Small Open-Economy DSGE Model with Natural Disaster Shocks and Foreign Aid

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DESPITE MARKET EXPECTATIONS, HURRICANE HARVEY MAY PUSH INTEREST RATES UP

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Hurricanes, Interest Rates And Student Loans

Stephen Dash, CONTRIBUTOR
FULL BIO

Rebuilding fuels economic activity, the theory goes, with investors also anticipating an elevated risk of inflation that would push the Federal Reserve to raise short-term interest rates.

Equities UK banks Markets Central Banks

Monetary policy in a time of natural disaster

FEBRUARY 23, 2011 4:33 PM
By: Tracy Alloway

Here's a counter-intuitive policy suggestion, if ever there was one.

> Also supporting the case against an emergency RBNZ easing is a paper released by the Federal Reserve Bank of St Louis research department titled, "Monetary Policy and Natural Disasters in a DSGE Model: How Should the Fed Have Responded to Hurricane Katrina? (http://econpapers.repec.org/paper/fipfedlwp/2007-025.htm)", 20 June 2007. **The authors' Taylor Rule modelling actually suggests the policy response to a natural disaster is an interest rate hike.**

Keen and Pakko (2011)

Article

Monetary Policy and Natural Disasters in a DSGE Model

Benjamin D. Keen, Michael R. Pakko

First published: 1 April 2011 Full publication history

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Abstract

In the immediate aftermath of Hurricane Katrina, speculation arose that the Federal Reserve might respond by easing monetary policy. This article uses a dynamic stochastic general equilibrium (DSGE) model to investigate the appropriate monetary policy response to a natural disaster. We show that the standard Taylor rule response in models with and without nominal rigidities is to *increase* the nominal interest rate. That finding is unchanged when we consider the optimal policy response to a disaster. A nominal interest rate increase following a disaster mitigates both temporary inflation effects and output distortions that are attributable to nominal rigidities.

Foreign Aid and Natural Disasters

Coping with Disaster: The Impact of Hurricanes on International Financial Flows, 1970-2002

Dean Yang

Published Online: 2008-06-17 | **DOI:** https://doi.org/10.2202/1935-1682.1903

Original Article

Foreign Aid in the Aftermath of Large Natural Disasters

Oscar Becerra, Eduardo Cavallo, Ilan Noy

First published: 10 July 2014 Full publication history

DOI: 10.1111/rode.12095 View/save citation

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Abstract

How well do countries cope with the aftermath of natural disasters? Do international financial flows buffer countries in the wake of disasters? This paper examines the impact of hurricanes on resource flows to developing countries. Using meteorological data, I construct a time-varying storm index taking into account the fraction of a country's population exposed to storms of varying intensities. Overall, hurricanes lead to large increases in foreign aid. For other types of international financial flows, the impact of hurricanes varies according to income level. For poorer countries, hurricanes lead to increases in migrants' remittances, so that total inflows from all sources in the three years following hurricane exposure amount to roughly four-fifths of estimated damages. For richer countries, by contrast, hurricanes stimulate inflows of new lending from multilateral institutions, but offsetting declines in private financial flows are so large that the null hypothesis of zero damage replacement cannot be rejected.

PHILIPPINES

Yolanda (Typhoon Haiyan): Aid, donations from int'l community

(7th UPDATE) More than 20 countries promise to help

Rappler.com

Published 1:20 PM, November 12, 2013
Updated 5:51 PM, November 28, 2013

Foreign aid for Yolanda survivors continues

Helen Flores, Ghio Ong (The Philippine Star) - December 2, 2013 - 12:00am

Foreign Aid and Dutch Disease

Aid, Dutch disease, and manufacturing growth

Raghuram Rajan and Arvind Subramanian

Journal of Development Economics, 2011, vol. 94, issue 1, 106-118

Abstract: We examine the effects of aid on the growth of manufacturing, using a methodology that exploits the variation within countries and across manufacturing sectors, and corrects for possible reverse causality. We find that aid inflows have systematic adverse effects on a country's competitiveness, as reflected in the lower relative growth rate of exportable industries. We provide some evidence suggesting that the channel for these effects is the real exchange rate appreciation caused by aid inflows. We conjecture that this may explain, in part, why it is hard to find robust evidence that foreign aid helps countries grow.

