Non-tradeable Sector and Inflation Targeting

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This paper examines the effects of inflation targeting policy in a small-open economy, that of Korea. It develops a two-sector model with tradeable and non-tradeable sectors, and compares the effects of aggregate inflation targeting and non-tradeable inflation targeting.

The tradeable and non-tradeable price index that the paper computes shows that non-tradeable inflation dominated tradeable inflation in the 1990s before the currency crisis. During 1998-1999, however, tradeable inflation dominated non-tradeable inflation. Meanwhile, from 2000 non-tradeable inflation was dominant again. And during 1986-2001 aggregate inflation was relatively sensitive to import price movements while non-tradeable inflation was more influenced by excess demand and unit labor costs.

From the model economy, it is found that non-tradeable inflation targeting is superior to aggregate inflation targeting in stabilizing non-tradeable inflation and output, but not in stabilizing aggregate inflation. In response to domestic shocks, non-tradeable inflation targeting exercises an active role in adjusting interest rates. But in response to exchange shocks, non-tradeable inflation targeting is passive in controlling interest rates while tolerating volatile exchange rate movements..

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Ⅰ. Introduction

Over the past decade inflation targeting has aroused considerable interest among the monetary authorities and academics. Inflation targeting in one form or another has been adopted in a number of countries including New Zealand, Canada, England, Sweden, Australia, Israel and Spain.

Korea also adopted this monetary policy strategy in 1998. The monetary authority has successfully achieved its inflation target in two years 2000 and 2002, but failed to meet it in three years 1998, 1999, and 2001. It is interesting to note that the exchange rate moved within a moderate range in 2000 and 2002, but the domestic currency appreciated in 1998 and 1999 when the monetary authority did not achieve its inflation target. Similarly, the Korean Won depreciated in 2001 when the monetary authority undershot inflation target. From these findings we make sure that for a small open economy such as Korea, domestic prices are largely influenced by shocks through the foreign sector.

To explore the effects of inflation targeting in Korea, we consider an open economy including the exchange rate. Specifically we set up a two-sector economy a tradeable and a non-tradeable sector. In the literature, some researchers similarly investigate inflation targeting in a two-sector open economy. For example, Svensson (2000) sets up a model with a domestically produced good and an imported good. He finds that flexible CPI inflation targeting does not limit the variability of the CPI, but brings about lower variability of the GDP-gap and the exchange rate.

Bharucha and Kent(1998) develop a model with a tradeable good and a non-tradeable good. They use the model to evaluate inflation targeting for Australia. They find that aggregate inflation targeting facilitates a more active monetary policy in response to foreign exchange rate shocks than does non-tradeable inflation targeting. However, in response to domestic shocks non-tradeable inflation targeting makes a more active monetary policy possible.

We utilize a model of a small open economy similar to that found in Bharucha and Kent. The economy produces a tradeable and a non-tradeable good. To estimate the two-sector model, we first compute the price indices of the tradeable sector and the non-tradeable sector. We investigate what determines aggregate inflation and non-tradeable inflation by estimating the inflation equation. Then we compare the effects of aggregate inflation targeting and non-tradeable inflation targeting by simulating the two-sector model.

The paper is organized as follows. Section II classifies the CPI index into a

tradeable sector and a non-tradeable sector, and regresses the aggregate inflation equation and the non-tradeable inflation equation. In Section III, we develop a small open economy of two sectors and describe solution method for a rational expectations linear model. We specify the parameter values of the model and simulate it to evaluate inflation targeting in Section IV. Finally, Section V concludes the paper.

Ⅱ. Price Index of Non-tradeable Sector

In order to investigate how an open economy responds to a foreign shock, we consider a two- sector economy with a tradeable and a non-tradeable sector. Before developing a two-sector model economy, in this section we compute the price indices of both the tradeable sector and the non-tradeable sector. To do this, we classify the items of the CPI index into a tradeable and a non-tradeable sector in terms of the inherent tradability of the item. Accordingly, most goods are classified within the tradeable sector, but most services are classified within the non-tradeable sector. Some goods that are not inherently tradeable, for example, newspapers or books, are also classified within the non-tradeable sector.

Meanwhile, we can use practical trade data to classify items into the tradeable or the non-tradeable sector. For example, using the Input/Output table we can define a tradeable good as one having above a certain share of exports or degree of import competition. To do this, we must set a certain ratio, for example, 10 percent or 20 percent as a criterion. It is, however, difficult to find an appropriate criterion for the export ratio or import competition ratio because no objective levels are to be found in the literature. As an alternative, I divide goods and services into the tradeable or the non-tradeable sector on an arbitrary criterion of tradability as mentioned above.

