which depends on the price ratio, \( \theta_t = \frac{P^F_{I}}{P^T_{I}} \), where \( P_T \) is the price of tradable good in units of domestic currency and \( P^F_I \) is the price of imported investment in units of domestic currency.

For any given rate of investment, \( I \), the firm’s minimization problem is as follows:

\[
\min_{\{I,H,F\}} I_H + \theta_I I_F \quad s.t. \quad \left[ \mu^\frac{1}{\rho} (I_H)_{\rho}^{\frac{\rho-1}{\rho}} + (1 - \mu) \frac{1}{\rho} (I_F)_{\rho}^{\frac{\rho-1}{\rho}} \right]_{\rho}^{\frac{\rho}{\rho-1}} \geq I_t.
\]

\(^5\)It has been documented that FDI flows to emerging market economies have financed increases in investment with a high imported capital content. (See Calvo, Leiderman and Reinhart (1994) and Montiel and Reinhart (1999)). Thus by this specification, an increase in the import content of investment could be interpreted as increase in FDI inflow.
The optimization yields demands for home and foreign investment respectively as

\[ I_{H,t} = \mu \left( \frac{1}{P_{I,t}} \right)^{-\rho} I_t, \quad (1.12) \]
\[ I_{F,t} = (1 - \mu) \left( \frac{\theta_t}{P_{I,t}} \right)^{-\rho} I_t, \quad (1.13) \]

where \( \mu \) is the share of investment expenditure on the domestic component of investment, \( \rho \) is the elasticity of substitution between home and foreign investment, and \( P_I \) is the minimum unit cost function for \( I \), which is expressed as:

\[ P_{I,t} = [\mu + (1 - \mu)(\theta_t)^{1-\rho}]^{\frac{1}{1-\rho}}. \quad (1.14) \]

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

\[ Y_{T,t} = \exp\{a_t\} K_t^\alpha L_{T,t}^{1-\alpha}; \quad 0 < \alpha < 1, \quad (1.15) \]

where \( a_t \) is a productivity shock to tradable good production which follows an \( AR(1) \) process given by,

\[ a_{t+1} = \eta^a a_t + \epsilon_{a,t+1}, \quad (1.16) \]
\[ 0 < \eta^a < 1; \epsilon_a \sim N(0, \sigma_a). \]
The unit solves the maximization problem by which total investment is determined. It maximizes the present discounted value of dividends:

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

subject to,

\[
K_{t+1} = I_t + (1 - \delta)K_t.
\]

The choice variables are \( K_{t+1}, I_t \) and \( L_{T,t} \). The set of efficiency conditions are:

\[
E_t \Omega_{t+1} \left( \frac{Y_{T,t+1}}{K_{t+1}} - P_{I,t+1} \left[ \frac{\phi}{2} \left( \frac{I_t}{K_t} - \delta \right)^2 - \phi \left( \frac{I_{t+1}}{K_{t+1}} - \delta \right) \frac{I_{t+1}}{K_{t+1}} \right] + \lambda_{t+1}(1 - \delta) \right) = \lambda_t, 
\]

(1.19)

\[
P_{I,t} \left( 1 + \phi \left( \frac{I_t}{K_t} - \delta \right) \right) = \lambda_t, 
\]

(1.20)

\[
(1 - \alpha) \frac{Y_{T,t}}{L_{T,t}} = w_t.
\]

(1.21)

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\[6\] The specification for the value of the production unit is obtained by deriving equation (3.14) from (3.5):

\[
v_t = E_t \sum_{s=t}^{\infty} \beta^{s-t} \frac{C_{T,t}}{C_{T,s}} \Omega_s d_s,
\]

where \( \beta^{s-t} \frac{C_{T,t}}{C_{T,s}} = \Omega_s \) for \( s = t, t+1, t+2, ... \) is the stochastic discount factor; and

\[
d_s = Y_{T,s} - P_{I,s} \left( I_s + \frac{\phi}{2} \left( \frac{I_s}{K_s} - \delta \right)^2 K_s \right) - w_s L_{T,s}
\]

is dividends.
Equation (1.19) is an investment Euler equation which describes the evolution of \( \lambda_t \), the shadow price of a unit of capital. At any time period \( t \), the shadow price of a unit of capital is the discounted sum of its marginal product and its shadow value in the period \( t + 1 \), taking into account future capital adjustment cost. Equation (1.20) determines the investment rate as a function of Tobin's \( q \), where \( q = \frac{\lambda_t}{P_{t,t}} \), the ratio of the shadow price of capital to the price of new investment. Equation (1.21) implies that labor is demanded up to the point where the marginal product of labor equals the wage in units of the tradable good. Using the definition of net investment, equation (1.20) can be rewritten as,

\[
\frac{I_t}{K_t} = \frac{1}{\phi} \left( \lambda_t - 1 \right),
\]

which shows that net investment equals zero when the shadow value of a unit of capital (\( \lambda \)) equals its replacement cost i.e. the price of new uninstalled capital (\( P_t \)).

**Nontradable Sector**

The nontradable good firm produces output with a technology linear in labor and described by

\[
Y_{N,t} = \exp \{ z_t \} L_{N,t},
\]

where \( z_t \) is the stochastic productivity to the nontradable sector which follows the \( AR(1) \) process.
\[ z_{t+1} = \eta z_t + \epsilon_{z,t+1}, \quad (1.24) \]

\[ 0 < \eta < 1; \epsilon_t \sim N(0, \sigma_z). \]

The static efficiency condition for the choice of labor demand is

\[ \frac{Y_{N,t}}{p_t L_{N,t}} = w_t. \quad (1.25) \]

### 1.2.3 Resource Constraints

The market clearing conditions are:

\[ L = L_T + L_N, \quad (1.26) \]

\[ Y_{N,t} = C_{N,t}, \quad (1.27) \]

\[ Y_{T,t} = C_{T,t} + I_{H,t} + X_t, \quad (1.28) \]

where \( X_t \) is the component of tradable sector output that is exported.

### 1.2.4 The Foreign Economy

A characteristic feature of a small open economy is that it can neither affect foreign prices nor output, and thus it takes these variables as given. Consequently, I assume that output of tradable good \( (Y^F_T) \) and nontradable good \( (Y^F_N) \) in the foreign economy are exogenously given with prices \( P^F_T \) and \( P^F_N \), respectively. I also assume the price of the nontradable
good is fixed, and specify the price of tradables in units of foreign currency as the following exogenous stochastic process:

\[ P_{f,t+1}^F = (P_{f,t}^F)^{\eta^f} \exp(\epsilon_{pf,t+1}), \]

\[ 0 < \eta^f < 1; \epsilon_{pf} \sim N(0, \sigma_{pf}). \]

Furthermore, given that the home economy exports some of its output, it makes sense to postulate an empirically reasonable reduced-form export demand curve.\(^7\) I therefore assume demand for the small open economy’s exports is given by

\[ X_t = \left( \frac{1}{P_{T,t}} \right)^{\varpi} GDP_t^*; \varpi > 0, \]

where \( P_{T,t} \) is the price of a unit of export in domestic currency and \( GDP_t^* \) is aggregate output in the foreign economy.

1.2.5 Real Exchange Rate and Current Account

The real exchange rate \( e_t \) is defined as the ratio of the price of foreign consumption basket to the domestic one,\(^8\)

\[ e_t = \frac{P_t^*}{P_t}, \]

\(^7\)This specification follows Gertler, Gilchrist and Natalucci (2003).

\(^8\)By definition, the real exchange is given by \( e_t = \frac{P_t^*}{P_t} \), where \( e \) is the nominal exchange rate but for the sake of conducting the analysis in real variables, I normalize the nominal exchange rate to a value of unity.
where $P^*$ is the foreign consumer price index in units of foreign currency, which is assumed to be a composite of tradable good and nontradable good prices. Given that the import price is the only foreign price relevant to the home economy, and the assumption that the foreign nontradable good price is fixed, movements in $P^*_t$ are entirely driven by movements in $P^*_t$. A log-linear approximation of equation (1.31) gives,

$$\hat{\varepsilon}_t = \hat{P}^*_t - \hat{P}_t. \quad (1.32)$$

Taking the log-linear versions of the price index $P$ and the price ratio $\theta$, and substituting into equation (1.32) yields a relationship between the real exchange rate on one hand, and the price ratio $\theta$, and the relative price of nontradables $p$ on the other hand given by

$$\hat{\varepsilon}_t = \hat{\theta} - (1 - \gamma)\hat{p}_t, \quad (1.33)$$

where $\hat{p}_t = (\hat{P}^*_t - \hat{P}_t)$. As equation (1.33) shows, a rise in the relative price of nontradables leads to an appreciation of the real exchange rate.

The current account equation for the domestic economy in real terms is

$$CA_t = r_t B_t + X_t - \theta_t I_{F_t}. \quad (1.34)$$

1.2.6 Equilibrium

The equilibrium is an allocation:

$$\{I_{H_t}, I_{F_t}, I_t, C_{T,t}, C_{N,t}, Y_{T,t}, Y_{N,t}, B_t, K_t, L_{T,t}, L_{N,t}, L_t, X_t, z_t, d_t, CA_t\}_{t=0}^{\infty},$$

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and a sequence of prices:

\[ \{ r_t, P_{t,t}, P_{X,t}, w_t, v_t, \lambda_t, p_t, e_t, \}_{t=0}^\infty, \]

satisfying the first-order conditions for the household's optimization problem, the first-order conditions for the firms' decisions, the random stochastic processes for technologies in the domestic economy and the price of foreign tradables, the resource constraints and the current account equation. The model has a unique steady-state equilibrium which is ensured by the introduction of the adjustment cost of holding bonds.

### 1.3 Solution and Model Dynamics

I derive a solution for the model using standard linear approximation techniques. I characterize the steady state of the model, and calibrate it choosing appropriate values for the parameters. I also present an analysis of the propagation mechanisms following an exogenous shock to the foreign price, after which I provide a brief discussion on the sensitivity of the results to changes in a chosen set of parameters of the model. I further examine the model's ability to capture business cycle properties in some emerging market economies that were recipients of foreign capital in the early 1990s.

#### 1.3.1 Steady State

The steady state representation of the model is obtained by solving for the endogenous variables in terms of the deep parameters of the model, and specifying values for exogenous variables. The steady-state levels are represented by the variables without time subscripts.
Here, I focus on the solution for certain key variables that enables me to pin down the levels of other endogenous variables. They are the following:

\[ r = \frac{1 - \beta}{\beta}, \]

\[ K = \gamma \left[ \frac{(1 - \beta + \beta \delta)}{\alpha \beta} \right]^{\frac{1}{(a+1)}}, \]

\[ L_T = \gamma, \]

\[ L_N = 1 - \gamma. \]

The expression for the interest rate \((r)\) follows from the steady-state version of equation (1.3). The expression for capital \((K)\) comes from the steady-state version of equation (1.19). The steady-state versions of the equations describing labor supply (1.6) and labor demand in both sectors, (1.21) and (1.25), are combined to solve for the level of the two categories of labor \((L_T \text{ and } L_N)\). Also, the fact that the shadow value of capital \((\lambda)\) must equal its replacement cost \((P_I)\) in steady-state means that the ratio of the two variables, the equivalent of Tobin's \(q\), is equal to 1 in steady-state. Having obtained the levels of the aforementioned variables, it is straightforward to pin down the levels of all other endogenous variables.\(^9\) The levels of all exogenously determined variables are conveniently set to 1.

1.3.2 Benchmark Calibration

I calibrate the model at quarterly frequency with the following choice of parameter values that are roughly consistent with features of the economic environment of a representative

\(^9\)The complete steady state representation of the model is given in the appendix.
developing economy. In accordance with the real business cycle literature, I set the household discount factor $\beta = 0.99$, so that the annual real interest rate is 4%. The share of capital in tradable good production is $\alpha = 0.33$, which is also standard to the small open economy literature. The depreciation rate $\delta$, is set to 0.03 as in Devereux and Lane (2001). Following Kose and Riezman (1999) I set the elasticity of labor supply, $\nu = 0.83$. In line with the strand of 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 0.008. The elasticity of substitution between home and foreign investment $\rho$, is set to 1, the parameter associated with the disutility of labor supply $\psi$, is set to 1, and the share of tradable good in consumption basket is set to $\gamma = 0.45$, all following Devereux and Lane (2003). I set as a benchmark value for the share of home investment in investment good production, $\mu = 0.5$. I choose a value for the parameter associated with the adjustment cost of capital, $\phi = 2.2$, as in Kose and Riezman (1999). The degree of persistence for all exogenous stochastic processes is set to 0.95.

