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Original Article

Age and Gender Group Differences in Employment Responses to Monetary Policy Shock in a Small Open Economy: The Case of Korea

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Abstract

A Factor Augmented Vector Autoregressive model is constructed in a way that it resolves the price puzzle problem and separately identifies domestic and foreign monetary policy shocks by imposing a small-open economy structure. An analysis on the employment data grouped by age and gender reveals that only the young male worker group exhibits an inverse relationship between employment and domestic policy rates. In the case of the foreign (the United States) policy rate rise, however, the negative response of employment could be observed for all of the worker groups.

Key words: employment, monetary policy, FAVAR, small open economy, IRF

JEL Classification: E24, E52, E58

1. Introduction

Although there are ongoing debates on whether the dual mandate is superior to the single monetary policy mandate of inflation targeting, the Federal Reserve Act states that the FRB should ‘promote effectively the goals of maximum employment ...’ anyway.¹ Both the debates and the statement implicitly assume that monetary policy can affect employment, at least in the short run. However, in their recent study on monetary policy effect on employment, Willis and Cao (2015) present that monetary policy might not affect employment anymore. They present that the employment response to monetary policy is insignificant when using the observations after the year 1985, and the point estimates of the impulse response functions are even reversed, i.e. negative employment response to an expansionary monetary policy is observed.

This paper aims to disentangle the issue on whether monetary policy has real effect on the labour market, using Korean employment data grouped by age and gender. Under the assumption that apparently impotent policy effect is due to the mixture of different responses of various workforce groups, workers

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1. Many studies such as Erceg and Levin (2014), Fontana and Palacio-Vera (2007), Fontana (2006), Gali (2011), Reifschneider *et al.* (2015) advocated that monetary policy should play a role in preventing employment hysteresis effect. Taylor (2011), on the contrary, blamed the Fed that ‘[they] used the full employment mandate to justify discretionary policy ...’

are categorized by age and gender instead of total employment. Because each age/gender group could face a different labour market supply and demand, they may react differently to interest rate shock. Thus, although a certain worker group shows a different response from others, the aggregated response of employment may not be significant or even the reverse of our expectations as in the point estimates of the response function that Willis and Cao (2015) present.

By categorizing workers according to age and gender, we may be able to conjecture which unknown factors are disturbing the relationship between interest rates and employment. The conventional belief is that a tight monetary policy regime or high-interest rates would shrink the labour demand by raising funding costs of firms. However, in reality, various factors such as labour market rigidity and the household side of labour can affect the interest rate channel to labour market outcomes. For instance, many middle-age workers with long tenure are mostly protected by the legal system, whereas young workers who are fresh to the job market can be relentlessly fired. Also, because women are considered an ancillary income source of a household in Korean culture, their participation in the labour force is affected by the role of a mother. As shown in Figure 1, women's labour force participation rates become lower in their 30 s, which approximately coincides with a period that requires a sense of motherhood for their preschool children. Seniority also plays a major role in the Korean labour market in

that many job positions are related to workers' age and gender; for example, restaurant servers are mostly young female workers, and apartment guards are old male workers. As in the figure, labour force participation rates and employment to population rates are very much alike; we can see that age and gender specific factors that affect the household decision to participate in the labour market are important determinants of overall aggregate-level employment.

The aforementioned figure provides another implication in analysing the labour market in which population should be controlled in order to identify the employment effect of economic activities such as monetary policy or global business cycles. In an aggregate analysis, especially where the cross-border labour mobility is limited, the supply of labour is limited by the population. Thus, when using a time series with several years of length as this paper's case, employment by the age group can be affected by the population structure change. Thus, in this paper, one of the main variables of interest is the employment to population ratio of age and gender groups.

Mainly, there are two reasons for assuming that monetary policy responses of various age and gender worker groups would be different from each other. One is that the labour supply side may be more responsive to interest rate shocks. Heckman (1974) notes that 'assuming that the rate of interest exceeds the rate of time preference, one finds that the consumption of goods and leisure tends to be pushed towards later ages (p.189).' If we consider the labour

Figure 1 Labour Force Participation Rate and Employment/Population rate

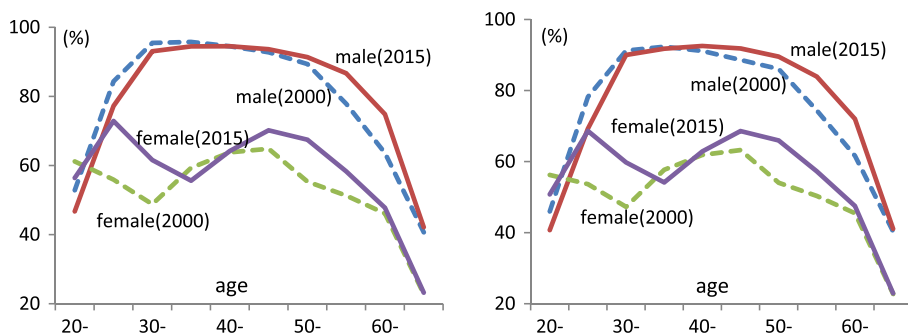
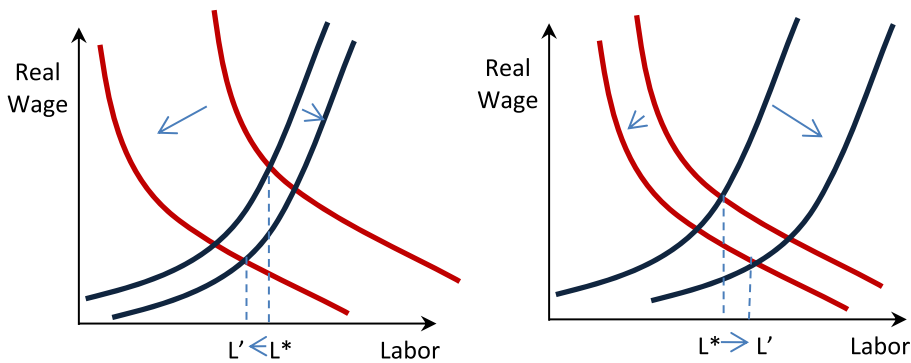


Figure 2 Labour Demand and Supply Response to Interest Rate Raise

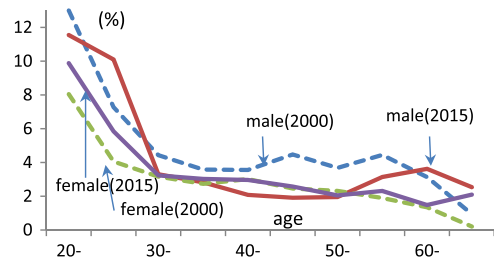


demand side only, a contractionary monetary policy would be able to reduce employment. However, if we consider the labour supply side in addition, interest rate shocks would alter the labour-leisure choice of households, thus acting as a driving force of employment at the equilibrium level as shown in Figure 2. When the labour market is segmented by age and gender, and each segment faces a different supply and demand curve depending on the interest rate elasticity of each curve, the equilibrium level of labour can either increase ($L^* < L'$) or decrease ($L^* > L'$). Especially recently, as the amount of household debts is larger than ever and life expectancy is extending, households may become more sensitive to interest rate shocks.

