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The Monetary Policy Reaction Function in Korea with Multi-level Factors

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The monetary policy reaction function in Korea is estimated. In particular, a variant of the Taylor rule is analyzed using information from a panel of macroeconomic variables in the United States (US) and Korea. The main findings are as follows. First, two global factors common to both countries are significant in the monetary policy reaction function, while no country-specific factors are significant. Second, the information contained in these factors is similar to variables, such as the credit spread in the US, the KRW/USD exchange rate, non-farm employment, and business survey indices for new contracts and sales in Korea. As such, these variables are also significant when added to the monetary policy reaction function. Third, the policy response to the inflation rate becomes significantly positive only when these additional variables are added, which is consistent with the legal purpose of monetary policy under the inflation targeting regime in Korea.

JEL Classification: E52, E58
Keywords: Monetary Policy Reaction Function, Factor Model, Inflation Targeting

I. Introduction

Studies on the monetary policy reaction function are conducted to explore the role of monetary policy using the Taylor rule (Taylor, 1993). One of the central issues is whether the inflation rate is significantly positive in the monetary policy reaction function, which is also related to the Taylor principle that the coefficient of inflation rate should be greater than one. This issue is particularly pertinent to the Korean economy because article 1 (1) of the Bank of Korea Act (2018) (BOK Act, hereafter) explicitly stipulates "the stabilization of the inflation rate" as the purpose of monetary policy. However, empirical evidence is divided in the literature on the

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Korean economy. For example, Baek (2009), Park (2010), and Kim and Kim (2012) provide evidence for a significant inflation rate, while Shin (2007) and Kim and Kwark (2016) find no such evidence.

Despite the conflicting claims in the literature, what seems important in analyzing the monetary policy reaction function of Korea is to consider an extended form of the Taylor rule. As a small open economy, monetary policy in Korea must take economic situations in larger countries into account. However, this is not the only reason to call for an extended version of the Taylor rule. Article 1 (2) of the BOK Act states that the BOK needs to consider financial stability in carrying out monetary policy. Since the term “financial stability” is quite broad, it is possible for any macroeconomic variable to be a part of the monetary policy reaction function.

I take a data-driven approach to discover exactly which variables other than the inflation rate and output gap enter the monetary policy reaction function. First, I extract common factors from a panel of macroeconomic variables from both the United States (US) and Korea.[1] The factors represent the strongest time variation common across all variables in the panel. Furthermore, I use a multi-level factor model that has both global and country-specific factors. This distinction between global and country-specific factors helps interpret the meaning of the selected common factors. Second, I examine which common factors significantly enter the monetary policy reaction function and evaluate whether the inclusion of common factors alters the function in any meaningful way. Of particular interest is whether the inflation rate is significantly positive in the presence of common factors. Finally, I investigate which variables in the panel can be substituted for the common factors. I do this by returning the selected factors to the panel. I collect variables highly correlated with the factors and then re-estimate the monetary policy reaction function by replacing the factors with these variables. This last step offers the final form of the monetary policy reaction function.

Note that my approach treats all variables in the panel as equal candidates for entering the monetary policy reaction function and allows the data to decide which one will eventually be selected. Thus, it has an advantage over the more prevailing approach that selects a particular variable first and then focuses on its empirical validity.[2]

The main findings are as follows. The inflation rate is not significant in the monetary policy reaction function without any control variables. Among the five global factors, three US-specific factors, and one Korea-specific factor, two global

[1] This is similar to Belviso and Milani (2006), who use factors extracted from a US panel to estimate the monetary policy reaction function.

[2] For example, Shin (2007), Park (2010), and Kim and Kwark (2016) add exchange rate, like Ball (1999) and Dolado et al. (2005). Kim and Kwark (2016) include the federal funds rate and asset accounting of the Federal Reserve System to consider the influence from US monetary policy. Kim and Kim (2012) use household debt to control financial credit risk and surges in housing prices.

factors are significant in the monetary policy reaction function while no country-specific factor is significant. The significance of the inflation rate and output gap is still not apparent despite the added factors. This finding is due to the high correlation between the factors and the inflation rate and output gap, which is confirmed by the predictive regressions of the future inflation rate and output gap on current factors. The individual control variables that can be substituted for the two global factors are credit spread in the US, the KRW/USD exchange rate, non-farm employment,[3] and business survey indices (BSI) for new contracts and sales in Korea. These variables are not only significant in the monetary policy reaction function but also make the inflation rate significantly positive while satisfying the Taylor principle.

Credit spread is understood to contain predictive information for economic activity,[4] and my results show that the business cycle of the US economy is a consideration of monetary policy in Korea. The exchange rate is one of the variables most frequently augmented to the monetary policy reaction function in the literature and is chosen again by my data-driven method. I use the cyclical component of the coincident composite index (coincident index, hereafter) as a measure of the output gap. Since both non-farm employment and business survey indices are other measures of the business cycle, they can be viewed as being selected by the data to complement the coincident index. This result is also a somewhat natural one given that the output gap is hard to measure with one index, unlike the inflation rate.

In fact, it is interesting to see non-farm employment and business survey indices selected by the data, because the minutes of the monetary policy board meetings from 2004 to 2017 (Bank of Korea, 2004–2017) frequently mention "employment status" and "business sentiment" as reasons for policy decisions. My analysis confirms empirically that monetary policy is consistent with publicized statements of the monetary policy board.

The rest of the paper is organized as follows. Section 2 describes the multi-level factor model and the monetary policy reaction function. Section 3 provides the details of the data and econometric methodology. Section 4 presents the estimation results and discusses their implications. Section 5 concludes.

II. Model

Suppose that the central bank utilizes information from a panel of

[3] Non-farm employment in Korea stands for total employment minus agriculture, forestry, and fishery employment.

[4] See Gilchrist and Zakrajšek (2012), for example.

macroeconomic variables. Because the stability of a small open economy relies on both internal and external economies, I include US macroeconomic variables in addition to Korean ones. Furthermore, I assume that the panel data have a multi-level structure given by (1).

$$\underset{(N_m\times 1)}{X_{mt}} = \underset{(N_m\times s)}{\Gamma_m}\,\underset{(s\times 1)}{G_t} + \underset{(N_m\times r_m)}{\Lambda_m}\,\underset{(r_m\times 1)}{F_{mt}} + \underset{(N_m\times 1)}{e_{mt}} = [\Gamma_m \ \Lambda_m]\begin{bmatrix} G_t \\ F_{mt} \end{bmatrix} + e_{mt}, \tag{1}$$

where m stands for a country ($m=1$ for the US and 2 for Korea), X_{mt} is a vector of macroeconomic variables in the m^{th} country, G_t is a vector of global factors, F_{mt} is a vector of country-specific factors, e_{mt} is a vector of idiosyncratic errors, and Γ_m and Λ_m are loading matrices for G_t and F_{mt}, respectively. Eq. (1) can be rewritten as

$$\begin{bmatrix} X_{1t} \\ X_{2t} \end{bmatrix} = \begin{bmatrix} \Gamma_1 & \Lambda_1 & 0 \\ \Gamma_2 & 0 & \Lambda_2 \end{bmatrix} \begin{bmatrix} G_t \\ F_{1t} \\ F_{2t} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}$$
$$X_t = \Theta \quad K_t + \varepsilon_t, \tag{2}$$

where $N(N = N_1 + N_2)$ by 1 vector X_t stands for the macroeconomic variables of all countries at time t, and a factor loading matrix Θ is N by $k(k = s + r_1 + r_2)$ with sub-blocks of zeros.