1.3.3 Impulse Response Analysis

I analyze impulse responses of variables following a 1 percent shock to the price of foreign investment.\textsuperscript{10} Figure 1 shows the dynamics generated by the shock under 3 scenarios. The objective is to draw implications of the model with respect to the presence of Dutch Disease effects.

\textsuperscript{10} Figure showing the impulse response functions is presented in the appendix.
Responses to foreign price shock

A temporary negative shock to the foreign price results in a rise in the level of foreign investment. There is a complementary increase in home investment as well since the shock also induces a fall in the price of investment, which is directly related to the foreign price. A lower price of investment causes an increase in the expected shadow value of capital. Since investment behavior is forward looking, expectations about future value of capital and the adjustment cost factor into the firm’s decision to add to capital stock. In response to the combined effect of an increase in the expected shadow value of capital and fall in the price of investment, there is an increase in investment, and subsequently an increase in the capital stock upon impact of the shock. As the shadow value of capital declines below its steady state level and investment price rises in the subsequent period, the capital stock gradually reverts to its steady state level over the medium-run.

These dynamics imply that in response to the shock, total investment increases over and above depreciated capital. However, this increase is barely significant. The increase in the capital stock generates a complementary increase in demand for tradable sector labor and consequently a fall in nontradable sector labor. As a consequence, tradable sector output increases whereas output of nontradables decreases. The movements in the output of these sectors are virtually dictated by responses in the labor units associated with each of the sectors. The real wage falls in response to the shock because of the relative magnitudes of the changes in tradables consumption and labor supply. The fall in tradables consumption is greater than the rise in labor supply and therefore the marginal utility of a unit of tradables consumption forgone exceeds the marginal disutility of a unit of labor
supplied, which implies lower real wage. The initial fall in consumption of tradables occurs
because more units of the available output of tradables are allocated to home investment
at the expense of consumption. The relative price of nontradables decrease as the demand
for nontradables fall, following a decline in demand for tradables. The real exchange rate
appreciates due to the fall in foreign price but this is moderated by the initial fall in the
price of nontradables. The current account deteriorates upon impact of the shock. This
initial negative response in the current account is mainly due to increased foreign borrowing
by the household and the increase in foreign investment.

In the period following the impact of the shock, consumption of tradables increases,
causing a complementary increase in consumption of nontradables. The increase in demand
for nontradables increases the relative price of nontradables which in turn leads to an
increase in output of nontradables. Increasing output of nontradables implies increasing
nontradable sector labor and decreasing tradable sector labor. Thus output of tradables
contracts, as nontradables output expands over the medium-run. The sustained increase
in the relative price of nontradables causes the observed initial appreciation in the real
exchange rate to be persistent over the medium-run. The current account reverts to the
steady state level over the medium-run.

These dynamics provide evidence for Dutch Disease effects. The resource movement
effect is captured by a fall in labor units used in the tradable sector and a rise in nontrad-
able sector labor, accompanied by a rise in nontradables production and a fall in output in
the tradable sector. The observed initial increase in the output of the tradable sector, the
recipient sector of foreign investment, is marginal and short-lived. An increase in foreign in-
vestment does translate into increased capital accumulation, which as expected, contributes
towards an initial rise in the level of tradable output. However, with the subsequent decline in tradable sector labor being of a magnitude greater than increase in the capital stock, tradable sector output declines over the medium-run. Thus there is a resource movement effect, in that the tradable sector loses labor to the nontradable sector. This is because as real wage increases in the period following the impact of the shock coupled with an increase in returns on shares, there is an increase in demand for nontradables which leads to an expansion of the nontradable sector. There is also evidence for the spending effect in the observed increase in the relative price of nontradables due to increased demand for nontradables. The persistence in the response of the relative price of nontradables causes the real exchange rate to remain appreciated, i.e. below its steady state level over the medium-run.

1.3.4 Sensitivity Analysis

This section examines the model’s dynamics for alternative values of certain key parameters. I vary values for parameters associated with the share of home investment ($\mu$), and the parameter associated with the rate of depreciation ($\delta$). As a first exercise, I choose a value of $\mu = 0.25$ while maintaining all other parameter values from the benchmark calibration. A lower value of $\mu$ allows me to analyze the dynamics of the model pertaining to the case where the share of foreign investment is greater. The second exercise examines the sensitivity of the model’s dynamics to the parameter associated with the depreciation rate of capital.\footnote{The motivation for analyzing the sensitivity of the model’s dynamics to the depreciation rate stems from Kose and Riezman (1999) who set $\delta = 0.1$ in the calibration of their model. Arguably, a value of $\delta$ between 0.025 (the standard choice in the RBC literature) and 0.1 is plausible for the sake of this analysis.} For this purpose, I set $\delta = 0.05$, while leaving all parameter values from the first exercise unchanged. The objective is to compare the differences in behavior of the variables key
to the Dutch Disease effects in each of these exercises relative to their behavior under the benchmark calibration.

**Sensitivity to degree of openness**

A greater share of foreign investment makes foreign investment, home investment and total investment, all more sensitive to the shock, each exhibiting an initial response greater in magnitude. The response in foreign investment is less persistent. The greater response in total investment results in a greater response in the capital stock relative to the benchmark case. The greater increase in the capital stock causes a greater demand for tradable sector labor generating an expansion in the tradable sector that is of a slightly greater magnitude. The decline in tradable sector labor in the period following the shock is smaller as the increase in the real wage is higher and therefore dampens the magnitude of the increase in nontradable sector labor. The combined effect of the different magnitudes of the reduction in tradable sector labor (smaller) and increase in the capital stock (greater) causes the contraction in tradable sector output to be smaller. In effect, the model’s prediction with respect to the resource movement effect is smaller in magnitude as the observed contraction in tradable sector labor and expansion in nontradable sector labor are dampened vis-a-vis the benchmark impulse responses.

The spending effect in terms of the response of the relative price of nontradables is marginally greater compared to the benchmark case. This could be attributed to excess demand for nontradables due to greater increase in the real wage as well as greater expected returns from investing in the tradable sector. The movement in the real exchange rate is again driven by movements in the relative price of nontradables over the medium-run.
Finally, the initial response in the current account is greater because of the greater response in both foreign investment and bond holdings.

**Sensitivity to depreciation rate of capital**

Given the choice of a higher parameter value for the depreciation rate, a temporary negative shock to the foreign price results in an amplification in the responses for foreign investment, home investment and total investment. The tradable sector firm incorporates its knowledge of the higher depreciation rate to take advantage of the resultant lower price of investment to increase the investment rate. Because the decline in the investment price is greater, the increase in the expected shadow value of capital is also greater. Capital accumulation is more pronounced and persistent in this case, being the greatest response relative to all the cases considered. Consequently, the tradable sector expands by the greatest magnitude. Over the medium-run, output of nontradables increases and so do nontradable consumption and nontradable sector labor, but each of these responses is of a slightly smaller magnitude relative to the other cases studied. The relative price of nontradables also increases by the greatest magnitude.

The expansion observed in the tradable sector is quite persistent because the effect of the increase in the capital stock dominates the decline in tradable sector labor. It should be noted that less tradable sector labor is lost to the nontradable sector in this case. The combination of all these effects results in a contraction in tradable output that is least, as well as short-lived, compared to the other cases. The real exchange rate exhibits an almost identical behavior as in the previous cases. It could however be inferred from the movement in the relative price of nontradables that the appreciation of the real exchange rate is most
persistent in this case. The current account balance deteriorates the most here because the increase in foreign investment and decline in bond holdings are the greatest.

1.3.5 Business Cycle Properties

I analyze the business cycle properties of the model economy by drawing comparisons with the quantitative and qualitative features of the business cycle in some emerging market economies that were recipients of foreign capital in the early 1990s. From a quantitative standpoint, the focus is on the model’s prediction with respect to the volatility of key macroeconomic variables and their contemporaneous correlations with aggregate output.\(^{12}\)

In order to compute moments I assume the following standard deviations for innovations; \(\sigma_a = .007\) and \(\sigma_z = .0035\) for tradable sector productivity and nontradable sector productivity, and for the foreign price shock, \(\sigma_{PF} = .005\). Tables 2 and 3 show business cycle statistics for Argentina and the Philippines, and theoretical moments from the model.

Table 2 shows the standard deviations for consumption, investment, output, current account, real exchange rate, tradables production, and the relative standard deviations of consumption and investment with respect to output. The model does not reproduce the observed volatility in consumption and aggregate output. The model predicts a higher volatility in these two variables in comparison to the observed volatility in Argentina and the Philippines. The model also overpredicts the volatility in investment, real exchange rate and tradables production vis-a-vis the observed volatility in the two emerging market economies. The predicted volatility of the current account is greater than observed in Argentina but higher than observed in the Philippines. In terms of the relative standard

\(^{12}\text{Aggregate output (GDP) in the model is defined as the sum of output of all sectors: } GDP = Y_T + Y_N.\)
deviations, the model predicts a volatility of consumption relative to output which is lower in comparison to the case of Argentina, but which is identical to that in the Philippines. It however predicts a greater volatility of investment relative to output than observed in both economies.

Table 3 presents the contemporaneous correlation of each variable with output. The model does well in matching the consumption-output correlation, producing a coefficient that lies between the observed values for Argentina and the Philippines. The investment-output correlation is identical to the coefficient in the Philippines. The real exchange rate-output correlation produced by the model is lower compared to what is observed in the data for Argentina but bears the same sign. The coefficient for the Philippines is however positive. The predicted correlation coefficient between the current account and output is negative as in the data and lies between the estimates for the reference economies. Furthermore, the model overpredicts the correlation between tradables production and total output, but the coefficient is not very different from those observed in the two economies. The model generally does well in terms of matching the respective correlations between aggregate output and each of the other variables but does not perform as well in terms of matching empirically observed volatility of key macroeconomic variables.

From a qualitative standpoint, the model delivers features that are consistent with several stylized facts on the experiences of the largest recipients of capital inflows in Asia and Latin America. These include current account deficits, increased borrowing, increased private consumption, increased share prices and real exchange rate appreciation. As the discussion of the impulse responses in the previous section indicates, the model economy exhibits all these features in response to increased capital inflow. It also delivers features of
the tradable and nontradable sectors in the reference economies, as depicted in figures (i) and (ii).

1.4 Concluding Remarks

This paper developed a two-sector dynamic stochastic general equilibrium model incorporating a role for an investment technology that combines home and foreign investment into a composite investment good. The aim is to examine the implication of foreign capital inflow for intersectoral allocation of resources, movements in domestic and international relative prices, and production activities in a small open economy that is subject to external shocks. The framework highlights the transmission mechanism through which a shock to the world price triggers the flow of foreign capital into a small open economy, and the consequences this generates, particularly for sectoral production activities and the real exchange rate within the context of the Dutch Disease.

The results suggest that an increase in the level of foreign investment initially causes a resource movement effect that favors the tradable sector. This happens only in the period that the shock occurs. Over the medium-run, there is a reverse resource movement effect as labor units in the tradable sector decrease while nontradable sector labor increases. This results in a contraction of the tradable sector and an expansion of the nontradable sector. The results also provide evidence for the spending effect, as rising expected incomes lead to an increase in demand for nontradable goods which causes the relative price of nontradables to rise thereby exerting pressure on the real exchange rate to remain appreciated.