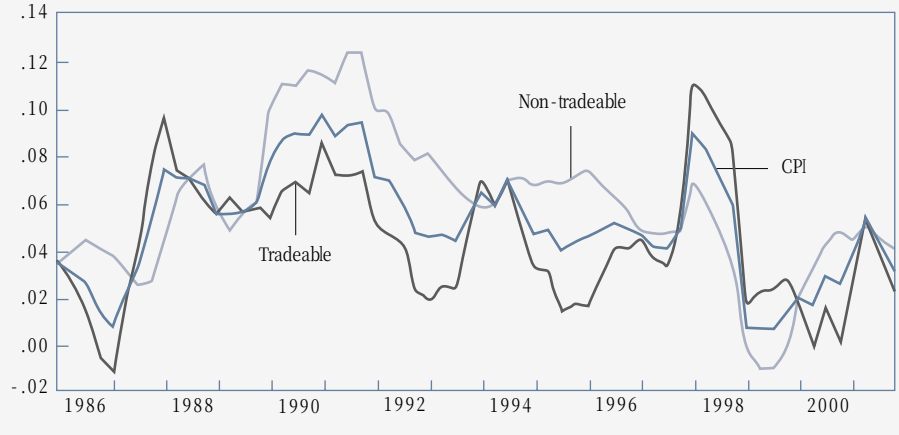
<Table 1> shows how the items of the CPI are classified into the tradeable and non-tradeable sectors. For classification, I use the CPI of year 2000, which contains 516 items. Among them, 342 items are classified into the tradeable sector, and 174 items into the non-tradeable sector. Of a total weight of 1,000, the tradeable sector accounts for 429.8, and the non-tradeable sector for 570.2. For details of which specific items are classified into the tradeable or the non-tradeable sector, please refer to the Appendix. The price index is computed by way of the Laspeyres' formula, whose base prices and weights are those of 2000, the base year.

Table 1 **Breakdown of CPI into Tradeable and Non-tradeable Price Indices.**

Classification	Number of items	Weight(total=1,000)
Tradeable Price Index	342	429.8
Non-tradeable Price Index	174	570.2

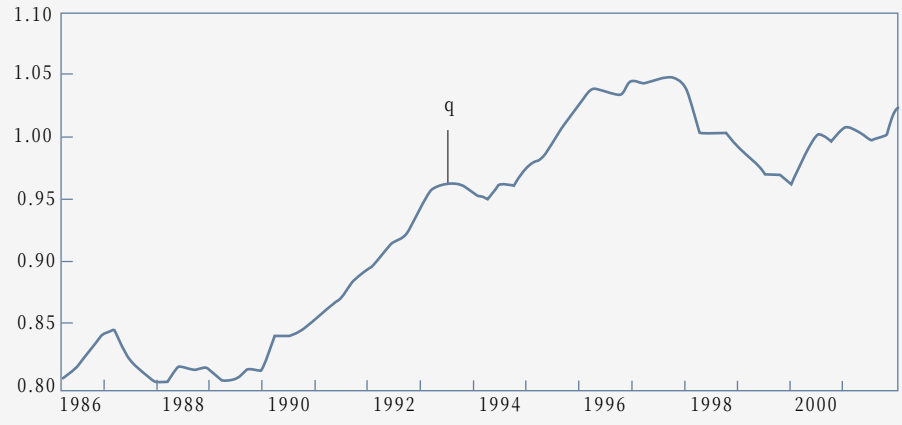
<Figure 1> shows aggregate, tradeable, and non-tradeable inflation from 1986 to 2001, respectively. In the 1990s before the currency crisis of 1997, non-tradeable inflation dominated tradeable inflation. This fact is comparable with <Figure 2>, which shows the relative prices of the non-tradeable sector on an increasing trend during 1990-97. For 1998-99, however, non-tradeable inflation was lower than tradeable inflation due to the sharp exchange rate depreciation that was passes through to the prices of tradeable goods. From 2000 non-tradeable inflation dominated tradeable inflation again.

Figure 1 **CPI, Tradeable, and Non-tradeable Inflation**



As we note from the above, non-tradeable inflation shows a different pattern from aggregate inflation. To investigate the difference between aggregate inflation and non-tradeable inflation, we estimate the inflation equation. Following Gordon (1982, 1985) we regress inflation on the GDP-gap, unit labor costs, and import prices. Before the regression, we test for Unit-Root on the log of those variables. Besides the GDP-gap, the CPI, the non-tradeable price index, the import price index, and unit labor costs turn out to have Unit-Root. Since the first difference of

Figure 2 **Price of Non-tradeable Goods relative to Tradeable Goods**



those variables shows stationarity, we use the first difference of those logged variables except for the GDP-gap on the following OLS regression equation.

$$\pi_t = \beta_0 + \beta_1 \pi_{t-1} + \beta_2 y_t + \beta_3 w_t + \beta_4 \pi_t^m \qquad (1)$$

where π is inflation, y GDP-gap, w growth rate of unit labor costs, π^m imported goods inflation. Unit labor costs are the nominal wage index divided by the labor productivity index. Both these indices are from National Statistical Office. The data cover the period from 1986. Q1 to 2001. Q4

Table 2 **Estimation Results of Aggregate and Non-tradeable Inflation.**

Dependent variable	Aggregate inflation [1]	Non-tradeable inflation
Independent variables		
constant	0.004 (1.514)	0.004 (1.472)
π_{t-1}	0.842(16.074)***	0.883(20.759)***
y_t [2]	0.077 (1.650)*	0.151 (2.719)***
w_t	0.055 (2.868)***	0.064 (3.284)***
π_t^m	0.073 (5.912)***	0.044 (3.397)***
$\bar{R}^2$	0.841	0.895

Notes : 1) Aggregate inflation implies CPI inflation
2) Data for y in the regression of aggregate inflation are from the GDP of the whole economy, while data for y in the regression of non-tradeable inflation are from the GDP of the following industries. Electricity, gas and water; Construction, wholesale and retail trade, restaurants and hotels; Transport, storage and communication; Finance, insurance, real estate and business services; and Community, social and personal services. Thus the tradeable sector is considered as comprising those industries not included above, for example, Agriculture, forestry and fishing; Mining and quarrying; and Manufacturing

From the results presented in <Table 2>, all coefficients are significantly positive as expected. Aggregate inflation responds more strongly to imported goods inflation, while non-tradeable inflation responds more strongly to the GDP-gap and an increase of unit labor costs.