Next, consider the simple monetary policy rule by Taylor (1993):

$$i_t^* = \bar{i} + \beta_1(\pi_t - \pi^*) + \beta_2(y_t - y_N), \tag{3}$$

where i_t^* stands for an optimal policy rate at time t, $\bar{i}$ is a long-run equilibrium level of a short-term interest rate in order for the inflation rate and output gap to be consistent with the target level of the inflation rate π^*, and the natural level of output y_N, respectively.

I extend Eq. (3) in three ways. First, I introduce the forward-looking behavior of the central bank by replacing current values for the inflation rate and output gap with their respective conditionally expected values up to h periods ahead given the currently available information. This approach is similar to that taken in Clarida et al. (2000). The rationale for doing this is the time lag of monetary policy effects. Second, I add control variables to Eq. (3). Article 1 (2) of the BOK Act explicitly states "The BOK shall take heed of financial stability in performing its monetary policy." This statement means that the inflation rate and the output gap are not the only determinants of the policy rate. In fact, it is much more plausible that the BOK keeps a close eye on the overall economy using various statistics. What is eventually reflected in monetary policy is not likely to be anomalies limited to a few variables. Rather, it is likely to derive from common movement across most of the variables under observation. This is why I consider factors extracted from a panel of macroeconomic variables as possible control variables. Similarly, Belviso and Milani (2006) estimated the monetary policy reaction function in the US with uni-level factors from a US panel to allow the central bank to refer to a wide range of information. In the literature on the Korean economy, there are a number of studies that augment a few specific macroeconomic variables to the standard Taylor rule, including Shin (2007), Park (2010), Kim and Kim (2012), and Kim and Kwark (2016). My study differs from these because I consider a much wider range of potential control variables and let the data decide which are actually relevant via multi-level factor analysis. With these modifications, the monetary policy reaction function becomes Eq. (4).

$$i_t^* = c + \beta_1 (E_t[\pi_{t,h_1} \,|\, \Omega_t] - \pi^*) + \beta_2 (E_t[y_{t,h_2} \,|\, \Omega_t] - y_N) + \beta_3 E_t[K_t \,|\, \Omega_t], \tag{4}$$

where $x_{t,h}$ denotes the average value between time t and time $t+h$, and Ω_t stands for the information available when the policy rate at time t is determined by the central bank. Finally, I introduce a smoothing operation for the policy rate to relieve the economy of shocks from abrupt changes in the policy rate, as in Eq. (5).

$$i_t = (1-\rho) i_t^* + \rho i_{t-1} + \varepsilon_t^i, \tag{5}$$

where ρ is a smoothing coefficient between zero and one and ε_t^i is an error with mean zero and variance σ_i^2. Then, by combining Eqs. (4) and (5), the non-linear monetary policy reaction function is derived as in Eq. (6).

$$\begin{aligned} i_t = (1-\rho)\{c + \beta_1 (E_t[\pi_{t,h_1} \,|\, \Omega_t] - \pi^*) + \beta_2 (E_t[y_{t,h_2} \,|\, \Omega_t] - y_N) + \beta_3' E_t[K_t \,|\, \Omega_t]\} \\ + \rho i_{t-1} + \varepsilon_t^i \end{aligned} \tag{6}$$

III. Methodology

3.1. Multi-level Factors

I employ a multi-step procedure with the canonical correlation analysis and principal components method proposed by Choi et al. (2018). The estimation procedure is summarized as follows.

(Step 1) Estimate K_{mt} by applying the principal component method to X_{mt}. Let $\hat{K}_{mt}$ denote the resulting estimate of K_{mt}. Estimate G_t by applying the canonical correlation analysis to $\hat{K}_{mt}$. Let $\hat{G}_t$ denote the resulting estimate for G_t and $\hat{G}$ be a matrix that vertically stacks $\hat{G}_t$.

(Step 2) Estimate Λ_m and F_{mt} by applying the principal component method to $M_{\hat{G}}X_m$, where X_m is a matrix that vertically stacks X_{mt} and $M_{\hat{G}} = I - \hat{G}(\hat{G}'\hat{G})^{-1}\hat{G}'$. Let $\hat{\Lambda}_m$ and $\hat{F}_{mt}$ denote the resulting estimates for Λ_m and F_{mt}, respectively.

(Step 3) Estimate Γ_m and G_t by applying the principal component method to $\begin{bmatrix} X_{1t} - \hat{\Gamma}_1\hat{F}_{1t} \\ X_{2t} - \hat{\Gamma}_2\hat{F}_{2t} \end{bmatrix}$. Let $\tilde{\Gamma}_m$ and $\tilde{G}_t$ denote the resulting estimates for Γ_m and G_t, respectively.

(Step 4) Estimate Λ_m and F_{mt} by applying the principal component method to $X_{mt} - \tilde{\Gamma}_m\tilde{G}_t$. Let $\tilde{\Lambda}_m$ and $\tilde{F}_{mt}$ denote the resulting estimates for Λ_m and F_{mt}, respectively.

3.2. Monetary Policy Reaction Function

In Section 2, I derive the non-linear monetary policy reaction function as Eq. (6) using the factor-augmented forward-looking policy rule of Eq. (4) and the smoothing operation of Eq. (5). Furthermore, Eq. (6) can be rewritten as a linear form,

$$\begin{aligned} i_t = \gamma_0 + \gamma_1(E_t[\pi_{t,h_1} \mid \Omega_t] - \pi^*) + \gamma_2(E_t[y_{t,h_2} \mid \Omega_t] - y_N) \\ + \gamma_3' E_t[K_t \mid \Omega_t] + \rho i_{t-1} + \varepsilon_t^i, \end{aligned} \tag{7}$$

where $\gamma_0 = (1-\rho)c$, $\gamma_j = (1-\rho)\beta_j$ for $j = 1,2,3$.

Following related studies in the literature, I use the uncollateralized overnight call rate (call rate, hereafter) or the BOK base rate for the policy rate i_t. For the inflation rate π_t, I use the log difference of the consumer price index. π^* is the target inflation rate announced by the BOK to the public. I use the coincident index for the output gap.

The panel of macroeconomic variables contains the same 84 variables for both the US and Korea; see the appendix for the complete list. The sample period is from February 2004 to December 2017 ($T = 167$). I conduct the KPSS test defined by Kwiatkowski et al. (1992) on all variables to check for stationarity and transform them by the first-difference or second-difference depending on the results of the KPSS test.[5,6] The variables expressed in rates are not adjusted. Details on the

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[5] The variables that need to be seasonally adjusted are differenced by year-on-year.

transformation of the variables are also included in the appendix. After transformation, I standardize all variables before estimating factors.

In Eq. (7) the conditional expectations are exogenous to the error term, but they are unobservable. It is a common approach to replace them with the realized future values, which then creates an endogeneity problem. I use three lags of each variable as instruments. Most studies in the literature estimate the non-linear monetary policy reaction function of Eq. (6) using the generalized method of moments (GMM). However, I estimate Eq. (7) via the two-stage least squares method and apply the delta method for inference on the original coefficients.