The results also reveal a key observation; that there exists a trade-off between the re-
source movement effect and the real exchange problem, which is influenced by the share of foreign investment and the rate of capital depreciation within the confines of the model's assumptions, such that for a higher depreciation rate and a greater share of foreign investment in the small open economy, the lesser is the extent to which labor moves from the tradable sector to the nontradable sector but the higher is the increase in the relative price of nontradables i.e. the more pronounced the real exchange rate problem. A higher investment rate sustains the boom in the tradable sector for a significant period over the business cycle, and this happens because as the rate of investment increases, tradable sector output also increases, requiring use of more labor but at the same time contributing to higher relative price of nontradables.
Bibliography


[12] Devereux M.B., and P.R. Lane (2003), "Exchange Rates and Monetary Policy in Emerging Market Economies", mimeo, University of British Columbia


1.5 Appendix

1.5.1 The linearized model

Letting a hat denote percentage deviation from the steady state, the log-linear system is as follows:

The Household

\[ \kappa_B \hat{B}_{t+1} - \hat{C}_{t,t} = \hat{r}_{t+1} - \hat{C}_{t,t+1} \]  
\[ \hat{C}_{t,t} = \hat{p}_t + \hat{C}_{N,t} \]  
\[ \hat{v}_t - \hat{C}_{t,t} = \beta \hat{v}_{t+1} + (1 - \beta) \hat{a}_{t+1} - \hat{C}_{t,t+1} \]  
\[ \hat{L}_t = \frac{1}{\nu} \hat{w}_t - \frac{1}{\nu} \hat{C}_{T,t} \]  
\[ \hat{B}_{t+1} + pC_N(\hat{p}_t + \hat{C}_{N,t}) + C_T \hat{C}_{T,t} = (1 + r) \hat{B}_t + d \hat{a}_t + wL(\hat{w}_t + \hat{L}_t) \]

The Firms

\[ \hat{I}_{F,t} = -\rho(\hat{\theta}_t - \hat{P}_{I,t}) + \hat{I}_t \]  
\[ \hat{I}_{H,t} = \rho \hat{P}_{I,t} + \hat{I}_t \]  
\[ \hat{K}_{t+1} = \delta \hat{I}_t + (1 - \delta) \hat{K}_t \]  
\[ \hat{P}_{I,t} = (1 - \mu) \hat{P}_{I,t} \]
\[
\dot{d}_t = \frac{Y_T}{d} \dot{Y}_{T,t} - \frac{P_t(I + \phi K)}{d} \dot{I}_t - \frac{P_tI}{d} \dot{P}_{I,t} + \frac{P_tK\phi}{d} \dot{K}_t - \frac{wL_T}{d}(\dot{w}_t + \dot{L}_{T,t}) \quad (1.36e)
\]

\[
\dot{\lambda}_t = \alpha \beta \frac{Y_T}{K} \dot{Y}_{T,t+1} + \beta \phi (1 - \delta) \dot{I}_{t+1} - \beta (\alpha \frac{Y_T}{K} - \phi (1 - \delta)) \dot{K}_{t+1} + \beta (1 - \delta) \dot{\lambda}_{t+1} \quad (1.36f)
\]

\[
\dot{\lambda}_t = \dot{P}_{I,t} + \dot{I}_t - \dot{K}_t \quad (1.36g)
\]

\[
\dot{w}_t = \ddot{p}_t + \dot{Y}_{N,t} - \dot{L}_{N,t} \quad (1.36h)
\]

\[
\ddot{w}_t = \ddot{Y}_{T,t} - \ddot{L}_{T,t} \quad (1.36i)
\]

**Market Clearing**

\[
\hat{C}_{N,t} = \hat{Y}_{N,t} \quad (1.37a)
\]

\[
\dot{Y}_{T,t} = \frac{C_T}{Y_T} \hat{C}_{T,t} + \frac{I_H}{Y_T} \hat{I}_{H,t} + \frac{X_t}{Y_T} \hat{X}_t \quad (1.37b)
\]

\[
\dot{L}_t = \frac{L_N}{L} \hat{L}_{N,t} + \frac{L_T}{L} \hat{L}_{T,t} \quad (1.37c)
\]

**Other Equations**

\[
\hat{e}_t = \hat{\theta}_t - (1 - \gamma)\hat{p}_t \quad (1.38a)
\]

\[
\hat{Y}_{T,t} = a_t + \alpha \dot{K}_t + (1 - \alpha) \dot{L}_{T,t} \quad (1.38b)
\]

\[
\hat{Y}_{N,t} = \hat{\theta}_t + \dot{L}_{N,t} \quad (1.38c)
\]

\[
\hat{CA}_t = \frac{r}{CA} \hat{B}_t + \frac{X}{CA} \dot{X}_t - \frac{\theta I_F}{CA} (\hat{\theta}_t + \dot{I}_{F,t}) \quad (1.38d)
\]

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1.5.2 Steady state representation of the model

\[ r = \frac{1 - \beta}{\beta} \]  \hspace{1cm} (1.39a)

\[ v = \frac{d}{r} \]  \hspace{1cm} (1.39b)

\[ C_T = \gamma \]  \hspace{1cm} (1.39c)

\[ C_N = 1 - \gamma \]  \hspace{1cm} (1.39d)

\[ I_F = (1 - \mu)I \]  \hspace{1cm} (1.39e)

\[ I_H = \mu I \]  \hspace{1cm} (1.39f)

\[ I = \delta K \]  \hspace{1cm} (1.39g)

\[ Q = P_t = 1 \]  \hspace{1cm} (1.39h)

\[ L_T = \gamma \]  \hspace{1cm} (1.39i)

\[ L_N = 1 - \gamma \]  \hspace{1cm} (1.39j)

\[ K = \gamma \left[ \frac{\lambda (1 - \beta + \beta \delta)}{\alpha \beta} \right]^{\frac{1}{\alpha - 1}} \]  \hspace{1cm} (1.39k)

\[ w = e = 1 \]  \hspace{1cm} (1.39l)

\[ P_T^F = 1 \]  \hspace{1cm} (1.39m)

\[ Y_N = C_N \]  \hspace{1cm} (1.39n)

\[ Y_T = K_t^{\alpha} L_{Tt}^{1 - \alpha} \]  \hspace{1cm} (1.39o)

\[ B = 0 \]  \hspace{1cm} (1.39p)

\[ d = Y_T - P_t I - wL_T \]  \hspace{1cm} (1.39q)

\[ CA_t = r_t B_t + X_t - \theta_t I_{F,t} \]  \hspace{1cm} (1.39r)
1.5.3 Miscellaneous

Table 1: Benchmark Calibration

<table>
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<th>Parameter</th>
<th>Value</th>
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<td>$\gamma$</td>
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<td>Share of tradable good</td>
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<td>$\kappa$</td>
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<td>Coefficient on adjustment cost for bond holding</td>
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<td>$\alpha$</td>
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<td>Share of capital in tradable sector</td>
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<td>$\phi$</td>
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<td>Elasticity of investment rate with respect to Tobin's $q$</td>
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<td>$\mu$</td>
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<td>Philippines</td>
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Notes: Sample moments for Argentina and The Philippines in Tables 2 and 3 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 (2004). All series are logged (except current account) and filtered using 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. Manufacturing sector output is used as proxy for tradables in computing empirical moments.
Fig i. Argentina

Fig ii. Philippines

Note: Figures are based on data from World Development Indicators (WDI) 2002. Manufacturing is as defined in the database; Nontradables represent services as defined in the database.
Fig. 1: Impulse Response Functions
Benchmark calibration (circles); $\mu = 0.25$ (triangles); $\delta = 0.05$ (squares)
Fig. 1 continued
Chapter 2

Capital Inflows and The Real Exchange Rate: An Empirical Study of Sub-Saharan Africa

2.1 Introduction

Recent years have witnessed the integration of poor developing countries into the global economy, an event that has been associated with a surge in private capital inflows. 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. The composition of private inflows has undergone some changes; bank loans accounted for about 48% and 30% of total private capital inflows in the 1970s and 1980s respectively, whereas foreign direct investment (FDI) flows, and portfolio investment and bonds have dominated net flows in the 1990s. FDI constituted
the bulk of inflows with a share of 34%, while portfolio equity and bonds accounted for 20%. Official inflows on the other hand have been on the decline, from about 46% in the 1980s to 20% in the 1990s (World Bank, 1999). FDI flows to poor developing countries rose from 0.4% of gross domestic product (GDP) in the late 1980s to about 3.2% in the late 1990s, which implies that they now receive about the same level of FDI as middle-income countries, relative to the size of their economies.¹

This recent wave of private capital inflows could result in the realization of some of the unfavorable side effects of foreign capital in these countries. One of these effects has been referred to as 'the real exchange rate problem' i.e. the possibility that capital inflows give rise to appreciation of the real exchange rate with adverse consequences for traded goods production in the domestic economy.

In this paper, I examine the effect of an increase in capital inflows on the real exchange rate using data on a group of sub-Saharan African countries. I estimate an econometric model that specifies different capital inflow variables, employing panel data techniques.

The existing empirical literature on capital inflow and the real exchange rate in developing countries has predominantly centered on Latin America and to some extent Asia. Besides, most of the studies on single countries or group of countries in sub-Saharan Africa have focused on foreign capital inflows in the form of official transfers. The fall in official transfers alongside the rising level of private capital inflows raise the question of whether different forms of capital inflow have variable impact on the real exchange rate. FDI is viewed as a safer form of investment compared to bank lending and portfolio investment because it is tied to real investment in plant and equipment and also results in transfer of

technology, whereas bank lending for instance may go into financing consumption. Presumably therefore, the degree of real appreciation from a given increase in FDI inflows should be smaller than that associated with changes in other forms of capital inflow.

I estimate static and dynamic real exchange rate models to examine the relationship between capital inflows and the real exchange rate. I also investigate whether different forms of capital inflow have variable impacts on the real exchange rate. As FDI currently dominates inflows to the sub-region, I focus on how different the impact of FDI on the real exchange rate is from those of other forms of capital inflows. The dynamic model is specified as an autoregressive distributed lag (ADL) model of the real exchange rate which allows for inclusion of past values of the real exchange rate as an explanatory variable. The main finding is that increases in the inflow of FDI and official aid cause the real exchange to appreciate, with the degree of real appreciation associated with official aid being greater.

2.1.1 Related Literature

The dependent economy model, also known as the ‘Salter-Swan-Corden-Dornbusch model’, serves as the theoretical foundation for empirical models used in analyzing the impact of foreign capital on the real exchange rate in developing economies. Within this theoretical framework, a surge in capital inflows to a sector of the economy increases the marginal product of labor, and hence the real wage, in the sector, drawing resources out of other sectors (resource movement) and giving rise to other adjustments in the economy. Higher real income triggers an expansion in aggregate demand, which for exogenously given prices of tradable goods, culminates in higher relative prices of nontradable goods (spending effect). A rise in the relative price of non-tradable goods corresponds to a real exchange rate appre-
ciation. The final outcome of such adjustments in the economy depends on which effect is
dominant and it is an issue that must be determined empirically\(^2\). The real exchange rate
therefore acts as a summary indicator of the outcome of macroeconomic adjustments that
occur following an increase in capital inflow. In effect, an appreciation of the real exchange
in response to an increase in capital inflow is indicative of the presence of Dutch disease
effects.\(^3\)

A number of empirical studies have examined the relationship between capital inflows
and the real exchange rate in developing economies. Edwards (1989) estimates an empir-
ical model specifying explanatory variables like international terms of trade, government
consumption of non-tradables, measure of extent of controls over capital flows, index of
severity of trade restriction and exchange controls, measure of technological progress and
ratio of investment to GDP. Several versions of the model were estimated using pooled data
for a group of 12 developing countries. Ordinary least squares and instrumental variables
techniques were used. The results provide support for the view that both real and nominal
variables cause short-run movements in real exchange rates. White and Wignaraja (1992)
also present an econometric model of real exchange rate behavior in Sri Lanka using a
general to specific modeling procedure. The model specifies the following variables: lagged
real exchange rate, total aid and remittances lagged one period, terms of trade, nominal
exchange rate and the nominal exchange rate lagged two periods. A major finding from the
study is that the substantial rise in total aid and remittances has caused a real appreciation.