Ⅲ. The Model

In this section, we build up a small open economy model based on a Keynesian AS-AD model. In the dynamic optimizing model, an economic agent behaves based on rational expectations. Hence the demand and supply function reflects the economic agent's expectations. In addition, the model economy includes the monetary authority's optimization problem through its loss function. Such models can be found in the literature including Svensson (2000), Flamini (2001), and Bharucha & Kent (1998).

First, the Phillips-curve determines supply in the non-tradeable sector.

$$\pi_t^N = \kappa\pi_{t-1}^N + (1-\kappa)E_t\pi_{t+1}^N + \alpha y_{t-1} + \beta\Delta e_{t-1} + \varepsilon_t^s, \qquad (2)$$

where denotes the degree of backward-lookingness in non-tradeable inflation, y represents GDP-gap in the non-tradeable sector, and e denotes the nominal exchange rate. We expect positive coefficients on non-tradeable inflation, one-period ahead GDP-gap, and one-period ahead nominal exchange rate depreciation. And ε^s is an i.i.d. cost-push shock, whose mean is zero and variance is σ_s^2.

The following form defines demand in the non-tradeable sector.

$$y_t = \mu y_{t-1} - \phi r_{t-1} - \gamma q_{t-1} + \varepsilon_t^D, \qquad (3)$$

where r denotes the real interest rate, q the price of the non-tradeable good relative to the tradeable good. We expect a positive coefficient on the one-period ahead GDP-gap. We do, however, anticipate negative coefficients on the real interest rate and the relative price of the non-tradeable good. And ε^D is an i.i.d. demand shock, whose mean is zero and variance is σ_D^2.

We assume that movements in the nominal exchange rate directly influence tradeable inflation in the following form.

$$\pi_t^T = \upsilon\Delta e_{t-1} + (1-\upsilon)\Delta e_{t-1}, \qquad (4)$$

where $0 \leq \upsilon \leq 1$ and υ denotes the degree of pass-through of the exchange rate on inflation. When $\upsilon = 1$, nominal exchange rate movements are completely passed through to tradeable inflation. When $\upsilon = 0$ nominal exchange rate movements are not passed through to tradeable inflation at all. And aggregate inflation is defined as the weighted average of tradeable and non-tradeable inflation.

$$\pi_t \equiv \eta \pi_t^T + (1-\eta)\pi_t^N, \tag{5}$$

where η denotes the share of tradeable good in the consumption basket. And the relative price of the non-tradeable good in terms of the tradeable good is defined as the following manner.

$$q_t \equiv p_t^N - p_t^T, \tag{6}$$

where p_t^N denotes the price level of the non-tradeable good, p_t^T, the price level of tradeable good. And Uncovered Interest-rate Parity holds as shown in (7)

$$E_t \Delta e_{t+1} = i_t - i_t^* - \rho, \tag{7}$$

where i denotes the nominal interest rate, i^* foreign nominal interest rate, while denotes risk premium, and is assumed to follow an AR(1) process, viz

$$\rho = \theta \rho_{-1} + \varepsilon_t^{\rho}, \tag{8}$$

where ε^{ρ} is an i.i.d. shock with mean zero and variance σ_{ρ}^2. We can derive the real interest rate by subtracting expected aggregate inflation from the nominal interest rate.

$$r_t = i_t - E_t \pi_{t+1} \tag{9}$$

The monetary authority controls the short-run nominal interest rate in order to stabilize economic variables. Hence, it minimizes the loss function in the following form.

$$L = E \sum_{t=0}^{\infty} \beta \{ \omega_{\pi} \pi_t^2 + \omega_{\pi^N} \pi_t^{N^2} + \omega_y y_t^2 + \omega_i \Delta i^2 \} \tag{10}$$

As shown in the loss function, the monetary authority targets aggregate inflation, non-tradeable inflation, or the GDP-gap. In addition, it tries to stabilize the interest

rate difference. In general, it is concerned that volatile movements in the interest rate result in financial instability, which in turn deteriorates its credibility. Thus, it makes an effort to stabilize the movements of the interest rate itself.

The model economy can be described as a state-space model.

$$\begin{bmatrix} x_{1t+1} \\ E_t x_{2t+1} \end{bmatrix} = A \begin{bmatrix} x_{1t} \\ x_{2t} \end{bmatrix} + Bu_t + \begin{bmatrix} \varepsilon_{+1} \\ O_{n_2 \times 1} \end{bmatrix}, \tag{11}$$

where x_1 denotes a $n_1 \times 1$ vector containing predetermined variables, x_2 a $n_2 \times 1$ vector containing non-predetermined variables such as expected inflation, and u a vector containing policy instrument variables. Hence x_1 contains inflation, the GDP-gap, the nominal interest rate, x_2 and the real exchange rate, contains expected inflation, the nominal and real exchange rates, and u contains a policy variable, the short-run nominal interest rate. And vector ε contains disturbances such as supply, demand, and exchange rate shock.

$$\begin{aligned} x_{1t} &= A[\pi_t^N \; y_t \; \rho \; i_{t-1} \; q_{t-1} \; e_{t-2} \; e_{t-1}]' \\ x_{2t} &= A[e_t \; E_t \pi_{t+1}^N]' \\ u_t &= i_t \end{aligned} \tag{12}$$