The other reason is that labour market rigidity can play a role in the interest rate channel of labour demand. As shown in Figure 3, the young male worker group presents the higher unemployment rate, or the gap between labour force participation rate and employment to population rate,² than other groups. This implies that the young male worker group should be more sensitive to the labour demand side shock because firms enjoy a superior position in this segment.

One thing to consider in analysing monetary policy effect on employment in a small open economy such as Korea is that the

Figure 3 Unemployment Rate



sources of interest rate shocks can be either domestic or foreign. Domestic monetary policy shock, or the Bank of Korea policy rate (BOK rate herein after), and foreign monetary policy shock, represented by the Federal Funds rate (FRB rate herein after) both have direct effect on the firm's cost of debt financing. However, they are different from each other in that foreign monetary policy can affect domestic monetary policy while domestic monetary policy has limited impact on foreign monetary policy because Korea is a small open economy. If foreign monetary policy shock is not considered in solving the research question, domestic monetary policy effect would be exaggerated because it represents interest rate shock as well as other foreign shock triggered by foreign monetary policy shock. In other words, as the change in the BOK rate itself is somewhat affected by foreign monetary policy, the pure interest rate effect net of foreign shocks can be

2. Unemployment rate = $(1 - \text{employment to population rate} / \text{labour force participation rate})$

limited, compared with previous studies on the monetary policy effect on macroeconomic variables that do not distinguish domestic and foreign shocks.

In sum, there are many circumstantial evidence that the employment series grouped by age and gender will show various responses to monetary policy shock. Additionally, in solving this research question, this paper considers the small open economy structure of Korea to prevent the biased estimates of domestic monetary policy effect on employment. The following section illustrates the identification strategy, a small open economy version of Factor Augmented Vector Autoregressive Model (FAVAR herein after) suggested by Bernanke et al. (2005). Section 3 presents the results, and Section 4 concludes.

2. Model Set-up and the Identification of Monetary Policy Shock

Factor Augmented Vector Autoregressive is used in identifying employment responses to monetary policy shock to prevent the price puzzle problem and to estimate multiple impulse response functions, which is not feasible with a standard vector autoregressive model (VAR). Regarding the price puzzle, this problem almost always appears when estimating monetary policy effect using the VAR system. Many researchers avoid this problem by ignoring it or simply not including a price variable in the model. Because in many countries, monetary authorities raise the policy rate when their economies are in expansionary phases, a policy rate variable is often confused with overall economic activities in the VAR system. Bernanke et al. (2005) assert that the price puzzle can be resolved by including proper variables representing the whole economic system. Because there are limitations in degrees of freedom when estimating VAR, factors representing various variables can be included in the system of constructing FAVAR.

In this sense, considering the fact that VAR and its relatives are not robust enough to select variables in the system, the model that can resolve the price puzzle problem is selected by

the criteria, that is, monetary policy should be identified properly. This paper determines the number of unobserved factors to be included under the premise that price variables should respond properly to interest rate shocks.

Another reason FAVAR should be used in solving the research question is that FAVAR can deal with many variables including 70 foreign and 66 domestic variables in this paper's case. Because we are interested in disaggregated employment series grouped by age and gender, too many variables are involved for a standard VAR to handle. Whereas VAR can normally include six to eight variables depending on the length of observations and lag orders, FAVAR does not have such limitation.

2.1. Application of Factor Augmented Vector Autoregressive to Small Open Economic System

When applying FAVAR to the small open economic system such as Korea, the sources of interest rate shock should be identified in order to properly understand monetary policy shock. A small open economy structure is imposed on FAVAR following the frameworks suggested by the previous studies on small open economies.³ Conceptually, international foreign factors can affect domestic factors, but domestic factors do not affect international foreign factors.

FAVAR assumes that macroeconomic dynamics are determined by observable fundamental forces of economy (Y_t) and unobservable ones (F_t). The unobservable factors (F_t) are defined the same as in Stock and Watson (1989)'s dynamic factor model. The law of motion of fundamental forces, or the factors follows a VAR structure as in state equation 1.

$$\begin{pmatrix} F_t \\ Y_t \end{pmatrix} = \Phi(L) \begin{pmatrix} F_{t-1} \\ Y_{t-1} \end{pmatrix} + v_t, \quad v_t \sim N(0, Q) \quad (1)$$

$$t = 1, \dots, T$$

$\Phi(L)$ is a lag polynomial, v_t is an error vector with average 0 and covariance matrix Q . Y_t is

3. See Buckle et al. (2007), Gjerde and Sættem (1999), Jacobson et al. (2001), Kose et al. (2003) and Uribe and Yue (2006) for more detail.

$M \times 1$ vector of observable factors, and F_t is $K \times 1$ vector of unobservable factors.

The motions of observable macroeconomic variables are determined by factor loadings as in observation equation 2.

$$X'_t = A^f F'_t + A^y Y'_t + e'_t, t = 1, \dots, T \quad (2)$$

X'_t is $N (\gg K+M)$ observable macroeconomic variables such as industry production, employment, foreign exchange rate and bond rate. A^f and A^y are $N \times K$ and $N \times M$ matrices of factor loadings. Thus, macroeconomic activities can be decomposed into observable factors, unobservable factors and error terms.

By adding a dual layer structure to the above equations, a small open economy version of FAVAR can be constructed as in Equations 3 and 4.