Dutch Disease Investigated: Empirical Evidence from Selected South-East Asian Economies.

Source: Journal of Economic Cooperation & Development . 2011, Vol. 32 Issue 4, p51-74. 24p. 5 Charts, 4 Graphs.

Author(s): Javaid, Shahid Hussain

Abstract:

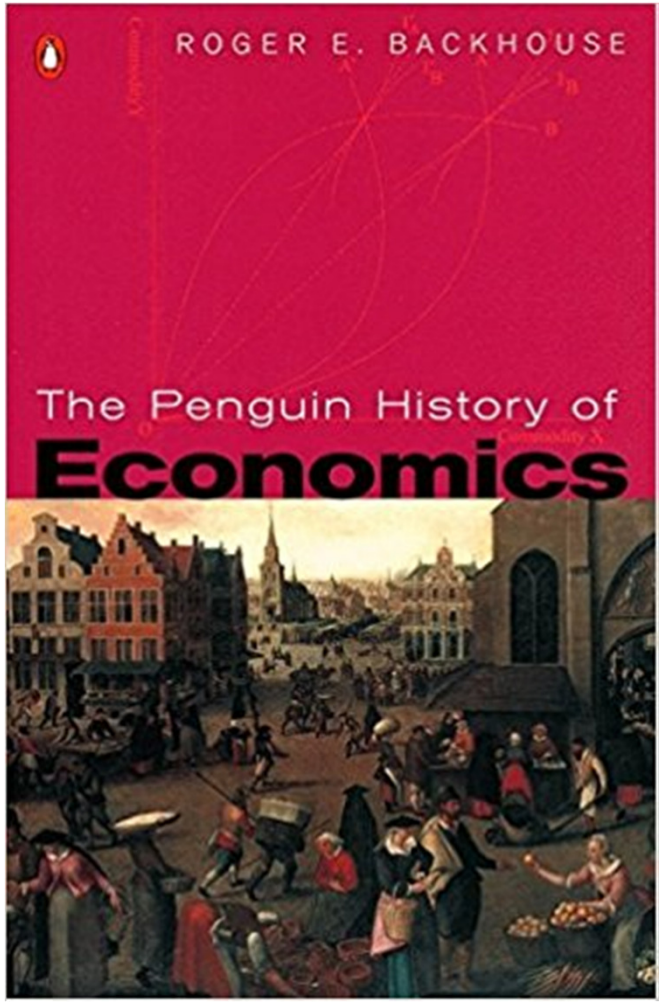
This paper investigates Dutch Disease hypothesis analyzing the impact of foreign inflows on appreciating real exchange rate. The paper also studies contraction in the tradable sector in selected South East Asian countries over 1981-2007. Using static and dynamic panel data techniques, the study first estimates real exchange rate appreciation due to surge in foreign inflows and then estimates contraction in the tradable and expansion in the non-tradable sector. On the basis of empirical evidence the study confirms the Dutch Disease hypothesis in the countries studied.

Objectives

This study has the following objectives that it aims to resolve:

- Development of a small open economy DSGE model with natural disaster shocks and foreign aid for the Philippine economy.
- Study the effects of natural disasters on a small open economy DSGE Model with foreign aid considerations.
- Evaluate results obtained from the model and compare with existing studies on the macroeconomics impact of natural disasters

Why DSGE?