And the A, B matrix in Equation (11) is defined as

$$A = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ -\gamma & \mu & -\phi\eta\upsilon & 0 & -\gamma & -\gamma(1-\upsilon) & (\gamma-\phi\eta)(1-\upsilon)-\gamma\upsilon & \phi\eta(1-\upsilon)+\gamma\upsilon & \phi\eta(1-\eta) \\ 0 & 0 & \theta & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ \frac{-\beta-\kappa}{1-\kappa} & \frac{-\alpha}{1-\kappa} & 0 & 0 & 0 & 0 & \frac{-\beta}{1-\kappa} & \frac{\beta}{1-\kappa} & \frac{1}{1-\kappa} \end{bmatrix} \tag{13}$$

$$B = 1$$

And the loss function of the monetary authority has the following form.

$$L_0 = E_0 \sum_{t=0}^{\infty} \beta [x_t \; u_t] \begin{bmatrix} Q & U' \\ U' & R \end{bmatrix} \begin{bmatrix} x_t \\ u_t \end{bmatrix}, \tag{14}$$

where $L_t = Y'_t K Y_t$ and K is a (4×4) diagonal matrix and Y_t has the following form.

$$Y_t = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & \eta & -\eta & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_{1t} \\ x_{2t} \\ u_t \end{bmatrix} \qquad (15)$$

Under the commitment regime where the monetary authority maintains its response function even if it faces a dynamic inconsistency problem, the Lagrangian function of the optimal policy is shown as

$$L = E_0 \sum_{t=0}^{\infty} \beta \{x'Qx + 2x_t'Uu_t + u_t'Ru_t + \rho_{t+1}(Ax_t + Bu_t + \xi_{t+1} - x_{t+1})\} \qquad (16)$$

And when we define (ρ_1, ρ_2) as Lagrangian multiplier corresponding to (x_1, x_2), the FOC is described as

$$GE_t \begin{bmatrix} k_{t+1} \\ \lambda_{t+1} \end{bmatrix} = D \begin{bmatrix} k_t \\ \lambda_t \end{bmatrix}, \text{ where } k_t = \begin{bmatrix} x_{1t} \\ \rho_t \end{bmatrix}, \quad \lambda_t = \begin{bmatrix} x_{2t} \\ u_t \end{bmatrix} = \begin{bmatrix} k_t \\ \lambda_t \\ \rho_t \end{bmatrix}, \qquad (17)$$

where G is a singular matrix. Sims (1999) and Klein (1998) proposed methods of solution using generalized Schur decomposition. I utilize that proposed by Klein. Square matrix, G and D can be decomposed into in the following manner. $G = QSZ^H$ and $D = QTZ^H$, where Z^H is the complex conjugate of Z. And Z is partitioned corresponding to k_t, λ_t, θ_t, δ_t.

$$\begin{bmatrix} k_t \\ \lambda_t \end{bmatrix} = \begin{bmatrix} Z_{k\theta} \\ Z_{\lambda\rho} \end{bmatrix} \theta_t, \quad \text{where} \begin{bmatrix} \theta_t \\ \delta_t \end{bmatrix} = Z^H \begin{bmatrix} k_t \\ \lambda_t \end{bmatrix} \qquad (18)$$

Therefore, the decision rule of the model economy is derived from

$$\begin{bmatrix} x_{1t+1} \\ \rho_{t+1} \end{bmatrix} = Z_{k\theta} S_{\theta\theta}^{-1} T_{\theta\theta} Z_{k\theta}^{-1} \begin{bmatrix} x_{1t} \\ \rho_t \end{bmatrix} + \begin{bmatrix} \xi_{t+1} \\ 0_{n_2 \times 1} \end{bmatrix}, \quad \begin{bmatrix} x_{2t} \\ u_t \\ \rho_t \end{bmatrix} = Z_{\lambda\theta} Z_{k\theta}^{-1} \begin{bmatrix} x_{1t} \\ \rho_t \end{bmatrix} \qquad (19)$$

Thus, when the monetary authority minimizes Equation (14) under the economic system of Equation (11), the decision rule is that expressed in Equation (19).

In order to evaluate the model economy, we will check impulse response functions in the next section. If the response of economic variables to exogenous

shocks is intuitive, we will investigate the effects of inflation targeting, and derive the optimal response function of the monetary authority from the minimum value of the Lagrangian. Thus from the optimal response function, we can investigate how the monetary authority controls the short-run interest rate in response to movements of inflation, GDP-gap, exchange rate, and expected inflation.

Ⅳ. Simulations

In order to simulate the model economy, we specify values of parameters in the model. Values of most parameters are set from GMM estimation of the equation system with Equation (2) and (3) by using quarterly data during 1986-2001. (See Table 3)

In the meanwhile, values of other parameters are set in the following manner. The share of tradeable goods in consumption (η) is set to share (429.8/1000) of the tradeable goods within the CPI index, which are classified in Section II. Standard deviations of supply, demand, and exchange rate shock are from Nam (2002a), and the persistence parameter of risk premium is from Nam (2002a) as well.

The discount rate of the monetary authority (β) is set at 1 as in Svensson (1997). The larger the discount rate of the monetary authority in the loss function of Equation (10), the more the monetary authority is concerned about losses in the long-run. When it is 1, the loss function of the monetary authority becomes an unconditional expectation.

$$E(L)_t = \omega_\pi \mathrm{Var}(\pi_t) + \omega_{\pi^N} \mathrm{Var}(\pi_t^N) + \omega_y \mathrm{Var}(y_t) + \omega_{\Delta i} \mathrm{Var}(\Delta i)\,, \qquad (20)$$

where Var denotes variance.