IV. Result

4.1. Estimation of Factors

I employ the information criterion IC_{p2} suggested by Bai and Ng (2002) to determine the total number of factors in each country. Table 1 shows the results. The total number of factors is estimated to be eight in the US and six in Korea.[7]

[Table 1] Estimated number of total factors

	5	6	7	8	9	10
US	-0.4425	-0.4454	-0.4513	**-0.4581**	-0.4508	-0.4460
Korea	-0.3383	**-0.3549**	-0.3549	-0.3536	-0.3490	-0.3449

Note: The reported values are those of IC_{p2} proposed by Bai and Ng (2002).

I use the method proposed by Dias et al. (2013) and Choi and Jeong (2019) to estimated the number of global and country-specific factors. I assume that at least one global factor and one country-specific factor should exist in each country. I set the possible number of global factors from one to five, which allows the number of country-specific factors to vary from three to seven in the US and from one to five in Korea. The information criterion IC_{p2} is computed across possible combinations of factor numbers. Table 2 reports the results. The estimated number of global factors is five, yielding three country-specific factors for the US and one country-specific factor for Korea. Indeed, this combination of factor numbers in Figure 1 is the only one consistent with the estimated numbers of factors.

[6] The results using the ADF-GLS unit root test by Ng and Perron (2001) are very similar. For several variables, both tests fail to reject the respective null and present conflicting results. I follow the KPSS test in these cases, which makes it the same as using only the KPSS test. However, the main findings of the paper are not affected in any significant way by this choice.

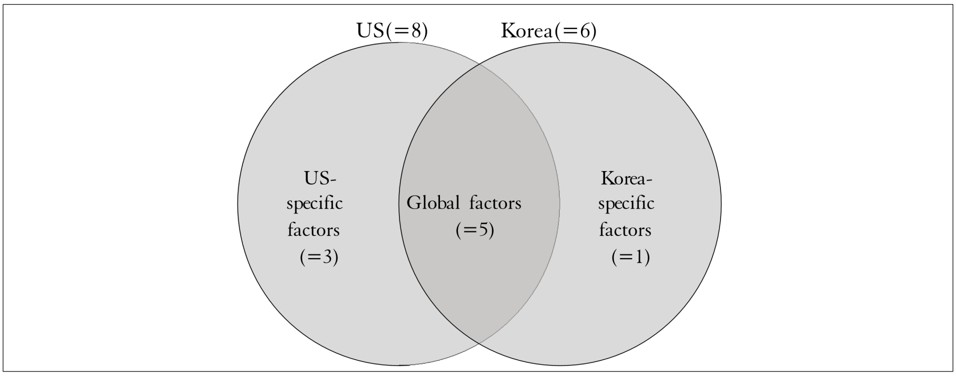
[7] The number of factors in the panel of two countries is always estimated to be eight for the US and six for Korea with $k\max = 8 - 16$ by IC_{p2}.

[Table 2] Estimated number of global factors

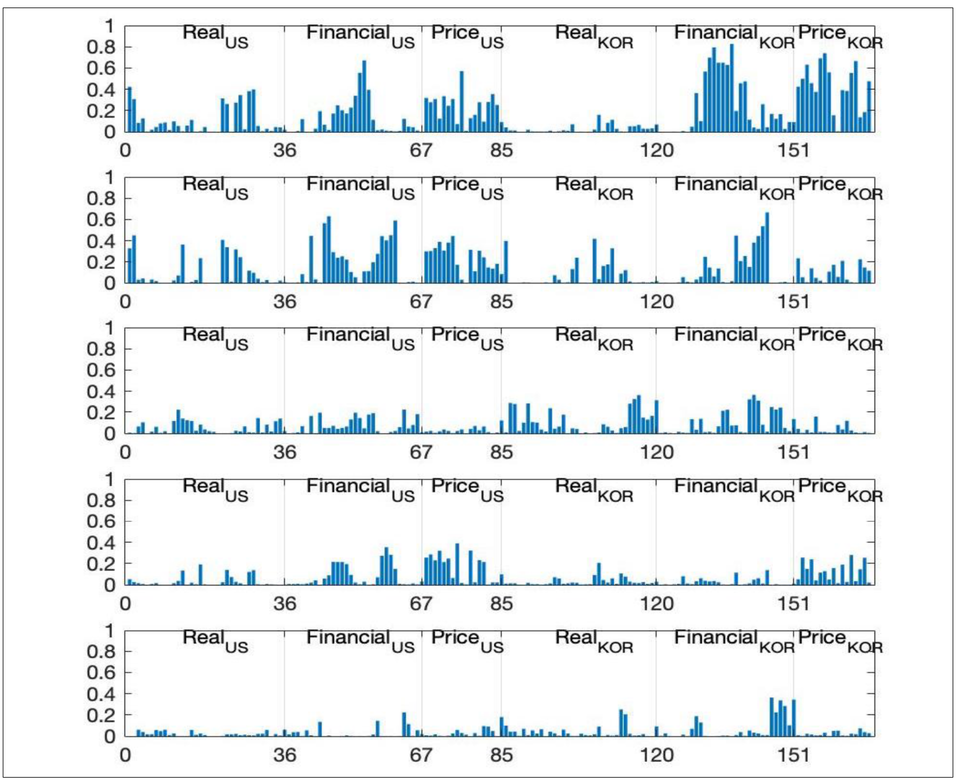
Global factors	1	2	3	4	5
IC_{p2}	-0.3367	-0.3571	-0.3766	-0.3855	**-0.3930**

Note: The reported values are those of IC_{p2} proposed by Dias et al. (2013) and Choi and Jeong (2018).

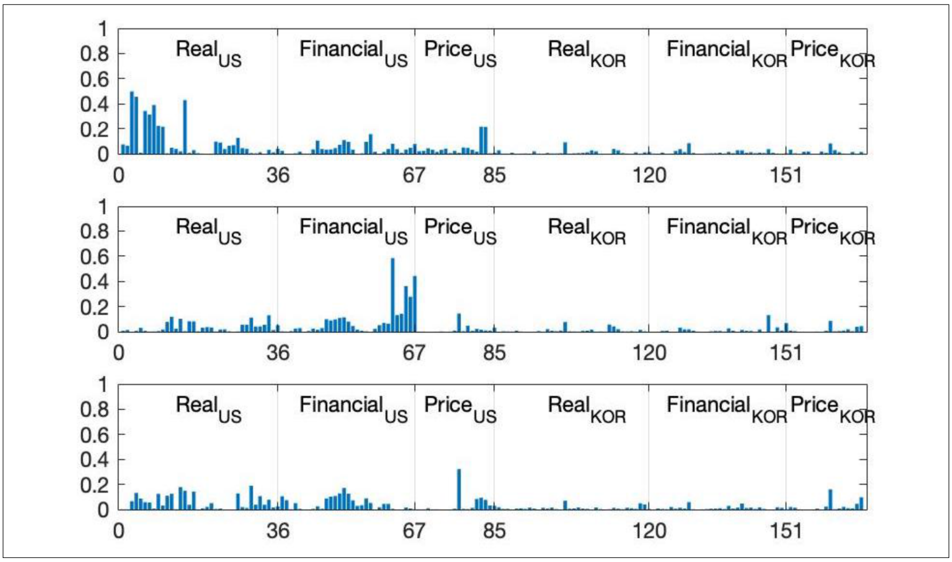
[Figure 1] Number of global and country-specific factors



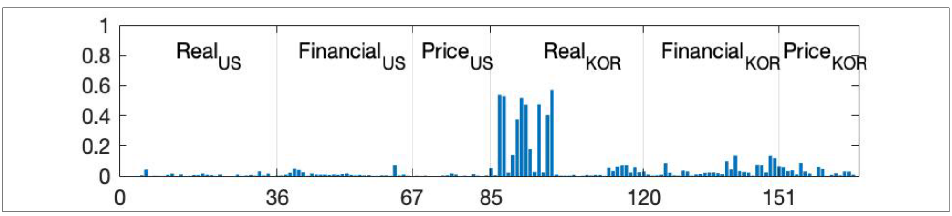
[Figure 2] Marginal R^2, global factors



[Figure 3] Marginal R^2, country-specific factors for the US



[Figure 4] Marginal R^2, country-specific factors for Korea



I estimate these factors and explore the correlation between the estimated factors and each individual variable in the panel. Figures 2–4 show the marginal R^2 values between the variables in the panel and each estimated factor, which is computed by regressing an individual variable on each factor.[8] As can be seen, global factors are correlated with variables in both countries, while country-specific factors are predominantly correlated with variables in one country.

