Which Monetary Shocks Matter in Small Open Economies? Evidence from SVARs

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This paper investigates the nature of monetary policy transmission in the U.S. and selected small open economies by estimating SVAR models using the external instrument identification method. Differing from related studies on the U.S., which employ high-frequency futures data on Federal Funds rates, we exploit alternative sets of external instruments for the focal economies. We find that U.S. monetary policy plays an important role in monetary transmission in SOE interest rates, presumably hampering the effectiveness of domestic monetary policy. We also provide some evidence that foreign exchange rates in this process respond to monetary shocks as Dornbusch (1976)'s overshooting hypothesis.

Keywords: Monetary policy transmission, External instrument identification, Structural VAR model

JEL Classification: E44, E52

I. Introduction

The frictionless transmission of monetary policy (hereafter ‘MP’) shocks through financial markets is a key assumption in conventional macroeconomics as well as in practical policy discussions. The central banks in many advanced countries currently choose overnight interest rates as an MP operating instrument, based on the belief that short-term interest rates, among other candidate instruments, are the most directly related to their macroeconomic targets. They attempt to steer inflation and/or output gaps towards targets via market interest rates at all maturities. Transmission of policy effects to other financial market asset prices are, in this sense, a crucial prerequisite for successful MP implementation.¹⁾

It is, however, yet to be determined whether, in a world of open financial markets, MP decisions transmit through a variety of financial markets effectively and in a timely way. U.S. financial markets, for instance, confronted Greenspan’s conundrum in the mid-2000s, during which a global savings glut kept long-term rates low even as the Federal Reserve raised short-term rates. This phenomenon is not confined to the U.S. To the extent that interest rate movements in small open economies (hereafter ‘SOEs’) are heavily influenced by international monetary and financial spillovers, their movements are more likely to deviate from a central bank’s policy stance (Turner (2013), Obstfeld (2015)).²⁾ As a result, central banks are faced with a dilemma in their efforts to achieve macroeconomic stability because focusing only on short-term rates can bias the assessment of a given policy stance.

Existing empirical studies on MP transmission in SOEs nevertheless have paid less attention to transmission through financial markets, focusing mainly on the direct relationship between MP shocks and macroeconomic variables,

1) As we discuss in Chapter 2, conventional models of monetary policy transmission regard financial markets as frictionless, thereby predicting long-term rates which rely entirely on the expected path of short-term rates in reaction to MP actions.

2) South Korea, for example, has experienced such a conundrum, with long-lasting, low levels of long-term rates despite consecutive MP tightening in 2010-11, and this was attributed to the influence of a strong surge in foreign investments into national bond markets.

typically assuming there are no frictions in capital and financial markets (e.g., Obstfeld et al. (2005), Frankel et al. (2004)). Specifically, few studies explicitly deal with how well market interest rates, e.g., long-term bond yields, respond to local MP shocks, assuming that the traditional interest rate channel performs well as theory predicts.³⁾⁴⁾ Moreover, there is still no conclusive consensus on the dynamic relationship between MP and foreign exchange (FX) rates in the literature. Despite many prior results on the puzzling movements of exchange rates in response to MP shocks, e.g., foreign exchange rate and forward premium puzzles,⁵⁾ several recent studies reconcile the empirical results with theory by adopting new identification strategies.⁶⁾ Moreover, to the extent that foreign MP shocks play an important role in explaining movements of domestic financial asset prices under financial integration, the transmission mechanism of foreign MP shocks must be equally considered in studies on domestic MP transmission.

Taking these issues into account, we seek to investigate the channels of MP transmission in SOEs within and across borders. To this end, we use an open-economy SVAR model—a main workhorse in the field of empirical MP transmission studies—with various financial market variables as well as macroeconomic variables. Identification of structural monetary policy shocks in SVAR can be problematic, however, especially in a model with multiple financial variables, because of simultaneity issues. Most studies in an open-economy setting impose arbitrary relationships on endogenous variables (e.g., a recursive structure or Cholesky restriction), which assume that some structural shock has no simultaneous effect on financial variables, thereby facing difficulties in sorting out the contemporaneous movements of MP shocks, exchange rates,

3) Studies on the U.S. market have progressed well. For instance, seminal studies, including Cochrane and Piazzesi (2002) and Gürkaynak et al. (2005), provide evidence that unanticipated MP shocks significantly influence long-term bond yields and other financial asset prices in the U.S. Another group of studies, including Evans and Marshall (1998) and Rudebusch et al. (2006), do not, however, find strong evidence of a close relationship, attributing the relationship to other factors, including appetite for risk.

4) As we discuss in Chapter 2, however, the capacity of SOEs to influence movements of long-term rates can be limited in a world of large capital flow across border and financial integration.

5) See Christiano and Eichenbaum (1995) for the puzzles.

6) See Kim and Roubini (2000) and Bjørnland (2009), for example.

long-term yields, etc. (Faust et al. (2003), Gertler and Karadi (2015)). In addition, identified monetary structural shocks in such a model can be quite different from each other depending on assumptions regarding the identification of such shocks (Rudebush 1998). This may work as a critical limitation when interpreting empirical results pertaining to the dynamic relationship between structural shocks and endogenous variables, e.g., impulse response functions (IRFs) and decomposition of forecast error variances.

The identification scheme proposed by Stock and Watson (2012) and Mertens and Ravn (2013), to which we refer as the external instrument identification scheme, has considerable appeal because it exploits the attractive features of SVARs while addressing the identification issues raised above by using information from external instruments. In the area of MP transmission studies, Gertler and Karadi (2015) combine a SVAR set-up with such an identification scheme, exploiting high-frequency external instrument variables, federal funds, and euro dollar futures rates. Contrary to findings in the literature on U.S. markets, this identification method has not yet been applied to related studies of other economies. One critical reason for this omission may be that there are no futures markets with active trading in such monetary policy operating targets in those countries, and thus external data for MP shocks are not easily obtainable.

Given these circumstances, we contribute to the literature in the following respects. This paper revisits the conventional topic of MP transmission in SOEs, but focuses on how well domestic MP shocks propagate through financial markets and on whether such transmission is distorted by international monetary spillovers. To that end, the SVAR models in this paper explicitly test and compare the impact of domestic as well as foreign (U.S.) MP shocks on multiple market interest rates at a variety of maturities. Furthermore, we test MP transmission in national currency markets, in light of prior theoretical and empirical findings that foreign exchange rates play an important role in domestic and foreign MP transmission in open countries.

In addition, we avoid a simultaneity problem involving MP actions and other macroeconomic or financial variables by identifying monetary shocks using

external instruments identification instead of making direct arbitrary assumptions about contemporaneous interaction between variables. Specifically, we exploit a variety of high-frequency financial data in the focal SOE countries as well as other measures obtained from econometric methods as external instruments to identify domestic and foreign MP shocks, and we provide a parsimonious characterization of MP shock transmission mechanisms in SOEs.⁷⁾

Our empirical findings are as follows. First, medium- and long-term interest rates in the SOEs under study respond quite weakly to domestic MP shocks, and these effects are short-lived, which represents a more readily discernible response than estimates for the U.S. suggest. Meanwhile, foreign MP shocks have significant and persistent effects on domestic financial and macroeconomic variables, indicating that MP implementations in our sample SOEs may have been either hampered or strengthened by international monetary spillovers. Considering that overnight and short-term interest rates are monetary policy instruments in SOEs, any significant response of those variables to foreign MP shocks may indicate some sort of policy interdependence among central banks, e.g., policy coordination. Second, foreign exchange rates in this process are seen to respond significantly to MP shocks, as Dornbusch (1976) predicted. Contrary to the findings of existing studies that have reported counter-evidence for the overshooting hypothesis (e.g., Eichenbaum and Evans (1995), Grilli and Roubini (1995), Cushman and Zha (1997)), we find that an increase in policy rates causes the nominal exchange rate to appreciate instantaneously and then to depreciate gradually in line with uncovered interest parity (UIP), with few exceptions. Finally, a group of external instrument variables for the identification are tested and selected, among which movements of overnight spot rates on MP decision dates turn out to be the most suitable instrument for such identifications.

7) Recent studies, including Rogers et al. (2015) and Passary and Rey (2015), adopt a similar identification strategy. This study, however, is differentiated with other related studies in several aspects. We focus, for instance, on the identification of local MP shocks in selected SOEs by testing a variety of economic variables in selected SOEs as instrumental variables for MP shocks. In so doing, we observe IRF results of macroeconomic variables in SOEs following U.S. and local MP shocks and furthermore compare the overall influence of the two structural MP shocks in the dynamic movements of variables in the SOEs.

The remainder of this paper is organized as follows. In Chapter 2 we provide an overview of theoretical relationships between endogenous variables in the context of open-economy structural models. In Chapter 3 we specify SVAR models and identifying restrictions. Chapter 4 summarizes the empirical results and Chapter 5 concludes.

II. Theoretical Motivation and Hypotheses

Standard New-Keynesian models with sticky prices and frictionless financial markets indicate that transmission of MP shocks to credit costs and thus to aggregate spending operates via yield curves assuming price rigidity. Given the expectation hypothesis of the term structure, the effect of MP decisions on the paths of current and expected short-term interest rates is summarized in equation (1):

$$R_t^m = m^{-1} E_t \left[\sum_{i=0}^{m-1} R_{t+i} \right] + \xi_t^m \quad (1)$$

where R_t^m is an m -period zero-coupon government bond yield at time t , R_t is a short-term interest rate (e.g., a central bank policy rate), and ξ_t^m is an m -period term premium. The term premium captures additional compensation for the interest rate (duration) risk inherent in medium- or long-term bond positions as well as residual effects of idiosyncratic market factors. If the premium is assumed to be constant over time, changes in the path of short-term policy rates will dominate changes in long-term rates, allowing central banks to influence movements of output and inflation (Gertler and Karadi (2015)).

The extent of a central bank's control, especially in SOEs, over macroeconomic developments is, however, controversial because policy and other monetary shocks migrate from other countries under international financial integration, possibly causing monetary spillovers even when exchange

rates float freely (Obstfeld (2015)). The international monetary transmission mechanism can be considered as operating with the following, direct and indirect, channels through the short- and long- term yield structure.

In integrated capital markets, a country's manipulation of short-term rates (R_t^*), especially if it is a large open economy such as the U.S., inevitably directly affects short-term rates (R_t) in other open countries following the interest-parity relationship represented in (2):

$$R_t = R_t^* + E_t \Delta(e_t) + \rho_t \quad (2)$$

where e_t is a nominal FX rate vis-à-vis the U.S. dollar and ρ_t is a currency risk premium in open economies at time t .