Based on the values of the parameters presented in Table 3, I experiment with the impulse response of the model economy. Experiments compare two cases aggregate inflation targeting and non-tradeable inflation targeting. Aggregate inflation targeting means $\omega_\pi = 1$ and $\omega_{\pi^N} = 0$ in Equation (20), while non-tradeable inflation targeting means $\omega_\pi = 0$ and $\omega_{\pi^N} = 1$.

<Figure 3> plots impulse responses in aggregate inflation targeting. Responses are presented in the order of aggregate inflation, non-tradeable inflation, GDP-gap, nominal interest rate, nominal exchange rate depreciation, and real interest rate. First, let us look at the effect of a supply shock on the model economy.

Table 3 Values of Parameters

Degree of pass-through of exchange rate on inflation	0.5
Degree of backward-lookingness in inflation expectation	0.5
Effect of GDP-gap on non-tradeable inflation	0.04
Effect of exchange rate movements on non-tradeable inflation	0.02
Share of tradeable goods in consumption	0.43
Persistence of output gap	0.8
Sensitivity of output gap to real interest rate	0.1
Sensitivity of output gap to the relative price of tradeable goods	0.05
Persistence of risk premium	0.5
Discount rate of the central bank	1.0
s.d of supply shock	0.02
s.d of demand shock	0.01
s.d of risk premium	0.04

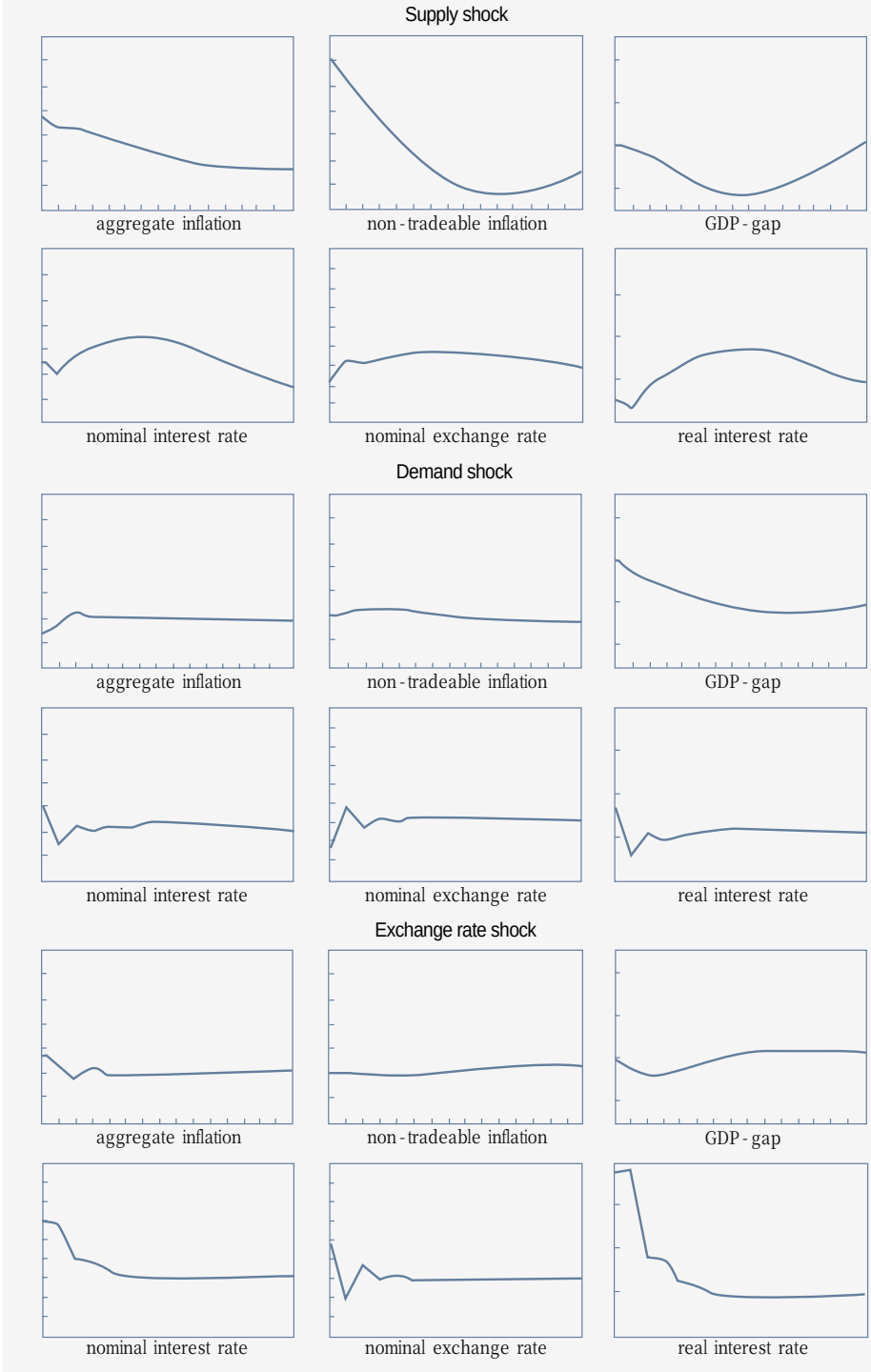
Supply shock, which is a sort of cost-push shock, leads to an upward pressure on both aggregate inflation and non-tradeable inflation, but a slow-down in the GDP-gap. The nominal interest rate increases as the monetary authority responds by raising the nominal interest rate. As the interest rate increases, the nominal exchange rate temporarily falls under the impact. But the exchange rate starts to rise and the currency depreciates as inflation persists.