(State Equation: Standard VAR(1) structure with short-run restriction example)

$$\begin{pmatrix} F_t^G \\ Y_t^G \\ F_t^L \\ Y_t^L \end{pmatrix} = \begin{pmatrix} * & 0 & 0 & 0 \\ * & * & 0 & 0 \\ * & * & * & 0 \\ * & * & * & * \end{pmatrix} \begin{pmatrix} F_t^G \\ Y_t^G \\ F_t^L \\ Y_t^L \end{pmatrix} + \begin{pmatrix} * & * & 0 & 0 \\ * & * & 0 & 0 \\ * & * & * & * \\ * & * & * & * \end{pmatrix} \begin{pmatrix} F_{t-1}^G \\ Y_{t-1}^G \\ F_{t-1}^L \\ Y_{t-1}^L \end{pmatrix} + v_t \quad (3)$$

$$v_t \sim N(0, \text{Diagonal}), t = 1, \dots, T$$

(Observation Equation)

$$X_t^{W'} = A_W^f F_t^{W'} + A_W^y Y_t^{W'} + e_t^{W'}, \quad t = 1, \dots, T, W = \{G, L\} \quad (4)$$

G and L represent foreign (global) and domestic (local) factors respectively, and other notations are the same as in Equations 1 and 2. By adding this dual layer structure, the sources of interest rate shocks are decomposed into foreign monetary policy (Y_t^G) and domestic counterpart (Y_t^L).

Because foreign factors are exogenous to domestic factors, the global part (G) of Equations 3 and 4 can be estimated separately from the total system, and treated as VAR(p). Thus, the local part (L) of the equations looks like VARX(s) form of domestic equations. The lag order of p and q of the global and the local part of the equations are set to be 3 and 2, respectively, by Akaike information criteria (AIC).

Additionally, in ordering variables in the state equation, unobservable factors are put in front of observable factors using short-run identification restrictions suggested by Sims (1992).⁴ Unobservable factors are extracted using the principal components from observed variables (X'_t), and in order to eliminate the effect of observable factors (that is, monetary policy in this case) on unobservable factors, the residuals after regressing to unobservable factors on Y_t are used as F_t . Because F_t is contemporaneously orthogonal to Y_t by construction, F_t is placed in front of Y_t in the system.⁵

The response of macroeconomic indicators (X'_t) to factor shocks (Y_t and F_t) can be calculated using the linear combinations of impulse response functions of factors because observed macroeconomic indicators are the linear combinations of factors.

2.2. Data Description

The data used in this paper is monthly macroeconomic data from July 1999 to May 2015.⁶

4. One might consider vector error correction model in setting the law of motion of factors, but this paper follows Bernanke *et al.* (2005)'s example of VAR with short-run restrictions. This is because it is not easy to impose economic meanings in the cointegration relationship between factors when using VECM. Also, the time series does not seem to contain sufficiently long observation of economically stable period to calculate the long-term equilibrium relationship between variables.

5. Bernanke *et al.* (2005) imposed short-run restrictions by categorising variables into slow moving and fast moving series following Christiano *et al.* (1999) type of structural restrictions. In this paper, however, for some unidentified reason, classifying variables into these two categories cannot solve the price puzzle problem for the case of Korea. Alternative method for imposing short-run restrictions suggested Park (2009) is adopted in this paper instead.

6. The full list of variables is available in Appendix 1.

The observations (X_t^G) used in extracting foreign factors (F_t^G) are macroeconomic indicators of the United States, EU, Japan and China. Especially for the United States, macroeconomic indicators are selected in order to represent various aspects of economy, such as interest rate, price level, monetary aggregates, employment, production, asset price and foreign exchange rates. Total of 40 US variables plus 30 non-US variables are selected to extract foreign factors. For domestic counterparts, 66 variables are selected, representing various aspects of economic activities and age/gender employment series.

Most of the variables are seasonally adjusted series, or series that do not have seasonality such as exchange rate and interest rate. The variables showing seasonality are adjusted using X-12 autoregressive integrated moving average. In addition to seasonal adjustments, some of the variables are differenced or log-differenced to secure the stationarity.

For the observable factors, the BOK rate (Y_t^L), FRB rate and international crude oil price (Y_t^G) are selected. FRB rate is assumed to represent foreign monetary policy for the Korean economy. Even though the United States is not the largest trade partner of Korea, the Korean financial market like other financial markets, is much more sensitive to FRB rate than any other central banks' policy rates. Because the United States is the single largest economy of the world with key currency, it is not so surprising that Korean domestic interest rates including BOK rates are responsive to the FRB rate shock. The central bank policy rates from other parts of the world will be taken into account by including the factors (F_t^G) in the FAVAR system. By introducing FRB rate in the model, the implications derived from the BOK rate shock can be interpreted as the effect of the standalone BOK rate shock or the BOK rate shock net of the FRB rate shock and other foreign factors.

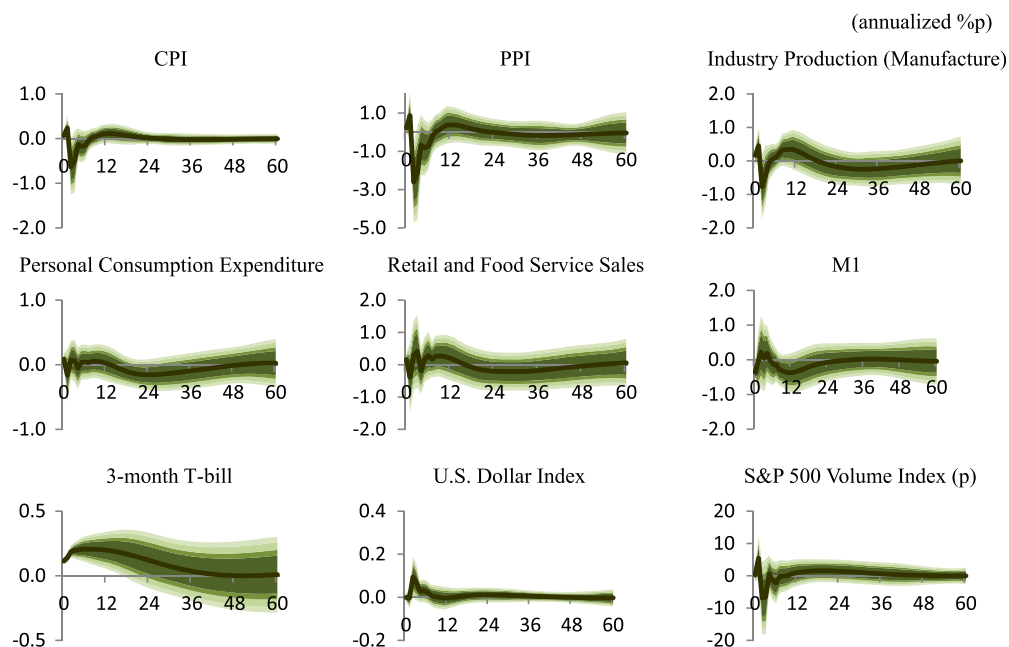
2.3. Identification of Monetary Policy Shock

In determining the number of unobservable factors, it should be ensured that price puzzle

does not appear. Thus, the number of unobservable factors is selected not by statistical criteria such as AIC or Schwarz information criterion, but by whether the model can resolve the price puzzle or not, although the lag length of VAR system is determined based on AIC. These model selection criteria should be adopted in this paper's case because the identification of monetary policy shock is especially troublesome in VAR analysis owing to a price variable in the system. In order for the model to be consistent with rational expectations on the dynamics of macroeconomic variables, price should respond downward with a lag of 1–2 quarters when there is a contractionary monetary policy shock.