4.2. Selection of Factors

I choose factors that will serve as control variables through the best subset selection procedure, which is applied to Eq. (8). In that regression, I use factors after projecting out the inflation rate and output gap to limit their influence in the selection procedure. Instead of relying on one particular sample, I apply the

[8] The variables are organized by sectors such as real, financial (including foreign exchange), and price.

selection procedure to 24 recursive samples with ending dates varying from January 2016 to December 2017.

$$i_t = \delta_0 + \delta_1' \tilde{K}_t^{subset} + \delta_2 i_{t-1} + u_t, \tag{8}$$

where $\tilde{K}^{subset} = M^{\pi,y} K^{subset}$, $M^{\pi,y} = I_T - X^{\pi,y}(X^{\pi,y\prime} X^{\pi,y})^{-1} X^{\pi,y\prime}$, and $X^{\pi,y} = (\pi - \pi^*, y - y_N)$. The criterion to select the best subset is the Bayesian information criterion (BIC). Table 3 shows the frequencies at which each factor is selected. For the policy rate, I use the call rate and the BOK base rate. With the call rate, the second and third global factors are chosen at all times, the first and fifth global factors are chosen 83% of the time, and the other factors are not chosen. With the BOK base rate, the second and third global factors are again chosen at all times, but no other factors are chosen.

[Table 3] Selection frequencies of factors

	G_1	G_2	G_3	G_4	G_5	F_1^{US}	F_2^{US}	F_3^{US}	F_1^{KOR}
Call rate	**0.83**	**1.00**	**1.00**	0.00	**0.83**	0.00	0.00	0.00	0.00
BOK base rate	0.00	**1.00**	**1.00**	0.00	0.00	0.00	0.00	0.00	0.00

Note: G, F^{US}, and F^{KOR} denote global, US, and Korean country-specific factors respectively.

4.3. Monetary Policy Reaction Function with Factors

In this subsection, I estimate the monetary policy reaction function. The forward-looking horizons for the inflation rate and the output gap are set at twelve and six ($h_1 = 12$ and $h_2 = 6$) and the alternative horizons for a robustness check are set at twelve and three ($h_1 = 12$ and $h_2 = 3$). Many previous studies have used one year for the inflation rate and a quarter or half-year for the output gap. Clarida et al. (2000) adopt $h_2 = 3$ or 6 based on the time lag in the monetary policy effects and informal materials of Federal Reserve officials. Meanwhile, Kim and Kwark (2016) in Korea use $h_2 = 0$.

Table 4 presents the estimation results with the standard horizon, $h_1 = 12$ and $h_2 = 6$. Table 5 shows the results with the alternative horizon, $h_1 = 12$ and $h_2 = 3$. In each table, the results with the call rate are on the upper part, while those with the BOK base rate are on the lower part. The first stage F statistic is reported to check for potential weak instruments and Sargan's J statistic for overidentifying restrictions. The adjusted R^2 is also provided to compare the goodness of fit by the model.

Column [1] in Tables 4 and 5 shows the estimation result for the benchmark model, which includes only the inflation rate and the output gap. Column [2] is for the model that has the second and third global factors as control variables. These two global factors are selected at all times in Eq. (8); see Table 3. Columns [3] and [4] are for the models that add even more control variables. Column [3] adds the first and fifth global factors, whose selection frequencies are 83%, while column [4] adds the Korea country-specific factor to control domestic information despite zero selection frequency in Table 3.

[Table 4] Estimation of monetary policy reaction functions with factors

$h_1=12$	Call rate							
$h_2=6$	[1]		[2]		[3]		[4]	
ρ	0.980***	(0.014)	0.927***	(0.016)	0.937***	(0.026)	0.914***	(0.018)
Constant	2.171	(2.514)	3.071***	(0.826)	3.466**	(1.186)	3.203***	(0.792)
$\pi_{t,h_1}-\pi^*$	0.312	(0.842)	0.502**	(0.244)	1.072**	(0.524)	0.612***	(0.233)
$y_{t,h_2}-y_N$	3.709***	(0.819)	-0.165	(0.315)	-0.347	(0.557)	-0.523	(0.347)
$G_{1,t}$					0.574	(0.664)		
$G_{2,t}$			-1.546***	(0.262)	-1.754***	(0.384)	-1.552***	(0.270)
$G_{3,t}$			1.256***	(0.163)	1.255***	(0.237)	0.979***	(0.144)
$G_{5,t}$					-0.292	(0.397)		
$F_{1,t}^{KOR}$							-0.256	(0.240)
1st F-stat	31.09	(0.000)	17.41	(0.000)	51.94	(0.000)	43.94	(0.000)
J-stat	29.64	(0.000)	3.06	(0.931)	22.43	(0.032)	18.85	(0.042)
Adj R^2	98.6		99.0		98.9		99.0	
$h_1=12$	BOK Base rate							
$h_2=6$	[1]		[2]		[3]		[4]	
ρ	0.980***	(0.016)	0.928***	(0.018)	0.920***	(0.028)	0.921***	(0.020)
Constant	2.086	(3.023)	3.042***	(0.936)	2.945***	(0.990)	3.132***	(0.926)
$\pi_{t,h_1}-\pi^*$	0.181	(1.001)	0.455*	(0.273)	0.295	(0.430)	0.536***	(0.271)
$y_{t,h_2}-y_N$	3.340***	(0.967)	-0.192	(0.352)	0.088	(0.457)	-0.431	(0.402)
$G_{1,t}$					-0.173	(0.543)		
$G_{2,t}$			-1.460***	(0.296)	-1.249***	(0.317)	-1.474***	(0.313)
$G_{3,t}$			1.198***	(0.180)	1.081***	(0.198)	1.018***	(0.167)
$G_{5,t}$					-0.298	(0.326)		
$F_{1,t}^{KOR}$							-0.172	(0.279)
1st F-stat	20.74	(0.000)	7.92	(0.000)	20.22	(0.000)	21.71	(0.000)
J-stat	18.72	(0.000)	5.44	(0.709)	15.90	(0.196)	17.91	(0.057)
Adj R^2	98.2		98.8		98.8		98.8	

Note: Numbers in parenthesis are the standard errors of coefficient estimates and p-values of the first stage F test and J test. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

[Table 5] Estimation of monetary policy reaction functions with factors for the alternative horizon