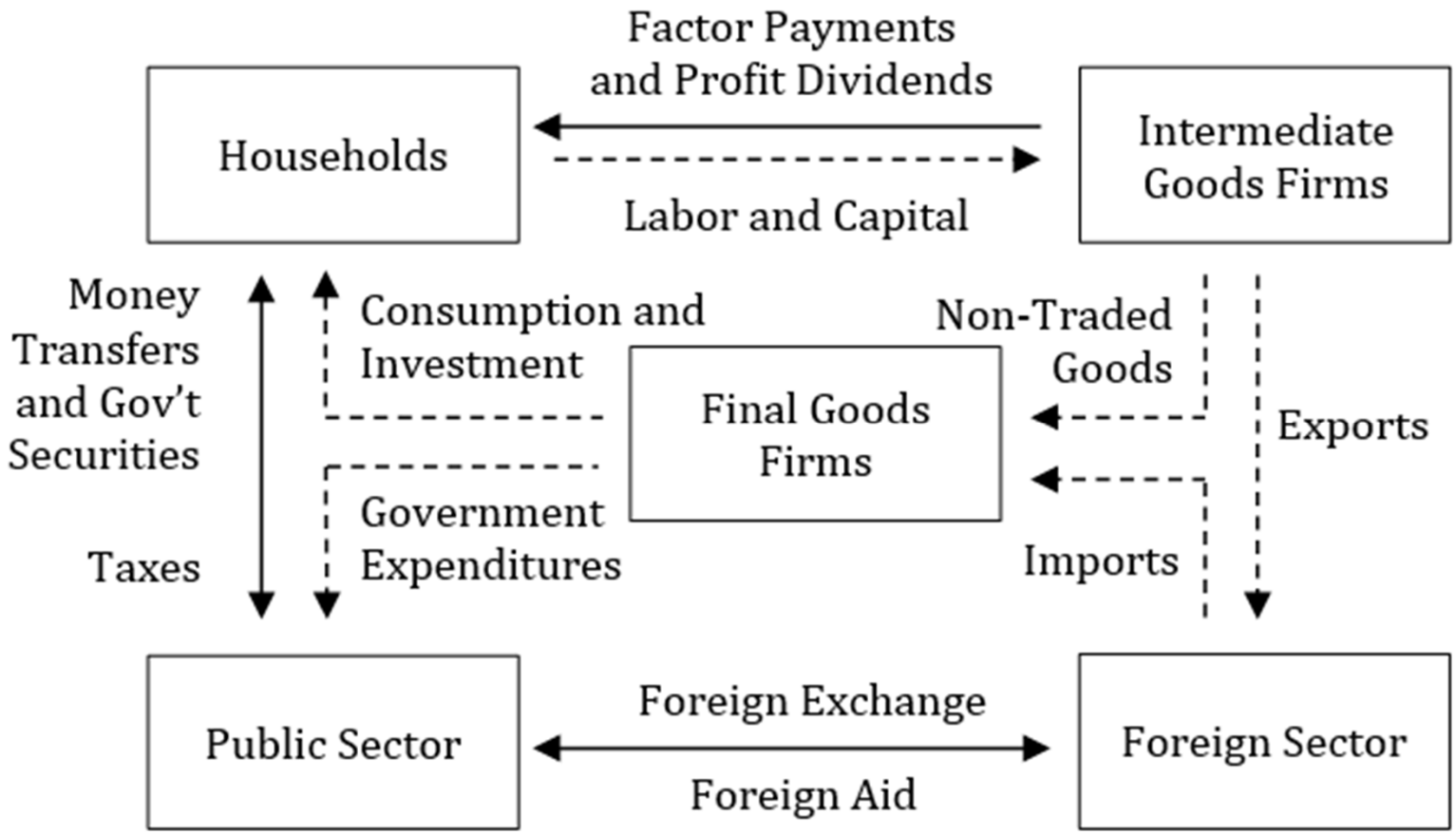
The New Classical Macroeconomics

In the 1970s, in the wake of the first oil crisis, macroeconometric forecasting models began to forecast very badly. Attempts were made to repair them, introducing new equations and redesigning existing ones. However, such attempts were not very successful. It became clear that, despite the enormous resources that had been put into them, these models did not perform significantly better than much simpler ones. An explanation of why this was so was provided by Robert E. Lucas Jr (1937–) in 1976. The essential argument in what has come to be called the 'Lucas critique' is that

the behaviour of the private sector depends on people's expectations of what the government is going to do.