Although changes in the interest rate difference between two countries are absorbed mainly by adjustments in exchange rates, market interest rates in an open country are significantly influenced by foreign MP shocks, depending on the behavior of the exchange rate and the risk premium. If the Federal Reserve cuts its policy rates but SOEs maintain the path of the short-term interest rate constant in response, for instance, the resulting decrease in the foreign short-term rate causes the nominal exchange rate and, accordingly, macroeconomic variables in SOEs, to fluctuate.⁸⁾ In order to avoid sharp exchange rate movements, SOE central banks are likely to enhance the correlation between the domestic policy rate and the federal fund rate (FFR).

MP actions abroad can also influence domestic market interest rates indirectly through the combination of domestic MP transmission and international spillovers. Equations (1) and (2) are combined to show the linkage between international long-term rates of the form (3):

$$R_t^m = R_t^{*m} + m^{-1} E_t \left[\sum_{i=0}^{m-1} (\Delta e_{t+i} + \rho_{t+i}) \right] + \xi_t^m - \xi_t^{*m} \quad (3)$$

8) Dornbusch's (1976) exchange rate overshooting hypothesis predicts that an increase in the interest rate should make the nominal exchange rate appreciate sharply at first and then depreciate. An initial sharp exchange rate adjustment may have a negative effect on the economy.

where R_t^m and ξ_t^m are an m -period zero-coupon bond yield and an m -period term premium in the U.S. at time t , respectively. The other notations are the same as those used in equation (1).

Equation (3) implies that unexpected MP shocks in a foreign country at first adjust movements of market interest rates for a variety of maturities in the country and then lead to the correlated movement of market rates in SOEs as long as the change in the expected exchange rates tends to be slow over time and term premiums are internationally correlated across countries (e.g., Turner (2014), Hellerstein (2011)).⁹⁾

Overall, these theoretical channels of international monetary transmission through integrated financial markets indicate that foreign MP adjustment can directly and/or indirectly have a significant impact on the movement of market interest rates in SOEs, and thereby influence the effectiveness of their domestic MP. Our empirical analysis leads to three implications of the MP transmission in SOEs that we can test. First, domestic MP shocks transmit through bond yields of multiple maturities instantaneously, with little response reflected in the term premium, based on the expectation hypothesis. We then investigate the role of U.S. MP shocks, as secondary MP shocks in the focal SOEs, by testing the second and third hypotheses: U.S. MP shocks transmit into overnight rates (MP instruments) in SOEs (direct international transmission), and U.S. MP shocks influence other market interest rates, e.g., medium- and long-term rates in non-U.S. open countries (indirect international transmission).

9) Foreign as well as domestic MP shocks also operate through the term premium and the currency risk premium. For example, consider first the case discussed above, an SOE central bank's effort to mitigate a sharp change in the exchange rate following a U.S. MP contractionary shock. Even when there is no monetary intervention such as synchronizing MP actions, consequential capital flows may occur, and thus affect the term premiums in SOE asset markets. Variations in term premiums on long-term assets caused by capital flow at times offset the impact of changes in short-term rates. In addition, SOE bond and currency risk premiums may fluctuate with changes in U.S. monetary policy. Tighter U.S. MP may, for example, raise perceived risk and uncertainty, which will compress capital inflows and boost risk premiums, thereby leading to potential unintended pro-cyclical dynamics in SOE bond markets (Bruno and Shin (2015)).

III. Estimation of SVAR Model

1. SVAR modeling

We assume the economy is described by a structural form equation (4):

$$AX_t = \sum_{i=1}^p B_i X_{t-i} + \varepsilon_t \quad (4)$$

where X_t is an $n \times 1$ vector of macroeconomic and financial variables, A and $B_i (\forall i \geq 1)$ are nonsingular coefficient matrices, and ε_t is an $n \times 1$ structural disturbances vector. ε_t is serially uncorrelated and $E(\varepsilon_t \varepsilon_t') = I$, an identity matrix. For brevity of notation, the specification in (4) omits constant terms and exogenous variables. By premultiplying the inverse of the A matrix on both sides of the equation, the reduced-form representation is obtained as (5):

$$X_t = \sum_{i=1}^p \alpha_i X_{t-i} + e_t \quad (5)$$

where $\alpha_i = A^{-1} B_i$, and e_t are the reduced-form residuals. The residuals are related to structural shocks, as seen in (6):

$$e_t = \begin{bmatrix} e_t^p \\ e_t^q \end{bmatrix} = S \varepsilon_t = [S^p S^q] \begin{bmatrix} \varepsilon_t^p \\ \varepsilon_t^q \end{bmatrix} \quad (6)$$

where $S = A^{-1}$. e_t^p denotes a vector for the residuals of domestic and foreign MP instruments (i.e., $e_t^p = [e_t^{MP*} e_t^{MP}]'$), and e_t^q is a vector for the residuals of the other variables, and the analogous definition applies to structural shocks ε_t^p and ε_t^q . s^p and s^q denote the columns in matrix S that correspond to the impact structural policy shocks ε_t^p and ε_t^q , on each element of the vector of reduced-form residuals e_t . The variance-covariance matrix of the reduced-form VAR is $\Sigma = E[e_t e_t'] = E[SS']$.

Next, the Wold representation as a function of the structural shocks is given as (7):

$$X_t = \sum_{j=0}^{\infty} C_j S \varepsilon_{t-j} = \sum_{j=0}^{\infty} C_j s^p \varepsilon_{t-j}^p + \sum_{j=0}^{\infty} C_j s^q \varepsilon_{t-j}^q \quad (7)$$

where C_j denotes the coefficients of the structural moving average (MA) form. Accordingly, if the financial variables respond to MP innovations, the IRFs of the k -th element of vector $X(X_k)$ to a unit shock of ε_t^p at time $t+j$ is obtained by (8):

$$IRF_{k,j} = \frac{\partial X_{k,t+j}}{\partial \varepsilon_{k,t}^p} = C_{k,j} s^p \quad (8)$$

where $C_{k,j}$ is the k -th row of C_j .

Forecast error variance decomposition (FEVD) at time $t+j$ can also be calculated from the structural MA representation by (9):

$$FEVD_{k,j} = \frac{\text{var} \left(\sum_{l=0}^j C_{k,l} s^p \varepsilon_{t-l}^p \right)}{\text{var} \left(\sum_{l=0}^j C_{k,l} e_{t-l} \right)} \quad (9)$$

2. Identification scheme in SVAR analyses

The identification strategy should be deliberately chosen since it considerably affects model specification results, most importantly the identification of structural shocks.¹⁰⁾ In the monetary VAR literature, exogenous MP shocks are typically obtained by a surprise component from the regression of a policy rate on suggested explanatory variables, e.g., its lags and/or other financial and

10) Obtaining identified ‘exogenous’ MP shocks is crucial in monetary VAR analyses because the response of variables to endogenous policy actions cannot distinguish the movement of the economy due to the policy action itself and to the variable that spurred that action.

macroeconomic variables. Dynamic responses of endogenous variables in the VAR to the identified structural shocks, i.e., IRF and FEVD results, therefore vary depending on the assumptions imposed on relationships between endogenous variables.¹¹⁾

In addition, if identification restrictions are assumed without modeling the relationships between variables correctly, the model may generate biased results. For purposes of ease and convenience, for instance, short-run zero restrictions on the impact matrix are conventionally assumed, which orthogonalize reduced-form disturbances by Cholesky decomposition. In the literature on MP transmission as well, the short-run zero restriction has been widely used on the assumption that MP transmission is occasionally uni-directional, i.e., MP shocks do not affect macroeconomic variables while the latter affect MP decisions, and propagation of MP surprises in the financial market in only one direction, from the short-term to the long-term rate. Such a restriction, however, may be distorting because within a given period policy shifts not only influence financial variables but may also be responding to them. Even if the central bank does not react directly to the movement of financial variables, it may respond to the other correlated variables in the VAR.¹²⁾ Furthermore, there is a growing body of literature, including Carlstrom et al. (2009), in which findings indicate that MP can influence economic variables simultaneously and that Cholesky identification can distort the results, producing price puzzles or muted responses of inflation and output.¹³⁾

In order to avoid possible identification problems, an identification strategy

11) In this respect, Rudebusch (1998) criticizes the limitations of applying VAR methodology in MP analyses. He argues that structural MP shocks identified recursively from the VAR may not be similar to the shocks obtained outside the VAR.

12) For instance, the results derived from our model with Cholesky identification show that residual series of most financial variables from the proposed VAR model interact simultaneously. Cross-correlations between short- and long-term rates are very high, as high as 0.4-0.9.

13) Since the 1990s, the Federal Reserve and central banks in other developed countries have increasingly relied on communication to influence market beliefs about the expected paths of policy rates and economic conditions, and in this way MP may have immediate effects on macroeconomic variables. If central banks have more information on the future economic situation, e.g., on aggregate demand and inflation, than the public, an announcement by central banks may change agents' expectations and thereby economic activity. A statement that causes economic agents to expect accommodative future aggregate demand may, for example, lead to a spontaneous increase in current consumption and output.

should avoid direct assumptions regarding elements of the impact matrix while it produces robust exogenous MP shocks regardless of structural identifying assumptions. In this respect, the identification method proposed by Stock and Watson (2012) and Mertens and Ravn (2013) offers attractive features for measuring the effects of structural shocks because it utilizes an information set pertaining to exogenous shocks that are identified outside the VAR and it does not assume direct restrictions on relationships between variables. Gertler and Karadi (2015), who adopt this approach, show that it can be extended to monetary VAR analyses by exploiting information about external MP shocks from the high frequency instrument to test whether MP and other macroeconomic and financial variables have simultaneous relationships.

3. External instrument identification scheme

We recover structural parameters related to domestic and foreign MP shocks by using external instrument identification. The main idea behind this identification scheme is to complement the required restrictions for recovering structural parameters from reduced-form VAR residual covariance and the moment conditions that external instruments can be considered orthogonal to other structural shocks but correlated with MP shocks. This scheme enables us to exploit information contained in external instruments and to avoid arbitrary assumptions about structural parameters. The procedures are summarized as follows.

