The Efficacy of Monetary and Fiscal Policy in Korea: How Do They Evolve Since the 2000s?

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Paper I: Monetary Policy

What We Do

- Estimate a time-varying coefficient vector autoregressive (TVC-VAR) model
  - as in Primiceri (2005, RES) and Galí and Gambetti (2015, AEJ-Macro)
  - with Korean data since the 2000s
- Attempt to seek econometric evidence on:
  - how does the effect of monetary policy shocks on GDP (and its components) change over time?
    - consumption and sub-categories (durable / non-durable)
    - investment and sub-categories (residential / non-residential)

What We Find (Preliminary)

1. A time-varying pattern for GDP?
   - the effects of expansionary monetary policy shocks on GDP decrease through the 2000s
   - they bounce back only marginally in the subsequent period
2. A time-varying pattern for consumption or investment?
   - consumption displays a quite similar time-varying pattern to that of GDP $\Longleftarrow$ due to nondurable consumption
   - for investment, however, the expansionary effects of MP shocks are still more restrictive in the recent period $\Longleftarrow$ caused jointly by residential and nonresidential investment

Reduced-form VAR Specification

- A quarterly VAR with time-varying coefficients:

$$z_t = \mu_0 + \mu_1 t + \mu_2 t^2 + D x_t + B_{1,t} z_{t-1} + \ldots + B_{\ell,t} z_{t-\ell} + u_t,$$

  - μ_0 is a constant, t & t^2 are linear and quadratic time trends
  - x_t: vector of exogenous variables
  - D: coefficients associated with the exogenous variables
  - z_t: vector of endogenous variables
  - $B_{i,t}$'s: matrices of time-varying coefficients
  - u_t: heteroskedastic reduced-form errors with $E(u_t u_t') = \Sigma_{u,t}$

Reduced-form VAR Specification

- A quarterly VAR with time-varying coefficients:

$$z_t = \mu_0 + \mu_1 t + \mu_2 t^2 + D x_t + B_{1,t} z_{t-1} + \ldots + B_{\ell,t} z_{t-\ell} + u_t,$$

  - x_t contains 4 variables having potential impacts on monetary policy decision-making
    - the growth rate of oil price, federal funds rate, US real GDP per capita, and real exchange rate (against dollar)
  - z_t consists of 4 variables
    - the benchmark specification has GDP (Y), consumption (C), inflation rate (π), and overnight call rate (R)
    - C of the benchmark model is replaced with investment (I), and C and I sub-components in order to calculate the responses of these variables to MP shocks
  - set $\ell = 3 \Leftarrow$ based on the information criteria (AIC and BIC)

CORRESPONDING STRUCTURAL VAR

- The structural VAR model:

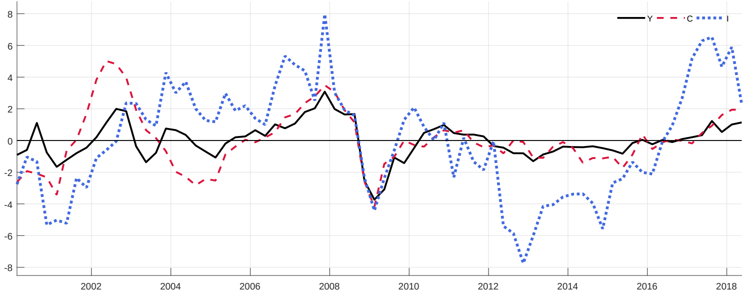
$$A_t z_t = A_t \left(\mu_0 + \mu_1 t + \mu_2 t^2 + D x_t\right) + A_t B_{1,t} z_{t-1} + A_t B_{2,t} z_{t-2} + A_t B_{3,t} z_{t-3} + e_t,$$

  - A_t: lower-triangular Cholesky decomposition of $\Sigma_{u,t}$
    - posit that the policy rate has no contemporaneous effect on macroeconomic variables, such as production and prices
    - e.g., Christiano, Eichenbaum, and Evans (1999, HoM)
  - e_t: structural innovations with $E(e_t e_t') = \Sigma_{e,t}$ where all the off-diagonal elements of $\Sigma_{e,t}$ are zero
    - $A_t u_t = e_t$ and $A_t \Sigma_{u,t} A_t' = \Sigma_{e,t} \Sigma_{e,t}'$

Definitions of the variables

- "Consumption" (C): private consumption
  - "durable consumption" (C^d) $=$ durable $+$ semi-durable
  - "nondurable consumption" (C^{nd}) $=$ nondurable $+$ service
  - $C \approx C^d + C^{nd}$
- "Investment" (I) $=$ "residential" (I^r) $+$ "nonresidential" (I^{nr})

Data and Estimation

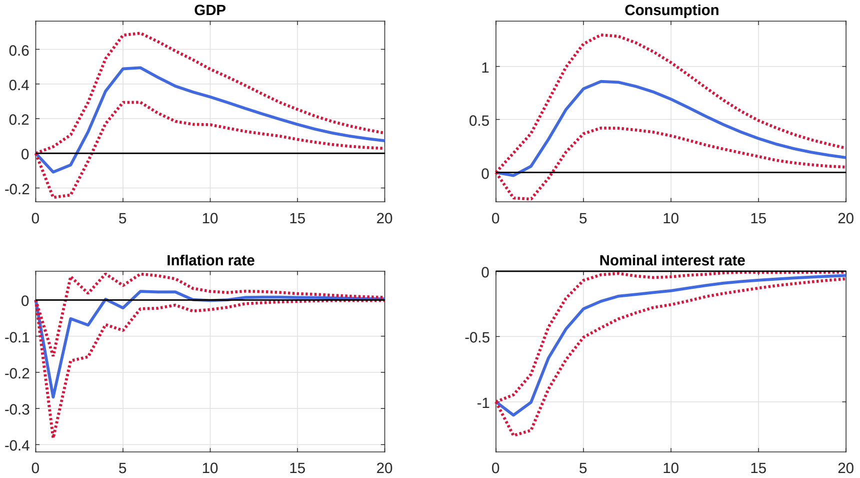


		Y	C	C^d	C^{nd}	I	I^r	I^{nr}
share	all periods	–	51%	17%	83%	31%	16%	84%
	2000-2007	–	54%	16%	84%	33%	17%	83%
	2011-2018	–	49%	19%	81%	30%	15%	85%
σ_X	all periods	1.2	1.8	4.1	1.3	3.5	18.8	2.6
	2000-2007	1.1	2.4	4.9	1.8	3.2	18.9	2.4
	2011-2018	0.6	0.9	2.5	0.8	3.9	19.0	2.6
σ_X/σ_Y	all periods	1.0	1.6	3.5	1.1	3.0	16.2	2.2
	2000-2007	1.0	2.1	4.3	1.5	2.8	16.5	2.1
	2011-2018	1.0	1.5	4.1	1.4	6.3	30.7	4.3