For the law of motion of the international economy, adding three unobservable factors to the system resolves the price puzzle problem, as shown in Figure 4. The inflations in term of consumer price (CPI) or producer price respond downward after an increase in the FRB rate. Other macroeconomic indicators also respond according to our rational expectations; industry production, personal consumption, retail sales, monetary aggregates and stock market index all respond downward, while interest rates and United States dollar index respond upward. Having four or more unobservable factors results in very similar responses to the FRB rate shock but having fewer than three unobservable factors incurs the price puzzle. For the parsimoniousness, three unobservable factors and two observable factors are selected in the foreign part of the FAVAR system.

For the law of motion of Korean economy, with the foreign factors selected previously, four additional unobservable factors are added to resolve the price puzzle problem. As in Figure 5, the rise in the BOK rate lowers the inflations of both CPI and producer price. Industry products, machinery orders, monetary aggregates and stock index respond downward, while inventory, foreign exchange rate and market interest rates respond upward, and some of the indicators' responses are statistically insignificant. Conclusively, four unobservable factors and one observable factor (BOK rate) are

Figure 4 Response of Selected Macroeconomic Indicators to 1% Increase of FRB Rate

* Shaded areas are 1, 1.3, 1.7 and 2 standard deviation confidence intervals calculated from bootstrapping. (Approximately correspond to 70%, 80%, 90% and 95% confidence intervals.)

adopted in the domestic part of the FAVAR system.

3. Response of Employment by Age and Gender to Monetary Policy Shock

As shown in Figure 6, only young male workers negatively respond to the contractionary monetary policy shock, and other worker groups respond either insignificantly or positively to the shock. As it can be conjectured from the relatively high unemployment rate of young male workers, the labour demand channel, which reduces the labour demand in response to the interest rate rise, seems to work dominantly for the young male workers' group only. Young female workers' response is insignificant, but other groups respond positively to the contractionary monetary policy shock, which contradicts our belief that the contractionary monetary policy shock would reduce

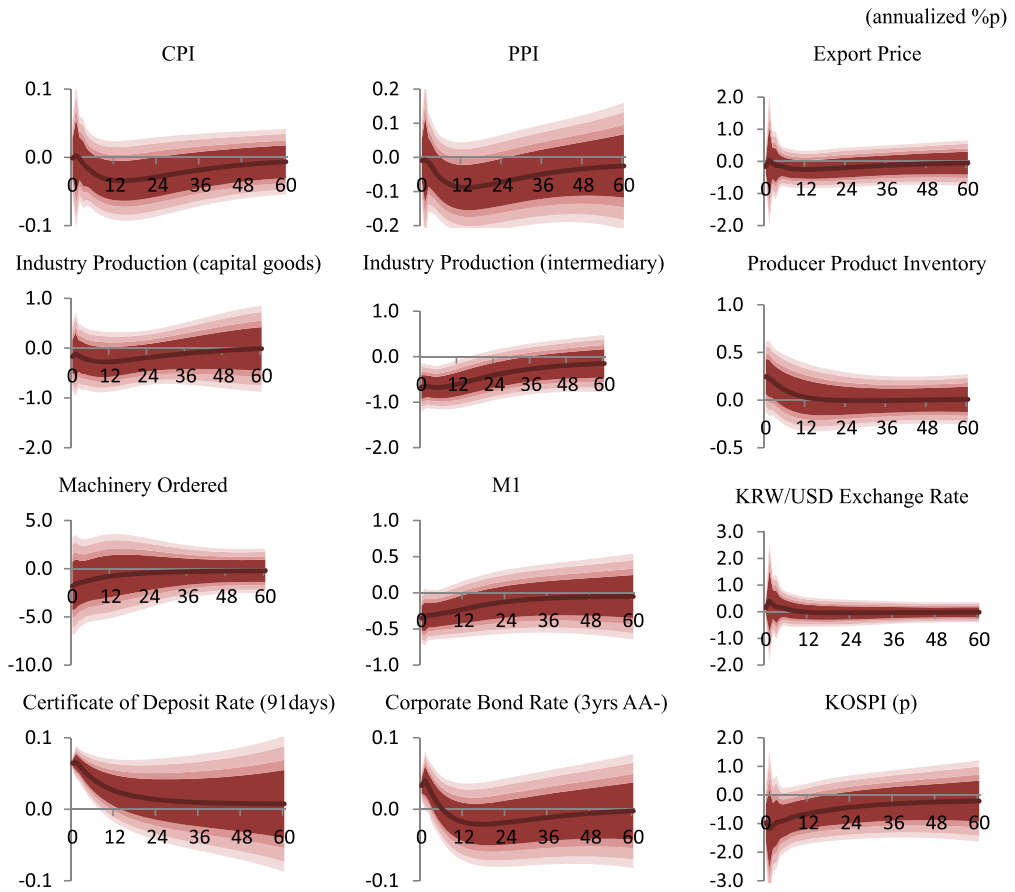
employment because of a reduction in the labour demand.⁷

It is also observed in the male worker group that 12-month cumulative responses exhibit a monotonic upward trend according to age, as presented in Figure 7. We can conjecture that younger workers are more responsive to the labour demand shock. However, older workers unexpectedly show strong responses to the policy rate rise, instead of non-responsiveness that can be regarded as the result of the labour market rigidity. Possible explanation is that the result owes to the supply side of labour because the labour supply reacts positively to interest rates.

The possibility that the labour supply channel is dominant in aged worker groups with

7. An alternative identification of the response of employment is also tried using a conventional VAR model in Appendix 2. The employment/population ratio decreases after an increase in the policy rate, but it suffers from the price puzzle problem.