$h_1 = 12$	Call rate							
$h_2 = 3$	[1]		[2]		[3]		[4]	
ρ	0.982***	(0.014)	0.928***	(0.017)	0.938***	(0.027)	0.921***	(0.019)
Constant	1.816	(2.833)	3.073***	(0.885)	3.338***	(1.261)	3.164***	(0.930)
$\pi_{t,h_1} - \pi^*$	-0.152	(0.967)	0.512*	(0.283)	0.921	(0.639)	0.602**	(0.304)
$y_{t,h_2} - y_N$	3.517***	(0.856)	-0.130	(0.324)	0.034	(0.597)	-0.308	(0.388)
$G_{1,t}$					0.486	(0.720)		
$G_{2,t}$			-1.541***	(0.285)	-1.607***	(0.414)	-1.531***	(0.318)
$G_{3,t}$			1.248***	(0.167)	1.312***	(0.282)	1.035***	(0.168)
$G_{5,t}$					-0.491	(0.395)		
$F_{1,t}^{KOR}$							-0.165	(0.261)
1st F-stat	37.45	(0.000)	17.84	(0.000)	55.97	(0.000)	44.96	(0.000)
J-stat	32.83	(0.000)	3.15	(0.924)	21.31	(0.046)	21.59	(0.017)
Adj R^2	98.6		99.0		98.8		99.0	
$h_1 = 12$	BOK Base rate							
$h_2 = 3$	[1]		[2]		[3]		[4]	
ρ	0.983***	(0.017)	0.929***	(0.019)	0.920***	(0.028)	0.928***	(0.021)
Constant	1.727	(3.470)	3.045***	(1.001)	2.805***	(1.009)	3.074***	(1.098)
$\pi_{t,h_1} - \pi^*$	-0.257	(1.171)	0.467	(0.317)	0.108	(0.505)	0.501	(0.356)
$y_{t,h_2} - y_N$	3.164***	(1.032)	-0.154	(0.362)	0.325	(0.471)	-0.202	(0.455)
$G_{1,t}$					-0.283	(0.567)		
$G_{2,t}$			-1.454***	(0.320)	-1.136***	(0.327)	-1.444***	(0.375)
$G_{3,t}$			1.187***	(0.184)	1.151***	(0.226)	1.095***	(0.195)
$G_{5,t}$					-0.399	(0.312)		
$F_{1,t}^{KOR}$							-0.073	(0.307)
1st F-stat	24.93	(0.000)	8.13	(0.000)	20.25	(0.000)	22.43	(0.000)
J-stat	20.47	(0.000)	5.54	(0.699)	15.13	(0.234)	19.23	(0.037)
Adj R^2	98.1		98.8		98.8		98.8	

Note: Numbers in parenthesis are standard errors of coefficient estimates and p-values of the first stage F test and J test. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

In column [1] of Table 4, the inflation rate is not significant while the output gap is significant. This finding seems to be disagreement with the legal purpose of monetary policy, the stabilization of the inflation rate. However, the observed insignificance may be only a statistical glitch. The existence of an omitted variable not only causes bias in the estimate but also affects the standard error. Since we find at least two statistically significant control variables in columns [2]–[4], the benchmark model is deemed mis-specified.

This result can be compared with a previous study on US monetary policy. Many related studies including Clarida et al. (2000) and Belviso and Milani (2006) show that the inflation rate and the output gap are significantly positive in the US benchmark model, even though Belviso and Milani (2006) find additional information using US factors that are significantly considered in monetary policy decisions. This finding implies that monetary policy decisions in the US are not heavily affected by information other than the key variables of the Taylor rule compared to Korea.

Column [2] shows that the second and third global factors are significant control variables, which means that the monetary policy in Korea reacts significantly to some information that affects both foreign and domestic economies. Moreover, columns [3] and [4] show that further control variables are insignificant. The inflation rate shows improved significance but the output gap becomes insignificant. The results of the J test also show that the validity of overidentifying restrictions is not guaranteed. Comprehensively, the preferred specification is column [2]. The adjusted R^2 value in column [2] slightly increases above that of the column [1] due to the augmented factors. Note that the best subset selection method does not take endogeneity into account, and thus a high frequency of selection in Eq. (8) does not necessarily imply statistical significance in the monetary policy reaction function. Table 5 carries the same implication for the control variables.

One way to understand these results is as follows. Suppose that the factors can be decomposed into two parts, one that resembles the inflation rate and the output gap and the other that is separate from them. The former is a cause for weak significance or insignificance of the inflation rate and the output gap while the latter is the actual additional control variable to be found. I explore the latter part in Section 4.4. I run predictive regressions of the inflation rate and output gap on the estimated factors to validate the former. The results are reported in Table 6. The forecasting horizons are the same as that specified for the monetary policy reaction function, and $h_1 = 6$ for the inflation rate is added for a robustness check. Standard errors are computed via a heteroskedasticity and autocorrelation consistent (HAC) covariance estimator with a quadratic spectral kernel. Table 6 shows that most factors are significant predictors for either the inflation rate or the output gap. Notably, the second and third global factors that serve as significant control variables are highly correlated with the future values of the inflation rate and output gap at the 1% significance level regardless of the forecasting horizons.

[Table 6] Results of predictive regressions for inflation rate and output gap with factors

	$\pi_{t,h_1} - \pi^*$				$y_{t,h_2} - y_N$			
	$h_1 = 6$		$h_1 = 12$		$h_2 = 3$		$h_2 = 6$	
Constant	-0.608***	(0.034)	-0.683***	(0.038)	0.077*	(0.041)	0.037	(0.036)
$G_{1,t}$	-0.893***	(0.033)	-0.795***	(0.036)	-0.091**	(0.036)	-0.034	(0.035)
$G_{2,t}$	-0.088***	(0.032)	-0.103***	(0.028)	-0.560***	(0.030)	-0.503***	(0.025)
$G_{3,t}$	0.191***	(0.032)	0.337***	(0.031)	0.097***	(0.032)	0.188***	(0.030)
$G_{4,t}$	0.442***	(0.029)	0.286***	(0.035)	-0.007	(0.031)	-0.086***	(0.029)
$G_{5,t}$	0.037	(0.030)	0.074**	(0.033)	0.296***	(0.034)	0.319***	(0.031)
$F_{1,t}^{US}$	-0.022	(0.033)	-0.043	(0.035)	-0.148***	(0.036)	-0.135***	(0.033)
$F_{2,t}^{US}$	-0.119***	(0.033)	-0.187***	(0.039)	0.014	(0.041)	0.023	(0.034)
$F_{3,t}^{US}$	-0.042	(0.033)	-0.021	(0.033)	-0.139***	(0.035)	-0.152***	(0.031)
$F_{1,t}^{KOR}$	0.057*	(0.031)	0.001	(0.032)	-0.077*	(0.039)	-0.125***	(0.031)

Note: Numbers in parenthesis are standard errors, which are computed by an HAC estimator with a quadratic spectral kernel. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

4.4. Monetary Policy Reaction Functions with Selected Individual Variables

I examine the information in the factors that are separate from the output gap and the inflation rate mentioned in Section 4.3. This examination is possible by identifying individual macroeconomic variables that are distinct from the inflation rate and the output gap but are correlated with the two selected global factors. I employ a simple top-down approach to find the relevant individual control variables. First, I categorize all variables into four sectors: real, financial, foreign exchange, and price. In each sector, I collect variables that exhibit a high correlation with the factors and then estimate the monetary policy reaction function by replacing the factors with these candidate variables. Based on the relevance of the sign and significance of the coefficients, I finally choose individual control variables.