Data and Estimation

- Sample: 1990:Q1–2018:Q2
  - the 10-year sample 1990:Q1–1999:Q4 is used to initiate the prior distributions
  - the empirical results are for the period 2000:Q1–2018:Q2
- Bayesian inference as in Galí and Gambetti (2015)
  - Gibbs sampling for 22,000 posterior draws
  - with the first 20,000 used as a burn-in period and every 2nd thinned, leaving a sample size of 1,000
- For comparison, the fixed-coefficient (FC) VAR results are also provided

IMPULSE RESPONSES: FC-VAR WITH C



IRF (%) to a 100 bp decrease in R

Solid: Point estimates; Dashed: 68% bands

Comparison to the Literature

- US VAR evidence: in response to a 100 bp decrease in the FFR, a peak rise in GDP is ranged from 0.3% to 0.8%
  - Leeper-Sims-Zha (1996) $\Rightarrow$ 0.35%
  - Bernanke-Gertler-Watson (1997) $\Rightarrow$ 0.4%
  - Faust-Swanson-Wright (2004) $\Rightarrow$ 0.6% (Futures markets for the FFR)
  - Uhlig (2005) $\Rightarrow$ 0.3% (sign restrictions)
  - Gorodnichenko (2006) $\Rightarrow$ 0.8% (factor-based VAR)
- Our GDP response is in line with these estimates
  - a peak effect in GDP of 0.5%
- However, a price puzzle seems to be present

Digression: Issues on Price Puzzle

- Rationale by Sims (1992, EER): Omitted variable problem
  - the missing information is the central bank's concern about future inflation
  - so a policy tightening in anticipation of future inflation would be erroneously interpreted as a policy shock
  - a possible resolution is the inclusion of a commodity price index to supplement information about future inflation
- Hanson (2004, JME):
  - the commodity price is unlikely to capture the central bank's expectations on future inflation
  - evidence of a price puzzle stands out for the pre-Volcker sample, when the Fed did not raise the interest rate sufficiently in response to inflation (passive MP)

DIGRESSION: ISSUES ON PRICE PUZZLE

- Castelnuovo and Surico (2010, EJ):
  - use a NK-DSGE model as the data generating process and estimate VARs with artificial data
  - Sims' (1992) argument is valid only when MP is passive
    - only when MP is passive, inflation expectations have explanatory power for inflation dynamics
    - thus they become helpful in mitigating the price puzzle
- Coibion (2012, AEJ-Macro)
  - studies the disparity in results from a standard VAR and the Romer and Romer (2004, AER) narrative approach
  - data from 1970:1 to 1996:12

DIGRESSION: ISSUES ON PRICE PUZZLE

Impulse responses to a MP tightening shock in Coibion (2012)

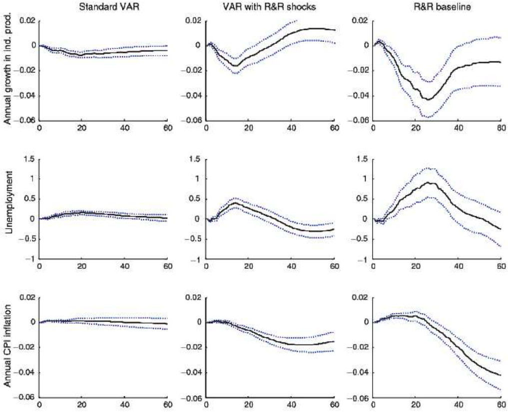
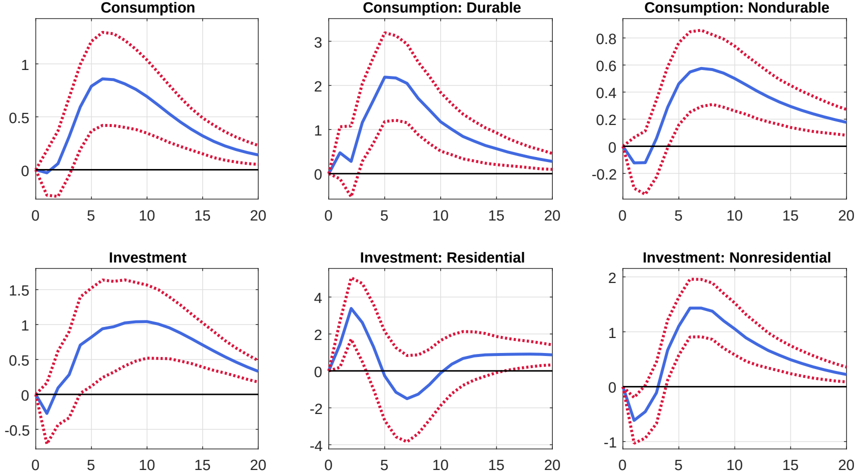


FIGURE 2. IMPULSE RESPONSES OF MACROECONOMIC VARIABLES TO MONETARY POLICY SHOCKS

$\Longrightarrow$ Price puzzle seems to prevail in the R&R framework as well

Impulse Responses: FC-VAR, C vs. I



IRF (%) to a 100 bp decrease in R

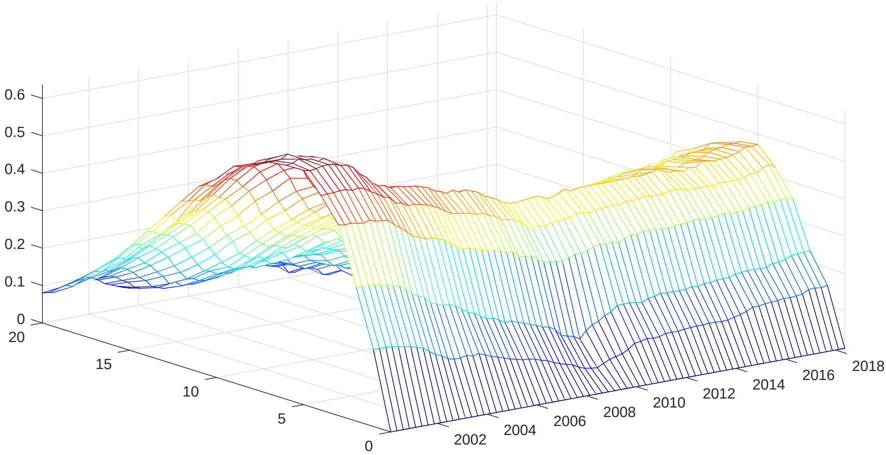
Solid: Point estimates; Dashed: 68% bands