\(^2\)See Falck (1997).
\(^3\)The aforementioned dynamics are similar to those in the the version of the dependent economy model
presented by Corden and Neary (1982)-a key feature is the distinction between resource movement effect and
spending effect from a Hicks-neutral technological progress in a sub-sector of the tradable good sector, which
is symptomatic of the Dutch Disease, and hence the reference to Dutch disease effects of capital inflows. See
Falck (1997) examines aid-induced real exchange rate appreciation in Tanzania. The model for the determination of the real exchange rate specifies among other variables the real exchange rate lagged one period, rate of change of the nominal exchange rate, foreign aid, macroeconomic policy proxied by the growth of excess domestic credit, international terms of trade and investment. He computes twelve different real exchange rate indexes for Tanzania, applies a three-stage selection procedure to each one of them and estimates the model by the use of ordinary least squares. The results show some similarities across the various equations with respect to the signs on the coefficient estimates. Notably, foreign aid causes the real exchange rate to appreciate. Nyoni (1998) also undertakes an assessment of the potential for Dutch disease in Tanzania following an inflow of foreign capital. He identifies the undesirable effects that might be generated by a boom in aid inflow to include a decline in export performance and manufacturing production. His long-run model specifies some of the conventional fundamental determinants including foreign aid while the short-run model includes excess domestic credit and nominal devaluation. Using an error-correction representation, he finds that foreign aid causes a depreciation of the real exchange rate, which is in sharp contrast to the findings made by Falck (1997).

Athukorala and Rajapatirana (2003) conduct a comparative study on capital inflows and the real exchange for the main capital importing countries in Asia and Latin America. Unlike the aforementioned studies, this paper focuses on the behavior of the real exchange rate in terms of private capital inflows, disaggregated into FDI and 'other capital flows', and a set of macroeconomic indicators. They find that the real exchange rate appreciates with rising levels of 'other capital flows' whereas increases in FDI lead to a depreciation of the real exchange rate. They further observe that the degree of appreciation associated with
capital inflows was lower in the Asian countries compared to the Latin American countries.

The available empirical evidence suggests increases in capital inflows have for the most part caused the real exchange rate to appreciate. However, a critical assessment of the preceding literature review reveals notable deficiencies in the studies, especially those on sub-Saharan African countries. Foremost, neither the pooled cross-section nor single country analysis control for country specific effects, which certainly leads to a bias in the coefficient estimates. The different single-country studies also employ different definitions of the real exchange rate and different capital inflow variables, which implies that these studies do not lend themselves for easy comparison. Moreover, these studies focus on official transfers as the main type of capital inflow. The change in the composition of these flows with the rising level of FDI suggests the need to incorporate measures of private capital flows as independent variables in studying real exchange rate behavior in sub-Saharan Africa.

Furthermore, previous pooled cross-section studies estimated models without the lagged real exchange rate as an explanatory variable although the real exchange rate has been observed to exhibit marked persistence. The absence of such an explanatory variable is a potential source of omitted variable bias and a mis-specified model. Finally, it could be argued lagged FDI should be introduced in such models since FDI undertaken in a given year may not produce significant effects in the same year but rather in years afterwards. This paper departs from these studies by examining the effect of foreign capital flows in 16 sub-Saharan African countries, making use of an estimation technique that allows unobserved country specific effects to be controlled for as well as makes possible the inclusion of the lagged real exchange rate as an explanatory variable.

The rest of the paper is organized as follows. Section 2 presents an overview of the trends and composition of capital inflows to sub-Saharan Africa in comparison to developing countries in general. In section 3, an empirical analysis of the link between real exchange rate behavior and capital inflows is presented. This includes specification of the econometric models, estimation, and an analysis of the results. The concluding remarks are given in section 4.

### 2.2 Capital Flows to Sub-Saharan Africa

Foreign capital inflows are an important source of investment finance, especially for low income developing countries. At the same time, the composition and variability of capital inflows are important to investment decisions and economic policy. In this section, I present an overview of the trends in the composition of capital inflows to developing countries in general, and sub-Saharan Africa in particular. Although the focus will be on FDI and other types of private capital, patterns in official flows will also be addressed. It is important to emphasize that data on capital inflows to Africa are underestimated and very unreliable. This is due to the difficulties in collecting data and the absence of recording systems for the main types of capital inflows.\(^5\)

Net private capital flows to developing countries increased from an annual average of about US$10 billion in the latter half of the 1980s to almost US$200 billion in the mid-1990s, peaking at about US$300 billion in 1997.\(^6\) Trends in the composition of capital inflows have also shown significant changes in the 1990s; the ratio of private capital inflows

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\(^5\)Other problems include discrepancies between source and recipient country data, and inadequate data coverage in source countries.

\(^6\)See Figure 1 (Based on data from Global Development Finance, 2002).
to total inflows rising to 81% in the 1990s from an average of about 55% in the 1980s. The composition of private inflows has also changed. In the 1970s and 1980s, bank loans made up the bulk of private capital inflows, accounting for about 48% and 30% respectively and the share of portfolio equity and bonds was about 2%. FDI accounted for the greatest share of private inflows in the 1990s contributing 34%, with portfolio equity and bonds making up 20% and bank loans falling to 23%. The proportion of official flows has varied over time, rising from 34% in the 1970s to 46% in the 1980s and then falling to 20% in the 1990s. As Figure 1 shows, in most recent years net private inflows have been on the decline although they still constitute a greater share of net capital inflows, with FDI dominating private capital inflows to all developing countries.

Sub-Saharan Africa experienced the sharpest decline in private flows following the debt crisis. Private capital inflows began to increase in the second half of the 1980s only to decline again at the beginning of the 1990s before recovering between 1993 and 1995. For most of the years between 1982 and 1992, annual private capital flows have been below the 1982 high of US$6 billion. The scale of private capital inflows has since been on the rise. Total private investment flows to sub-Saharan Africa peaked in 1999 at US$11.8 billion, up from US$7 billion the previous year, having been at US$9.7 billion in 1997. Underlying the trend in the aggregate private flows are marked differences in the trends in the various types of private capital inflow. Private loans, which dominated private flows to sub-Saharan Africa in the late 1970s and early 1980s have been either negative or close to zero during most of the 1990s. In contrast, FDI in the region has been on an upward trend since the 1980s, and now dominates total private inflows to the sub-region, although as Figure 2 shows, FDI has been up and down between 1997 and 2000. Portfolio equity flows to the sub-region on the
other hand was virtually non-existent prior to 1992 but has picked up since, reaching levels of US$641 million in 1994, US$1.5 billion in 1997, and a peak of US$3.9 billion in 1999.

Sub-Saharan Africa received on average about 4% of total FDI flows to developing countries between 1997 and 2000.\(^7\) This is a relatively small share in absolute terms, but when measured as a percentage of GDP, they are attracting about the same level of FDI as recipient countries in Asia and Latin America. For instance during the period 1994-95, Ghana, Mozambique and Nigeria all received more FDI relative to the size of their economies than Brazil, Mexico and the Philippines.\(^8\) Figure 3 shows how the ‘real’ value of FDI flows to sub-Saharan African countries compares to that of all developing countries.\(^9\) As the graph depicts, the FDI-GDP ratio for sub-Saharan Africa is quite high in comparison to that for all developing countries.

FDI flows to sub-Saharan Africa are unevenly distributed. In 2000 for instance, Angola, Nigeria and South Africa received 25%, 16% and 14.4% respectively of FDI flows to the sub-region, whereas Sudan, Mauritius, Uganda, Zambia and Tanzania, together accounted for 19%.\(^10\) The major recipients of FDI in the sub-region can be classified into 3 groups. The first comprises countries that were early recipients of FDI namely, Botswana, Mauritius, Seychelles, Swaziland and Zambia. The second is made up of Angola, Cameroon, Gabon, Ghana, Guinea, Lesotho, Madagascar, Mozambique, Namibia, Nigeria and Zimbabwe. Countries in this group registered huge increases in FDI flows in the 1990s. The final group consists of countries for which FDI flows have been low prior to the mid-1990s.

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\(^8\) See Bhattacharya, Montiel, and Sharma, 1997.
\(^9\) When FDI and other types of capital flows for that matter are expressed as a percentage of GDP, it provides a measure of the ‘real’ value of that capital inflow.
but have since recorded a significant increase in FDI flows; Uganda is a typical example.

Official flows accounted for a higher proportion of foreign capital inflows to sub-Saharan Africa between 1990 and 1995, constituting 26% of total official development assistance to developing countries. They still remain an important source of external finance even in the wake of growing private capital flows, although they have been on the decline in recent years. Table A1 shows that although FDI flows have increased significantly over the years and almost caught up with official flows, official development assistance still contributes a bulk of foreign capital to sub-Saharan Africa. Nevertheless, the picture that emerges from the foregoing discussion is that of increasing private capital inflows to sub-Saharan Africa; and with this comes increased exposure to volatility of capital inflows which undermines policies aimed at maintaining a stable macroeconomic environment. The prevailing environment of more liberalized exchange rate regimes in the sub-region also provides grounds for currency overvaluation as capital inflows increase. Lastly, rising levels of private capital exerts pressure on the real exchange rate towards an appreciation.

2.3 Econometric Analysis

I develop and estimate static and dynamic panel models of the real exchange rate using panel data for 16 sub-Saharan African countries. Using different estimation techniques, I first estimate an equation that specifies a type of private capital inflow as the sole explanatory variable and subsequently estimate equations specifying different forms of capital inflows while controlling for other macroeconomic variables that potentially influence the real exchange rate. The objective is to investigate how capital inflows affect the real exchange rate
with a focus on FDI inflows.

2.3.1 Determinants of the Real Exchange Rate

Conventionally, an empirical real exchange rate model links the real exchange rate to some capital inflow variable, openness to trade and a set of policy variables. The policy variables include government expenditure and excess money growth which capture policy actions that affect the real exchange rate. These policies are fiscal contraction or expansion and foreign exchange market interventions.

A fiscal expansion puts pressure on the real exchange rate to appreciate because government expenditure tends to be allocated more towards non-tradable goods. The extent to which government expenditure affects the real exchange rate also depends on the marginal propensity to spend on non-tradables; the higher it is the more likely an increase in government expenditure will cause the real exchange rate to appreciate. On the other hand, a fiscal contraction in the wake of rising levels of foreign capital inflows will work to mitigate the real exchange rate effect of the investment boom. The way in which capital inflows can be translated into real exchange rate appreciation also depends on the nature of the exchange rate system and the way monetary authorities react to changes in key macroeconomic variables.

Under a fixed exchange rate regime, increases in capital inflow lead to accumulation of international reserves at the central bank and a monetary expansion. Excess money supply growth puts an upward pressure on the prices of non-tradable goods thereby inducing inflation, which in turn causes the real exchange rate to appreciate. Most countries resort
to sterilized intervention in the foreign exchange market to curtail this problem.\textsuperscript{11} When a central bank pursues a non-sterilized intervention in the foreign exchange market upon excessive inflow of foreign capital, the outcome is an increase in domestic money supply which gives rise to inflationary tendencies and puts pressure on the real exchange rate to appreciate. Sterilized intervention may work to shield the real exchange rate from appreciating in the short-term but could well trigger further capital inflows as it causes short-term interest rates to increase, and hence induce an appreciation in the real exchange rate.

The openness variable proxies trade restrictions. An increase in import tariffs, for instance, increases import prices and hence results in a terms of trade deterioration. Such an event affects prices of non-tradables through an income effect and a substitution effect. The negative income effect from a terms of trade deterioration decreases demand for all goods and services, resulting in lower prices of non-tradables and hence a depreciation of the real exchange rate. On the other hand, the substitution effect implies increased demand for domestic non-tradables as consumers switch from imported goods. This increases prices of non-tradables leading to an appreciation of the real exchange rate. Thus, the income effect causes non-tradables prices to decrease whereas the substitution effect leads to an increase in these prices. Although one cannot state which effect dominates a priori, Edwards (1988) argues that the income effect is less likely to dominate, and therefore trade liberalization should lead to real depreciation. In other words, the more open an economy is, the more likely it is for the real exchange rate to depreciate.

2.3.2 Methodology and Model Specification

First, I specify a static panel model that is estimated using fixed effects (within) estimator. I then specify a dynamic panel model that is estimated using a generalized method of moments (GMM) estimator. This estimator is tailored to deal with potential endogeneity in all explanatory variables. In particular, it accounts for endogeneity due to the introduction of a lagged dependent variable as an explanatory variable.