In a series of papers starting in 1972, Lucas argued that macroeconomic models ought to be based on the assumption that individuals were completely rational and that they took advantage of all opportunities open to them.

Structure of the Model



Household

- Representative household maximizes

$$\mathbb{E}_t \sum_{s=0}^{\infty} \beta^{t+s} \left[\ln C_{t+s}(j) - \frac{\vartheta}{1+\psi} L_{t+s}(j)^{1+\psi} + \frac{1}{1-\eta} \left(\frac{M_{t+s}(j)}{P_{t+s}} \right)^{1-\eta} \right]$$

subject to

$$\begin{aligned} M_{t+s}(j) + B^p_{t+s}(j) + P_{t+s}[C_{t+s}(j) + I_{t+s}(j)] \\ = M_{t+s-1}(j) + (1 + i_{t+s-1}) B^p_{t+s-1}(j) + \int_0^1 \Pi^d_{t+s}(i) di + W_{t+s} L_{t+s}(j) \\ + R_{t+s} K_{t+s}(j) - T_{t+s} \end{aligned}$$

$$K_{t+s+1}(j) = (1-\delta) K_{t+s}(j) + I_{t+s}(j) - \frac{\phi}{2} \left(\frac{I_{t+s}(j)}{K_{t+s}(j)} - \delta \right)^2 K_{t+s}(j)$$

Households

$$\vartheta L_t^{\psi} = \frac{1}{C_t}\frac{W_t}{P_t}$$

$$\frac{1}{1+i_t} = \beta \mathbb{E}_t\left[\frac{C_t}{C_{t+1}}\frac{1}{\pi_{t+1}}\right]$$

$$\left(\frac{M_t}{P_t}\right)^{-\eta} = \frac{i_t}{1+i_t}\frac{1}{C_t}$$

$$\frac{I_t}{K_t} - \delta = \frac{1}{\phi}\left(1 - \frac{1}{q_t}\right)$$

$$1 = \beta \mathbb{E}_t\left[\frac{C_t}{C_{t+1}}\frac{q_{t+1}}{q_t}\left[\frac{R_{t+1}/P_{t+1}}{q_{t+1}} + (1-\delta) - \frac{\phi}{2}\left(\frac{I_{t+1}}{K_{t+1}} - \delta\right)^2 + \phi\left(\frac{I_{t+1}}{K_{t+1}} - \delta\right)\frac{I_{t+1}}{K_{t+1}}\right]\right]$$

Final Goods Production

- Production of final goods is given by a CES production function

$$Y_t = \left[\varphi^{\frac{1}{\sigma}}(Q_t^n)^{\frac{\sigma-1}{\sigma}} + (1-\varphi)^{\frac{1}{\sigma}}(Q_t^m)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

- Profit maximization yields the demand function for each intermediate good and the consumer price index

$$Q_t^n = \varphi\left(\frac{P_t^n}{P_t}\right)^{-\sigma} Y_t$$

$$Q_t^m = (1-\varphi)\left(\frac{P_t^m}{P_t}\right)^{-\sigma} Y_t$$

$$P_t = [\varphi(P_t^n)^{1-\sigma} + (1-\varphi)(P_t^m)^{1-\sigma}]^{\frac{1}{1-\sigma}}$$

Intermediate Goods Production

- Domestic intermediate goods are produced by the following aggregate Cobb-Douglas production function

$$Y_t^d = Z_t (K_t')^{\alpha} L_t^{1-\alpha}$$

- Domestic intermediate goods are sold to both domestic and foreign final goods market. Cost minimization yields the firm's labor and capital demand functions

$$L_t = \frac{Y_t^d}{Z_t}\left(\frac{R_t}{W_t}\frac{1-\alpha}{\alpha}\right)^{\alpha}$$

$$K_t' = \frac{Y_t^d}{Z_t}\left(\frac{R_t}{W_t}\frac{1-\alpha}{\alpha}\right)^{\alpha-1}$$