Peak Impulse Responses: FC-VAR

	Y	C	C^d	C^{nd}	I	I^r	I^{nr}
Peak estimate (%)	0.49	0.86	2.19	0.58	1.04	3.38	1.43
Peak horizon (QTR)	6	6	5	7	10	2	7

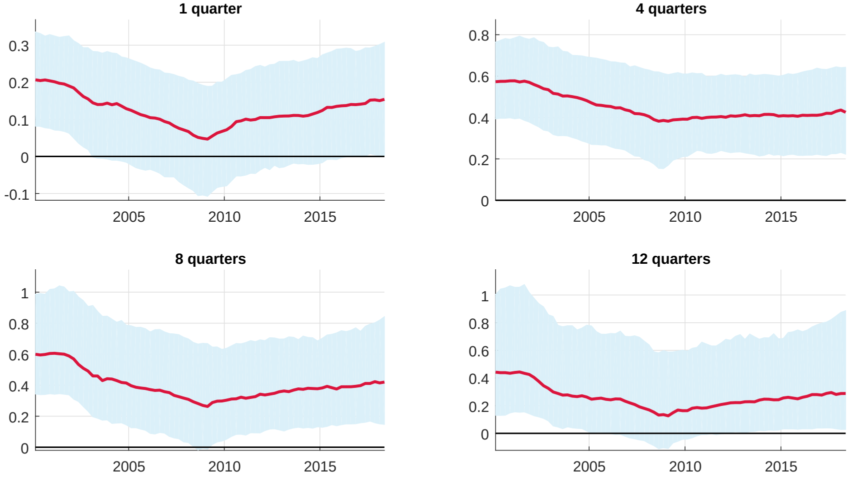
Summary of the peak responses to a 100 basis point decrease in R

Impulse Responses: TVC-VAR



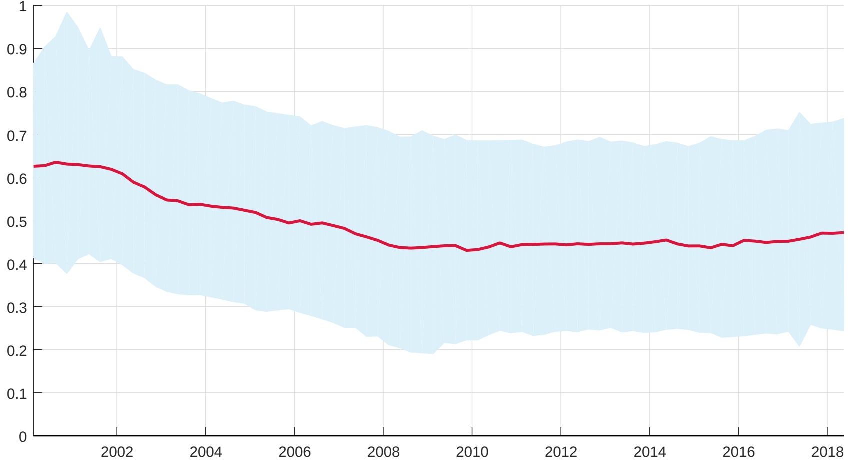
Median GDP IRF estimates to 100 bp decreases in R

Impulse Responses of Y: TVC-VAR



Y responses, median and 68% band estimates

Peak Impulse Responses of Y: TVC-VAR



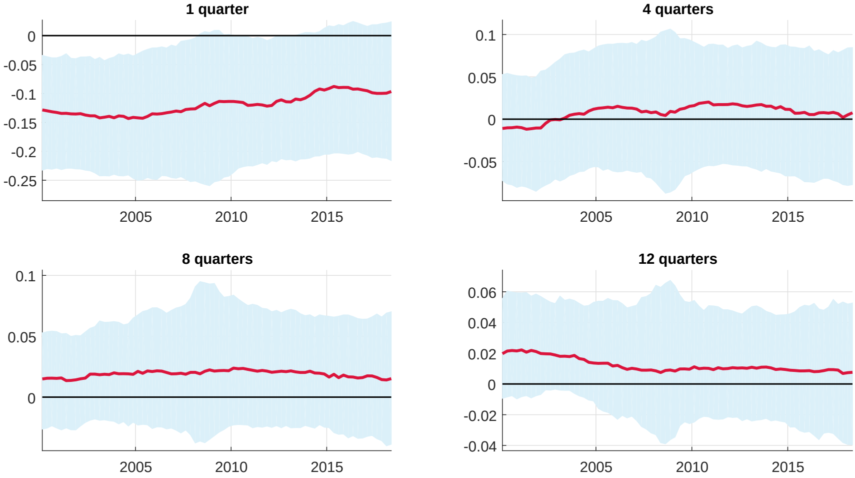
Peak Y responses, median and 68% band estimates

Impulse Responses of Y: TVC-VAR

	2000:Q2	2004:Q2	2008:Q2	2012:Q2	2016:Q2	2018:Q2
1 quarter	0.20	0.14	0.06	0.10	0.14	0.15
4 quarters	0.57	0.50	0.39	0.41	0.41	0.43
8 quarters	0.59	0.43	0.29	0.34	0.39	0.42
12 quarters	0.44	0.27	0.15	0.22	0.27	0.29
Peak (QTR)	0.63 (6)	0.53 (5)	0.44 (5)	0.45 (5)	0.45 (5)	0.47 (5)

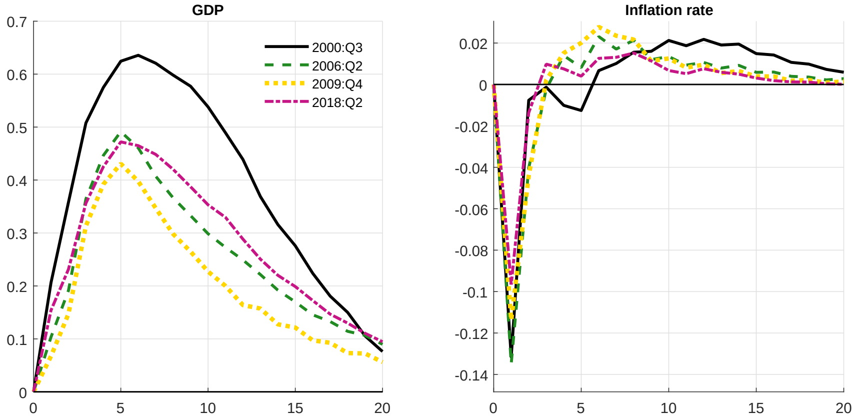
Summary of the Y responses to a 100 basis point decrease in R (%), median estimates