Next, demand shock affects both inflation and GDP-gap in the same direction. A positive demand shock puts upward pressure on inflation and raises the GDP-gap. But the magnitude of the impact of the demand shock is weaker than that of a supply shock. As the monetary authority raises the nominal interest rate in response to the demand shock, aggregate prices temporarily fall. The nominal exchange rate falls under the impact, but soon later, turns to a rise as aggregate prices rise.

Lastly, an exchange rate shock induces an immediate rise of the nominal exchange rate. In response to an exchange rate shock, the monetary authority sharply raises the nominal interest rate. As a result, the demand for the non-tradeable good declines and the prices of the non-tradeable and the tradeable good slow down. In other words, the GDP-gap and inflation shifts to a downward trend.

However, the demand for the non-tradeable good recovers as the real interest rate decreases and the relative price of non-tradeable good decreases. That is GDP-gap increases as time goes by. Aggregate inflation including tradeable inflation increases due to depreciation of the currency. The shape of the response function of aggregate inflation resembles that of the nominal exchange rate.

Figure 3 **Impulse Response (Aggregate Inflation Targeting)**



Now let us look at <Figure 4>, which presents the impulse responses functions of non-tradeable inflation targeting, and compare it with <Figure 3>, which presents those of aggregate inflation targeting.

Most responses of variables are similar for aggregate inflation and non-tradeable inflation, but the magnitude of the impact differs to some extent. In non-tradeable inflation targeting, the magnitude of the responses of aggregate inflation, the nominal exchange rate, and the real interest rate is larger in non-tradeable inflation targeting than in aggregate inflation targeting. In contrast, the nominal interest rate responds more weakly to an exchange rate shock in non-tradeable inflation targeting.

And in non-tradeable inflation targeting, the GDP-gap gradually widens in response to an exchange rate shock while it falls in aggregate inflation. In aggregate inflation targeting the monetary authority sharply increases the nominal interest rate in order to deter a pass-though of currency depreciation into inflation. This, in turn, leads to a narrowing of the GDP-gap. On the other hand, in non-tradeable inflation targeting, the monetary authority changes the interest rate less, but lets the nominal exchange rate floating. A rise in demand due to a drop in the relative price of the non-tradeable good offsets the contractive effect of an increase in the interest rate. Accordingly, the GDP-gap in the non-tradeable sector gradually widens.

Figure 4 **Impulse Response (Non-tradeable Inflation Targeting)**

<Table 4> presents the variability of variables when three shocks supply, demand and exchange rate are given to the model economy. Aggregate inflation is less volatile in aggregate inflation targeting than in non-tradeable inflation targeting, while non-tradeable inflation is less volatile in non-tradeable inflation targeting than in aggregate inflation targeting. And the GDP-gap in the non-tradeable sector is less volatile in non-tradeable inflation targeting than in aggregate inflation targeting. Nominal interest rate and nominal exchange rate movements are more volatile in non-tradeable inflation targeting than in aggregate inflation targeting.

Table 4 **Variability under Three Shocks**

Aggregate inflation targeting (A)	Non-tradeable inflation targeting (B)	B/A
1.8153	3.8257	2.11
3.5451	3.1930	0.90
3.7184	3.3255	0.89
4.6243	4.8016	1.04
3.6201	9.8692	2.73
4.6622	4.1678	0.89
18.3267	17.4868	0.95
3.7276	3.0751	0.83

The results of <Table 4> will change if the magnitude of three shocks given to the model is varied. In order to analyze the effect of an exogenous shock separately, we will give an independent shock to the model in the below. <Table 5>, <Table 6> and <Table 7> present the results when a supply, demand and an exchange rate shock are each given to the model alone. From the results we can summarize following facts.

First, we cannot find a dominant inflation targeting policy. Neither aggregate inflation targeting nor non-tradeable inflation targeting is superior in stabilizing the economy. Aggregate inflation targeting is superior in stabilizing aggregate inflation, but inferior in stabilizing non-tradeable inflation and the GDP-gap. The situation with non-tradeable inflation is the opposite.

Second, non-tradeable inflation targeting is not greatly concerned about movements in the nominal exchange rate. In contrast, aggregate inflation targeting is deeply concerned about them because changes in the exchange rate are passed through to the tradeable good price.

Third, the non-tradeable inflation target actively controls the interest rate in response to domestic shocks supply and demand shocks. As a result, non-tradeable inflation targeting is successful in stabilizing the GDP-gap, but not in stabilizing the exchange rate and aggregate inflation.

Fourth, non-tradeable inflation targeting is not much concerned about movements in the nominal exchange rate. Thus the nominal interest rate responds less to an exchange rate shock in non-tradeable inflation targeting. In contrast, aggregate inflation targeting is concerned about movements in the nominal exchange rate, which affect the prices of the tradeable good. Thus the interest rate responds actively under aggregate inflation targeting to an exchange rate shock.