The relationship between residuals of reduced-form VAR (e_t) and structural shocks (ε_t) in equation (6) can be rearranged as (10):

$$\begin{bmatrix} e_t^p \\ e_t^q \end{bmatrix} = \begin{bmatrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{bmatrix} \begin{bmatrix} \varepsilon_t^p \\ \varepsilon_t^q \end{bmatrix} = \begin{bmatrix} s_{11}\varepsilon_t^p + s_{12}\varepsilon_t^q \\ s_{21}\varepsilon_t^p + s_{22}\varepsilon_t^q \end{bmatrix} \quad (10)$$

where s_{11} represents the response of the residuals of the MP instrument to its own shock and s_{21} represents the responses of residual series of the other variables to the structural MP shock. Since we are interested in understanding

how variables respond to MP shocks, s_{11} and s_{21} are the only two parts of the impact matrix (S) to be identified. Next, VAR residuals e_t^p and e_t^q can be expressed by the other reduced-form residuals and structural shocks ε_t^p or ε_t^q because those are composites of structural shocks, as shown in (11) and (12).

$$e_t^p = \eta e_t^p + C_1 \varepsilon_t^p \quad (11)$$

$$e_t^q = \theta e_t^p + C_2 \varepsilon_t^q \quad (12)$$

where $\eta = s_{12}s_{22}^{-1}$, $\theta = s_{21}s_{11}^{-1}$, $C_1 = s_{11} - s_{12}s_{22}^{-1}s_{21}$, and $C_2 = s_{22} - s_{21}s_{11}^{-1}s_{12}$. In particular, the 2×2 matrix C_1 represents variance-covariance between two structural MP shocks, and it has the following relationship with s_{11} and s_{21} , as shown in (13) and (14).¹⁴⁾

$$\begin{bmatrix} s_{11} \\ s_{21} \end{bmatrix} = \begin{bmatrix} (I - s_{12}s_{22}^{-1}s_{21}s_{11}^{-1})^{-1} \\ s_{21}s_{11}^{-1}(I - s_{12}s_{22}^{-1}s_{21}s_{11}^{-1})^{-1} \end{bmatrix} C_1 \quad (13)$$

$$C_1 C_1' = (I - s_{12}s_{22}^{-1}s_{21}s_{11}^{-1})s_{11}s_{11}'(I - s_{12}s_{22}^{-1}s_{21}s_{11}^{-1})' \quad (14)$$

Thus, obtaining s_{11} and s_{21} requires identification of two parts: One is $s_{21}s_{11}^{-1} (= \theta)$, which can be estimated by two-stage least squares (2SLS) estimation, and the others are $s_{11}s_{11}'$, and $s_{12}s_{22}^{-1}$, which can be calculated by restrictions from the covariance matrix.

(Restriction from 2SLS estimation: $s_{21}s_{11}^{-1} (= \theta)$)

Consider first the regression of equation (12). Since the reduced-form residual

14) C_1 can be rearranged as $C_1 = s_{11} - s_{12}s_{22}^{-1}s_{21} = (I - s_{12}s_{22}^{-1}s_{21}s_{11}^{-1})s_{11}$ and thus $s_{11}C_1^{-1} = (I - s_{12}s_{22}^{-1}s_{21}s_{11}^{-1})^{-1}$. Similarly, C_2 can be expressed in terms of partitions of the S matrix as the following form: $s_{21}C_1^{-1} = s_{21}s_{11}^{-1}s_{11}C_1^{-1} = s_{21}s_{11}^{-1}(I - s_{12}s_{22}^{-1}s_{21}s_{11}^{-1})^{-1}$.

for MP instrument $(e_t^p (= s_{11}\varepsilon_t^p + s_{12}\varepsilon_t^q))$ is correlated with $C_2\varepsilon_t^q$, denoting it as u_t hereafter, we can obtain consistent estimates of θ of regression e^q on e^p from 2SLS, employing appropriate IVs that satisfy the following moment conditions:

$$E[Z_t u_t] = 0 \text{ or } E[Z_t \varepsilon_t^q] = 0 \quad (15)$$

$$E[Z_t e_t^p] = \pi(\pi \neq 0) \text{ or } E[Z_t \varepsilon_t^p] = \phi(\phi \neq 0) \quad (16)$$

(Restriction from covariance matrix: $s_{11}s'_{11}$, and $s_{12}s_{22}^{-1}$)

In addition to the restrictions derived from IV estimation, identification of s_{11} and s_{21} requires the additional restrictions from the covariance matrix. Consider the following reduced form variance-covariance and its partitioning:

$$\Sigma = E[SS'] \Rightarrow \begin{bmatrix} \Sigma_{11} & \Sigma_{12} \\ \Sigma_{21} & \Sigma_{22} \end{bmatrix} = \begin{bmatrix} s_{11}s'_{11} + s_{12}s'_{12} & s_{11}s'_{21} + s_{12}s'_{22} \\ s_{21}s'_{11} + s_{22}s'_{12} & s_{21}s'_{21} + s_{22}s'_{22} \end{bmatrix} \quad (17)$$

Then, $s_{11}s'_{11}$, $s_{12}s_{22}^{-1}$ is obtained by the following closed-form solution:

$$s_{11}s'_{11} = \Sigma_{11} - s_{12}s'_{12} \quad (18)$$

$$s_{12}s_{22}^{-1} = (s_{12}s'_{12}\theta' + (\Sigma_{21} - \theta\Sigma_{11})')(s_{22}s'_{22})^{-1} \quad (19)$$

where $s_{12}s'_{12} = (\Sigma_{21} - \theta\Sigma_{11})'Q^{-1}(\Sigma_{21} - \theta\Sigma_{11})$, $s_{22}s'_{22} = \Sigma_{22} + s_{21}s_{11}^{-1}(s_{12}s'_{12} - \Sigma_{11})(s_{21}s_{11}^{-1})$ and $Q = \Sigma_{22} - (\Sigma_{21}\theta' + \theta\Sigma_{21}) + \theta\Sigma_{11}\theta'$.¹⁵⁾

15) Consider first the fact that $\Sigma_{21} - \theta\Sigma_{11} = C_2s'_{12}$ because $\Sigma_{21} - \theta\Sigma_{11} = s_{21}s'_{11} + s_{22}s'_{12} - s_{21}s_{11}^{-1}(s_{11}s'_{11} + s_{12}s'_{12}) = s_{22}s'_{12} - s_{21}s_{11}^{-1}s_{12}s'_{12} = (s_{22} - s_{21}s_{11}^{-1}s_{12})s'_{12}$.

The derivation of $s_{12}s_{22}^{-1}$ is straightforward, noticing that $s_{12}s'_{22} = s_{12}s'_{12}\theta' + (\Sigma_{21} - \theta\Sigma_{11})'$.

$Q = Q'$ because Q is symmetric, and it is the same as $u_t u_t'$ or $C_2 C_2'$. Using this fact, $s_{12}s'_{12}$ can be obtained by the following form: $s_{12}s'_{12} = s_{12}C_2' C_2^{-1} C_2^{-1} C_2 s'_{12} = s_{12}C_2' Q^{-1} C_2 s'_{12} = (\Sigma_{21} - \theta\Sigma_{11})' Q^{-1} (\Sigma_{21} - \theta\Sigma_{11})$. And from the covariance matrix, $s_{21}s'_{21} = s_{21}(s_{11}^{-1}s_{11}s'_{11} + s_{12}s'_{12})s'_{21} = (s_{21}s_{11}^{-1})(\Sigma_{11} - s_{12}s'_{12})(s_{11}^{-1}s'_{21})$.

These restrictions from 2SLS and VAR residual covariance allow for the identification of $C_1 C'_1$ and the covariance of $C_1 \varepsilon_t^p$. If structural shocks to domestic MP are uncorrelated with foreign MP shocks and vice versa, C_1 is a diagonal and can be directly identified up to a sign convention from equation (18).¹⁶ However, if we cannot impose zero cross-correlations between structural shocks, we must make an arbitrary assumption regarding how domestic MP shocks respond contemporaneously to unanticipated movements in foreign MP instruments, and vice versa, in order to disentangle the causal effects of shocks on both MP shocks. To the extent that the model considers two countries, the U.S. and an SOE, Cholesky decomposition of $C_1 C'_1$, supposing that the foreign MP shock is ordered before the domestic MP shock, permits economically meaningful results in this analysis. Finally, by plugging the identified C_1 back into equation (13), s_{11} and s_{21} are uniquely pinned down.

4. Data

We choose nine monthly (except for Australia, for which it is quarterly)¹⁷ macroeconomic and financial variables in the VAR, reflecting the theoretical set-up described in Chapter 2. In particular, the VAR model comprises logs of the domestic consumer price index (P , ‘price’ hereafter), logs of seasonally adjusted industrial production (Y , ‘output’ hereafter), domestic and foreign policy interest rates (MP and MP^*), three-month, three-year, and ten-year government bond yields ($R3_m$, $R3_y$, and $R10_y$), bank lending rates ($Lend$), and logs of the foreign exchange rate against one unit of the U.S. dollar (FX).¹⁸ In addition, following procedures employed in prior literature, four external variables are included to isolate exogenous latent factors that may influence

16) If so, a simpler identification approach, such as the one Gertler and Karadi (2015) employ, can be directly applied to identify s_{11} and s_{21} .

17) Since Australia reports macroeconomic variables (output, price, etc.) only in the quarterly base, we employ quarterly averages of its financial data.

18) The variables are specified in levels to implicitly determine any potential co-integrating relationship between them; see Hamilton (1994).

Table 1: List of Variables in SVAR System

Variable	Category	U.S.	Australia	Canada	Korea	U.K.
<i>MP*</i>	U.S. MP	–	Effective FFR			
<i>Y</i>	Output	Industrial production (Seasonally Adjusted)				
<i>P</i>	Price	Consumer Price Index				
<i>MP</i>	Overnight rate	Effective FFR	Cash rate	MMF rate	Call rate	Bank rate
<i>R3m</i>	Short-term rate	TB (3-month) rate (Korea: CD 91-days rate)				
<i>R3y</i>	Medium-term rate	TB (3-year) rate				
<i>R10y</i>	Long-term rate	TB (10-year) rate (Korea: TB 5-year rate)				
<i>Lend</i>	Lending	Overall lending rate including loan rates to households and firms				
<i>FX</i>	FX rate	–	FX rates per US dollar			
Control Variables		Commodity price index, Dummy variable for the period between August 2008 ~ June 2009, CBOE volatility index, U.S. dollar index				

Note: Sample periods are U.S. (1980~2008), Korea (1999~2013), Canada (1996~2013) Australia (1990~2013), U.K. (1997~2013).