I select the Baa-FFR spread in the US (IS^{US}) from the financial sector[9]; the KRW/USD exchange rate ($FX^{KOR/US}$) from the foreign exchange sector; and non-farm employment in Korea (EMP^{KOR}), BSI for new contracts (BSI_N^{KOR}) and BSI for sales (BSI_S^{KOR}) in the manufacturing industry in Korea from the real sector as relevant control variables. Table 7 shows the marginal R^2 value of each variable. The interest rate spread and non-farm employment show the marginal R^2 at 0.63

[9] Baa and FFR denote Baa-rated corporate bonds with maturities 20 years and above in the US and the federal fund rate respectively.

and 0.42 on the second global factor, respectively. The KRW/USD exchange rate and the BSIs have relatively high correlation with the third global factor, indicating that the marginal R^2 at 0.22 and 0.32–0.33, respectively.

[Table 7] Marginal R^2 of selected individual variables on factors

	Financial	Foreign exchange	Real		
	IS^{US}	$FX^{KOR/US}$	EMP^{KOR}	BSI_N^{KOR}	BSI_S^{KOR}
G_2	0.6303		0.4180		
G_3		0.2234		0.3295	0.3233

I do not choose control variables from the price sector because the BOK clearly states that its inflation target is set in terms of changes in the consumer price index. On the other hand, I include control variables from the real sector in despite of the coincident index. These choices are because there are many ways to measure the output gap among which the coincident index that I use is only one. The Korean economy is often described as being polarized. Large firms that make significant profits from exports and small firms that struggle in the domestic markets coexist. Highly skilled workers enjoy good compensation, while low-skilled workers face high entry barriers into the labor market and deterioration of working conditions. Hence, one index obtained as a particular average of economic activity might not be enough to provide a precise portrayal of the status of the economy. In fact, the minutes of the monetary policy board meetings frequently refer to sentiment indices and labor market situations for particular groups of workers, such as the younger generations. Specifically, they mention "number of employees" eight times and "sentiment indices for corporations" ten times as reasons for their decisions to change the policy rate in a total of 30 meetings during the sample period.[10] Therefore, the coincident index, employment, and BSI should be understood as collectively forming a measure of the output gap relevant for the monetary policy.

Tables 8 and 9 report the estimation results with the selected individual macroeconomic variables as control variables. For the estimation, lags of each variable are used as instruments because of endogeneity. Column [5] includes the interest rate spread in the US and the KRW/USD exchange rate, but no other control variables from the real sector. Column [6] adds employment in Korea to column [5], and columns [7] and [8] further augment the BSI in Korea.

The results of Tables 8 and 9 are quite similar. In columns [5]–[8], most coefficients of the control variables are significant and have reasonable signs for the monetary policy reaction, even though the adjusted R^2 values are lower than those of the regression with the factors in column [2] of Tables 4 and 5.[11] A negative

[10] See Bank of Korea (2004–2017) for the details.

[11] This finding might be caused by the reduction in information of regressors by replacing the

change in employment and BSI leads to expansionary monetary policy. Furthermore, the policy rate declines in response to the depreciation of KRW against USD. However, the interest rate spread in the US has a negative effect on the policy rate, which can be interpreted in several ways, and I will return to this issue later.

[Table 8] Estimation of monetary policy reaction functions with individual variables

$h_1 = 12$	Call rate							
$h_2 = 6$	[5]		[6]		[7]		[8]	
ρ	0.909***	(0.021)	0.907***	(0.021)	0.965***	(0.027)	0.953***	(0.026)
Constant	6.038***	(1.376)	5.238***	(1.253)	3.574	(4.565)	4.212	(3.128)
$\pi_{t,h_1} - \pi^*$	1.028***	(0.248)	1.057***	(0.239)	1.668**	(0.758)	1.481***	(0.534)
$y_{t,h_2} - y_N$	0.309	(0.260)	-0.018	(0.284)	1.091	(0.844)	0.543	(0.604)
IS^{US}	-0.571***	(0.136)	-0.565***	(0.129)	-0.592	(0.441)	-0.577*	(0.306)
$FX^{KOR/US}$	-0.208*	(0.109)	-0.216**	(0.202)	-0.660**	(0.277)	-0.554***	(0.202)
EMP^{KOR}			0.499***	(0.193)	1.658***	(0.558)	1.231***	(0.411)
BSI_N^{KOR}					0.598***	(0.174)		
BSI_S^{KOR}							0.344***	(0.106)
1st F-stat	49.71	(0.000)	46.71	(0.000)	51.57	(0.000)	53.79	(0.000)
J-stat	22.63	(0.004)	20.89	(0.022)	10.65	(0.559)	10.83	(0.544)
$Adj\ \ R^2$	98.7		98.6		98.4		98.4	
$h_1 = 12$	BOK Base rate							
$h_2 = 6$	[5]		[6]		[7]		[8]	
ρ	0.900***	(0.023)	0.901***	(0.022)	0.936***	(0.025)	0.935***	(0.025)
Constant	5.942***	(0.239)	5.232***	(1.260)	4.588**	(2.282)	4.569**	(2.176)
$\pi_{t,h_1} - \pi^*$	0.947***	(0.388)	0.970***	(0.240)	1.139***	(0.388)	1.172***	(0.379)
$y_{t,h_2} - y_N$	0.126	(0.245)	-0.148	(0.281)	0.153	(0.431)	0.094	(0.426)
IS^{US}	-0.556***	(0.129)	-0.558***	(0.129)	-0.549**	(0.222)	-0.547**	(0.214)
$FX^{KOR/US}$	-0.087	(0.101)	-0.118	(0.099)	-0.219	(0.144)	-0.264*	(0.142)
EMP^{KOR}			0.461**	(0.191)	0.847***	(0.293)	0.869***	(0.295)
BSI_N^{KOR}					0.209**	(0.086)		
BSI_S^{KOR}							0.199***	(0.073)
1st F-stat	24.18	(0.000)	23.45	(0.000)	24.75	(0.000)	23.79	(0.000)
J-stat	15.89	(0.044)	16.63	(0.083)	16.27	(0.179)	13.35	(0.344)
$Adj\ \ R^2$	98.3		98.4		98.5		98.4	

Note: Numbers in parenthesis are standard errors of coefficient estimates and p-values of the first stage F test and J test. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

factors with individual variables.