Table 5 **Variability under Supply Shock**

Aggregate inflation targeting (A)	Non-tradeable inflation targeting (B)	B/A
1.6371	2.3417	1.43
3.4569	3.1720	0.92
3.2002	3.0530	0.95
2.0674	3.5869	1.74
2.3299	4.4252	1.90
2.1033	1.9609	0.93
16.8672	15.5370	0.92
0.7103	1.7136	2.41

Table 6 **Variability under Demand Shock**

Aggregate inflation targeting (A)	Non-tradeable inflation targeting (B)	B/A
0.4370	1.9559	4.48
0.5002	0.2368	0.47
1.5321	1.1508	0.75
0.8073	2.8814	3.57
1.6499	5.9034	3.58
0.9767	2.9578	3.03
4.6930	5.5976	1.19
1.1416	2.4127	2.11

Table 7 **Variability under Exchange Rate Shock**

Aggregate inflation targeting (A)	Non-tradeable inflation targeting (B)	B/A
0.4583	1.8181	3.97
0.4830	0.1943	0.40
0.9035	0.3673	0.41
4.0671	1.4770	0.36
2.1855	6.5043	2.98
4.0774	2.2928	0.56
4.7873	5.3200	1.11
3.4829	0.9172	0.26

Now we consider the reaction function of the monetary authority, which means an optimal policy rule minimizing the loss function, Equation (10). The reaction function of the nominal interest rate in response to an exogenous shock is a linear function of all predetermined variables.

<Table 8> presents reaction functions that change as the degree of pass-through (υ) changes from 0 to 1. When the degree of pass-through is 0.5 as in the benchmark model, reaction to non-tradeable inflation and GDP is stronger in non-tradeable inflation targeting, but reaction to an exchange rate shock is stronger in aggregate inflation targeting. Reaction to the shadow price of the exchange rate (ρ_t) and the shadow price of the expectation of next period non-tradeable inflation ($\rho_{E_t \pi^N_{t+1}}$) is stronger in non-tradeable inflation.

Now look at how reaction functions change as the degree of pass-through changes. When the exchange rate is completely passed through to the current price, i.e., υ=1, the monetary authority does not react to the past exchange rate. As the degree of pass-through increases, i.e., $\upsilon = 0 \rightarrow 0.5 \rightarrow 1$, the more strongly the monetary authority reacts in adopting aggregate inflation targeting to the exchange rate. As the degree of pass-through increases, the more weakly the monetary authority reacts in adopting non-tradeable inflation targeting to non-tradeable inflation, the GDP-gap, or the exchange rate, but the more strongly it reacts to the shadow price of the exchange rate or the shadow price of expectations of next-period non-tradeable inflation.

Table 8 **Impulse Response**

	π^N_t	y_t	ρ	i_{t-1}	q_{t-1}	e_{t-1}	e_{t-2}	ρ_{e_t}	$\rho_{E_t \pi^N_{t+1}}$
Aggregate Inflationtargeting : υ= 0	0.0139	-0.0741	0.9947	0.0354	0.1597	-0.1597	0.1597	-0.8657	0.0424
υ= 0.5	0.1231	0.5783	0.7316	0.1124	0.0042	0.2927	-0.2927	-5.8247	-0.0833
υ= 1	-0.1721	-0.1980	1.0109	0.0378	0.1514	0.0000	0.0000	-0.8523	0.0719
Non-tradeable inflation targeting : υ= 0	1.0343	2.2305	0.2198	0.3000	0.0265	-0.0265	0.0265	-14.6950	-0.2183
υ= 0.5	0.6766	2.1410	0.1775	0.3429	0.0196	-0.0098	0.0098	-19.3215	-0.2236
υ= 1	0.1211	1.9436	0.1499	0.3903	0.0047	0.0000	0.0000	-25.6334	-0.2424

Now we compare the effect of flexible inflation targeting with that of strict inflation targeting. A monetary authority adopting strict inflation targeting only targets inflation, but not GDP or other economic variables. That is, ω$_y$=0 in strict

inflation targeting. However, a monetary authority adopting flexible inflation targeting targets inflation as well as GDP. That is, $\omega_y>0$ in flexible inflation targeting.

<Table 9> and <Table 10> shows how the strictness of the targeting policy changes the variability and reaction function, respectively. Regardless of the targeting regime aggregate inflation targeting or non-tradeable inflation targeting the GDP-gap becomes less volatile as its weight (ω_y) increases, that is, the targeting policy becomes more flexible. This finding is comparable with that from <Table 10> that the coefficient of the reaction to the GDP-gap increases as the weight put on it increases both in aggregate inflation targeting and non-tradeable inflation targeting.

Table 9 Variability

	π	π^N	y	i	Δe	r	q	Δi
Aggregate Inflation targeting : $\omega_y=0$	0.3863	3.8994	5.3917	5.7970	5.5677	5.9081	27.1612	4.2323
$\omega_y=0.5$	1.8153	3.5451	3.7184	4.6243	3.6201	4.6622	18.3267	3.7276
$\omega_y=1$	2.4801	3.6477	3.1776	4.4106	4.2461	4.3853	15.6192	3.8811
Non-tradeable inflation targeting : $\omega_y=0$	11.9430	2.0603	11.3283	7.2401	35.4263	14.1378	58.9072	7.2401
$\omega_y=0.5$	3.8257	3.1930	3.3255	3.0751	9.8692	4.1678	17.4868	3.0751
$\omega_y=1$	4.1130	3.4776	2.8485	4.1357	9.8456	4.5042	14.9642	4.1357