Sources: Bloomberg, IFS, CEIC database

endogenous variables in the VAR system simultaneously: the international commodity price index, a crisis dummy, the CBOE volatility index, and the dollar index (e.g., Kim 2001 and Bjørnland 2009, among many others).

The four focal open countries represent open economies that depend heavily on foreign economies, especially the U.S., from both real economic and financial market perspectives. These countries have employed inflation targeting as an MP regime and used short-term interest rates as an MP operating instrument. Moreover, they are also commonly equipped with well-developed financial markets with sufficient trading volume to validate our use of financial asset prices to identify IVs. And, for the purpose of comparing the empirical results, we also estimate a SVAR model with U.S. data as well as a benchmark. Table 1 summarizes the detailed description of the data.

Table 2: Instrumental Variables

*Panel A: Short-term spot rates

Category	IV	Country	Instruments
Short-term spot rates	IV1 (overnight rates)	AU CA KO UK US	Overnight cash rates Overnight MMF rates Overnight call rates Average 4 UK bank's rates Effective FFR rates
	IV2 (1-month spot rates)	AU CA KO UK US	Bank bills rates (1-month) Bank deposit rates (1-month) – TB (1-month) rates Euro-dollar deposit (1-month) rates
	IV3 (3-month spot rates)	AU CA KO UK US	Bank bills rates (3-month) Bank deposit rates (3-month) CD rates (3-month) Deposit rates (3-month) U.S. TB (3-month) yield
	IV4 (FX rates)	SOEs	FX rates per U.S. dollar

Notes: 1) '-' indicates that the IV is not available for a given country.

2) AU: Australia; CA: Canada; KO: Korea; SOEs: the selected four small open economies.

*Panel B: Futures rates and others

Category	IV	Country	Instruments
Futures rates under financial instruments	IV5 (short-term futures)	AU CA KO UK US	Futures under 3-month rates – CD rates (3-month) futures Futures under 3-month rates FFFRs with maturity 1 month, and 3 months, Eurodollar futures rates with 3 months, 6 months, 9 months, 12 months
	IV6 (medium-term futures)	SOEs	Futures under 3-year TB
	IV7 (long-term futures)	SOEs	Futures under 10-year TB
	IV8 (currency futures)	SOEs	Futures under FX rates per USD
	IV9 (stock price futures)	SOEs	Futures under national stock price index
BN	IV10 (BN)	SOEs	BN-decomposed overnight rates
TR	IV11 (Taylor rule)	SOEs	Estimated Taylor-rule residual

Notes: 1) '-' indicates that the IV is not available for a given country.

2) AU: Australia; CA: Canada; KO: Korea; SOEs: the selected four small open economies.

4.1 Instrumental variables (IVs)

Prior studies on U.S. MP use mostly high-frequency movements of Federal Fund futures rates around FOMC meetings as ideal instruments for identifying MP shocks. Other economies, however, are not yet equipped with derivative markets for MP instruments. Given this limitation, we propose various sets of alternative IVs for external instrument identification based on prior theoretical and empirical findings, including short-term spot rates, futures rates under financial instruments, and surprise in overnight rates estimated by statistical method and Taylor rule assumption. See the details in Appendix 1.

IVs tested for focal SOEs and the U.S. are summarized in Table 2. For the U.S., we use IV data proposed by Gertler and Karadi (2015) and Gürkaynak et al (2005), and FFFR changes within a narrow (thirty-minute) window around FOMC meetings. In addition, we test some daily movements of financial instruments for comparison.

IV. Empirical Analysis Results

1. IV selection

To apply external instrument identification, we first turn to the issue of instrument choice in our VAR models. We select suitable instruments in our analysis based on the following conditions:

$$\begin{aligned} \text{(relevancy)} \quad & \text{rank}(E[Z_t \varepsilon_t^p]) = L \\ \text{(orthogonality)} \quad & E[Z_t \varepsilon_t^q] = 0 \end{aligned}$$

where L is the number of endogenous variables. In particular, we use the F -statistic of the first-stage regression of VAR residual of a particular policy indicator regressed on various instrument sets to test the relevance of IVs.¹⁹⁾

Moreover, considering that we choose a combination of multiple IVs, we test the over-identification restriction for selected IVs with each first-stage residual series using Hausman-Sargan (hereafter, ‘Sargan’)²⁰⁾ statistics.²¹⁾

In estimating open-economy SVAR models for the selected SOEs, following the test results as well as those of prior studies, including Gertler and Karadi (2015), we use intraday movements of Federal fund futures rates and Eurodollar futures rates for some maturities (IV5a, IV5b, IV5d, IV5e, and IV5f) as IVs for U.S. MP shocks. In addition, as for IVs of SOEs’ local MP shocks, we use movements of overnight rates (IV1), overnight-rate surprises estimated by statistical method (IV10), and Taylor rule assumption (IV11), which are found to be most suitable, in terms of relevancy and exogeneity. Those instruments are comparable to the traditional IVs (high frequency FFR movements) for the US. IV test results for the U.S. and the focal SOEs are summarized in Appendix 2.

2. Results from SVAR: Impulse response functions (IRFs)

To show how the MP transmission mechanism works in the focal SOEs, we first present the IRFs of interest rates at various maturities for domestic MP innovation. Contrary to conventional theory, the increase in long-term interest rates following monetary tightening proved to be much smaller and more short-lived than those of short-term rates. We then show how the interest rates responded to U.S. MP shocks to address the other central question of this paper: namely, how foreign MP shocks influence domestic interest rates, directly or indirectly. In response to surprise foreign MP tightening moves,

19) A weak instruments problem is generally tested by the F -statistic of the first-stage regression residual regressed on instruments, which must be greater than ten for the bias in the estimators to be less than 10%, according to Staiger and Stock (1997). However, the F -statistic above ten may not ensure the unbiased estimators if heteroskedasticity and autocorrelation exist in the regression, as argued by Olea and Pflueger (2013). This paper determines the presence of weak instruments based on the F -statistic following Gertler and Karadi (2015), considering the fact that economic structure and monetary policy regime of focal countries have not changed during the analysis period.

20) We can test for endogeneity of the IVs using Sargan statistics only if we have more IVs than potentially endogenous explanatory variables (over-identification).

21) If the Sargan statistic, which follows χ^2 distribution, is statistically different from zero, then some of the instruments used for estimation are not exogenous.

interest rates at all maturities exhibit significant and persistent increases of several basis points. We also find that nominal exchange rates respond to monetary policy shocks in line with the overshooting hypothesis in this process, contrary to findings in the existing literature, which report the exchange rate puzzle or delayed overshooting (e.g., Cushman and Zha (1997)).

2.1 Effects of MP shocks on the interest rates²²⁾

When a domestic MP shock occurs, market interest rate responses weaken with longer maturity, contrary to what the conventional New Keynesian framework predicts. The first column in Figure 1 displays the effect of a contractionary MP shock on short-term interest rates, with the shock normalized to an initial one-percentage-point increase, while the second and third columns show the corresponding effects on medium- and long-term bond yields, respectively. Clearly, short-term rates respond spontaneously to the shock, increasing one to two percentage points at a maximum. However, medium- and long-term bond yields respond much more weakly and these responses are shorter-lived than those of short-term rates. Especially in Canada, market rates do not seem to react significantly to an MP-tightening shock, even showing negative movement in the early stages of such shocks. The above-reported empirical results indicate that domestic MP does not propagate sufficiently and quickly enough from short-term rates to medium- or long-term rates. To shed light on this aspect of MP, Figure 2 displays the responses of interest rate spreads to a contractionary MP shock of (1%). Compared with the benchmark (U.S.) case, the responses of spreads between medium- or long-term rates and short-term rates in the focal SOEs are distinctively shorter. Considering the characteristics of SOEs, the above disturbance in the MP transmission mechanism may more or less result from the influence of international monetary and financial spillovers, such as the flow of global

22) U.S. MP shocks may have impact on policy rates of SOEs due to several reasons like policy coordination. However, it should be considered that endogenous changes in policy rates are not identified separately in an impulse response analysis.

Figure 1: Response of Interest Rates to a 1% Domestic MP Shock

- Notes: 1) The Y axis indicates %.
 2) The X axis indicates month(s) for the U.S., Canada (CA), Korea (KO), and the U.K. and quarter(s) for Australia (AU).
 3) Broken lines are the 16th and 84th quantiles of the empirical distribution of IRFs based on 5,000 draws.

Figure 2: Response of Interest Rates Spreads to a 1% Domestic MP Shock

Note: Black broken lines are the 16th and 84th quantiles of the empirical distribution based on 5,000 draws for the U.S.

Figure 3: Response of SOE Interest Rates to a 1% U.S. MP Shock

- Notes: 1) The Y axis indicates %.
 2) The X axis indicates month(s) for the U.S., Canada (CA), Korea (KO), and the U.K. and quarter(s) for Australia (AU).
 3) Broken lines are the 16th and 84th quantiles of the empirical distribution of IRFs based on 5,000 draws.

liquidity or movements of the exchange rate caused by changes in domestic or foreign MP stances.

To infer further details of the transmission mechanism for MP shocks, we examine the effects of U.S. MP shocks on market interest rates in each focal country. In Figure 3, market rates show positive and persistent responses to a contractionary U.S. MP shock. Overall, two results stand out concerning our hypotheses that test international monetary transmissions. First, overnight and short-term interest rates in the focal SOEs show significantly positive responses of up to 1% to the shock in most non-U.S. countries. One possible interpretation of this result is that contractionary U.S. MP shocks lead to international

synchronization of MP, or of the corresponding market expectations, which helps absorb the impact of a dramatic change in the exchange rate that applies to direct cross-border monetary transmission. This synchronization of monetary policies may be explained by the monetary coordination between the U.S. and other SOEs. As a monetary transmission from the U.S. takes place, the shock comes to reflect the policy stance of the country through which it passes.²³⁾

Second, we also investigate the reactions of longer-term yields to examine the indirect channel of foreign MP transmission. Medium- and long-term rates react to foreign MP shocks similarly to short-term rates; in the UK and Canada the shock has negative effects at first but the confidence intervals suggest that these initial reactions are not significantly different from zero. Combining our findings of the linkage between U.S. MP shocks and U.S. market rates and prior results in the literature, which have documented significant co-movements among long-term bond yields in multiple countries (e.g., Ehrmann et al., 2011), this result may indicate that U.S. MP shocks also transmit indirectly to domestic long-term bond markets through the linkage between the U.S. and the focal SOE long-term bond markets (indirect cross-border monetary transmission).