Figure 5 Response of Selected Macroeconomic Indicators to 1% Increase of BOK Rate



* Shaded areas are 1, 1.3, 1.7 and 2 standard deviation confidence intervals calculated from bootstrapping.
(Approximately correspond to 70%, 80%, 90% and 95% confidence intervals.)

relatively lower unemployment rates should be owing to the different levels of sensitivity of households to policy shock. One way to examine if the labour supply channel of domestic monetary policy shock dominates the labour demand channel for aged workers is to check the wage level of each gender/age group worker. Unfortunately, however, gender/age-specific wage series is available only at annual frequency, so the differential policy effect on wage according to gender/age group can be checked only in an indirect way. Instead of looking at the gender/age group specific wage, industry specific wage can give some clues about the differential policy effect

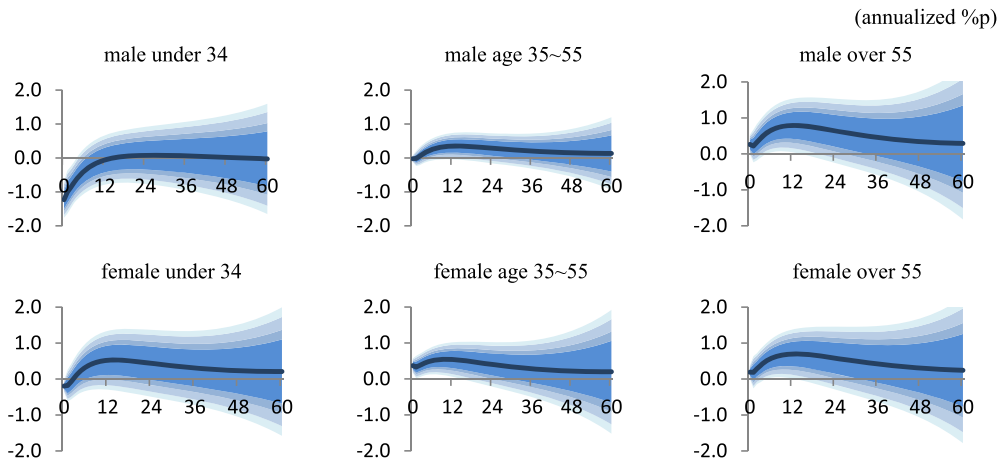
on wage resulting from the supply side of interest rate shock.

According to 2012–2014 survey of aged workers, some industries such as real estate and facility cares⁸ are composed of aged workers, while other industries exhibit relatively smaller portion of aged workers (Table 1). Among such industries, those with more than 200 000 workers and exhibiting some concentration of age groups are selected, and their wage responses are estimated.⁹

8. Examples include building guards, street cleaners and equipment services.

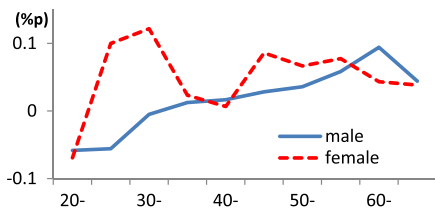
9. The real hourly wage series were seasonally adjusted, detrended and demeaned for the estimation.

Figure 6 Response of Gender/Age Group Employment to 1% Increase of BOK Rate



* Shaded areas are 1, 1.3, 1.7 and 2 standard deviation confidence intervals calculated from bootstrapping.
(Approximately correspond to 70%, 80%, 90% and 95% confidence intervals.)

Figure 7 Point Estimates of 12-month Cumulative Response of Gender/Age Group Employment to 1% Increase of BOK Rate



Looking at the industry level wage response to monetary policy shock, it is expected that the wages of industries with relatively young workers respond in various directions, while those composed of relatively aged workers respond negatively to the contractionary monetary policy shock. Thus, although it is not precisely revealed by the available data, it can be conjectured that the real hourly wages of aged workers respond more significantly to the contractionary monetary policy shock in a negative way, implying that the labour supply channel of policy impact may dominate the labour demand

channel. As shown in Figure 8, overall, the real hourly wages of industries with aged workers decrease more than those with younger counterparts after 1 per cent increase of the BOK rate.

On the contrary, the employment to population ratios of all age/gender groups respond negatively to an increase in the FRB rate, as shown in Figure 9. Foreign monetary policy shock not only affects international factors that in turn affect domestic factors but also directly affects domestic factors including domestic monetary policy. In Korea's case, because the economy heavily relies on international trade, foreign factors can have larger impact on the real activities of Korean economy.

By decomposing the sources of shock into domestic and foreign, it seems that the shocks originated outside the border have larger impacts on the aggregate demand. As shown in Figure 10, the BOK rate affects the worker groups relatively evenly across the ages. On the contrary, the FRB rate affects the younger male worker group more than others, which seems to be related to the fact that young male workers belong to the demand dominant labour market.

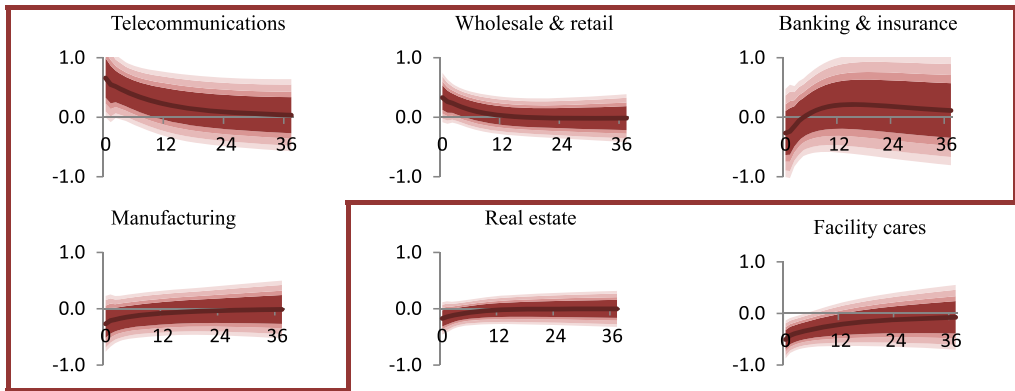
Table 1 Ratio of Workers over Age 55 by Industry

Industry	Total	Agriculture	Mining	Manufacturing	Utility	Waste disposal	Construction
Number of workers (A)	3,582	1	2	1,144	49	4	122
Number of workers over Age 55 (B)	382	0	0	59	6	0	12
B/A (%)	10.7	14.0	17.2	5.2	11.5	11.8	10.1
Industry	Wholesale /Retail	Transportation	Lodging	Telecommunications	Banking/Insurance	Real Estate	Science & Technology
Number of workers (A)	319	159	130	201	305	33	133
Number of workers over Age 55 (B)	8	25	7	5	8	12	13
B/A (%)	2.7	15.8	5.7	2.7	2.8	36.4	9.7
Industry	Facility Care	Education	Health	Art & Sports	NGO	Public Service	International & Foreign Org.
Number of workers (A)	595	90	167	34	20	59	15
Number of workers over Age 55 (B)	180	16	10	2	4	8	5
B/A (%)	30.2	17.5	5.8	6.1	19.0	14.0	34.3

Bold emphasis are those industries with larger portion of youth or elderly workers.