Table 10 Impulse Response

	π^N	y_t	ρ	i_{t-1}	q_{t-1}	e_{t-1}	e_{t-2}	ρ_t	$\rho_{E_t \pi^N_{t+1}}$
Aggregate Inflation targeting : $\omega_y=0$	-0.0305	-0.2078	0.8501	0.1218	0.0576	-0.3200	0.3200	-6.8810	-0.1159
$\omega_y=0.5$	0.1231	0.5783	0.7316	0.1124	0.0042	0.2927	-0.2927	-5.8247	-0.0833
$\omega_y=1$	0.2793	1.1371	0.6579	0.1051	-0.0180	-0.2706	0.2706	-5.1610	-0.0688
Non-tradeable inflation targeting : $\omega_y=0$	1.6011	0.0099	0.1158	0.6900	0.0616	0.0308	-0.0308	-100.640	-2.4547
$\omega_y=0.5$	0.6766	2.1410	0.1775	0.3429	0.0196	-0.0098	0.0098	-19.3215	-0.2236
$\omega_y=1$	1.0066	2.8660	0.2041	0.2714	0.0302	0.0151	-0.0151	-13.235	-0.1410

Ⅴ. Conclusions

In this paper, we developed a small open economy producing a tradeable good and a non-tradeable good. We compared the effects of aggregate inflation with non-tradeable inflation.

We broke down the CPI into a tradeable and a non-tradeable sector. From the tradeable and non-tradeable price index we compute, we find that non-tradeable inflation outpaced tradeable inflation in the 1990s before currency crisis in 1997, so that the relative price of the non-tradeable good increased. During 1998-99, however, non-tradeable inflation was lower than tradeable inflation due to the sharp currency depreciation that was passed on through the tradeable good price. From 2000 non-tradeable inflation was again higher than tradeable inflation.

We estimated the aggregate inflation and non-tradeable inflation equation to investigate the determinants of inflation. From the regression results, we found that aggregate inflation responds more strongly to imported goods inflation, while non-tradeable inflation responds more strongly to the GDP-gap and an increase of unit labor costs.

Firstly, from the simulation of the model, we cannot find a dominant inflation targeting policy. Neither aggregate inflation targeting nor non-tradeable inflation targeting is superior in stabilizing the economy. Aggregate inflation targeting is superior in stabilizing aggregate inflation, but inferior in stabilizing non-tradeable inflation and the GDP-gap. With non-tradeable inflation the situation is the other way around.

Secondly, non-tradeable inflation targeting is not much concerned about movements in the nominal exchange rate. In contrast, aggregate inflation targeting is concerned about them because the currency depreciation is passed on through the tradeable good price.

Thirdly, non-tradeable inflation target controls the interest rate positively in response to domestic shocks supply and demand shocks. As a result, non-tradeable inflation targeting is successful in stabilizing the GDP-gap, but not in stabilizing the exchange rate and aggregate inflation.

Fourthly, non-tradeable inflation targeting is little concerned about movements in the nominal exchange rate. Thus the nominal interest rate responds less to an exchange rate shock under non-tradeable inflation targeting. Aggregate inflation targeting, in contrast, is concerned about movements in the nominal exchange rate, which affect the prices of the tradeable good. Thus the interest rate responds actively under aggregate inflation targeting to an exchange rate shock.

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Appendix

Classification of Tradeables and Non-tradeables

Division	Sub-division	Items	Tradeables	Non-tradeables
Food	Cereals		○	
	Meat		○	
	Dairy products		○	
	Fish		○	
	Vegetables & seaweed		○	
	Fruits		○	
	Oils, fats & condiments		○	
	Bread & confectionary		○	
	Tea & beverages		○	
	Alcoholic beverages		○	
	Others		○	
	Eating out			○
Housing	Rent			○
	House repair & maintenance	Materials	○	
		Service		○
	Others			○
Fuel, light & water	Electric charges			○
	Water charges			○
	Fuels	Briquette	○	
		Kerosene	○	
		LPG for cook	○	
		City gas		○
		Potable butane gas	○	
Furniture & utensils	Furniture		○	
	Household appliances		○	
	Dinner set & kitchen utensils		○	
	Household miscellaneous & expendable goods		○	
	Bedding & clothing products		○	
	Household services			○
Clothing & footwear	Outer garments		○	
	Sweater & shirts		○	
	Underwear		○	
	Others		○	
	Clothing services			○
Medical care	Medicine		○	
	Medical items		○	
	Medical services			○
Education	School fees			○
	Other education			○
	Stationery		○	
Culture & recreation	Newspaper & books			○
	Durables		○	
	Services			○

Classification of Tradeables and Non-tradeables

Division	Sub-division	Items	Tradeables	Non-tradeables
Transporation & communication	Public Transportation			○
	Private Transportation	Bicycles	○	
		Passenger cars(small)	○	
		Passenger cars(medium)	○	
		Passenger cars(large)	○	
		Passenger cars (1000cc and less)	○	
		Jeeps	○	
		Tires for passenger car	○	
		Gasoline	○	
		Light Oil	○	
		LPG for cars	○	
		Lubrication oil exchange charges		○
		Car inspection service sharge		○
		Automobile liability insurance premium		○
		Automobile comprehensive insurance premium		○
		Express highway tolls		○
		Automobile rent		○
		Car wash fee		○
	Communication	Basic call rate		○
		Local area call rate		○
		Long distance call rate		○
		Public phone charges		○
		International call rate		○
		Mobile phone call rate		○
		Land to mobile call rate		○
		PC communication fee		○
		Fee for use of communication line		○
		Additional service charge using mobile phone		○
		Domestic postage		○
		Oversea postage		○
		Telephone	○	
		Mobile phone	○	
Other miscellaneous	Personal care products		○	
	Personal care services			○
	Personal outfitting		○	
Excluding Food	Cigarettes		○	
	Lodging charges			○
	Service charges			○