To illustrate the characteristics of the IRFs of each MP shock, Figure 4 compares the influence of domestic and foreign MP shocks on market interest rates in each country. This confirms our conclusion that foreign MP shocks seem to have weaker but much more persistent effects on the focal SOEs' market interest rates.

The above-reported results contradict the findings of previous studies such as Kim (2001), who suggests that non-U.S. G-6 countries do not react strongly to U.S. MP by documenting that negative U.S. FFR innovations do not lead to a significant and substantial decrease in non-U.S. short-term interest rates. However, those past studies may be limited significantly in their ability to isolate exogenous U.S. MP shocks. In particular, their identified MP structural shocks depend largely on the questionable assumption of a simultaneous relationship between the variables. After identifying the shocks based on external

23) Many studies have discussed the potential benefits between large economies and SOEs, both theoretically and empirically. See, for instance, Frankel and Roubini (2001) or Taylor (2013).

Figure 4: Response of Domestic Interest Rates to 1% Domestic and U.S MP Shocks

Note: Y axis indicates % and X axis is month(s) for Canada, Korea, and the U.K., and quarter(s) for Australia.

information outside the VAR framework, we conclude that the endogenous reaction of focal SOE MP and interest rates to U.S. MP surprises is substantial and lasts longer than domestic shocks, consistently with what Faust et al. (2003), who study the U.K. and Germany cases, find.

2.2 Effects of MP shocks on the nominal foreign exchange rates

Turning now to consider the effect of MP shocks on the exchange rate, there is no evidence of a puzzle, which is consistent with the overshooting hypothesis of Dornbusch (1976). This is surprising insofar as most empirical VAR studies that have reported that, on a contractionary MP shock, the exchange rate either depreciates (this is the exchange rate puzzle; see Grilli and Roubini, 1995; Sims, 1992), or, appreciates for a prolonged period of up to three years, thereby violating the UIP condition (delayed overshooting; see Eichenbaum and Evans (1995) and Cushman and Zha (1997)).

Figure 5: Response of FX Rates to a 1% Domestic and U.S. MP Shock

- Notes: 1) The Y axis indicates %.
 2) The X axis indicates month(s) for Canada (CA), Korea (KO), and the U.K. and quarter(s) for Australia (AU).
 3) Broken lines are the 16th and 84th quantiles of the empirical distribution of IRFs based on 5,000 draws.
 4) Orange lines indicate estimated IRFs with new identification and blue lines indicate the results with Cholesky identification.

In particular, as shown in the first columns of Figure 5, the initial appreciation of the focal SOE currencies following a contractionary monetary shock is not followed by long and persistent appreciation, as found in previous studies. Except for Australia, which shows a puzzling response (a drop) after the initial appreciation,²⁴ the exchange rates start to depreciate (rise) gradually after a

Figure 6: Response of Macroeconomic Variables to a 1% Domestic and U.S. MP Shock

- Notes: 1) The Y axis indicates %.
 2) The X axis indicates month(s) for the U.S., Canada (CA), Korea (KO), and the U.K. and quarter(s) for Australia (AU).
 3) Broken lines are the 16th and 84th quantiles of the empirical distribution of IRFs based on 5,000 draws.

few quarters. The confidence intervals obtained from bootstrap method also indicate that there is no significant, persistent appreciation while the exchange rates do not depreciate promptly following the impact appreciation. Meanwhile,

24) One possible explanation of this is that, as compared with the other focal countries, the Australian economy as a major commodity-exporting country has become less dependent on the US while the impact of the export activity of other trading partners, such as China and the EU, has strengthened more over the period.

in response to U.S. MP tightening, the currencies of the focal SOEs appreciate gradually, thus depreciating the US dollar, followed by initial depreciation in line with the overshooting hypothesis (except in Korea, whose currency appreciates without initial depreciation). Such a response is quite consistent with previous IRF results regarding domestic MP shocks. In line with several studies (e.g., Bjørnland (2009), Kim and Roubini (2000), Cushman and Zha (1997)), this result suggests that the inappropriate identification of MP shocks may account for the puzzles observed in the prior literature.²⁵⁾

2.3 Effects of MP shocks on the macroeconomic variables

Finally, it is also important to verify whether output and price react to MP shocks as expected given available theories, because we cannot say that our identified structural shocks are valid if any puzzles in their responses persist. In all countries, output and the price levels decline smoothly over a given horizon following monetary contraction, consistently with conventional theory. The output of the focal SOEs decreases by one to two percent maximum after 1-2 years, and the effect on prices is also negative and reaches a minimum after 1-1.5 years.

Another notable finding is that the macroeconomic variables show a positive simultaneous response to the shock, although the response is in some cases not statistically significant. This is quite at odds with the conventional belief that MP transmission is a long and complicated mechanism and thereby has uncertain time lags for feasible effects on macroeconomic variables to manifest. We can explain this by noting that MP decisions can significantly influence market expectations regarding future economic situations. Central banks have been influencing market expectations by forward guidance since the 1990s, and in this channel MP may have an immediate effect on macroeconomic variables

25) For comparison purpose, we compare IRFs from Cholesky restrictions with ordering as [MP^* , Y , P , FX , MP , $R3_m$, $R3_y$, $R10_y$, $Lend$] in Figure 5. Contrary to the results drawn from the external instrument identification scheme, the responses of exchange rate produce puzzles under the Cholesky scheme as do previous studies.

under the belief that central banks have better information regarding future economic situations through earlier access to data or superior economic analysis, and thus statements by central banks somehow reveal private information pertaining to future paths of economic activities and inflation. The direction that responses of macroeconomic variables to news of expectation shocks takes may depend on which news regarding future economic situations is disseminated.²⁶⁾

The responses of focal SOE outputs to U.S. MP shocks are mixed. Korea shows a significant negative impact of contractionary shocks, while the other focal SOEs respond positively but less significantly. Meanwhile, the responses of prices to U.S. MP shocks are persistently negative with a time lag, except in Australia. This result may be explained by an import price decrease due to appreciation of the domestic exchange rate relative to the U.S. dollar and a decrease in domestic aggregate demand.

3. Forecast error variance decomposition (FEVD) results

How much do foreign MP shocks affect the overall variability in the process of domestic MP transmission? To shed some light on this issue, as shown in Table 3, we quantify the contributions of each MP shock to the variance in market interest rates on the impact for the first four years.²⁷⁾

On a short-run forecast horizon, domestic MP shocks seem to have greater influence on market interest rates than foreign MP shocks, but this relationship reverses on the longer-run horizon; the effect of domestic shocks fade quickly while that of foreign shocks decreases (or even increases in some cases) gradually. In particular, domestic MP shocks explain from 10% to 30% of the variation in focal SOE market interest rates (based on a long-run forecast horizon). Domestic shocks have greater explanatory power for short-term and bank lending rates than for medium- or long-term rates. The effect of foreign

26) If economic agents believe, for example, that an MP decision to tighten a central bank's supply of money is based on future accommodative economic activities, outputs will respond positively to the shock.

27) Note that only the columns related to MP shocks, i.e., the first and fourth columns of the S matrix, are identified, so we can quantify the contribution of only domestic and foreign MP shocks.

Table 3: Contribution of Domestic and U.S. MP Shocks to Market Rate Variation

Forecast horizon (month)	Canada		Korea		UK		Australia	
	MP*	MP	MP*	MP	MP*	MP	MP*	MP
(Short-term interest rates)								
1	0.7	39.0	17.5	6.9	6.6	63.2	5.1	68.5
12	5.6	16.0	15.7	13.8	7.5	25.6	7.0	33.2
24	6.9	10.2	14.4	11.7	18.3	14.4	7.9	32.3
48	10.2	10.1	13.2	9.7	24.8	8.9	7.8	32.0
(Medium-term interest rates)								
1	0.3	2.5	14.5	1.6	0.6	10.0	2.6	29.9
12	2.6	1.6	5.5	3.0	6.8	8.8	9.9	18.0
24	3.9	1.3	7.2	5.9	19.9	6.3	11.1	18.7
48	7.0	1.9	8.3	6.0	27.0	4.4	11.1	18.7
(Long-term interest rates)								
1	1.1	0.5	11.7	1.0	4.7	0.0	0.0	19.8
12	0.6	1.1	3.7	3.5	6.7	7.8	6.2	12.0
24	0.8	1.4	5.9	6.8	13.4	9.6	7.4	13.9
48	1.0	1.6	7.3	6.9	21.6	8.0	7.4	14.0
(Bank lending rates)								
1	1.4	59.7	6.7	2.0	0.5	20.9	5.8	62.4
12	5.3	20.6	12.0	14.7	5.0	25.3	8.1	34.3
24	6.7	12.3	13.5	12.7	20.2	19.3	9.0	33.1
48	10.2	11.8	13.0	9.8	27.8	14.7	9.0	32.7

(U.S.) MP also explains a substantial portion of market interest rate movements. In particular, the contribution of foreign MP shocks to the variation in medium- and long-term rates is greater than that of domestic MP.

Of the four focal open countries, Australia displays a relatively greater share of domestic MP effects on medium- and long-term rates compared with those of foreign MP shocks. But foreign MP shocks also play a nonnegligible role in explaining variations in market rates. In Canada and the U.K., the variation in short- and medium-term rates is affected mainly by foreign MP.²⁸⁾ For long-term rates, foreign MP shocks are still important for explaining the variation in rates in the U.K., but not in Canada. In Korea, U.S. MP shocks play a slightly stronger role in explaining market rates than domestic MP.

28) These results are overall consistent with Cushman and Zha (1997), who found a weak role of domestic MP shocks and strong impacts of foreign factors.