[Table 9] Estimation of monetary policy reaction functions with individual variables for the alternative horizon

$h_1=12$, $h_2=3$	Call rate [5]		[6]		[7]		[8]	
ρ	0.907***	(0.020)	0.908***	(0.020)	0.964***	(0.025)	0.951***	(0.024)
Constant	6.036***	(1.234)	5.231***	(1.145)	3.926	(3.912)	4.392	(2.720)
$\pi_{t,h_1}-\pi^*$	0.993***	(0.240)	1.053***	(0.242)	1.497**	(0.714)	1.393***	(0.509)
$y_{t,h_2}-y_N$	0.291	(0.217)	0.013	(0.258)	1.062	(0.711)	0.529	(0.516)
IS^{US}	-0.575***	(0.118)	-0.563***	(0.115)	-0.611*	(0.368)	-0.586**	(0.259)
$FX^{KOR/US}$	-0.213**	(0.107)	-0.223**	(0.103)	-0.641**	(0.261)	-0.542***	(0.193)
EMP^{KOR}			0.494**	(0.206)	1.444***	(0.555)	1.121***	(0.416)
BSI_N^{KOR}					0.576***	(0.164)		
BSI_S^{KOR}							0.332***	(0.101)
1st F-stat	51.19	(0.000)	49.05	(0.000)	51.08	(0.000)	53.89	(0.000)
J-stat	22.73	(0.004)	20.89	(0.022)	10.21	(0.598)	10.75	(0.550)
Adj R^2	98.6		98.6		98.4		98.4	
$h_1=12$, $h_2=3$	BOK Base rate [5]		[6]		[7]		[8]	
ρ	0.898***	(0.022)	0.903***	(0.021)	0.936***	(0.024)	0.935***	(0.023)
Constant	5.951***	(1.206)	5.191***	(1.163)	4.620**	(2.089)	4.596**	(1.975)
$\pi_{t,h_1}-\pi^*$	0.935***	(0.234)	0.985***	(0.244)	1.114***	(0.389)	1.157***	(0.376)
$y_{t,h_2}-y_N$	0.109	(0.208)	-0.135	(0.257)	0.186	(0.388)	0.103	(0.380)
IS^{US}	-0.559***	(0.114)	-0.554***	(0.116)	-0.550***	(0.197)	-0.548***	(0.188)
$FX^{KOR/US}$	-0.088	(0.101)	-0.119	(0.102)	-0.225	(0.144)	-0.266*	(0.142)
EMP^{KOR}			0.479**	(0.205)	0.820***	(0.310)	0.851***	(0.310)
BSI_N^{KOR}					0.213**	(0.086)		
BSI_S^{KOR}							0.199***	(0.072)
1st F-stat	25.31	(0.000)	24.96	(0.000)	25.01	(0.000)	24.28	(0.000)
J-stat	16.00	(0.042)	16.53	(0.085)	16.21	(0.182)	13.36	(0.343)
Adj R^2	98.4		98.4		98.5		98.4	

Note: Numbers in parenthesis are standard errors of coefficient estimates and p-values of the first stage F test and J test. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

Note that all the coefficients of the inflation rate are significantly positive in columns [5]–[8]. This finding is highly consistent with the legal purpose of monetary policy, the stabilization of the inflation rate. In addition, the hypothesis of the Taylor principle is not rejected in all columns. Using individual variables as control variables instead of estimated factors seems to improve the efficiency of estimation by limiting mutual correlation among independent variables. The coefficients of the output gap are consistently insignificant; however, this fact does not imply that the BOK has a relatively low weight on the output gap. Rather, as evidenced by the significance of employment and BSI, the central bank seems to assess the output gap from diverse angles.

Now I return to the negative coefficient of interest spread in the US. I split interest spread into credit spread (CS^{US}) and term spread (TS^{US}) as in Eq. (9).

$$Baa - FFR = (Baa - Aaa) + (Aaa - FFR)\,, \tag{9}$$

where Aaa denotes Aaa-rated corporate bonds with maturities of 20 years and above in the US. Then I re-estimate the monetary policy reaction functions of columns [7] and [8] by replacing interest spread with either credit spread or term spread. Table 10 provides the estimation results. Columns [9] and [10] are for credit spread and columns [11] and [12] are for term spread.

Credit spread in columns [9] and [10] is significantly negative for both dependent variables, but term spread is not significant at the 5% significance level. Note that the output gap is significant for the call rate and at the borderline for the BOK base rate, and the adjusted R^2 values are slightly higher than those of columns [7] and [8]. These results imply that the monetary policy in Korea has reacted to the credit spread in the US. Since the US credit risk can be contagious and is one of the leading indicators of the financial crisis, it may be important information for forward-looking monetary policy in Korea. It can also be related to the results of Curdia and Woodford (2010), which show that the adjustment of the credit spread is helpful for the monetary policy rule using the dynamic stochastic general equilibrium model with credit frictions. On the other hand, Gilchrist and Zakrajšek (2012) show that the credit spread contains predictive information for real activities. Thus, it is also possible to suggest that monetary policy decisions in Korea are likely to be influenced by the business cycle of the US economy.

I highlight the finalized monetary policy reaction function in Korea as column [9] or [10] in Table 10. The result with the call rate as a dependent variable shows that both the inflation rate and output gap are significant, which imply that the monetary policy in Korea plays a role in the stabilization of the inflation rate and economic growth. It confirms that the Taylor principle is satisfied by showing a higher response to the inflation rate than the previous results. This confirmation is derived only from the monetary policy reaction function with the control variables in columns [9] and [10]. Although non-farm employment is not significant, these control variables provide meaningful implications for BOK monetary policy decisions. The exchange rate is one of the important control variables for the monetary policy reaction function in Korea, similar to any other small open economy. The credit spread in the US that represents foreign impact is also an important control variable. Lastly, the output gap might be better represented by multiple measures such as the coincident index, business survey indices, and non-farm employment.

[Table 10] Estimation of monetary policy reaction functions with interest rate spreads

$h_1=12$	Call rate							
$h_2=6$	[9]		[10]		[11]		[12]	
ρ	0.986***	(0.013)	0.982***	(0.013)	0.986***	(0.032)	0.967***	(0.030)
Constant	3.784	(4.192)	4.288	(3.165)	-3.511	(7.109)	0.291	(2.882)
$\pi_{t,h_1}-\pi^*$	3.218***	(1.099)	2.752***	(0.858)	2.733	(2.013)	1.701**	(0.835)
$y_{t,h_2}-y_N$	2.976**	(1.266)	2.172**	(1.001)	3.476	(2.146)	1.050	(0.908)
CS^{US}	-4.406***	(1.242)	-3.811***	(0.944)				
TS^{US}					-0.836	(1.913)	-0.821	(0.789)
$FX^{KOR/US}$	-1.192**	(0.499)	-1.056***	(0.392)	-1.517**	(0.673)	-0.814***	(0.285)
EMP^{KOR}	0.280	(1.587)	-0.095	(1.229)	4.397***	(1.536)	2.054***	(0.666)
BSI_N^{KOR}	0.958***	(0.343)			1.760***	(0.448)		
BSI_S^{KOR}			0.528**	(0.227)			0.587***	(0.158)
1st F-stat	34.72	(0.000)	37.59	(0.000)	60.96	(0.000)	63.87	(0.000)
J-stat	12.19	(0.431)	13.95	(0.304)	11.37	(0.498)	12.68	(0.393)
Adj R^2	98.8		98.8		98.2		98.3	
$h_1=12$	BOK Base rate							
$h_2=6$	[9]		[10]		[11]		[12]	
ρ	0.984***	(0.015)	0.984***	(0.015)	0.957***	(0.030)	0.947***	(0.029)
Constant	3.581	(4.022)	2.793	(4.063)	1.044	(2.245)	1.459	(1.737)
$\pi_{t,h_1}-\pi^*$	2.336**	(1.066)	2.435**	(1.109)	1.254*	(0.649)	1.213**	(0.512)
$y_{t,h_2}-y_N$	2.100*	(1.226)	2.013	(1.288)	0.670	(0.691)	0.360	(0.553)
CS^{US}	-3.466***	(1.200)	-3.256***	(0.944)				
TS^{US}					-0.798	(0.606)	-0.799*	(0.475)
$FX^{KOR/US}$	-1.099**	(0.483)	-1.181**	(0.504)	-0.334	(0.220)	-0.370**	(0.174)
EMP^{KOR}	0.098	(1.540)	0.606	(1.585)	1.489***	(0.506)	1.264***	(0.411)
BSI_N^{KOR}	0.578*	(0.327)			0.486***	(0.140)		
BSI_S^{KOR}			0.682**	(0.290)			0.321***	(0.094)
1st F-stat	24.27	(0.000)	23.06	(0.000)	25.85	(0.000)	26.48	(0.000)
J-stat	18.25	(0.108)	15.23	(0.229)	11.38	(0.497)	11.33	(0.501)
Adj R^2	98.6		98.5		98.2		98.2	

Note: Numbers in parenthesis are standard errors of coefficient estimates and p-values of the first stage F test and J test. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

V. Conclusion

This paper estimates the monetary policy reaction function in Korea using multi-level factors extracted from a panel of macroeconomic variables in two countries, the US and Korea. Using these factors, I study the relevant control variables of the function and investigate the significance of inflation rate for monetary policy.