IMPULSE RESPONSES OF π: TVC-VAR



π responses, median and 68% band estimates

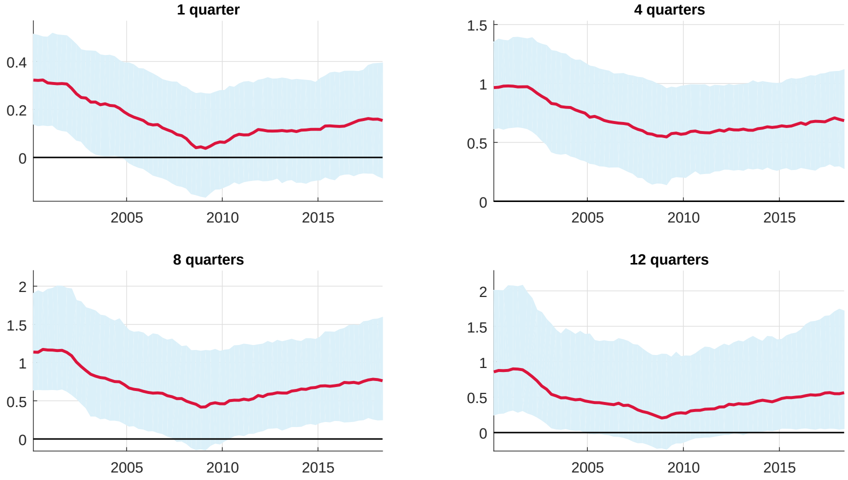
Impulse Responses: TVC-VAR



Y and π responses for selected periods, median estimates

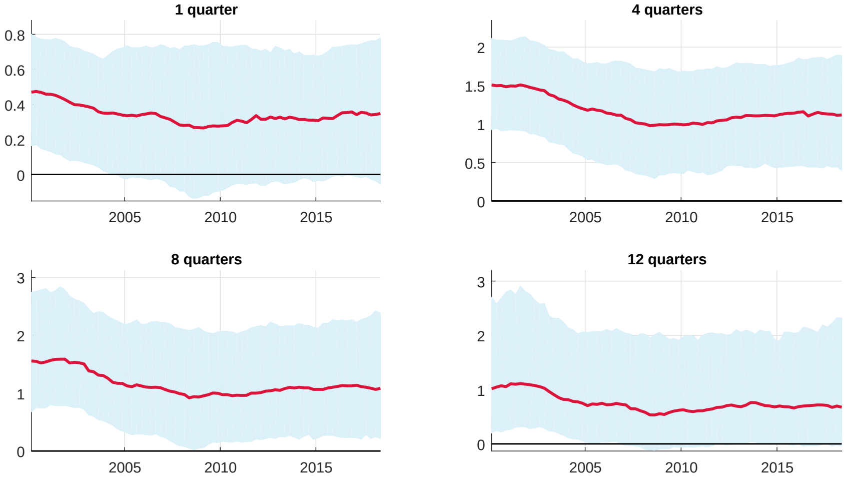
2000:Q3; 2006:Q2; 2009:Q4; 2018:Q2

Impulse Responses of C: TVC-VAR



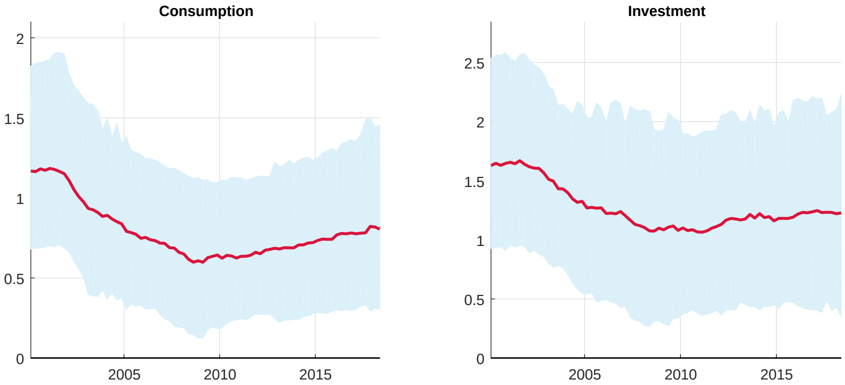
C responses, median and 68% band estimates

Impulse Responses of I: TVC-VAR



I responses, median and 68% band estimates

Peak Impulse Responses of C and I: TVC-VAR



Peak C (left) and I (right) responses, median and 68% band estimates

Peak Impulse Responses of C and I: TVC-VAR

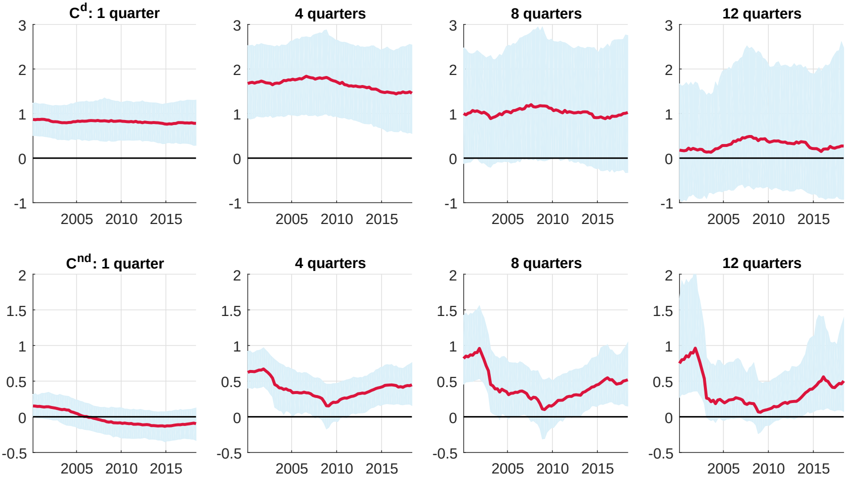
	2000:Q2	2004:Q2	2008:Q2	2012:Q2	2016:Q2	2018:Q2
C peak (QTR)	1.16 (7)	0.87 (5)	0.62 (5)	0.67 (5)	0.78 (6)	0.81 (6)
I peak (QTR)	1.65 (6)	1.35 (5)	1.08 (6)	1.17 (6)	1.23 (6)	1.23 (6)