Table 4: Contribution of Domestic and U.S. MP Shocks to Macroeconomic Variables

(%)

Forecast horizon (month)	Canada		Korea		UK		Australia	
	MP*	MP	MP*	MP	MP*	MP	MP*	MP
(Industrial Production)								
1	1.5	0.0	6.7	2.6	0.1	4.2	10.9	13.0
12	4.8	2.0	5.6	2.8	2.1	4.8	7.2	13.1
24	3.2	3.5	4.3	4.6	7.0	7.8	6.3	10.8
48	2.4	4.5	3.3	5.9	12.3	7.0	6.6	9.5
(Consumer price index)								
1	4.8	0.4	0.1	0.4	1.8	1.2	0.1	2.3
12	12.9	3.8	1.6	0.4	0.6	4.7	3.3	3.0
24	7.5	4.5	3.5	0.4	6.3	3.7	5.9	6.0
48	5.1	2.8	3.5	1.1	20.8	1.9	6.8	6.6
(Foreign exchange rates)								
1	7.1	1.1	2.3	1.6	10.5	14.1	0.2	4.1
12	15.3	8.0	6.5	9.6	10.5	9.2	17.6	11.9
24	16.3	12.3	7.1	11.1	9.2	9.4	17.6	12.0
48	15.4	12.7	6.4	10.4	9.5	9.3	17.6	12.0

These results emphasize that the short-term rates respond systematically to domestic monetary surprises, but on the long-run horizon they react more strongly to foreign MP shocks. However, domestic monetary shocks do not play an important role in explaining the variation in longer-term bond yields in the focal SOEs, while the other factors, including U.S. MP shocks, do.

Table 4 exhibits FEVD results for macroeconomic variables (output, prices, and exchange rates). Consistently with the FEVD results for market interest rates, U.S. MP shocks show substantial influence on movements of the focal SOE macroeconomic variables as well. The two MP shocks, in sum, account for 5% to 20% of the forecast error regarding the output and price variables of the focal SOEs, among which the U.K. shows the greatest impact of U.S. MP shocks. Around 20% to 30% of the movement in the exchange rates of the focal SOEs is explained by the domestic and foreign MP shocks in all the countries.

V. Conclusion

This paper revisits the conventional topic of MP transmission in SOEs, but focuses on how easily MP shocks propagate through financial markets and on whether such transmission is hampered by international monetary spillover. To that end, the SVAR model in this paper explicitly tests the impact of domestic and foreign MP shocks, as proxied by U.S. MP shocks, on multiple financial variables including market interest rates at a variety of maturities, which other studies implicitly assume to be ideally strong. Furthermore, this paper tests MP transmission in national currency markets in light of the findings in the literature that foreign monetary shocks and exchange rates play an important role in MP transmission in open countries.

The study's empirical findings are threefold. First, responses to MP shocks of medium- and long-term interest rates in the focal SOEs are weak and sluggish, discernibly more so than estimates for the U.S., while foreign MP shocks have statistically significant and persistent impacts on domestic financial and macroeconomic variables. Second, foreign exchange rates are seen to respond significantly to MP shocks, consistently with Dornbusch's (1976) prediction. Finally, a group of external instrument variables for the identification are tested and selected, among which IVs, movements of overnight spot rates on MP decision dates, turn out to be the most suitable instrument for identification.

The empirical results indicate that market interest rates do not always react in the way that central banks intend. Other structural shocks, most likely external shocks, may lead them to diverge from domestic MP and thereby attenuate the effects of domestic MP. In our analysis, movements of domestic variables are indeed substantially influenced by foreign MP shocks. FEVD results, which show a non-negligible contribution of foreign MP shocks to the variation in medium-and long-term rates, also support this idea. Recalling the conundrum that occurred in the U.S. during the 1990s and 2000s, and the vulnerability of the focal SOEs' financial markets to external factors, the empirical results in this paper may serve to warn central banks that MP implementations in the focal SOEs may be hampered by external influences.

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Appendix 1: IV Candidates for MP Shocks

Daily short-term spot rate changes on MP decision dates: IV 1 through 4

Following Cochrane and Piazzesi (2002) and others, we test daily movements of short-term interest rates around MP decision announcements, by defining an MP shock as the daily change in the spot rates on that day. Financial market participants anticipate MP decisions before actual policy announcements, and short-term rates may have already been adjusted beforehand. If on the contrary the MP announcement is a mere surprise, market rates will adjust only after the announcements. We test the following four short-term interest rates: overnight rates (IV1), market interest rates with maturity of 1 month (IV2), Treasury bill rates with maturity of 3 months (IV3), and daily exchange rates per U.S. dollar (IV4).

Daily futures prices of financial instruments on MP decision dates: IV 5 through 9

A variety of futures assets, even though the underlying instrument is not directly related to MP, exist in financially developed SOEs. Like spot rates, futures prices also retain meaningful information about market expectations regarding future paths of MP. We test here the following five futures contracts under financial assets: futures prices under short-term (IV5), medium-term (IV6), and long-term (IV7) fixed-income (bond) instruments,²⁹⁾ currency futures rates per USD (IV8), and national stock price futures rates (IV9).³⁰⁾³¹⁾

29) Although the relationship with the MP instrument is not as close as those with short-term instruments, there are also good reasons to regard movements of futures prices under long-term fixed-income instruments as embedding market expectations for MP announcements. If we follow the expectation hypothesis regarding the term structure, long-term rates can be explained by expectations for short-term rates and the liquidity premium, assuming there is no credit risk with the financial instruments.

30) Theoretical and empirical studies have suggested a relationship between currency or equity prices and MP surprises. For example, a representative theory of the relationship between MP and currency would be the uncovered interest rate parity (UIP) theory. According to UIP, risk-neutral investors are indifferent between the interest rates in two countries since the exchange rate between those countries is expected to be adjusted such that the return on deposits in each country equalizes, thereby eliminating the potential for uncovered interest arbitrage profits. However, as is well-known in international macroeconomics, many

Beveridge-Nelson decomposed overnight rates: IV10

If there is no other economic news except MP announcements on MP decision dates, we may define MP shocks as deviations of MP instruments on that day from the expected future paths. What is an ‘expected future path’? Here we use an econometric technique of Beveridge and Nelson (1981) (‘BN’ hereafter) and seek to provide potential instruments for unexpected MP shocks.

Following BN, we define the mean-adjusted permanent component of an I(1) series with drift as its limiting forecast for the infinite time-horizon, as shown in (20).

$$\begin{aligned} x_t = r_t - z_t &= r_t + \psi^*(L)e_t = r_t + \psi_0^*e_t + \psi_1^*e_{t-1} + \dots \\ &= r_t + \sum_{j=1}^{\infty} E(\Delta r_{t+j} - \mu | I_t) = \lim_{j \rightarrow \infty} r_{t+j|t} - \mu j \end{aligned} \quad (20)$$

where x_t is the (adjusted) permanent component of r_t and z_t is the transitory component. According to the Box-Jenkins’s method, we find that daily MP instruments in each country follow the ARIMA process, as reported in (21).

$$\begin{aligned} \text{US [ARIMA(1,1,2)] : } \Delta r_t &= 0.58 \Delta r_{t-1} + e_t - 0.77 e_{t-1} - 0.06 e_{t-2} \\ &\quad (25.41) \quad (-32.00) \quad (-4.30) \\ \text{AU [ARIMA(2,1,2)] : } \Delta r_t &= 0.61 \Delta r_{t-1} - 0.95 \Delta r_{t-2} + e_t - 0.61 e_{t-1} + 0.92 e_{t-2} \\ &\quad (47.64) \quad (-64.98) \quad (-38.33) \quad (49.48) \\ \text{CA [ARIMA (1,1,0)] : } \Delta r_t &= -0.17 \Delta r_{t-1} + e_t \\ &\quad (-11.67) \\ \text{KO [ARIMA(1,1,2)] : } \Delta r_t &= 0.58 \Delta r_{t-1} + e_t - 0.77 e_{t-1} - 0.06 e_{t-2} \\ &\quad (25.41) \quad (-32.00) \quad (-4.30) \\ \text{UK [ARIMA (1,1,0)] : } \Delta r_t &= 0.05 \Delta r_{t-1} + e_t \\ &\quad (4.96) \end{aligned} \quad (21)$$

empirical studies report that high-interest-rate currencies tend to appreciate (the UIP puzzle). Therefore, we need to use these carefully.

- 31) Following Gertler and Karadi (2015), because the day of an FOMC meeting varies from month to month, we take the following step in constructing daily MP instruments. First, for each day of the month, we cumulate the surprise on any FOMC days during the last 31 days; and second, we create cumulative daily surprise series by cumulating all MP decision-day surprises.

where Δr_t is the first difference of the overnight rate, e_t is the residual, and the numbers in parenthesis are t -values. Following Morley (2002), we can transform this result into a state-space representation, $R_t = FR_{t-1} + \varepsilon_t$, and implement BN decomposition. For example, for the US case, state space representation can be expressed as (22):

$$\begin{bmatrix} \Delta r_t \\ e_t \\ e_{t-1} \end{bmatrix} = \begin{bmatrix} \phi_1 & \theta_1 & \theta_2 \\ 0 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} \Delta r_{t-1} \\ e_{t-1} \\ e_{t-2} \end{bmatrix} + \begin{bmatrix} e_t \\ e_t \\ 0 \end{bmatrix} \quad (22)$$

Then, the BN trend is $r_t + (1, 1)$ element of $F(I(n) - F)^{-1}R_1$ where n denotes a dimension of the state-space matrix, and the transitory component, an MP shock, is the $(1,1)$ element of $-F(I(n) - F)^{-1}R_t$. Assuming that there is no economic news on an MP decision day and that overnight financial markets behave consistently with the market efficiency hypothesis, the BN trend on an MP decision date is the market participants' long-run forecast conditional on information up to the date, and the transitory component on the day is the unexpected MP shock.³²⁾

Residuals from forward-looking Taylor-rule estimation: IV11

Following Clarida et al. (2000) and many others, we estimate the forward-looking Taylor rule as equation (23) assuming that the policy rate adjusts to gaps between expected inflation and output and their respective target levels. Residuals from the policy rule estimation can be interpreted as the difference between actual policy rates and the rates implied by the rule had monetary authorities followed it. Roughly speaking, the residuals indicate the unintended policy shocks caused by a central bank that strictly obeys the rule.

$$r_t = \rho r_{t-1} + (1 - \rho) [rr^* + (\beta - 1)\pi^* + \beta\pi_{t,k} + \gamma x_{t,q}] + v_t \quad (23)$$

32) We assume market efficiency in the overnight interest rate market, so the market price may be determined based on the entire information set available up to time $t(I_t)$.