The static panel model is given by

\[ y_{it} = \beta' x_{it} + \eta_i + \epsilon_{it}, \]  

(2.40)

where \( x_{it} \) is a vector of explanatory variables, \( \eta_i \) is a country specific effect which is unobserved, and \( \epsilon_{it} \) is an error term.\(^{12}\) The dependent variable is the real exchange rate, and the explanatory variables are foreign direct investment (FDI), other private capital inflows (OCF), official development aid (ODA), government expenditure (GEXP), excess money growth (EXMG) and openness of the economy (OPEN).\(^{13}\)

The dynamic equation is represented by an autoregressive-distributed lag model of the form

\[ y_{i,t} = \alpha y_{i,t-1} + \beta'(L) x_{it} + \eta_i + \epsilon_{it}, \]  

(2.41)

This is a dynamic model for the level of \( y_{it} \), where \( y_{i,t-1} \) is the one period lag of \( y_{it} \), \( x_{it} \) is

\(^{12}\)A baseline model featuring a single explanatory variable in either FDI or OCF, each serving as a proxy for private capital inflows is estimated as a first step before the fully specified model is estimated.

\(^{13}\)Arguably, it is unlikely that FDI undertaken in a given year will generate much output in the same year, therefore the one-period lag of FDI is included as an explanatory variable.
a vector of other explanatory variables, and $\beta(L)$ is a vector of associated polynomials in the lag operator. Applying the fixed-effects (within) estimator to equation (2.41) yields a biased and inconsistent estimate of the coefficient on the lagged dependent variable because it makes use of a transformation by which the country specific effect is eliminated, and which culminates in a correlation between the lagged dependent variable and the error term.\textsuperscript{14}

A simple transformation of equation (2.41) to eliminate the country-specific effect yields

$$y_{it} - y_{i,t-1} = \alpha(y_{i,t-1} - y_{i,t-2}) + \beta'(x_{it} - x_{i,t-1}) + (\epsilon_{it} - \epsilon_{i,t-1})$$  \hspace{1cm} (2.42)

This representation shows that the lagged difference in the real exchange rate is correlated with the error term. The use of instruments is required to deal with this problem as well as the possible endogeneity of other explanatory variables. Under the assumptions that the error term is not serially correlated, and the lagged levels of the explanatory variables are weakly exogenous i.e. they are uncorrelated with future realizations of the error term, the GMM \textit{difference} estimator uses the lagged level of the explanatory variables as instruments.\textsuperscript{15} Generally, the instruments available for the equation in first-differences are likely to be weak when the individual series have near unit root properties. Blundell and Bond (1998) show that persistence in the explanatory variables may have adverse effects on

\textsuperscript{14}The fixed effects estimator transforms the data by subtracting the time series mean of each variable, thereby eliminating the country specific effects.

\textsuperscript{15}Under these assumptions, the GMM difference estimator is based on the following moment conditions:

$$E[y_{i,t-s}(\epsilon_{it} - \epsilon_{i,t-1})] = 0 \text{ for } s \geq 2; t = 3, \ldots, T,$$

$$E[x_{i,t-s}(\epsilon_{it} - \epsilon_{i,t-1})] = 0 \text{ for } s \geq 2; t = 3, \ldots, T.$$
the small-sample and asymptotic properties of the difference estimator. The GMM system estimator thus combines the difference estimator with an estimator in levels in a system, in order to minimize the potential biases associated with the difference estimator under such circumstances. The equation in levels uses the lagged differences of the explanatory variables as instruments under two conditions: 1) that there is no serial correlation in the errors, and 2) that the differences of the explanatory variable and the errors are uncorrelated.

The country-specific effect and the levels of the explanatory variables may be correlated in the levels equation, however. The inclusion of a levels equation also allows the use of information on cross-country differences, which is otherwise impossible when using the difference estimator.

The validity of the instruments determine whether the GMM estimator is consistent or not. I therefore employ two specification tests to address this issue. These are a test of over-identifying restrictions based on the Hansen J-statistic and a test for second-order serial correlation in the error term. The Hansen test of overidentifying restrictions has the null that the instruments appear exogenous, and the Arellano-Bond test for second-order serial correlation has the null that there is no second-order serial correlation in the error term.

Table 1 shows the main explanatory variables with a description for each and the expected signs on the coefficients from the estimations. A plus sign (+) implies that an

\[ E [(y_{i,t-s} - y_{i,t-s-1})(\eta_i + \varepsilon_t)] = 0 \text{ for } s = 1, \]
\[ E [x_{i,t-s} - x_{i,t-s-1}(\eta_i + \varepsilon_t)] = 0 \text{ for } s = 1. \]

See Arellano and Bond (1991) and Blundell and Bond (1998) for technical details on the GMM difference and system estimators.
increase in the variable causes a real exchange rate depreciation whereas a minus sign (-) means that an increase in the variable causes an appreciation of the real exchange rate.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Expected Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ODA$</td>
<td>Official Development Assistance</td>
<td>(-)</td>
</tr>
<tr>
<td>$OCF$</td>
<td>Other Capital Flows</td>
<td>(-)</td>
</tr>
<tr>
<td>$FDI$</td>
<td>Foreign Direct Investment</td>
<td>(-)</td>
</tr>
<tr>
<td>$EXMG$</td>
<td>Excess Money Growth</td>
<td>(-)</td>
</tr>
<tr>
<td>$GEXP$</td>
<td>Government Expenditure</td>
<td>(-)</td>
</tr>
<tr>
<td>$OPEN$</td>
<td>Openness of Economy</td>
<td>(+)</td>
</tr>
</tbody>
</table>

2.3.3 Description of the Data

The data set is based on annual observations for 16 sub-Saharan African countries covering the period 1980-2000. The data comes from three sources; the Penn World Table (PWT) 6.1, the International Financial Statistics (IFS) 2003, and the World Development Indicators (WDI) 2002. The series on the openness index comes from the Penn World Table. The series on ‘other investment liabilities’ from the IFS database is used as a proxy for other forms of private capital inflows excluding FDI, represented by the variable described as ‘other capital flows’. The data on all other variables come directly from the WDI database, except for the series on ‘excess money growth’ which is constructed as the difference between

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17 The countries are selected based on data availability. These are Burundi, Cameroon, Central African Republic, Cote d'Ivoire, Equatorial Guinea, Gabon, The Gambia, Ghana, Lesotho, Malawi, Nigeria, Sierra Leone, South Africa, Togo, Uganda, Zambia.
growth rate of M2 and real GDP, both of which are extracted from the WDI database.\textsuperscript{18}

Table A2 presents the correlation matrix for the variables, and Table A3 gives some descriptive statistics on the variables. Table A2 shows that all three categories of capital inflow are negatively correlated with the real exchange rate whereas excess money growth is positively correlated with the real exchange rate in contrast to expectation. Government expenditure is negatively correlated with the real exchange rate as expected, while the coefficient describing the correlation between the real exchange rate and openness bears a sign that is contrary to expectation.

2.3.4 Results

I analyze the results obtained from estimating equations (2.40) and (2.41) and variants of these specifications. Table A4 presents results from the static panel regressions and Tables A5 and A6 show the dynamic panel regressions results. The dynamic regressions satisfy both the Hansen test of overidentifying restrictions and the serial correlation test.\textsuperscript{19}

The coefficient estimates in columns (1) and (2) of Table A4 show that when FDI or OCF is the only explanatory variable entering the real exchange rate model, each type of capital inflow is statistically significant and bears a negative sign. In Column (3) of Table A4 which shows results from estimating equation (2.40), ODA has a statistically significant coefficient with a negative sign but neither FDI, FDI lagged one period nor OCF is statistically significant. I suppose that the insignificance of the private capital inflow variables in the model which controls for official inflows and policy variables is due to

\textsuperscript{18}For estimation purposes, all data series are converted into logarithms. Detailed definitions of all variables are provided in the appendix.

\textsuperscript{19}I use both the levels and appropriate lagged values of the growth rate of GDP for OECD countries and gross domestic capital formation as additional instruments in the dynamic regressions.
specification error in the form of omitted variable bias; the omitted variable being the one-period lag of the real exchange rate. Real exchange rates are quite persistent and therefore a correctly specified model should include the lagged real exchange rate as an explanatory variable as in equation (2.41).

The estimates from the baseline dynamic equation presented in Table A5 show that the FDI coefficient is positive and statistically significant whereas lagged FDI is positive but statistically insignificant when the GMM difference estimator is applied. On the other hand lagged FDI is statistically significant and bears the expected negative sign whereas FDI is statistically insignificant when the GMM system estimator is used. Of the other two capital inflow variables, ODA has a negative and statistically significant coefficient, whereas OCF has an insignificant coefficient across both estimations. In the case of the control variables, OPEN and GEXP both have statistically significant coefficients with the expected signs but EXMG is statistically insignificant when either the GMM difference estimator or the system estimator is used. The results also reveal a positive and significant coefficient on the lagged real exchange rate in both estimations, an evidence of some persistence in the variable. The GMM difference estimator however is associated with potential biases when variables have near unit root properties, in which case the system estimator minimizes such biases. It is therefore reasonable to consider the results generated by the GMM system estimator as more reliable as it provides better instruments vis-a-vis the difference estimator.\textsuperscript{20} It should be noted that with the exception of the coefficients on FDI, FDI(-1), OCF and EXMG,

\textsuperscript{20}Ideally an examination of the time series properties of the variables should be pursued in order to determine which estimator to use. However the available panel unit root test routines in Stata are designed for balanced panels and could not be applied to panel data used for this exercise which happens to be unbalanced.
estimates are identical across estimators for all other variables with respect to sign and statistical significance of the coefficients.

In order to further examine the impact of foreign direct investment on the real exchange rate, FDI and FDI(-1) are dropped from the baseline dynamic model, one at a time, and the resultant equations estimated using the system estimator. The results are given in columns (1) and (2) of Table A6, respectively. The estimates in column (1) show that FDI enters that specification with a negative coefficient but is statistically insignificant while columns (2) shows a negative and statistically significant coefficient on FDI(-1). The results are identical across the two specifications for all other variables with respect to sign and statistical significance of the coefficients except for EXMG. Lastly, another specification which excludes FDI and EXMG, the only control variable that has entered all regressions with a statistically insignificant coefficient, is estimated and the results given in columns (3) of Table A6. All coefficient estimates are robust to this specification as FDI(-1) remains statistically significant with a negative coefficient likewise ODA. OCF on the other hand still has a statistically insignificant coefficient. The control variables OPEN and GEXP both remain statistically significant and bear the expected signs.

The results suggest that an increase in FDI inflow does not affect the real exchange rate in the same period but rather with a lag, such that a 1 percent increase in FDI inflow in a given year causes the real exchange rate to appreciate by about .05 percent in the following year. This is consistent with the hypothesis that FDI undertaken in a given year may not have a significant impact on the economy in the same year. The estimates also suggest that changes in the inflow of other forms of private capital, proxied by variable OCF, do not affect the real exchange rate. This could be explained by the fact that of the three categories
of capital inflow considered, 'other capital inflows' have been minimal and in some cases, even negative over the period under consideration. Thus the amount of inflows of other forms of private capital may not have been at levels high enough to generate any significant variation in the real exchange rate. The estimates also indicate that an increase in ODA inflows induces an appreciation in the real exchange, with a 1 percent increase in official aid resulting in about .1 percent real appreciation. Since the real exchange rate acts as a summary indicator of the outcome of macroeconomic adjustments that occur following an increase in capital inflow, the results are implicative of the existence of Dutch disease effects caused by increases in FDI and ODA inflows.

The results further show that the substitution effect of trade liberalization dominates the income effect, therefore as the degree of openness of a country increases, the real exchange rate tends towards a depreciation. The estimates also indicate that a fiscal contraction leads to a depreciation of the real exchange rate, consistent with the claim that government expenditures are generally allocated towards non-tradable goods. The statistically insignificant coefficient on EXMG suggest one possibility; excess credit creation due to foreign exchange market interventions have not had any repercussions in terms of fuelling inflation. Lastly, having obtained a statistically significant coefficient on the lagged RER justifies its inclusion in the model and confirms the widely documented stylized fact about persistence in real exchange rates. It also suggests that there is a lagged impact of changes in the explanatory variables on the real exchange rate.