Summary of the C and I peak responses to a 100 basis point decrease in R (%), median estimates

Peak Impulse Responses of C and I: TVC-VAR

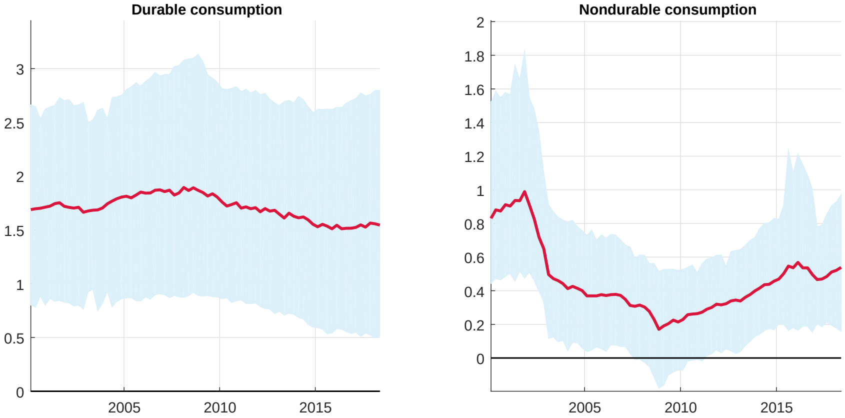
- For shorter horizons, a similar pattern to those of GDP is observed for the consumption responses
  - the effects of MP shocks to C decrease from the early 2000s to the GFC period
  - they bounce back mildly in the subsequent sample
- However, the impacts on investment is slightly different
  - the expansionary effects of MP shocks are relatively more restrictive in the recent period
- The disparate patterns of the C and I responses are also observed in the peak responses

IMPULSE RESPONSES OF SUB-C: TVC-VAR



Durable (above) and nondurable (below) consumption responses, median and 68% band estimates

PEAK IMPULSE RESPONSES OF SUB-C: TVC-VAR



Peak C^d (left) and C^{nd} (right) responses, median and 68% band estimates

Peak Impulse Responses of Sub-C: TVC-VAR

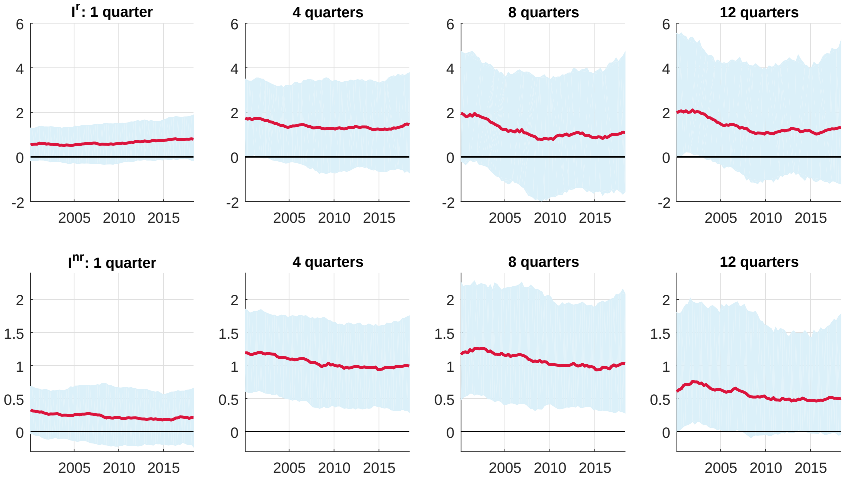
	2000:Q2	2004:Q2	2008:Q2	2012:Q2	2016:Q2	2018:Q2
C^d peak (QTR)	1.70 (5)	1.77 (5)	1.87 (5)	1.70 (5)	1.51 (5)	1.55 (5)
C^{nd} peak (QTR)	0.88 (9)	0.43 (6)	0.28 (5)	0.32 (4)	0.54 (10)	0.54 (6)

Summary of the C^d and C^{nd} peak responses to a 100 basis point decrease in R (%), median estimates

Impulse Responses of Sub-C: TVC-VAR

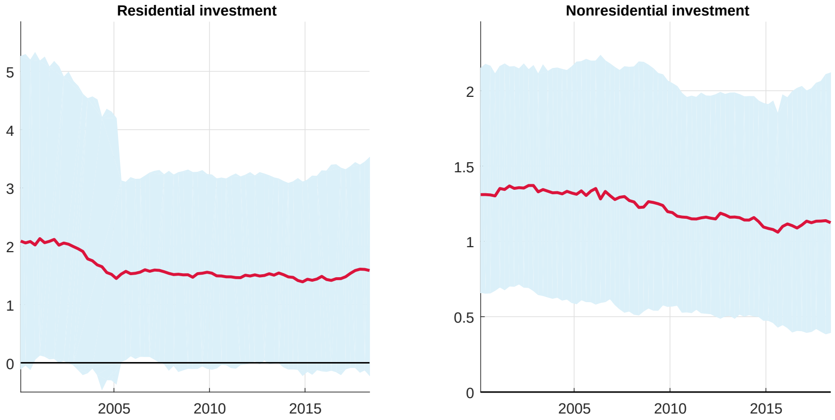
- A stark contrast in results
  - C^d: the effects of MP shocks declines only marginally over time
  - C^{nd}: they are, however, diminished considerably from the early 2000s, and are recovered only partially after the GFC
  - this finding is also observed in the peak responses
- Since the share of C^{nd} is substantially larger than C^d, the time-varying pattern in C is largely affected by that of C^{nd}

Impulse Responses of Sub-I: TVC-VAR



Residential (above) and nonresidential (below) investment responses, median and 68% band estimates

Peak Impulse Responses of Sub-I: TVC-VAR



Peak I^r (left) and I^{nr} (right) responses, median and 68% band estimates

PEAK IMPULSE RESPONSES OF SUB-I: TVC-VAR

	2000:Q2	2004:Q2	2008:Q2	2012:Q2	2016:Q2	2018:Q2
I^r peak (QTR)	2.06 (11)	1.65 (11)	1.52 (3)	1.51 (3)	1.41 (3)	1.58 (3)
I^{nr} peak (QTR)	1.31 (6)	1.32 (6)	1.23 (6)	1.15 (6)	1.10 (6)	1.12 (6)

Summary of the I^r and I^{nr} peak responses to a 100 basis point decrease in R (%), median estimates