Table 5: Estimation Results for Forward-looking Policy Rule

	β	γ	ρ	π^*
US [1980~2013]	3.46 (0.55)	0.44 (0.56)	0.90 (0.03)	4.08 (0.27)
CA [1982~2013]	3.63 (0.40)	-0.64 (0.64)	0.57 (0.13)	2.58 (0.16)
AU [1991~2013]	3.24 (0.56)	-2.68 (0.71)	0.83 (0.03)	2.60 (0.17)
KO [1996~2013]	1.77 (0.51)	-0.21 (0.17)	0.85 (0.02)	4.60 (1.12)
UK [1989~2013]	1.84 (0.17)	1.13 (0.27)	0.44 (0.14)	0.68 (0.48)

Note: Numbers in parentheses are standard errors.

where r^* , $\pi_{t,k}$, $x_{t,q}$, ρ are the target interest rate, the inflation rate at time $t+k$, the output gap in period $t+q$,³³⁾ and the degree of smoothing of interest rate changes, respectively. The real rate and its long-run equilibrium are $rr_t^* \equiv r_t^* - E[\pi_{t,k}|\Omega_t]$ and $rr_t^* \equiv r_t^* - \pi^*$, where Ω_t is the information set at the time that the interest rate is set. Note that the residual from the rule is the form $v_t = -(1-\rho)[\beta[\pi_{t,k} - E(\pi_{t,k}|\Omega_t)] + \gamma[x_{t,q} - E(x_{t,q}|\Omega_t)]]$.

Unless $\pi_{t,k} = E[\pi_{t,k}|\Omega_t]$ and $x_{t,q} = E[x_{t,q}|\Omega_t]$, the explanatory variables and the error term become correlated. In order to solve this orthogonality problem, we estimate with the Generalized Method of Moments, which utilizes an optimal weight matrix that accounts for the possible serial correlation in v_t .³⁴⁾ The estimation results are summarized in Table 5.

33) The output gap is measured by the difference between industrial production and its HP filtered series.

34) We use instrument sets, which include four lags of policy rates, inflation, the output gap, and the spread between long-term and TB (3-month) rates.

Appendix 2: IV Test Results

IVs for U.S. MP shocks

Table 6 summarizes the results of the weak IV test, for each suggested IV for U.S. MP shocks. Each row displays the t -value and R^2 for the first-stage least square. We find that almost all the IV candidates have strong relationships with the residual series of the MP instrument. Spot short-term rates (IV1~3) have significant explanatory power at the 95% significance level through all sample periods tested. As already shown clearly in other studies, intraday movements of Federal Fund Futures rates and Eurodollar futures rates (IV5a~5e) are significantly relevant to the MP instruments, reporting the highest t -values and R^2 .³⁵⁾ The BN decomposed rate (IV10) also shows high relevancy while the residual from the Taylor rule estimation (IV11) shows mixed results, which are significant for the full sample but not for the subsamples.

Table 7 exhibits over-identification test results for the proposed U.S. IVs. The IV set consisting of intraday FFRs (IV5 series) shows very low Sargan statistics, indicating that they are sufficiently orthogonal to residual series of other endogenous variables in the VAR system. Spot short-term rates (IV1~4) show mixed results; through the 1980~2008 sample, the IVs cannot reject the null hypothesis that the IVs are endogenous with other residual series of other financial instruments (3-month, 3-year, and 10-year TBs) at the 5% significance level, but through other sub-samples the null hypothesis is not rejected.

35) According to Swanson (2016), U.S. monetary shocks identified through FFR changes must contain different factors before and after 2009 when FFR was lowered to the zero lower bound (ZLB) as shown in the table below. FFR changes reflect forward guidance (FG) and large-scale asset purchase (LSAP) shocks during the ZLB period, but FFR changes and FG shocks in the pre-ZLB.

	pre-ZLB periods	ZLB periods
FFR changes	○	×
FG shocks	○	○
LSAP shocks	×	○

Table 6: Explanatory Power of Suggested IVs for U.S. MP Shocks

	1980~2008	1984~2008	1989~2008
IV1	1.82[0.01]	2.84[0.03]	2.36[0.03]
IV2	3.95[0.04]	2.65[0.02]	-0.97[0.00]
IV3	4.04[0.05]	5.00[0.08]	4.89[0.10]
IV5a	—	—	6.73[0.17]
IV5b	—	—	6.08[0.15]
IV5c		3.38[0.04]	4.00[0.07]
IV5d	—	3.79[0.05]	3.67[0.06]
IV5e	—	3.30[0.04]	3.29[0.05]
IV5f	—	2.59[0.02]	2.83[0.04]
IV10	7.58[0.14]	5.59[0.09]	2.75[0.03]
IV11	2.41[0.02]	1.28[0.01]	1.34[0.01]

Notes: 1) t -values and R^2 (parentheses) of each IV in the firststage regression of the VAR residual of MP and each IV.

2) '-' indicates that the selected IV is not available for a given sample period.

3) Bold results are significant at the 95% confidence level.

Table 7: Sargan Statistics for Selected U.S. IVs

Sample	1980~2008	1984~2008		1989~2008		
	[IV1~3,10]	[IV1~3,10]	[IV5c~5f]	[IV1~3,10]	[IV5c~5f]	[IV5a~5b]
Y	6.75	2.19	1.79	5.03	1.29	3.57
P	2.49	2.29	0.22	8.07	0.89	0.39
$R3m$	15.90	3.11	0.06	0.24	1.73	2.87
$R3y$	15.90	0.84	1.06	2.67	6.44	7.57
$R10y$	20.50	2.76	1.54	4.60	4.32	4.74
$Lend$	5.10	2.80	0.79	3.25	8.28	1.82
L	1	1	1	1	1	1
K	4	4	4	4	4	2
$\chi^2_{0.99(0.95)} > K-L$		9.21(5.99)		6.64(3.84)		

Note: Reject H_0 at the 1% (5%) significance level if $\chi^2_{0.99(0.95)} > K-L$, where K and L are the number of IVs and endogenous variables, respectively.

IVs for SOE MP shocks

We summarize the relevancy of IVs for each of the focal SOEs in Table 8. Above all, spot overnight rates (IV1) turn out to be the most highly relevant to the residual of the MP instruments, in line with Cochrane and Piazzesi (2002). In all analyzed SOEs, IV1 is significant at the 5% level and the explanatory power of the IV (R^2) ranges from 0.07 to 0.23. Short-term rates (with 3-month maturity, IV2) have a close relationship with the MP instruments that is significant at the 10% level in all SOEs. Daily innovation of overnight rates through BN decomposition (IV10) produces almost the same results as were obtained for IV1. However, the results for the remaining IVs are mixed by country: residuals from Taylor rule estimation (IV11) show significant relevancy except in the UK. Spot market rates (3-month maturity, IV3) and futures rates for fixed-income or bond instruments (IV5~7) are significantly relevant to MP shocks in Canada and the UK. Spot FX rates per US dollar (IV4) and futures rates under FX rates (IV8) or under a sovereign stock price index (IV9) offer little explanation of the portions of the MP instruments.

The evidence in Table 8 leads us to select the best combination of multiple IVs in terms of relevancy. The selected IV sets for each country and their F -values in the first-stage least square are displayed at the bottom row of Table 8.

Finally, in Table 9, the over-identification test results are summarized for the selected IV combinations for both the focal SOEs and U.S. MP shocks. At the 5% significance level, almost none of the residual series rejects the null hypothesis. This indicates that the selected IV combinations for each country are exogenous to residual series of other variables.

Table 8: Explanatory Power of SOE IVs on the First-stage Residual of MP Shock

	Australia	Canada	Korea	U.K.
IV1	3.47 [0.14]	7.66 [0.23]	5.78 [0.19]	4.71 [0.11]
2	1.90 [0.05]	5.39 [0.13]	3.59 [0.08]	5.85 [0.17]
3	1.44 [0.03]	6.88 [0.20]	-2.25 [0.03]	4.56 [0.11]
4	0.60 [0.00]	1.73 [0.02]	—	1.42 [0.01]
5	-1.59 [0.03]	-10.70 [0.37]	—	-7.38 [0.24]
6	-0.26 [0.00]	—	1.13 [0.01]	—
7	-0.12 [0.00]	-2.69 [0.04]	—	-0.62 [0.00]
8	0.40 [0.00]	1.94 [0.02]	-1.47 [0.01]	1.86 [0.02]
9	—	-1.53 [0.01]	-0.76 [0.00]	0.18 [0.00]
10	4.12 [0.18]	7.66 [0.23]	5.71 [0.18]	-4.71 [0.11]
11	2.09 [0.06]	2.50 [0.03]	2.73 [0.05]	0.21 [0.00]
IV combinations	[IV1,5, 10,11] (<i>F</i> -value 7.4)	[IV 1,2,11] (<i>F</i> -value 34.6)	[IV1,8,10,11] (<i>F</i> -value 14.3)	[IV1,2,3,5] (<i>F</i> -value 23.7)

Notes: 1) *t*-values and R^2 (parentheses) of each IV in the first-stage regression of the VAR residual of MP and each IV.

2) '—' indicates that the selected IV is not available for a given sample period.

3) Bold results are significant at the 95% confidence level.

Table 9: Over-identification Test Results for Selected IVs

Residuals	Australia	Canada	Korea	UK
<i>Y</i>	6.70	9.68	9.70	2.19
<i>P</i>	4.83	7.95	5.77	5.40
<i>R3m</i>	1.49	4.41	4.13	8.77
<i>R3y</i>	3.83	11.66	6.99	5.90
<i>R10y</i>	3.37	10.89	7.98	3.86
<i>LEND</i>	2.71	1.05	14.33	0.13
<i>FX</i>	5.62	15.75	25.13	6.83
<i>K</i>	9	8	9	9
<i>L</i>	1	1	1	1
$\chi^2_{0.99(0.95)} > K-L$	15.5	14.1	15.5	15.5

Note: Reject H_0 at the 1% (5%) significance level if $\chi^2_{0.99(0.95)} > K-L$, where *K* and *L* are the number of IVs and endogenous variables.

<Abstract in Korean>

소규모 개방경제에서의 통화정책 식별에 관한 연구

하종림*, 소인환**

본고는 미국과 대표적 소규모 개방경제국들의 통화정책 파급 특성을 외부도구식별법(external instrument identification)을 이용한 구조적 벡터자기회귀 모형 추정을 통해 살펴보았다. 본고는 미 연방기금금리 선물 데이터를 이용하여 미국 통화정책 효과를 분석한 기존 연구와 달리 분석대상국에 대한 대안적인 외부 도구변수들을 활용하였다. 실증분석 결과, 미국의 통화충격은 소규모 개방경제국 통화정책의 금융시장을 통한 파급효과를 약화시키는 것으로 분석되었다. 또한, 통화충격에 대해 환율은 Dornbusch (1976)의 오버슈팅(overshooting) 가설에서와 같이 반응하는 것으로 나타났다.