Figure 8 Response of Industry Specific Wage (per hour) to 1% Increase of BOK Rate

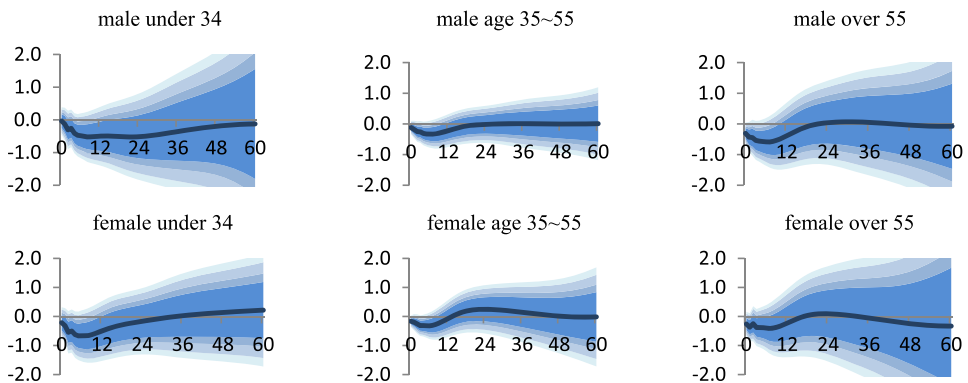
(100 KRW by 2010 constant price)



* Shaded areas are 1, 1.3, 1.7 and 2 standard deviation confidence intervals calculated from bootstrapping. (Approximately correspond to 70%, 80%, 90% and 95% confidence intervals.)

Figure 9 Response of Gender/Age Group Employment to 1% Increase of FRB Rate

(annualized %p)



* Shaded areas are 1, 1.3, 1.7 and 2 standard deviation confidence intervals calculated from bootstrapping. (Approximately correspond to 70%, 80%, 90% and 95% confidence intervals.)

Interest rate shock is not identified in this model because it is treated as the consequence of the state of economy such as monetary policy. However, because interest rate shocks are mostly originated from both domestic and foreign monetary policy shocks, it is probable that an inverse relationship between the equilibrium level of employment and interest rates

would be preserved in our observed sample period. Thus, there is a possibility that the effect of domestic monetary policy on real economic activities such as employment might be exaggerated in a certain model that does not take into account the dual layer structure of economy. Especially in a small open economy with high dependency on exports and imports

Figure 10 Forecast Error Variance Decomposition (5 year ahead, point estimates)

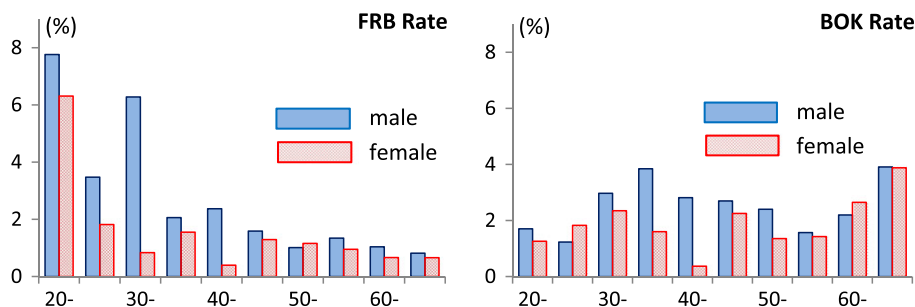
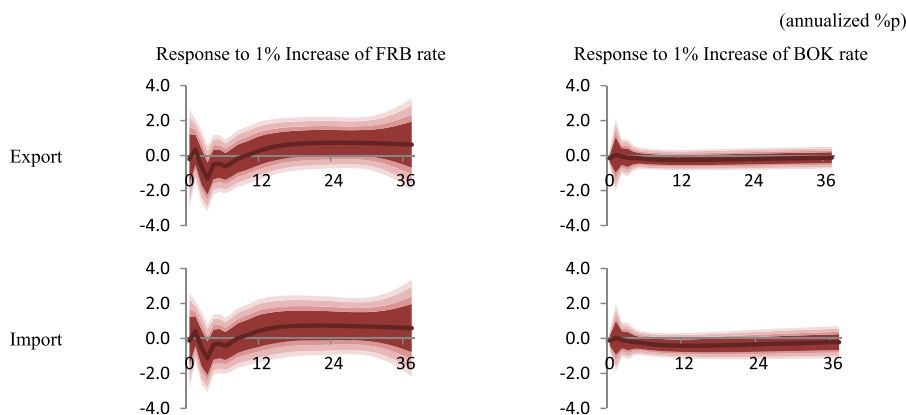


Figure 11 Response of Export and Import of Korea to Increase of FRB Rate



* Shaded areas are 1, 1.3, 1.7 and 2 standard deviation confidence intervals calculated from bootstrapping. (Approximately correspond to 70%, 80%, 90% and 95% confidence intervals.)

as in Korea,¹⁰ domestic monetary policy effect on real activities can have much more limited effect on the aggregate demand.

It is also revealed that foreign monetary policy shock has larger significant impact on

the export and import of Korea (Figure 11). In checking the differential effect of interest rate shock originated from foreign and domestic monetary policy shock, the responses of exports and imports to policy shocks are estimated, and the IRFs are provided on the graph with the same scale of axis. Both exports and imports respond similarly to foreign monetary policy shock, but they do not exhibit any significant responses to domestic monetary policy shock, implying that foreign monetary policy shock can have more significant impact on both the aggregate demand and the labour demand when economy heavily relies on the foreign demand.

10. As of 2015, trade volume (exports + imports) occupies approximately 85 per cent of GDP. The trade volume between the United State and Korea is approximately 13 per cent of GDP, which is less than China or ASEAN countries, but considering the status of the US economy to the world economy and the Korean financial markets reaction against the US economy, the US monetary policy should be treated as one of the most important foreign factors to the Korean economy.