Intermediate Goods Production

- The total and marginal cost functions, respectively, are

$$\Psi\left(Y_t^d\right) = \frac{Y_t^d}{Z_t} \frac{R_t^{\alpha} W_t^{1-\alpha}}{(1-\alpha)^{1-\alpha}\alpha^{\alpha}}$$

$$\Psi_t' = \frac{1}{Z_t} \frac{R_t^{\alpha} W_t^{1-\alpha}}{(1-\alpha)^{1-\alpha}\alpha^{\alpha}}$$

Nontraded Goods Sector

- Representative Firm maximizes

$$\mathbb{E}_t \sum_{s=0}^{\infty} \rho_{t,t+s} \left[P_{t+s}^n(i) Q_{t+s}^n(i) - \Psi'_{t+s} Q_{t+s}^n(i) - P_{t+s}^n \frac{\theta}{2} \left(\frac{P_{t+s}^n(i)}{P_{t+s-1}^n(i)} - 1 \right)^2 Q_t^n \right]$$

- Profit maximization gives the inflation equation

$$1 - \frac{\nu}{\nu - 1} \frac{\Psi'_t}{P_t^n} = -\frac{\theta}{\nu - 1} (\pi_t^n - 1)\pi_t^n + \frac{\theta}{\nu - 1} \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}^1}{\lambda_t^1} \frac{Q_{t+1}^n}{Q_t^n} (\pi_{t+1}^n - 1)\pi_{t+1}^n \right]$$

Imported Goods Sector

- Importing firms are assumed to purchase foreign goods at the exogenous world price P_t^* and resells them in the domestic market such that

$$P_t^m = \frac{\nu}{\nu - 1} e_t P_t^*$$

where P_t^m is price of imported intermediate goods and e_t is the nominal exchange rate. The markup set by importing firms is assumed to be the same as that of the domestic firms.

Exported Goods Sector

- The demand for exported goods Q_t^x is assumed to have the same structure as the domestic non-traded demand

$$Q_t^x = \varphi \left(\frac{P_t^x}{P_t^*} \right)^{-\varsigma}$$

where P_t^x is the price of exported goods and ς is the foreign elasticity of substitution. The law of one price is also assumed to hold in the export market such that $e_t P_t^x = P_t^n$.

Public Sector

- The public sector is composed of the government and central bank which serves as the fiscal and monetary authority, respectively.
- The central bank balance sheet is given by

$$\Delta M_t = e_t \Delta X_t + \Delta B_t$$

- The government budget constraint is given by

$$\Delta B_t + \Delta B_t^p = P_t G_t + i_{t-1} B_{t-1}^p - T_t - e_t A_t$$

Public Sector

- The government commits to the fiscal rule of fully spending any foreign aid received

$$P_t G_t = PG + (e_t A_t - eA)$$

- The central bank follows a policy rule on foreign exchange intervention and open-market operations.

$$\Delta X_t = \gamma_{11}(X - X_{t-1}) + (1 - \gamma_{12})(A_t - A) + \gamma_{13} \ln\left(\frac{g_t}{g}\right) + \gamma_{14} \ln\left(\frac{\pi_t}{\pi}\right)$$

$$\Delta B_t^p = \gamma_{21} e_t \Delta X_t + \gamma_{22} \ln\left(\frac{\pi_t}{\pi}\right) + \gamma_{23}(Y_{t-1} - Y) + \gamma_{24}\left(B^p - B_{t-1}^p\right)$$

Aggregation and Market Clearing

- Aggregate profits from domestic firms are given by

$$\int_0^1 \Pi_t^d(i)di = P_t^n Q_t^n + e_t P_t^x Q_t^x - W_t L_t - R_t K_t$$

- The aggregated household budget constraint is given by the equation

$$\Delta M_t + \Delta B_t^p + P_t(C_t + I_t) = i_{t-1} B_{t-1}^p + P_t^n Q_t^n + e_t P_t^x Q_t^x - T_t$$