IMPULSE RESPONSES OF SUB-I: TVC-VAR

- For I, results also vary widely across its subcomponents
  - I^r: the short- and longer-run effects are different
    - based on the 1-period responses, the expansionary effects of MP shocks are more pronounced over time
    - the pattern, however, becomes more L-shaped as the horizon increases
  - I^{nr}: the expansionary effects of MP shocks decrease constantly over time
- These findings account for the time-varying pattern in the investment responses

Paper II: Fiscal Policy

(The importance of monetary policy stance to the size of government spending multipliers)

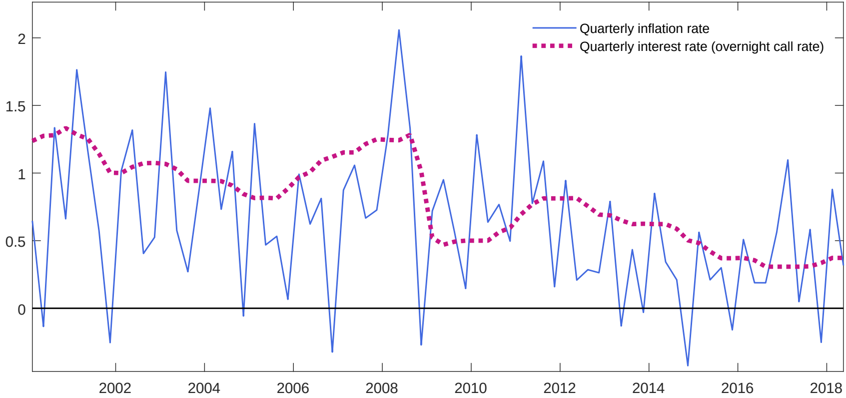
Motivation

- What is the G multiplier?
- It hinges upon
  (1) source of fiscal financing for initially debt-financed $G \uparrow$: lump-sum taxes vs. distorting income taxes [Uhlig (2010)]
  (2) $G \uparrow$ is anticipated or not: narrative approach [Ramey (2011)] vs. VAR study [Blanchard & Perotti (2002)]
  (3) how monetary policy behaves when $G \uparrow$: normal times (inflation targeting) vs. liquidity trap [Erceg & Lindé (2014)]
- This paper is about (3)
  - is the central bank's policy stance a crucial determinant of the size of G multiplier for Korea?

What We Do

- Utilize a time-varying coefficient vector autoregressive (TVC-VAR) model
  - as in Primiceri (2005, RES) and Galí and Gambetti (2015, AEJ-Macro)
  - with Korean data for the post-Asian currency crisis period
- In order to identify evidence in data about:
  1. how has G multiplier changed over time?
  2. although often presumed as an IT regime, are there any notable changes in the MP behavior toward inflation?
  3. if any, what are the implications of 2 for 1?

INFLATION AND INTEREST RATE

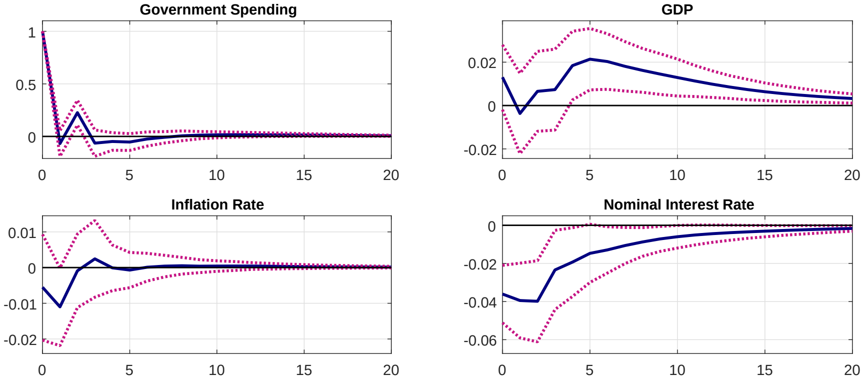


Solid: Quarterly inflation rate; Dashed: Quarterly policy rate

Fixed-coefficient VAR Results

4-variable VAR with a Cholesky ordering of G, Y, π, R

IRF (%) to a 1% government spending shock



Solid: Point estimates; Dashed: 68% bands

What We Find (Preliminary)

1. A clear time-varying pattern is observed in the G multiplier
   - for longer runs, G multipliers start rising from the global financial crisis (GFC) period of 2008-09
2. Responses of inflation and interest rate also vary over time
   - 2.A. G shocks become less inflationary as time elapses
   - 2.B. plunges in the interest rate associated with G shocks are more pronounced in the recent sample
3. MP response to inflation has weakened since the GFC
4. The MP stance is a crucial determinant of G multipliers
   - 2.A. and 3. jointly result in 2.B.
   - 2.B. then has a substantial impact on the finding of 1.

Reduced-form VAR Specification

A quarterly VAR with time-varying coefficients:

$$z_t = \mu_0 + \mu_1 t + \mu_2 t^2 + D x_t + B_{1,t} z_{t-1} + \ldots + B_{\ell,t} z_{t-\ell} + u_t,$$

- x_t contains 4 variables
  - the growth rate of oil price, federal funds rate, US real GDP per capita, and real exchange rate (against dollar)
- z_t consists of 4 variables $\Longrightarrow$ minimal statistic for our research interest
  - government spending (G), GDP (Y), inflation rate (π), and overnight call rate (R)
    - G and Y to measure gov't spending multipliers
    - R decisions conditioning on Y and π (dual mandate)
- set $\ell = 3 \Leftarrow$ based on the information criteria

Corresponding Structural VAR

- The structural VAR model:

$$A_t z_t = A_t \left(\mu_0 + \mu_1 t + \mu_2 t^2 + D x_t\right) + A_t B_{1,t} z_{t-1} + A_t B_{2,t} z_{t-2} + A_t B_{3,t} z_{t-3} + e_t,$$

  - A_t: lower-triangular Cholesky decomposition of $\Sigma_{u,t}$
    - assume that government spending is the most exogenous
    - accordingly, the ordering is G, Y, π, and R
  - e_t: structural innovations with $E(e_t e_t') = \Sigma_{e,t}$ where all the off-diagonal elements of $\Sigma_{e,t}$ are zero
    - $A_t u_t = e_t$ and $A_t \Sigma_{u,t} A_t' = \Sigma_{e,t} \Sigma_{e,t}'$

Definitions of G and PV Multiplier

- G: the broadest concept of the government spending
  - G comprises three categories
    - "gov't expenditure on goods and services"
    - "subsidies and current transfers"
    - "capital expenditure"
  - source: the Ministry of Strategy and Finance