21 See Table 1.
2.4 Conclusions

The recent wave of private capital inflows to poor developing countries could potentially lead to the realization of Dutch disease effects in these economies. This paper examines the link between capital inflows and the real exchange rate in sub-Saharan Africa with a focus on FDI inflow which dominates total private inflows to the sub-region. The main objective is to determine whether an increase in capital inflow results in a real appreciation. I estimate a real exchange rate model specifying official flows and two categories of private capital inflows i.e. FDI inflows and 'other capital inflows'. The results show that an increase in FDI inflow leads to a real appreciation whereas changes in 'other capital inflows' do not affect the real exchange rate. The results also show that an increase in official aid causes a real appreciation, which is greater in magnitude than that associated with an increase in FDI inflow. In summary, the study finds that increases in the inflow of FDI and ODA cause Dutch disease effects in sub-Saharan Africa.
Bibliography


2.5 Appendix

2.5.1 Figures

Figure 1: Capital Flows to Developing Countries
Figure 2: Private Inflows and Some Components (sub-Saharan Africa); Data Source: WDI database, 2002

Figure 3: FDI, net inflows (% of GDP). Data Source: WDI database, 2002
### Table A1: Trends in Capital Inflows (million US$)

<table>
<thead>
<tr>
<th>Period</th>
<th>FDI</th>
<th>OCF</th>
<th>ODA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-1982</td>
<td>37</td>
<td>219</td>
<td>115</td>
</tr>
<tr>
<td>1983-1985</td>
<td>44</td>
<td>32.6</td>
<td>113</td>
</tr>
<tr>
<td>1986-1988</td>
<td>49</td>
<td>-157</td>
<td>202</td>
</tr>
<tr>
<td>1989-1991</td>
<td>87</td>
<td>-93.7</td>
<td>326</td>
</tr>
<tr>
<td>1995-1997</td>
<td>341</td>
<td>192</td>
<td>357</td>
</tr>
<tr>
<td>1998-2000</td>
<td>278</td>
<td>8</td>
<td>283</td>
</tr>
</tbody>
</table>

Notes:

Figures are period-averages based on annual data for the 16 sub-Saharan African countries over the period 1980-2000 (See section 3.3, footnote 18.).

Variables are as defined in the appendix.
### Table A2 Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>ODA</th>
<th>OCF</th>
<th>FDI</th>
<th>EXMG</th>
<th>GEXP</th>
<th>OPEN</th>
<th>RER</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODA</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OCF</td>
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<td>1.000</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>FDI</td>
<td>-0.153</td>
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<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td>-0.358</td>
<td>1.000</td>
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<td></td>
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<tr>
<td>GEXP</td>
<td>-0.411</td>
<td>-0.171</td>
<td>0.426</td>
<td>-0.564</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>-0.519</td>
<td>-0.295</td>
<td>0.504</td>
<td>-0.347</td>
<td>0.745</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>RER</td>
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<td>-0.017</td>
<td>-0.351</td>
<td>0.416</td>
<td>-0.591</td>
<td>-0.210</td>
<td>1.000</td>
</tr>
</tbody>
</table>

### Table A3 Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>ODA</th>
<th>OCF</th>
<th>FDI</th>
<th>EXMG</th>
<th>GEXP</th>
<th>OPEN</th>
<th>RER</th>
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<tbody>
<tr>
<td>Mean</td>
<td>18.92</td>
<td>18.25</td>
<td>.0144</td>
<td>2.740</td>
<td>3.154</td>
<td>4.102</td>
<td>4.868</td>
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<tr>
<td>Std. Dev.</td>
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<td>1.504</td>
<td>1.504</td>
<td>1.151</td>
<td>0.478</td>
<td>0.544</td>
<td>0.440</td>
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<tr>
<td>Max</td>
<td>21.43</td>
<td>21.91</td>
<td>4.978</td>
<td>5.159</td>
<td>4.073</td>
<td>6.088</td>
<td>7.503</td>
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</table>

**Notes:**

Estimates in Tables A2 and A3 are based on annual data for the 16 sub-Saharan African countries over the period 1980-2000.
<table>
<thead>
<tr>
<th>Regressors</th>
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<th>(3)</th>
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<tbody>
<tr>
<td>FDI</td>
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<tr>
<td></td>
<td>(.000)</td>
<td>(.455)</td>
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</tr>
<tr>
<td>FDI(-1)</td>
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<td>(.216)</td>
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<tr>
<td>OCF</td>
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<td>.051</td>
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<tr>
<td></td>
<td>(.002)</td>
<td>(.538)</td>
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<td>ODA</td>
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<tr>
<td>OPEN</td>
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<tr>
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<td>GEXP</td>
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<tr>
<td></td>
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<tr>
<td>EXMG</td>
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<td>(.000)</td>
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<td>Adjusted R²</td>
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<td>F-statistic</td>
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<td>Prob(F-stat)</td>
<td>.000</td>
<td>.002</td>
<td>.000</td>
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Notes:
Results are based on Fixed Effect (within) estimator with robust standard errors.
**Coefficient is significant at either 1% or 5% level.

*Coefficient is significant at 10%.

x(-1) represents one-period lag of variable x.

Numbers in parenthesis below coefficient estimates are p-values.
<table>
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<tr>
<th>Regressors</th>
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<th>GMM-Sys</th>
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<td>.549**</td>
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<tr>
<td>FDI</td>
<td>.080**</td>
<td>.015</td>
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<td></td>
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<td>(.454)</td>
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<td>FDI(-1)</td>
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<td>ODA</td>
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<td>-.135**</td>
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<td></td>
<td>(.005)</td>
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<td>OPEN</td>
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<td>(.001)</td>
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<td>(.005)</td>
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</table>

Hansen test  (.989)

Serial correlation test  (.294)    (.425)
Notes:

GMM-Diff: Difference estimator; GMM-Sys: System estimator

Results are on one-step estimates with robust standard errors.

GMM-Diff one-step estimator with robust standard errors does not produce a Hansen J-statistic.

**Coefficient is significant at either 1% or 5% level.

x(-1) represents one-period lag of variable x.

Numbers in parenthesis below coefficient estimates are p-values.

Serial correlation (second order) and Hansen tests show p-values.
<table>
<thead>
<tr>
<th>Regressors</th>
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<td>-.048**</td>
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<td>OCF</td>
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<td>(.011)</td>
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<tr>
<td></td>
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</table>

Hansen test  
(.988)    
(.989)    
(.990)  

Serial correlation test  
(.434)    
(.434)    
(.465)   

76
Notes:

Results are one-step estimates with robust standard errors (GMM System Estimator).

**Coefficient is significant at either 1% or 5% level.

$x(-1)$ represents one-period lag of variable $x$.

Numbers in parenthesis below coefficient estimates are p-values.

Serial correlation (second order) and Hansen tests show p-values.
2.5.3 Data Sources and Definitions

**Official Development Assistance**  Official development assistance and official aid (current US$) (DT.ODA.ALLD.CD) (WDI)

**Other Capital Inflows**  This is proxied by Other Investment Liabilities, N.I.E. (181), 78BGD (IFS)

**Foreign Direct Investment**  Foreign direct investment, net inflows (% of GDP) (BX.KLT.DINV.DT.GD) (WDI)

**Excess Money Growth**  This is obtained as the difference between the series Money and quasi money growth (annual %) (FM.LBL.MQMY.ZcG) and GDP growth (annual %) (NY.GDP.MKTP.KD.ZG) (IFS)

**Government Expenditure**  Expenditure, total (% of GDP) (GB.XPD.TOTL.GD.ZS) (WDI)

**Openness of Economy**  Openness in constant prices (PWT)

**Real Exchange Rate**  Real effective exchange rate index (1995 = 100) (PX.REX.REER) (IFS)
Chapter 3

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

"The analysis of the paper has been conducted subject to many limiting assumptions, including a concern with real and not nominal magnitudes, absence of international capital mobility...the key distinction between the resource movement effect and the spending effect of the boom would remain important ingredients in a more complete analysis of the issues arising from the 'Dutch disease'...We have also not touched on the issue of whether a deliberate policy of preventing a real appreciation...should be pursued.” W.M. Corden and J.P. Neary, Economic Journal (1982), p 841.
3.1 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.¹ Capital inflows have therefore been both beneficial and problematic. Thus, despite their long-term benefits in increased efficiency in investment and associated technology transfers and economic growth, capital inflows raised serious concerns among policy makers 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.² One aspect of capital inflow dynamics that has received little attention in the literature is its potential to induce resource reallocation.³ 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.⁴ This recent wave of private capital inflows could

¹The recipients include Argentina, Brazil, Chile, Colombia, Indonesia, Malaysia, Mexico, Philippines and Thailand.
³As Figures (i) and (ii) in the appendix show, 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 Philippines during the peak inflow period of 1990-1994, the changes being more pronounced in Argentina than in Philippines.
⁴Net 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 percent of gross domestic product (GDP) in the late 1980s to 2.8% in the late 1990s, which
potentially lead to the realization of the Dutch disease\(^5\) 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.

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. The aim is to ascertain the desirability of such a policy in an economy that is subject to this phenomenon. I develop a two-sector small open economy model with sticky nontradable prices, incorporating key elements of Corden and Neary’s (1982) model. I study the effects of an increase in capital inflow to the small open economy with respect to resource reallocation and real exchange rate movement when prices of nontradable goods are sticky and there exists a monetary authority that follows a specific policy rule. 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 policy maker 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. This captures a policy stance where the monetary authority is not only concerned with real appreciation via nominal exchange rate but also increasing prices of nontradables.

\(^5\)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).
I address the fundamental issue of whether monetary policy has any desirable properties in such an economy by analyzing the welfare implications of an optimal generalized Taylor rule vis-a-vis welfare under a fixed nominal exchange rate regime and a policy rule that mimics flexible prices.

The results show that an increase in capital inflow causes Dutch disease effects when monetary policy is designed to keep the nominal exchange rate fixed whereas when monetary policy follows a generalized Taylor interest rate rule featuring either the nominal exchange rate or the real exchange rate, Dutch disease effects do not occur. The differences in dynamics emanate from the variable impact of monetary policy on investment decisions. Welfare results also reveal that the optimal rule is a generalized Taylor-type rule consistent with nominal exchange rate flexibility. The intuition for this is that flexibility in the nominal exchange rate is necessary to generate optimal movements in international relative prices in response to exogenous shocks when prices are sticky. This in turn leads to optimal responses in the household’s consumption and labor supply.

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.

---

6The dependent economy model, also known as the ‘Salter-Swan-Corden-Dornbusch model’ is essentially a partial equilibrium set up of a small open economy model. It has been extensively utilized in the resource boom, capital inflow and Dutch disease literature. Corden and Neary (1982) use a dependent economy model to show the resource movement effect and spending effect from Hicks-neutral technological progress in a sub-sector of the tradable good sector, which is symptomatic of the Dutch disease. The same dynamics are associated with an exogenous inflow of capital, hence the reference to Dutch disease effects of capital inflows. See Corden and Neary (1982) for details.
effects. The existing contributions to this area of research have generally studied issues relating to real exchange rate fluctuations and current account dynamics. Examples of such studies include Serven (1995), Agenor (1998) and Gopinath (2000). Serven examines the link between real exchange movements, capital accumulation and output, and also considers effects of fiscal policy disturbances and wealth transfers on the current account. Agenor (1998) studies the effects of a fall in world interest rates on capital flows and the real exchange rate in an optimizing framework with imperfect capital markets. Gopinath (2000) models foreign investment as the outcome of a search process to derive the response of the economy to capital market liberalization, in terms of real exchange rate movements. In general, these studies make no reference to the Dutch disease effects of capital inflows. 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.

The rest of the paper is organized as follows. Section 2 presents the details of the model. Section 3 describes the solution and calibration of the model. Section 4 presents an analysis of the dynamics of the model under alternative policy rules and section 5 discusses quantitative implications of the model. Section 6 analyzes the welfare implications of monetary policy and concluding remarks are given in section 7.

3.2 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.