- Market equilibrium in the intermediate and final goods markets are, respectively

$$Y_t^d = Q_t^n + Q_t^x$$

$$Y_t = C_t + I_t + G_t$$

Balance of Payment

- Combing both public and private budget constraints with the market equilibrium conditions gives the balance of payment equation

$$e_t \Delta X_t = e_t A_t + e_t P_t^x Q_t^x - P_t^m Q_t^m$$

Natural Disasters

- A natural disaster is assumed to occur at the beginning of the period before production begins. Since disasters seldom occur, the disaster shock is modeled using a two-state Markov switching process

$$\mathbf{P} = \begin{bmatrix} p_{11} & 1 - p_{22} \\ 1 - p_{11} & p_{22} \end{bmatrix}$$

where $p_{ij} = \text{Prob}\left(D_t = D^j \middle| D_{t-1} = D^i\right)$.

Natural Disasters

- Following the discussion in Hamilton (1994), a log-linearized version of the Markov switching process is expressed in the following form

$$\widetilde{D}_t = \rho_D \widetilde{D}_{t-1} + \varepsilon_t^D$$

Natural Disasters

- The nondestroyed capital K_t' that is available for use in production is assumed to follow

$$\tilde{K}_t' = \tilde{K}_t - \kappa \tilde{D}_t$$

- The productivity factor is composed of the usual productivity shock z_t that follows an AR(1) process and an additional component related to the natural disaster shock variable

$$\tilde{Z}_t = \tilde{z}_t - \zeta \tilde{D}_t$$

$$\tilde{z}_t = (1 - \rho_z) \upsilon \tilde{Q}_t^x + \rho_z \tilde{z}_{t-1} + \varepsilon_t^z$$

- The occurrence of natural disasters triggers a surge of emergency foreign aid such that

$$\tilde{A}_t = \tilde{a}_t + \varrho \tilde{D}_t$$

$$\tilde{a}_t = \rho_a \tilde{a}_{t-1} + \varepsilon_t^a$$

Welfare Evaluation

- Following Parrado (2004), the welfare criterion used in the study is specified as follows