핵심 주제어: 통화정책 파급, 외부도구식별법, 구조적 벡터자기회귀 모형

JEL Classification: E44, E52

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제2014-12	비대칭 금리기간구조에 대한 실증분석	김기호
13	The Effects of Globalization on Macroeconomic Dynamics in a Trade-Dependent Economy: the Case of Korea	Fabio Milani • Sung Ho Park
14	국제 포트폴리오투자 행태 분석: 채권-주식 투자자금간 상호관계를 중심으로	이주용 • 김근영
15	북한 경제의 추격 성장 가능성과 정책 선택 시나리오	이근 • 최지영
16	Mapping Korea's International Linkages using Generalised Connectedness Measures	Hail Park • Yongcheol Shin
17	국제자본이동 하에서 환율신축성과 경상수지 조정: 국가패널 분석	김근영
18	외국인 투자자가 외환시장과 주식시장 간 유동성 동행화에 미치는 영향	김준한 • 이지은
19	Forecasting the Term Structure of Government Bond Yields Using Credit Spreads and Structural Breaks	Azamat Abdymomunov • Kyu Ho Kang • Ki Jeong Kim
20	Impact of Demographic Change upon the Sustainability of Fiscal Policy	Youngguk Kim • Myoung Chul Kim • Seongyong Im
21	The Impact of Population Aging on the Countercyclical Fiscal Stance in Korea, with a Focus on the Automatic Stabilizer	Tae-Jeong Kim • Mihye Lee • Robert Dekle
22	미 연준과 유럽중앙은행의 비전통적 통화정책 수실행원칙에 관한 고찰	김병기 • 김진일
23	우리나라 일반인의 인플레이션 기대 형성 행태 분석	이한규 • 최진호

제2014-24	Nonlinearity in Nexus between Working Hours and Productivity	Dongyeol Lee · Hyunjoon Lim
25	Strategies for Reforming Korea's Labor Market to Foster Growth	Mai Dao · Davide Furceri · Jisoo Hwang · Meeyeon Kim · Tae-Jeong Kim
26	글로벌 금융위기 이후 성장잠재력 확충: 2014 한국은행 국제컨퍼런스 결과보고서	한국은행 경제연구원
27	인구구조 변화가 경제성장률에 미치는 영향: 자본이동의 역할에 대한 논의를 중심으로	손종철
28	Safe Assets	Robert J. Barro
29	확장된 실업지표를 이용한 우리나라 노동시장에서의 이력현상 분석	김현학 · 황광명
30	Entropy of Global Financial Linkages	Daeyup Lee
31	International Currencies Past, Present and Future: Two Views from Economic History	Barry Eichengreen
32	금융체제 이행 및 통합 사례: 남북한 금융통합에 대한 시사점	김병연
33	Measuring Price-Level Uncertainty and Instability in the U.S., 1850-2012	Timothy Cogley · Thomas J. Sargent
34	고용보호제도가 노동시장 이원화 및 노동생산성에 미치는 영향	김승원
35	해외충격시 외화예금의 역할 : 주요 신흥국 신용스프레드에 미치는 영향을 중심으로	정호성 · 우준명
36	실업률을 고려한 최적 통화정책 분석	김인수 · 이명수
37	우리나라 무역거래의 결제통화 결정요인 분석	황광명 · 김경민 · 노충식 · 김미진
38	Global Liquidity Transmission to Emerging Market Economies, and Their Policy Responses	Woon Gyu Choi · Taesu Kang · Geun-Young Kim · Byongju Lee

제2015-1	글로벌 금융위기 이후 주요국 통화정책 운영체계의 변화	김병기 · 김인수
2	미국 장기시장금리 변동이 우리나라 금리기간구조에 미치는 영향 분석 및 정책적 시사점	강규호 · 오형석
3	직간접 무역연계성을 통한 해외충격의 우리나라 수출입 파급효과 분석	최문정 · 김근영
4	통화정책 효과의 지역적 차이	김기호
5	수입중간재의 비용효과를 고려한 환율변동과 수출가격 간의 관계	김경민
6	중앙은행의 정책금리 발표가 주식시장 유동성에 미치는 영향	이지은
7	은행 건전성지표의 변동요인과 거시건전성 규제의 영향	강종구
8	Price Discovery and Foreign Participation in The Republic of Korea's Government Bond Futures and Cash Markets	Jaehun Choi · Hosung Lim · Rogelio Jr. Mercado · Cyn-Young Park
9	규제가 노동생산성에 미치는 영향: 한국의 산업패널 자료를 이용한 실증분석	이동렬 · 최종일 · 이종한
10	인구 고령화와 정년연장 연구 (세대 간 중첩모형(OLG)을 이용한 정량 분석)	홍재화 · 강태수
11	예측조합 및 밀도함수에 의한 소비자물가 상승률 전망	김현학
12	인플레이션 동학과 통화정책	우준명
13	Failure Risk and the Cross-Section of Hedge Fund Returns	Jung-Min Kim
14	Global Liquidity and Commodity Prices	Hyunju Kang · Bok-Keun Yu · Jongmin Yu
15	Foreign Ownership, Legal System and Stock Market Liquidity	Jieun Lee · Kee H. Chung

제2015-16	바젤Ⅲ 은행 경기대응완충자본 규제의 기준지표에 대한 연구	서현덕 · 이정연
17	우리나라 대출 수요와 공급의 변동요인 분석	강종구 · 임호성
18	북한 인구구조의 변화 추이와 시사점	최지영
19	Entry of Non-financial Firms and Competition in the Retail Payments Market	Jooyong Jun
20	Monetary Policy Regime Change and Regional Inflation Dynamics: Looking through the Lens of Sector-Level Data for Korea	Chi-Young Choi · Joo Yong Lee · Roisin O'Sullivan
21	Costs of Foreign Capital Flows in Emerging Market Economies: Unexpected Economic Growth and Increased Financial Market Volatility	Kyoungsoo Yoon · Jayoung Kim
22	글로벌 금리 정상화와 통화정책 과제: 2015년 한국은행 국제컨퍼런스 결과보고서	한국은행 경제연구원
23	The Effects of Global Liquidity on Global Imbalances	Marie-Louise DJIGBENOU-KRE · Hail Park
24	실물경기를 고려한 내재 유동성 측정	우준명 · 이지은
25	Deflation and Monetary Policy	Barry Eichengreen
26	Macroeconomic Shocks and Dynamics of Labor Markets in Korea	Tae Bong Kim · Hangyu Lee
27	Reference Rates and Monetary Policy Effectiveness in Korea	Heung Soon Jung · Dong Jin Lee · Tae Hyo Gwon · Se Jin Yun
28	Energy Efficiency and Firm Growth	Bongseok Choi · Wooyoung Park · Bok-Keun Yu
29	An Analysis of Trade Patterns in East Asia and the Effects of the Real Exchange Rate Movements	Moon Jung Choi · Geun-Young Kim · Joo Yong Lee
30	Forecasting Financial Stress Indices in Korea: A Factor Model Approach	Hyeongwoo Kim · Hyun Hak Kim · Wen Shi

제2016-1	The Spillover Effects of U.S. Monetary Policy on Emerging Market Economies: Breaks, Asymmetries and Fundamentals	Geun-Young Kim · Hail Park · Peter Tillmann
2	Pass-Through of Imported Input Prices to Domestic Producer Prices: Evidence from Sector-Level Data	JaeBin Ahn · Chang-Gui Park · Chanhoo Park
3	Spillovers from U.S. Unconventional Monetary Policy and Its Normalization to Emerging Markets: A Capital Flow Perspective	Sangwon Suh · Byung-Soo Koo
4	Stock Returns and Mutual Fund Flows in the Korean Financial Market: A System Approach	Jaebeom Kim · Jung-Min Kim
5	정책금리 변동이 성별·세대별 고용률에 미치는 영향	정성엽
6	From Firm-level Imports to Aggregate Productivity: Evidence from Korean Manufacturing Firms Data	JaeBin Ahn · Moon Jung Choi
7	자유무역협정(FTA)이 한국 기업의 기업내 무역에 미친 효과	전봉걸 · 김은숙 · 이주용
8	The Relation Between Monetary and Macroprudential Policy	Jong Ku Kang
9	조세피난처 투자자가 투자 기업 및 주식 시장에 미치는 영향	정호성 · 김순호
10	주택실거래 자료를 이용한 주택부문 거시 건전성 정책 효과 분석	정호성 · 이지은
11	Does Intra-Regional Trade Matter in Regional Stock Markets?: New Evidence from Asia-Pacific Region	Sei-Wan Kim · Moon Jung Choi
12	Liability, Information, and Anti-fraud Investment in a Layered Retail Payment Structure	Kyoung-Soo Yoon · Jooyong Jun
13	Testing the Labor Market Dualism in Korea	Sungyup Chung · Sunyoung Jung
14	북한 이중경제 사회계정행렬 추정을 통한 비공식부문 분석	최지영

제2016 –15	Divergent EME Responses to Global and Domestic Monetary Policy Shocks	Woon Gyu Choi • Byongju Lee • Taesu Kang • Geun-Young Kim
16	Loan Rate Differences across Financial Sectors: A Mechanism Design Approach	Byoung-Ki Kim • Jun Gyu Min
17	근로자의 고용형태가 임금 및 소득 분포에 미치는 영향	최충 • 정성엽
18	Endogeneity of Inflation Target	Soyoung Kim • Geunhyung Yim
19	Who are the First Users of a Newly-Emerging International Currency? A Demand-Side Study of Chinese Renminbi Internationalization	Hyoung-kyu Chey • Geun-Young Kim • Dong Hyun Lee
20	기업 취약성 지수 개발 및 기업 부실화와의 연관성	최영준
21	US Interest Rate Policy Spillover and International Capital Flow: Evidence from Korea	Jieun Lee • Jung-Min Kim • Jong Kook Shin
제2017 –1	가계부채가 소비와 경제성장에 미치는 영향 – 유량효과와 저장효과 분석 –	강종구
2	Which Monetary Shocks Matter in Small Open Economies? Evidence from SVARs	Jongrim Ha • Inhwan So