### 3.2.1 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 \( (\frac{M}{P}) \), 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.\(^7\) The household maximizes the intertemporal utility function:

\[
U = E_t \sum_{t=0}^{\infty} \beta^t \left[ \frac{1}{1-\sigma} C_t^{1-\sigma} + \frac{\kappa}{1-\zeta} \left( \frac{M_t}{P_t} \right)^{1-\zeta} - \psi \frac{L_t^{1+\nu}}{1+\nu} \right],
\]  

(3.1)

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

The consumption index is a CES aggregate of the nontradable good \( C_N \) and the man-

\(^7\) 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.
ufactured good $C_T$:

$$C_t = \left[ \gamma \frac{\hat{b}}{\theta} \left( C_T(t) \right)^{\theta-1} + (1 - \gamma) \frac{\hat{b}}{\theta} \left( C_N(t) \right)^{\theta-1} \right]^{\frac{\theta}{\theta-1}},$$

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:

$$C_N = \left( \int_0^1 C_N(i) \frac{\theta-1}{\theta} \right)^{\frac{\theta}{\theta-1}},$$

with $\theta > 1$ being the elasticity of substitution between individual nontradable goods. The consumer price index is:

$$P_t = \left[ \gamma \left( P_T(t) \right)^{1-\theta} + (1 - \gamma) \left( P_N(t) \right)^{1-\theta} \right]^{\frac{1}{1-\theta}},$$

where $P_N = \left( \int_0^1 P_N(i) \frac{\theta-1}{\theta} \right)^{\frac{\theta}{\theta-1}}$ 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:

$$B_{t+1} + \varepsilon_t B_{t+1}^* + \frac{\kappa}{2} (\varepsilon_t B_{t+1}^*)^2 + P_t C_t + V_t x_{t+1} + M_t$$

$$= (1 + \hat{\tau}_t) B_t + \varepsilon_t (1 + \hat{\tau}_t^*) B_t^* + (V_t + \hat{D}_t)x_t + W_t L_t + M_{t-1} + \tau_t + P_t T_t + \Pi_t. \quad (3.2)$$

$\frac{\kappa}{2} (B_{t+1}^*)^2$ 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), and more recently in Benigno (2001). This cost can be thought of as financial intermediation costs, where the financial intermediaries are local perfectly com-
petitive 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 household, so that in equilibrium, \( P_t T_t = M_t - M_{t-1} \). \( W_t \) 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:

\[
C_{T,t} = \gamma \left( \frac{P_t}{P_i} \right)^{-\theta} C_t,
\]

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

The household maximizes the intertemporal utility function (3.1) subject to the budget constraint (3.2). The optimality conditions are as follows:

\[
C_t^{-\sigma} = \beta E_t \left[ C_{t+1}\sigma(1 + i_{t+1}) \frac{P_t}{P_{t+1}} \right], \tag{3.3}
\]

\[
C_t^{-\sigma} \left[ \varepsilon_t + \kappa \left( \frac{\varepsilon_t B_{t+1}^*}{P_t} \right) \right] = \beta E_t \left[ C_{t+1}^{-\sigma} \varepsilon_{t+1}(1 + i_{t+1}^*) \frac{P_t}{P_{t+1}} \right]. \tag{3.4}
\]
Equation (3.3) in conjunction with (3.4) yields uncovered interest parity:

\[ E_t \left\{ C_{t+1}^{-\sigma} \left( \frac{P_{t+1}}{P_t} \right) \left[ (1 + i_{t+1}^*) - \frac{(1 + i_{t+1}^* + 1 + \epsilon_{t+1}^*) (\frac{s_{t+1}}{s_t})}{(1 + \kappa - \frac{B_{t+1}}{B_t})} \right] \right\} = 0, \]  

(3.7)

where \( i^* \) is the foreign interest rate which is exogenously given and assumed to follow the AR(1) process

\[ 1 + i_{t+1}^* = (1 + i_t^*)^{\eta_i^*} \exp\{\epsilon_{t^*, t+1}^*\}, \]

\[ 0 < \eta_i^* < 1; \epsilon_i^* \sim N(0, \sigma_i^*). \]
The optimality conditions (3.3)-(3.5) together imply the absence of unexploited arbitrage opportunities between bonds and shares.

The consumption-based real interest rate $r_t$ is defined by the Fisher parity condition:

$$1 + r_{t+1} = (1 + i_{t+1}) \frac{P_t}{P_{t+1}} = \frac{(1 + i_{t+1})}{1 + \pi_{t+1}},$$  

where $\pi_{t+1}$ is CPI inflation.\footnote{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.}

### 3.2.2 Firms

Production occurs in two sectors; a manufacturing sector and a nontradable sector.\footnote{Typically, a model of the Dutch disease has a tradable sector that consists of two sub-sectors 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.} 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 $I_t$, 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

$$\frac{\phi}{2} \left( \frac{I_t}{K_t} - \delta \right)^2 K_t,$$
where $\phi$ governs the size of the adjustment cost. The adjustment cost is applicable to net investment $I_t^a$, which is defined as

$$I_t^a = K_{t+1} - K_t = I_t - \delta K_t.$$  

I assume that capital is used in the manufacturing sector only, hence the nontradable good is produced using a single input in labor.\textsuperscript{10}

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

$$L = L_T + L_N,$$

where $L_T$ 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.\textsuperscript{11} In effect, capital inflow is captured by an increase in foreign investment in response to a

\textsuperscript{10}This assumption makes possible the generation of a capital-inflow-induced boom in one sector in order to capture the Dutch disease phenomenon.

\textsuperscript{11}For a related treatment of investment in studies that do not focus on Dutch disease effects, see Gertler, Gilchrist and Natalucci (2003) and Devereux and Lane (2003).
negative shock to the price of foreign investment.\textsuperscript{12}

Manufacturing Sector

**Investment Unit**  I assume that the investment unit uses a constant returns to scale technology that combines home investment ($I_H$) and foreign investment ($I_F$) to produce investment ($I$) required to maintain and accumulate capital.\textsuperscript{13} The equation describing the technology is

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

(3.9)

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 minimized unit-cost function denoted $P_I$, the replacement cost of capital expressed as

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

$P_{I,t}$ is the price of domestic manufactured good in units of domestic currency and $P_{T,t}^F$ is the price of foreign investment in units of domestic currency. I assume the law of one price holds so that $P_{T,t}^F = \varepsilon_t P_{T,t}^F$, where $P_{T,t}^F$ is the foreign currency price of foreign investment.

\textsuperscript{12} 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.

\textsuperscript{13} It has been documented that FDI flows to emerging market economies have financed increases in investment with a high imported capital content (See Calvo, Leiderman and Reinhart (1994) and Montiel and Reinhart (1999)). Therefore by this assumption, an increase in the import content of investment could be rationalized as increase in FDI inflow.
which is exogenous and follows the stochastic process

\[ P_{t+1} = (P_{t})^{\eta_{t}} \exp \{ \epsilon_{pf,t+1} \}, \]

\[ 0 < \eta_{pf} < 1; \epsilon_{pf} \sim N(0, \sigma_{pf}). \]

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

\[
\begin{align*}
\min_{\{I_H, I_F\}} & \quad P_{t} I_{H,t} + P_{t}^{F} I_{F,t} \\
\text{s.t.} & \quad \left[ \mu (I_{H,t})^{\frac{\alpha-1}{\rho}} + (1 - \mu) (I_{F,t})^{\frac{\alpha-1}{\rho}} \right]^{\frac{\rho}{\alpha-1}} = I_t.
\end{align*}
\]

The optimization yields demands for foreign and home investment respectively as

\[ I_{F,t} = (1 - \mu) \left( \frac{P_{t}^{F}}{P_{t}} \right)^{-\rho} I_t, \quad \text{(3.10)} \]

\[ I_{H,t} = \mu \left( \frac{P_{t}^{F}}{P_{t}} \right)^{-\rho} I_t. \quad \text{(3.11)} \]

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

\[ Y_{T,t} = \exp \{ a_t \} K_t^\alpha L_{T,t}^{1-\alpha} ; \quad 0 < \alpha < 1, \quad \text{(3.12)} \]

where \( a_t \) is a sector-specific productivity shock which follows an AR(1) process given by
\[ a_{t+1} = \eta_a a_t + \epsilon_{a,t+1}, \quad (3.13) \]

\[ 0 < \eta_a < 1; \epsilon_a \sim N(0, \sigma_a). \]

The unit maximizes the present discounted value of dividends,\(^{14}\)

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

subject to

\[ K_{t+1} = I_t + (1 - \delta) K_t. \quad (3.15) \]

The set of efficiency conditions for the choice variables \( K_{t+1}, I_t \) and \( L_{T,t} \) respectively are

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

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

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

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

is dividends.

\(^{14}\)The specification for the value of the production unit is obtained by deriving equation (3.14) from (3.5):
Equation (3.16) is an investment Euler equation which describes the evolution of $Q_t$, the shadow price of a unit of capital. It shows that the shadow price of a unit of capital at the end of period $t$ is equal to the expected discounted sum of the shadow price of capital at period $t+1$ net of depreciation, the marginal revenue product of capital and the installation costs of capital at period $t+1$. It represents an arbitrage condition in implicit form that equates the marginal cost of capital to the marginal gain of adding an extra unit to the capital stock. Equation (3.17) determines the investment rate as a function of Tobin's $q$, which in this case is $\frac{Q_t}{P_{t,t}}$, 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 $\frac{Q_t}{P_{t,t}} = 1$ and $\delta = \frac{1}{K}$. Equation (3.18) implies that labor is demanded up to the point where the marginal revenue product of labor equals the wage. Using the definition of net investment, equation (3.17) can be rewritten as:

$$\frac{I^n}{K_t} = \frac{Q_t}{P_{t,t}} - 1,$$  

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 ($P_{t,t}$).
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

\[ Y_{N,t}(i) = \exp \{ z_t \} L_{N,t}(i), \quad (3.20) \]

where \( z_t \) is a stochastic productivity parameter for the nontradable sector following the AR(1) process

\[ z_{t+1} = \eta_z z_t + \epsilon_{z,t+1}, \quad (3.21) \]
\[ 0 < \eta_z < 1; \epsilon_z \sim N(0, \sigma_z). \]

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:

\[ m_c \frac{Y_{N,t}(i)}{L_{N,t}(i)} = \frac{W_t}{P_{N,t}}, \quad (3.22) \]

where \( m_c = \frac{MC}{P_N} \) 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
let \( \varphi^k \) 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:

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

subject to

\[
Y_{N,t+k}(i) \leq \left( \frac{P_{N,t}(i)}{PN,t} \right)^{-\varphi} C_{N,t},
\]

where \( \Lambda_{t+k} \) is the marginal utility based discount factor. The optimal pricing condition is:

\[
\tilde{P}_{N,t}(i) = \frac{\varphi}{1-\varphi} \frac{E_t \sum_{k=0}^{\infty} \beta^k \varphi^k \Lambda_{t+k} MC_{t+k} Y_{N,t+k}(i)}{E_t \sum_{k=0}^{\infty} \beta^k \varphi^k \Lambda_{t+k} Y_{N,t+k}(i)}, \tag{3.23}
\]

where \( \tilde{P}_{N,t}(i) \) represents the newly set price for a firm that adjusts in price at period \( t \).

Equation (3.23) 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

\[
P_{N,t} = \left[ \varphi P_{N,t-1}^{1-\varphi} + (1-\varphi) \tilde{P}_{N,t}^{1-\varphi} \right]^{\frac{1}{1-\varphi}}. \tag{3.24}
\]

A combination of the log-linearized versions of (3.23) and (3.24) yields the familiar forward-looking Philips curve,

\[
\hat{\pi}_{N,t} = \beta E_t \hat{\pi}_{N,t+1} + \frac{(1-\varphi)(1-\beta \varphi)}{\varphi} \hat{m}_{C,t}, \tag{3.25}
\]

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where $\bar{mc}_t$ represents the log deviation of real marginal cost from its steady-state level. Equation (3.25) 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.

### 3.2.3 Resource Constraints

The resource constraints are:

$$L_t = L_{T,t} + L_{N,t}, \quad (3.26)$$

$$Y_{N,t} = C_{N,t}, \quad (3.27)$$

$$Y_{T,t} = C_{T,t} + I_{H,t} + X_t, \quad (3.28)$$

where $X_t$ is the component of manufacturing sector output that is exported.