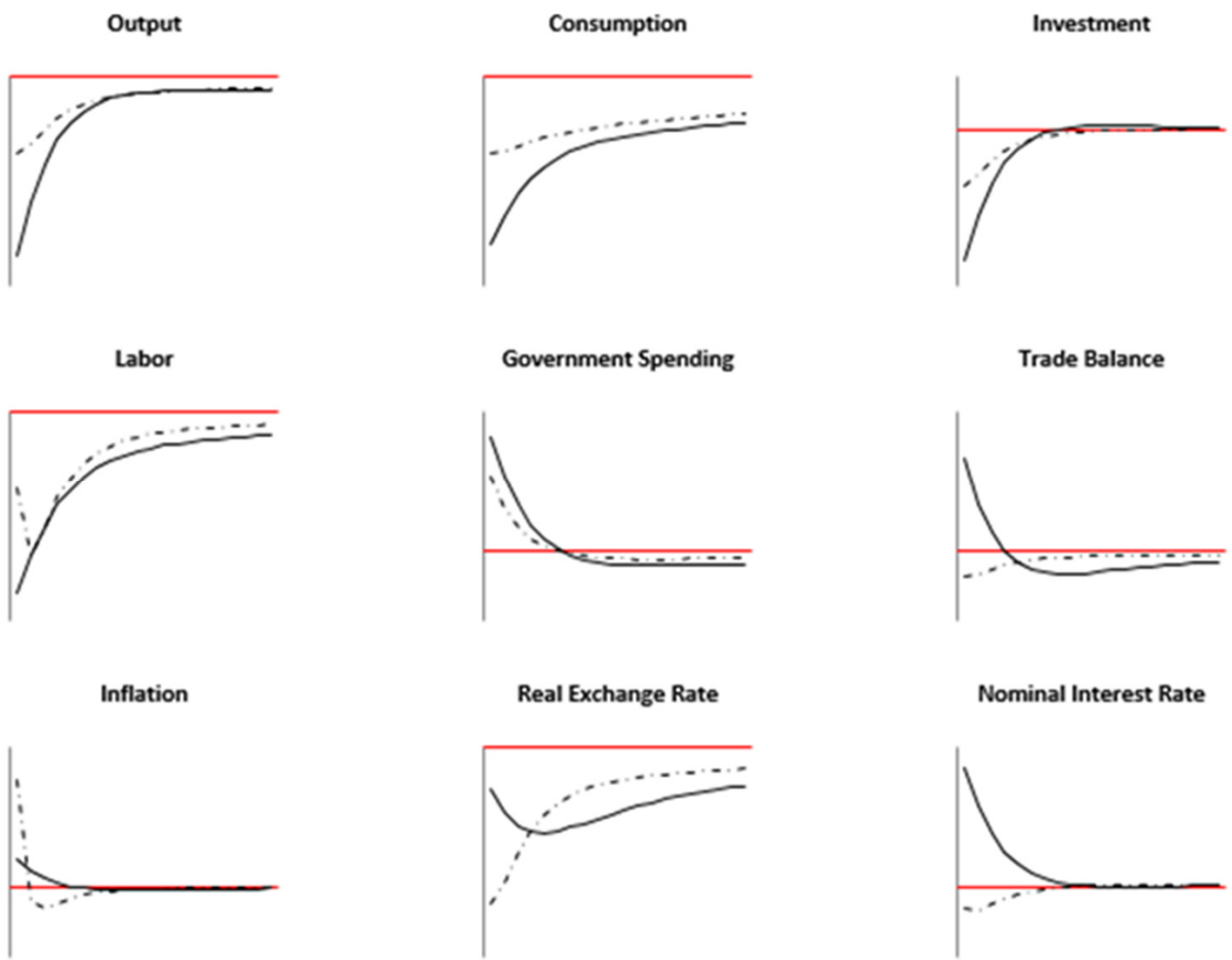
$$L = \Phi_Y \mathbb{V}[Y_t] + \Phi_\pi \mathbb{V}[\pi_t] + \Phi_\epsilon \mathbb{V}[\epsilon_t]$$

where ϵ_t denotes the real exchange rate in terms of domestic goods per foreign goods and the parameters Φ_Y, Φ_π , and Φ_ϵ reflect the weights attached to each macroeconomic indicator.

Calibration

Parameter	Symbol	Value
Discount Factor	β	0.990
Depreciation Rate	δ	0.025
Share of Capital	α	0.330
Home Bias	φ	0.450
Degree of Learning-by-Doing	υ	0.300
Inverse Frisch Elasticity	ψ	1.000
Disutility of Labor	ϑ	3.000
Inverse Money Elasticity	η	2.000
Elasticity of Substitution Between Domestic and Imported Goods	σ	1.500
Elasticity of Substitution Among Domestic Intermediate Goods	ν	10.00
Price Elasticity of Foreign Intermediate Goods	ς	3.500
Capital Adjustment Cost	ϕ	1.000
Price Adjustment Cost	θ	10.00
Disaster Elasticity to Capital	κ	1.000
Disaster Elasticity to Productivity	ζ	1.540
Disaster Elasticity to Foreign Aid	ϱ	0.700

Simulation Results



Optimal Monetary Policy

- The table below summarizes the variances of total output, inflation, and real exchange rates as well as the welfare losses computed using equation in the previous section for each monetary policy regime.

Monetary Policy Rule	Y	π	ϵ	L
Inflation Targeting	6.78E-04	1.08E-06	4.00E-05	3.61E-04
Exchange Rate Intervention	2.14E-04	1.02E-05	3.36E-05	1.39E-04

Concluding Remarks

- The conclusion of Keen and Pakko (2011) may be valid for advanced economies such as the US where open market considerations can be omitted from the analysis; however, for developing countries that are export reliant and recipients of foreign aid, open market considerations are indeed paramount in policy analysis.
- The key contribution of this study to the literature is that it provides sufficient evidence that the optimal monetary policy response may vary in certain economic problems.
- Occasional discretion on the part of the monetary authority may be advised.