- Present value multiplier:

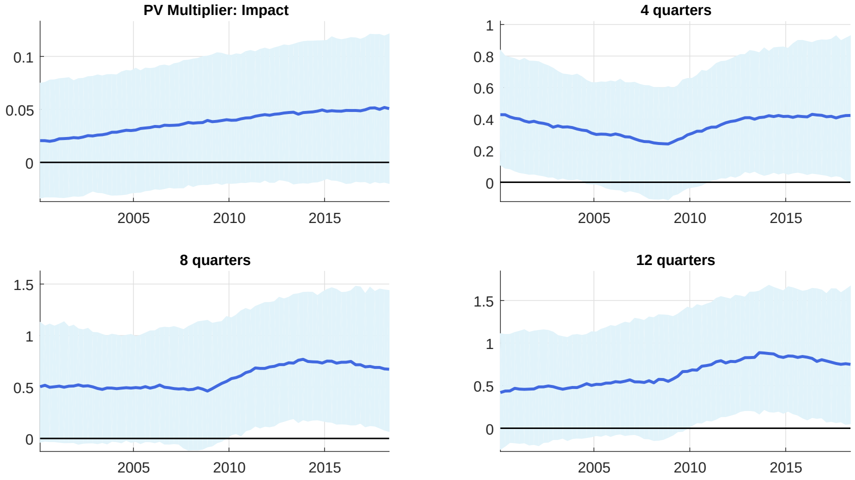
$$\text{Present Value Multiplier}(Q) = \frac{\sum_{t=0}^{Q}(1+\bar{r})^t Y_t}{\sum_{t=0}^{Q}(1+\bar{r})^t G_t}\frac{1}{\bar{Y}/\bar{G}}$$

where r is the real interest rate

DATA AND ESTIMATION

- Sample: 1994:Q1–2018:Q2
  - the 6-year sample 1994:Q1–1999:Q4 is used to initiate the prior distributions
  - the empirical results are for the period 2000:Q1–2018:Q2
- Bayesian inference as in Galí and Gambetti (2015)
  - Gibbs sampling for 22,000 posterior draws
  - with the first 20,000 used as a burn-in period and every 2nd thinned, leaving a sample size of 1,000

PRESENT-VALUE MULTIPLIERS



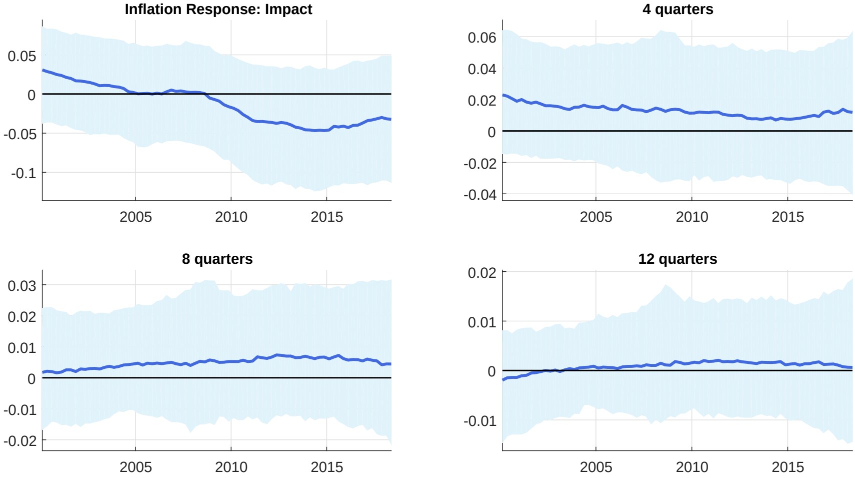
PV multiplier, median and 68% band estimates

Present-value Multipliers

	2000:Q2	2004:Q2	2008:Q2	2012:Q2	2016:Q2	2018:Q2
Impact	0.02	0.03	0.04	0.05	0.05	0.05
4 quarters	0.43	0.33	0.39	0.39	0.43	0.42
8 quarters	0.52	0.49	0.29	0.70	0.75	0.67
12 quarters	0.44	0.50	0.15	0.78	0.82	0.75
Peak (QTR)	0.54 (7)	0.51 (11)	0.65 (39)	0.85 (39)	0.88 (30)	0.82 (31)

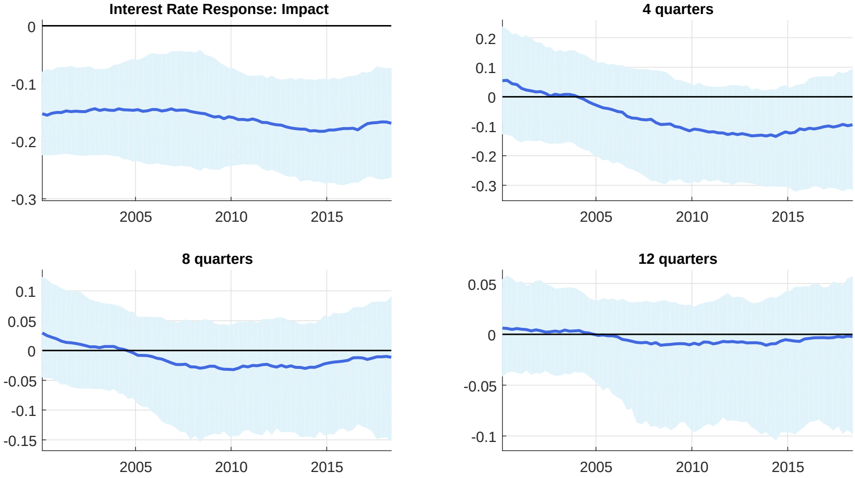
Summary of the present-value multiplier estimates (in Korean won), median estimates

IMPULSE RESPONSES OF π



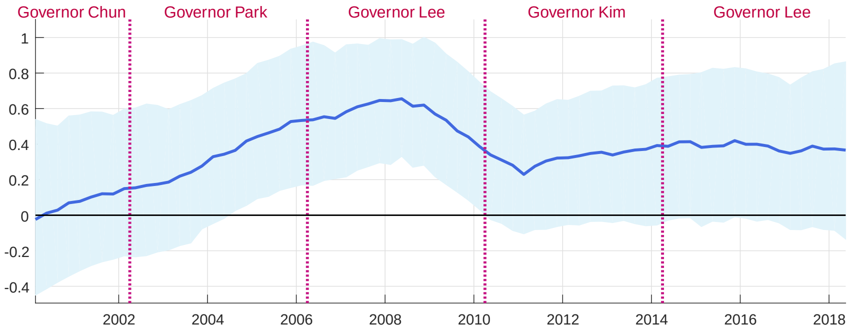
π response (%), median and 68% band estimates