### 3.2.4 The Foreign Economy

I assume the foreign economy produces a tradable good ($Y^F_T$) and non tradable good ($Y^F_N$), with prices $P^F_T$ and $P^F_N$ respectively, in units of foreign currency. A characteristic feature of a small open economy is that it can neither affect foreign prices nor output, and thus it 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,

$$X_t = \left( \frac{1}{P_{T,t}} \right)^\omega GDP^*_t; \quad \omega > 0, \quad (3.29)$$
where $X_t$ is units of manufactured good exported and $GDP_t^*$ is aggregate output in the foreign economy.\(^{15}\)

### 3.2.5 Terms of Trade, Real Exchange Rate and Current Account

The terms of trade is defined as the price of imports relative to the price of exports:

$$S_t = \frac{P^F_t}{P^{T,t}_t}. \tag{3.30}$$

The real exchange rate $e_t$ is defined as the ratio of the price of foreign consumption basket to the domestic one:

$$e_t = \frac{\epsilon_t P^*_t}{P_t}, \tag{3.31}$$

where $P^*$ is the foreign consumer price index in units of foreign currency, and is assumed to be a composite of tradable and nontradable prices.\(^{16}\) Equation (3.31) shows that an increase in domestic nontradables prices leads to an increase in the corresponding consumer price index which results in an appreciation of the real exchange rate.

The current account equation for the domestic economy is given by

$$CA_t = \epsilon_t i_t^* B_t^* + P_{T,t} X_t - P^F_{T,t} I_{F,t}. \tag{3.32}$$

\(^{15}\)See McCallum and Nelson (1998) and Gertler, Gilchrist and Natalucci (2003) for similar representations.

\(^{16}\)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.
3.2.6 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 labelled 'FER rule' delivers a fixed exchange rate regime and is given by

\[(1 + i_{t+1}) = \frac{(1 + i^*_t)}{(1 + \kappa \frac{B_{t+1}}{P_t})} \left( \frac{\varepsilon_t}{\bar{\varepsilon}} \right)^{\omega_e}, \tag{3.33} \]

where \(\omega_e > 0\), and \(\varepsilon_t = \bar{\varepsilon} \forall t\). 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.\(^{17}\)

The alternative policy rules are formulated so that the policy maker 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.\(^{18}\) The general form of the equation describing the policy rules is,

\[(1 + i_{t+1}) = (1 + r^{ss})(1 + \pi_{N,t})^{\omega_{\pi}} \left( \frac{gd_{p,t}}{gd_{p,ss}} \right)^{\omega_{gd}} \left( \frac{\varepsilon_t}{\varepsilon_{t-1}} \right)^{\omega_e} \left( \frac{g_{d,t}}{g_{d,ss}} \right)^{\omega_{gd}}, \tag{3.34} \]

where \(\omega_{\pi} > 1, \omega_{gd} > 0, \omega_e \geq 0, \) and \(\omega_{gd} \geq 0, \) are the reaction coefficients on nontradable good price inflation, GDP, nominal exchange rate depreciation and real exchange depreciation respectively, and \(r^{ss}\) and \(gd_{p,ss}\) are the steady-state real interest rate and GDP.

\(^{17}\)Benigno, Benigno and Ghironi (2005) show that such a rule ensures determinacy of the exchange rate.

\(^{18}\)Aggregate output (GDP) in the model is defined as the sum of output of all sectors: \(GDP = Y_T + Y_N.\)

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respectively. The first alternative rule, 'NER rule', is given by equation (3.34) with $\omega_e = 0$, and the second alternative, the 'RER rule' is given by the same equation with $\omega_e = 0$.

### 3.3 Solution and Calibration

I obtain a numerical solution for the model by taking log-linear approximations of the equilibrium conditions and employing the methods described in Uhlig (1999). 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.

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\(^{19}\) 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 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

\(^{19}\)The calibration for the parameters of the manufacturing sector generally follows features of the tradable sector in an otherwise conventional two-sector small open economy model.
cost of capital, \( \phi = 3 \), all following Devereux and Lane (2003). I follow the standard in the literature on Calvo-style pricing behavior, and set the probability of price non-adjustment \( \varphi = 0.75 \), 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 parameters, I set \( \omega_{\pi_N} = 1.5 \) and \( \omega_{gdp} = 0.5 \) as in the familiar Taylor rule. I set \( \omega_e = 0.45 \) following Svensson (2000) when monetary policy is described by the RER rule and \( \omega_e = 0 \) otherwise. For the NER rule, \( \omega_e \) is set to 0.2, otherwise it is set to 0. With respect to the standard deviations of innovations, I assume that of the manufacturing sector, \( \sigma_a = .007 \) and for the nontradable sector, \( \sigma_z = .0035 \) following the RBC literature. I also assume the standard deviation of innovation to the foreign interest rate and price of foreign investment to be \( \sigma_i = .0032 \) and \( \sigma_{pi} = .005 \) respectively. The degree of persistence for all exogenous stochastic processes is set to 0.95.

### 3.4 Model Dynamics

I analyze impulse responses of selected variables to a 1 percent negative shock to the price of foreign investment. Firstly, 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 under different monetary policy rule specifications. The objective is to draw implications of the model with respect to the Dutch disease. 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
3 shows a comparison of impulse responses under the NER and RER rules. The focus is on the behavior of variables that are key to Dutch disease effects.

### 3.4.1 Flexible Price Setting

As Figure 1 shows, 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 whiles nontradable sector labor rises.\(^{20}\)

### 3.4.2 The Dynamics under Alternative Policy Rules

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. When monetary policy is designed to follow the FER rule, the capital stock declines in response to the shock. 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,\(^{20}\)These dynamics are identical to the results given by Corden and Neary's (1982) partial equilibrium model.
which also depends on the expected discounted marginal revenue product of capital and the future value of capital, declines upon 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.

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 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.

When monetary policy is given by the RER rule, the dynamics are essentially the same.
as under the NER rule. There is accumulation of capital and expansion in output of manufactures when the shock hits the economy. Consumption of both manufactures and nontradables decline upon impact of the shock. Consumption of both goods increase in the following period but the rise in nontradables demand is only to the extent that it approaches the steady state level. Nontradable price inflation falls and the real exchange rate depreciates following the shock.

These dynamics suggest that an increase in foreign capital due to negative foreign price shock 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.

3.4.3 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. The introduction of price stickiness and monetary policy 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 manufacturing sector labor by the manufacturing sector to the nontradable sector observed in a flexible price setting.

However the dynamics under the FER rule show an expansion of the nontradable sector and a contraction of the manufacturing sector. This could be explained by the non-targeting of nontradable inflation which makes possible the increase in nontradables consumption and its consequent rise in nontradable inflation. The observed increase in nontradable sector labor and the effect of nontradable price increase on the real exchange rate are stronger under the FER rule relative to the flexible price case. The differences in the model’s dynamics are generated by the variable impact of the policy rules on consumption and investment decisions.

3.5 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). Tables 2 and 3 show business cycle
statistics for Argentina and the Philippines, and theoretical moments from the model.

Table 2 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-a-vis the observed volatility in the two
emerging market economies. The predicted volatility of the current account is greater than
observed in Argentina but higher 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 Philippines. It
however predicts a smaller volatility of investment relative to GDP than observed in both
economies.

Table 3 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 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 Philippines.

3.6 Welfare Analysis

The dynamics of the model show that under sticky nontradable prices, a nominal exchange rate peg appears 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.\(^{21}\) 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.

\(^{21}\)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).
The welfare criterion used is the unconditional expectation of the second-order Taylor expansion of the household’s utility function around the steady state given by

\[ W_t = \frac{C^{1-\sigma}}{1-\sigma} - \psi \frac{L^{1+\nu}}{1+\nu} - \frac{\sigma}{2} \var(C_t) - \frac{\psi \nu L^{1+\nu}}{2} \var(L_t), \] (3.35)

where \( C \) and \( L \) are steady state values of consumption and labor respectively, and variables with a hat notation denote percentage deviations from the steady state.\(^{22}\)

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.\(^{23}\) I allow for a more general specification of the interest rate rule for this class of rules given by

\[(1 + i_{t+1}) = (1 + i_t)^{\omega_i} (1 + r^{eq}) (1 + \pi_{N,t})^{\omega_{\pi}} N \left( \frac{gdp_t}{gdp_{ss}} \right)^{\omega_{gdp}} \left( \frac{e_t}{e_t^{-1}} \right)^{\omega_e}, \] (3.36)

where \( \omega_i \geq 0 \) is the degree of interest rate smoothing; all other variables are as previously defined.\(^{24}\)

The optimal reaction parameters are as follows: \( \omega_i = 0.75, \omega_{\pi} = 2.8282, \omega_{gdp} = 0, \omega_e = 0, \omega_e = 0.05. \) 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

\(^{22}\)I follow the literature and assume that real money balances do not affect welfare of the representative household.

\(^{23}\)Such rules are optimal for the given class of rules under consideration. Solution for optimal policies is obtained using numerical methods.

\(^{24}\)I introduce interest rate smoothing to accommodate other possible representations in this class of rules.
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 policy maker 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. In particular, as shown in Figure 5, the optimal rule prevents the initial fall in consumption that occurs on impact of the shock 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.

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25 A policy rule that mimics flexible prices can be achieved by aggressively reacting to nontradable inflation. I label this policy rule as NIT rule elsewhere in the paper.

26 Benigno and Benigno (2003) show that a flexible price allocation is optimal in a small open economy only under special conditions, which are not satisfied in this model. Thus this shows a situation where the flexible price allocation can be improved upon.
3.7 Conclusions

This paper developed a two-sector dynamic stochastic general equilibrium model to examine 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 policy maker 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 no occur under this rule, and therefore the results suggest that addressing Dutch disease effects via such a rule in a representative economy is desirable.
Bibliography


### 3.8 Appendix

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
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<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>
</tr>
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<td>$\kappa$</td>
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<td>Coefficient on adjustment cost for bond holding</td>
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<td>Coefficient on labor in utility</td>
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<td>Elasticity of substitution between home and foreign investment</td>
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<td>$\nu$</td>
<td>0.83</td>
<td>Inverse of elasticity of labor supply</td>
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<td>$\alpha$</td>
<td>0.33</td>
<td>Share of capital in manufacturing sector</td>
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<td>$\phi$</td>
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<td>Capital adjustment cost parameter</td>
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</tr>
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<td>$\sigma_{PF}$</td>
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<td>Standard deviation of foreign price shock</td>
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<td>$\sigma_{i^*}$</td>
<td>0.0032</td>
<td>Standard deviation of foreign interest rate shock</td>
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<td>$\sigma_a$</td>
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<td>Standard deviation of innovation (Manufacturing)</td>
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<tr>
<td>$\sigma_z$</td>
<td>0.0035</td>
<td>Standard deviation of innovation (Nontradable)</td>
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Table 2: Standard Deviations and Relative Standard Deviations

<table>
<thead>
<tr>
<th>Variable</th>
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<th>Philippines</th>
<th>FER</th>
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<tbody>
<tr>
<td>GDP</td>
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<td>0.01</td>
<td>0.01</td>
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<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>
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<tr>
<td>Consumption/GDP</td>
<td>1.38</td>
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<tr>
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<td>2.53</td>
<td>6.29</td>
<td>0.58</td>
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<td>0.21</td>
<td>0.06</td>
<td>0.15</td>
</tr>
<tr>
<td>Manufactures</td>
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<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>
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Table 3: Contemporaneous Correlation with GDP

<table>
<thead>
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<th>Philippines</th>
<th>FER</th>
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</thead>
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<tr>
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<tr>
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<td>-0.20</td>
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</table>

Note: Sample moments for Argentina and The Philippines in Tables 2 and 3 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 (2004). All series are logged (except current account) and filtered using 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.
Table 4: Policy Rules and Macroeconomic Volatility

<table>
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<th>RER</th>
<th>NIT</th>
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<td>0.02</td>
<td>0.01</td>
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Note: NIT represents a strict nontradable inflation targeting policy rule that mimics flexible prices. In this table, I present the standard deviation of selected variables under alternative policy rules for comparison purposes only.
Fig i. Argentina

Fig ii. Philippines

Notes: Figures are based on data from World Development Indicators (WDI) 2002. Nontradables represent services as defined in the database
Fig. 1: Impulse Response Functions—Flexible prices (squares), FER (circles)
Fig. 2: Impulse Response Functions-NER (squares), FER (circles)
Fig. 3: Impulse Response Functions-NER (squares), RER (circles)
Fig. 4: Impulse Response Functions - Optimal Rule
Fig. 5: Top panel-optimal rule (squares), FER (circles)
Bottom panel-optimal rule (squares), Flexible prices (circles)