4. Conclusion

This paper is distinguished from other papers, analysing monetary policy impact on real economic activities in that it decomposes the sources of shocks into domestic and foreign by imposing a small open economy structure and actively deals with the price puzzle problem to properly identify monetary policy shocks. Because a small open economy where trade occupies big part of its domestic production is sensitive to foreign factors, the implications drawn from domestic macroeconomic factors such as interest rates can be exaggerated if we do not take into account their sources of change such as foreign monetary policy or domestic monetary policy. The price puzzle problem should also be resolved because the monetary policy variable is often confused with business activities because of their high correlation.

In sum, domestic monetary policy seems to have limited impact on the labour demand as only young male workers respond inversely to the policy rate shock. On the contrary, foreign monetary policy exhibits the inverse relationship between employment and the policy rate, which is normally expected in the relationship between domestic monetary policy and employment. The overall shocks estimated from the forecast error variance decomposition support the fact that the US monetary policy shock has larger impact on the young male worker group that is deemed more sensitive to the demand side of labour.

Theoretically, when analysing monetary policy impact on real activities, flexible labour markets and households are presumed as saving agents. However, in reality, the labour market is segmented and households usually have more debts than savings. Other circumstances such as international trade or institutional factors can also disturb the relationship between the labour market demand and monetary policy. Although many studies support monetary policy intervention for the labour market slack, a single mandate of inflation targeting might be a better guideline for monetary authorities, considering the effectiveness of the policy rate in the labour market.

There are some limitations on the analysis of this paper, however. First, the sample period is deemed so long that the relationship between variables might be changed, for example, after the 2008 global financial crisis. Thus, it would be more interesting if we identified the coefficient change after the financial crisis, because the identified relationship from VAR model depends on the sample period. However, this is not considered in this paper for the reason that the real policy rate has stayed at around 0 per cent for a long period of time after the crisis, causing a singularity problem in estimating the system. Second, it is well known that monetary policy impact on macroeconomic activities is asymmetric depending on the phase of the business cycle, but this asymmetry is not considered here. If an expansionary monetary policy shock has larger impact during a contractionary business cycle phase, monetary policy might be effective in resolving the labour market slack during recession, which can provide empirical justifications to monetary policy intervention in preventing hysteresis effect in the labour market. A more delicate and precise study should be performed in analysing the relationship between monetary policy and real economic activities including employment in the future.

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Appendix 1. List of Variables

<i>Observations (the United States)</i>	<i>Source</i>	<i>trans.</i>
3-month Treasury Bill Rate	Federal Reserve Economic Data	
1-year Treasury Constant Maturity Rate	Federal Reserve Economic Data	
10-year Treasury Constant Maturity Rate.	Federal Reserve Economic Data	
1-year Bond Yield: Moodies' AAA Corporate	Federal Reserve Economic Data	
1-year Bond Yield: Moodies' BAA Corporate	Federal Reserve Economic Data	
CPI (all urban consumers)	Federal Reserve Economic Data	logdiff
PPI	Federal Reserve Economic Data	logdiff
St. Louis Adjusted Monetary Base	Federal Reserve Economic Data	logdiff
M1	Federal Reserve Economic Data	logdiff
M2	Federal Reserve Economic Data	logdiff
Civilian unemployment rate	BLS Current Population Survey	
Average duration of unemployment	BLS Current Population Survey	
Number of employees (total nonfarm payrolls)	BLS Current Population Survey	logdiff
Employed, usually work part time	BLS Current Population Survey	logdiff
Civilian labour force participation rate	BLS Current Population Survey	
Average hourly earnings (production employees)	BLS Current Population Survey	logdiff
Civilian employment-population ratio	BLS Current Population Survey	
Industrial Production Index	Federal Reserve Economic Data	logdiff
Capacity utilization (total Inds)	Federal Reserve Economic Data	
Value of manufacturers' new orders (manufacturing)	Federal Reserve Economic Data	logdiff
Manufacturers' new orders (nondefense capital goods)	Federal Reserve Economic Data	logdiff
Total construction spending	Federal Reserve Economic Data	logdiff
Industrial production (manufacturing)	Federal Reserve Economic Data	logdiff
Real personal consumption expenditures	Federal Reserve Economic Data	logdiff
Real retail and food services sales	Federal Reserve Economic Data	logdiff
Real disposable personal income	Federal Reserve Economic Data	logdiff
Light weight vehicle sales (autos and light trucks)	Federal Reserve Economic Data	
Personal consumption expenditures (durable goods)	Federal Reserve Economic Data	logdiff
Personal consumption expenditures (nondurable goods)	Federal Reserve Economic Data	logdiff
Housing starts: total	Federal Reserve Economic Data	log
Building permits (new private housing units)	Federal Reserve Economic Data	log
New one family houses sold	Federal Reserve Economic Data	log
Kansas City Financial Stress Index	Federal Reserve Economic Data	
S&P 500 monthly average trade volume	Yahoo Finance	logdiff
S&P 500 monthly average closing price	Yahoo Finance	logdiff
Travelers checks outstanding	Federal Reserve Economic Data	logdiff
Imports	Federal Reserve Economic Data	logdiff
Trade Weighted US Dollar Index	Federal Reserve Economic Data	diff
Henry Hub Natural Gas Spot Price	Federal Reserve Economic Data	logdiff
Inventories to Sales Ratio (merchant wholesalers)	Federal Reserve Economic Data	
Observations (EU)		
Money Market Rates (1 day)	Eurostat	
Money Market Rates (3 months)	Eurostat	
Money Market Rates (1 year)	Eurostat	
All-items HICP	Eurostat	logdiff
Unemployment Rate	Eurostat	
Index of Production (durable goods)	Eurostat	logdiff
Index of Production (nondurable goods)	Eurostat	logdiff
Index of Production (intermediate goods)	Eurostat	logdiff
Index of Production (capital goods)	Eurostat	logdiff
Total Output Price Index	Eurostat	logdiff
Real imports	Eurostat	logdiff

(Continues)