The following four main results are suggested. First, the benchmark model without any control variables shows the insignificance of the inflation rate because of a model misspecification. Second, some global factors that contain common information on two economies serve as important control variables for monetary policy decisions. However, the factor-augmented regression seems to be inefficient due to the highly correlated independent variables. Thus, I find individual control variables that can be substituted for the factors. Third, through a top-down approach, credit spread in the US, the KRW/USD exchange rate, non-farm employment, and BSIs in Korea are selected as relevant control variables. Lastly, the results with these control variables show that the policy response to the inflation rate is significantly positive, which is consistent with the legal purpose of monetary policy in Korea under the inflation targeting system and demonstrates that the Taylor principle is satisfied.

In future studies, analyzing the dynamic monetary policy responses for foreign factors would be interesting. Generally, factors from a static factor model can contain both current and lagged values of dynamic factors, but they are not separately identified due to the static framework. Hence, to overcome this problem, a multi-level dynamic factor model must be used, for which identification strategies and asymptotic theories need to be developed further.

Appendix A List of Macroeconomic Variables

No	Variable	Sector	Trans.
1	Business cycle: Leading composite index	Real	level (%)
2	Business cycle: Coincident composite index	Real	level (%)
3	Industrial production index: Total	Real	1st diff
4	Industrial production index: Manufacturing	Real	1st diff
5	Industrial production index: Electronics, gas	Real	1st diff
6	Industrial production index: Business equipment	Real	1st diff
7	Industrial production index: Materials	Real	1st diff
8	Industrial production index: Consumer goods	Real	1st diff
9	Industrial production index: Durable goods	Real	1st diff
10	Industrial production index: Non-durable goods	Real	1st diff
11	Sales: Retailer	Real	1st diff
12	Sales: Manufacturing	Real	1st diff
13	Manufacturing inventory index	Real	1st diff
14	Manufacturing inventory / sales	Real	1st diff
15	Capacity Utilization: Manufacturing	Real	1st diff
16	Labor Force	Real	1st diff
17	Unemployment rate	Real	level (%)
18	Unemployed persons to 14 weeks	Real	1st diff
19	Unemployed persons 15 weeks +	Real	2nd diff
20	Unemployed persons 27 weeks +	Real	2nd diff
21	Employees: Total	Real	2nd diff
22	Employees: Non-farm	Real	1st diff
23	Employees: Manufacturing	Real	1st diff
24	Employees: Government	Real	1st diff
25	Employees: Construction	Real	1st diff
26	Employees: Financial activities	Real	1st diff
27	Average weekly hours of all employees	Real	1st diff
28	Housing starts: Total	Real	1st diff
29	Housing authorized: Total	Real	1st diff
30	Business survey index: Total	Real	1st diff
31	Business survey index: Sales of manufacturing (supplier deliveries)	Real	1st diff
32	Business survey index: New orders of manufacturing	Real	1st diff
33	Business survey index: Inventories of manufacturing	Real	1st diff
34	Business survey index: Prices of manufacturing	Real	1st diff
35	Business survey index: Employment of manufacturing	Real	1st diff
36	Consumer survey index: Consumer sentiment	Real	1st diff
37	Money stock: M1	Financial	2nd diff
38	Money stock: M2	Financial	2nd diff
39	Money stock: Currency	Financial	2nd diff
40	Money stock: Monetary base	Financial	1st diff
41	Loans: Commercial and industrial loans at all commercial banks	Financial	2nd diff
42	Loans: Change in commercial and industrial loans at all commercial banks	Financial	level (%)
43	Loans: Commercial credit	Financial	1st diff

44	Stock: KOSPI 200 (S&P 500)	Financial	1st diff
45	Stock: Dividend yield	Financial	level (%)
46	Stock: Price earnings ratio	Financial	level (%)
47	Interest rate: Call rate (Federal funds rate)	Financial	level (%)
48	Interest rate: 3-month yields of CD (AA non-financial CP)	Financial	level (%)
49	Interest rate: 3-month yields of CP (AA financial CP)	Financial	level (%)
50	Interest rate: 1-year yields of treasury bond	Financial	level (%)
51	Interest rate: 5-year yields of treasury bond	Financial	level (%)
52	Interest rate: 10-year yields of treasury bond	Financial	level (%)
53	Interest rate: 3-year yields of AA- corporate bond (Moody's Aaa, 20-year+)	Financial	level (%)
54	Interest rate: 3-year yields of BBB- corporate bond (Moody's Baa, 20-year+)	Financial	level (%)
55	Spread: CD - call spread (AA non-financial CP - call)	Financial	level (%)
56	Spread: CP - call spread (AA financial CP - call)	Financial	level (%)
57	Spread: TB 1yr - call spread	Financial	level (%)
58	Spread: TB 5yr - call spread	Financial	level (%)
59	Spread: TB 10yr - call spread	Financial	level (%)
60	Spread: AA- - call spread (Aaa - call)	Financial	level (%)
61	Spread: BBB- - call spread (Baa - call)	Financial	level (%)
62	Exchange rate: Nominal effective exchange rate, unit labor costs	FX (Foreign exchange)	1st diff
63	Exchange rate: Korea / US (US / Korea)	FX	1st diff
64	Exchange rate: Korea / Japan (US / Japan)	FX	1st diff
65	Exchange rate: Korea / UK (US / UK)	FX	1st diff
66	Exchange rate: Korea / Canada (US / Canada)	FX	1st diff
67	Exchange rate: Korea / Switzerland (US / Switzerland)	FX	1st diff
68	Production price index: Finished goods	Price	1st diff
69	Production price index: Finished consumer goods	Price	1st diff
70	Production price index: Intermediate materials	Price	1st diff
71	Production price index: Crude materials	Price	1st diff
72	Export price index: Total	Price	1st diff
73	Import price index: Total	Price	1st diff
74	Consumer price index: All items Price	Price	1st diff
75	Consumer price index: All items less food and energy	Price	1st diff
76	Consumer price index: Food and energy	Price	1st diff
77	Consumer price index: Apparel	Price	1st diff
78	Consumer price index: Transportation	Price	1st diff
79	Consumer price index: Medical	Price	1st diff
80	Consumer price index: Commodities	Price	1st diff
81	Consumer price index: Services	Price	1st diff
82	Housing price index: National	Price	1st diff
83	Housing price index: Seoul (Principal 20 cities)	Price	1st diff
84	Consumer survey index: Inflation expectation	Price	1st diff

Note: The contents in parenthesis of the column "Variables" are the description of variable of the US different from those of Korea.

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