Impulse Responses of R



R response (%), median and 68% band estimates

R RESPONSES TO π SHOCKS

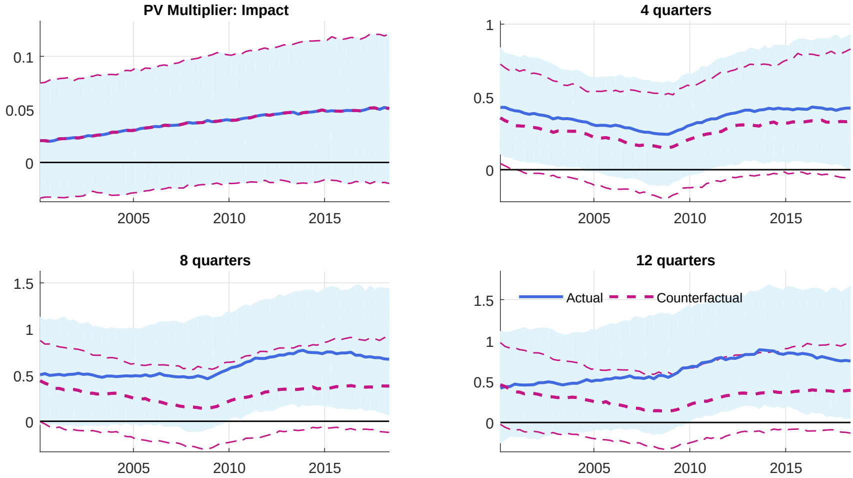


R response (%) at impact to a 1% inflation shock,
median and 68% band estimates

Counterfactual Impulse Responses

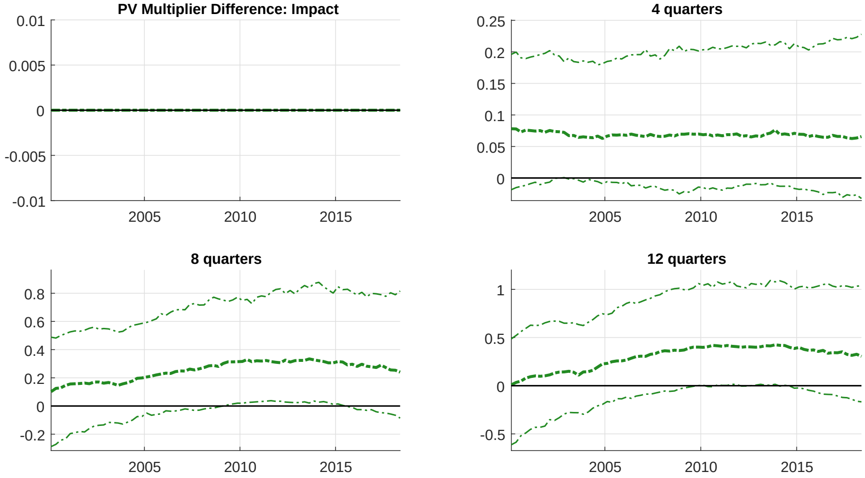
- Conduct a counterfactual experiment to gauge how much the fall in the interest rate boosts the spending multiplier
  - the counterfactual assumes that the interest rate did not change in response to a G shock
  - this can be implemented by using the actual VAR estimated coefficients from the other equations, while restricting the coefficients in the interest rate rate equation to be zero
  - e.g., Ramey (2013)

Present-value Multipliers: Actual vs. Counterfactual



PV multiplier, actual and counterfactual estimates

Present-value Multiplier Gap



PV multiplier, actual *minus* counterfactual estimates

PRESENT-VALUE MULTIPLIER GAP

	2000:Q2	2004:Q2	2008:Q2	2012:Q2	2016:Q2	2018:Q2
4 quarters	0.08	**0.06**	0.07	0.07	0.06	0.07
	[−0.02, 0.20]	**[0.00, 0.19]**	[−0.02, 0.21]	[−0.01, 0.21]	[−0.03, 0.21]	[−0.03, 0.23]
8 quarters	0.13	0.18	0.28	**0.33**	0.30	0.24
	[−0.27, 0.48]	[−0.10, 0.57]	[−0.02, 0.75]	**[0.03, 0.80]**	[−0.03, 0.81]	[−0.09, 0.82]
12 quarters	0.03	0.16	0.36	**0.40**	0.37	0.30
	[−0.59, 0.52]	[−0.23, 0.69]	[−0.06, 1.00]	**[0.00, 1.02]**	[−0.09, 1.05]	[−0.17, 1.04]

Summary of the present-value multiplier gap estimates (in Korean won), median and [16%, 84%] interval estimates

Technical Appendix

Appendix 1: Methodology

- Assumptions: states follow random walks

$$B_t = \text{vec}([c_t, B_{1,t}, B_{2,t})], \quad B_t = B_{t-1} + \nu_t, \quad \nu_t \sim NID(0, Q)$$

$$\alpha_t = \text{vec}(A_t^{-1}), \quad \alpha_t = \alpha_{t-1} + \zeta_t, \quad \zeta_t \sim NID(0, S)$$

$$\sigma_t = \text{vec}(\text{diag}(\Sigma_{e,t})), \quad \log \sigma_t = \log \sigma_{t-1} + \eta_t, \quad \eta_t \sim NID(0, W)$$

- Informative but diffuse conditional prior distributions
  - calibrated based on 40 initial training samples (90:Q1-99:Q4)
  - OLS estimates parameterize prior means, serve as starting values

- MCMC algorithm to generate sample from unknown joint posterior distribution $p(B^T, \Sigma_u^T, Q, S, W | Z^T)$

APPENDIX 2: SUMMARY OF GIBBS SAMPLER

1. Initialize A^T, Σ_e^T, hyperparameters Q, S and W
2. Draw coefficients from $p(B^T|Z^T, A^T, Q)$, Carter-Kohn (1994)
3. Draw covariances from $p(A^T|Z^T, \Sigma_e^T, S)$, Carter-Kohn (1994)
4. Draw volatilities from $p(\Sigma_e^T|Z^T, B^T, A^T, W)$, Carter-Kohn (1994)
5. Draw hyperparameters from $p(Q|Z^T, B^T)$, $p(S|Z^T, A^T)$, $p(W|Z^T, \Sigma_e^T)$
6. Go to 2, generate 22k after 20k burn-in iterations