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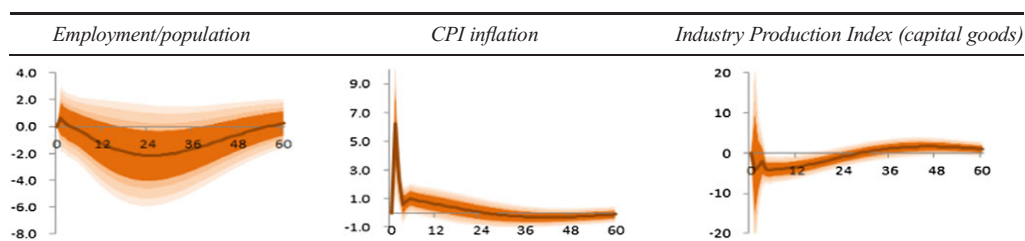
<i>Observations (the United States)</i>	<i>Source</i>	<i>trans.</i>
Real exports	Eurostat	logdiff
Observations (China)		
CPI	National Bureau of Statistics of China	logdiff
PPI	National Bureau of Statistics of China	logdiff
M0	People's Bank of China	logdiff
M1	People's Bank of China	logdiff
M2	People's Bank of China	logdiff
HH Savings Deposit Rate (3 months)	People's Bank of China	
HH Savings Deposit Rate (1 year)	People's Bank of China	
HH Savings Deposit Rate(3 years)	People's Bank of China	
Fixed Asset Investment	National Bureau of Statistics of China	logdiff
Shanghai Stock Exchange Index	National Bureau of Statistics of China	logdiff
Observations (Japan)		
Monetary base	Bank of Japan	logdiff
Call rates, uncollateralized overnight	Bank of Japan	
PPI	Bank of Japan	logdiff
Real exports	Bank of Japan	logdiff
Real imports	Bank of Japan	logdiff
Production Volume Index (manufacturing)	Bank of Japan	logdiff
Industry Production Index (manufacturing)	Bank of Japan	logdiff
Total employment	Bank of Japan	logdiff
Observations (Korea)		
Employment/population by age/gender	KOSIS	
Money base	Bank of Korea	logdiff
M1	Bank of Korea	logdiff
M2	Bank of Korea	logdiff
Lf	Bank of Korea	logdiff
Interbank Call Rate (1 day)	Bank of Korea	
Certificate of Deposit Rate (91 days)	Bank of Korea	
Exchange Bond Rate (3 year)	Bank of Korea	
Monetary Stabilization Bond Rate (1 year)	Bank of Korea	
Corporate Bond Rate (3 year, AA-)	Bank of Korea	
Promissory note trade volume	Bank of Korea	logdiff
Promissory note trade amount	Bank of Korea	logdiff
Default rate (monetary value)	Bank of Korea	
Daily average count of default	Bank of Korea	log
KOSPI Index	Bank of Korea	logdiff
PPI	Bank of Korea	logdiff
CPI	Bank of Korea	logdiff
Core CPI	Bank of Korea	logdiff
Export Price Index	Bank of Korea	logdiff
Import Price Index	Bank of Korea	logdiff
Current account	Bank of Korea	log
FX rate (KRW/USD)	Bank of Korea	diff
FX rate (KRW/JPY)	Bank of Korea	diff
FX rate (KRW/EUR)	Bank of Korea	diff
FX rate (KRW/CNY)	Bank of Korea	diff
Apartment price	nlandkbsstar.com	logdiff
Production Index (capital goods)	KOSIS	logdiff
Production Index (intermediary goods)	KOSIS	logdiff
Production Index (durable goods)	KOSIS	logdiff
Production Index (nondurable goods)	KOSIS	logdiff
Producer Product Inventory Index	KOSIS	logdiff

(Continues)

(Continued)

<i>Observations (the United States)</i>	<i>Source</i>	<i>trans.</i>
Machinery Order Index	KOSIS	logdiff
Construction Order Index	KOSIS	logdiff
Employment (agriculture)	KOSIS	logdiff
Employment (mining)	KOSIS	logdiff
Employment (construction)	KOSIS	logdiff
Employment (wholesale & Retail)	KOSIS	logdiff
Employment (finance)	KOSIS	logdiff
Employment (education services)	KOSIS	logdiff
Employment (transportation and others)	KOSIS	logdiff
Employment (private sector)	KOSIS	logdiff
Unemployment Rate	KOSIS	

Appendix 2. Employment/population Ratio Response to 1 Per Cent Increase in BOK Rate from 5 Variables VAR Model¹¹



*Shaded areas are 1, 1.3, 1.7 and 2 standard deviation confidence intervals calculated from bootstrapping. (Approximately correspond to 70, 80, 90 and 95 per cent confidence intervals.)

A conventional form of vector autoregressive model (monthly frequency) is set to analyse the effect of a rise in the Bank of Korea policy rate on the Employment/Population Rate of Korea. Employment decreases owing to a contractionary monetary policy shock with 1–2 years of delay, which we conventionally believe it should be.

However, the CPI response exhibits a typical price puzzle that price level rises in response to a contractionary monetary policy. This implies that the monetary policy variable is not identified properly, and that we need to use proper forms of identification strategy such as FAVAR instead of ignoring or not using price variables.

11. Using the VAR Granger causality test, the variables used in the model are ordered as employment/population ratio, CPI inflation rate, industry production index (capital goods), real effective exchange rate, and the Bank of Korea policy rate. In addition to those variables, international crude oil price is used to control for the global factor of the VAR system. Optimal lag is set to be two months by Akaike information criterion.

Appendix 3. Vector Autoregressive Model
Granger Causality Test

Y	Excluded	χ^2	df	Prob > χ^2	Y	Excluded	χ^2	df	Prob > χ^2
Real Effective Exchange Rate (FX)	IPI	4.96	2	0.08	CPI	FX	3.31	2	0.19
	Emp	6.19	2	0.05		IPI	0.46	2	0.79
	CPI	7.56	2	0.02		Emp	0.44	2	0.80
	BOK	12.08	2	0.00		BOK	9.73	2	0.01
	All	29.15	8	0.00		All	15.81	8	0.05
Industry Production Index (IPI)	FX	10.17	2	0.01	Employment/Population Rate (Emp)	FX	1.27	2	0.53
	Emp	10.69	2	0.01		IPI	3.41	2	0.18
	CPI	0.56	2	0.76		CPI	0.84	2	0.66
	BOK	2.54	2	0.28		BOK	0.23	2	0.89
	All	19.92	8	0.01		All	7.31	8	0.50
BOK Policy Rate (BOK)	FX	31.26	2	0.00	H_0 : Excluded variables does not Granger cause Y				
	IPI	5.86	2	0.05					
	Emp	10.53	2	0.01					
	CPI	15.49	2	0.00					
	All	54.00	8	0.00					