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US Purchasing Managers' Index and its Impact on Korea and US

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Abstract

Purpose - The study is to examine the impact of the US Purchasing Managers' Index (PMI) on Korea and the US industrial economy including the distribution industry. We analyze its effect on the industrial economy centered on the distribution industry using economy indices in Korea and the US.

Research design, data, and methodology – The variables are used to analyze the dynamic relationship which occurs among the US PMI, the industrial production index, producer price index, unemployment rate, and manufacturing Inventories Index in Korea and the US from January 1990 to July 2016 using Vector Error Correction Model.

Results – As a main result, the impact of the US PMI on all the economy indices both Korea and the US has the same cyclical movement. The US PMI is positively related to the producer price and the industrial production index of Korea and the US, while it is negatively related to unemployment rate, and the manufacturing inventories index in Korea and the US.

Conclusions - The US PMI as an advanced index has a power to predict the economies on Korea and the US. In the end, we find that the US PMI has a great impact on Korea and the US industrial economy.

Keywords: Distribution Industry, PMI, IPI, PPI, VECM.

JEL Classifications: C32, G15.

1. Introduction

According to the Wall Street Journal in early January 2017, the "Brexit" referendum in June 2016 resulted in a steep rise in the Purchasing Managers' Index (PMI), which hit a record high of 56.1 in December 2016. The rapid rise of PMI means that production and new export businesses have grown significantly about for six months since Brexit's announcement and that demand for British companies has increased from the US, Asia, Europe, China and the Middle East markets. As such, the figures implied by the PMI have a symbolic meaning to imply economic activity. We can predict the current situation of the current month through PMI announced at the beginning of each month. For this reason, many countries have actively developed and used the PMI to help economic analysts, business policy makers, and purchasing professionals understand and appreciate current industry conditions. It is important for companies and countries to identify and forecast the economic situation of the nation through PMI and to prepare future strategies and prepare for the reality throughout the economy.

PMI is a preliminary economic index that considers the economic conditions of the previous month and scored data from over 30 countries and over 20,000 purchasing managers. The well-designed PMI model contributes to the long-term corporate strategy and goals of the CEO. In addition, the Institute for Supply Management (ISM), a non-profit purchasing manager association, has asked purchasing professionals to verify changes in PMI (Cho & Ogwang, 2006). In addition, Eathington and Swenson (2010) divide industries into industries that are largely divided into manufacturing and non-manufacturing industries, and are examining the effects of the comparison on the PMI. The sales expectations of the retail industry are more sensitive to the PMI than those of the manufacturing industry. The employment sector has a stronger influence on the distribution industry than that of the manufacturing industry.

We study the effects of the US PMI on the economic indicators of the United States and Korea, which both countries have a relationship as one of the largest trading

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nations each other. We will examine closely the major items that can identify the industrial economy centered on domestic industries including the distribution industry, and compare the economic indicators of both countries to understand the influence of the US PMI. There is significance to understand the influence of the US PMI. This study has been analyzed with VECM (Vector Error Correction Model) based on the data from January 1990 to July 2016. The US PMI is estimated by using the five survey indices which are composed of new orders (30%), production (25%), employment (20%), supplier delivery (15%), and inventory (10%). The main data of this study are industrial production index (IPI), producer price index (PPI), unemployment rate, and manufacturing inventory Index including the US PMI. This study is to investigate the effects of the PMI on the industrial economy in Korea and the US through economic indicators. Empirical results show that the US PMI has shifted to the economic indicators of Korea and the US in the same direction. The PMI was positively related to the IPI and the PPI, but was in negative relation with the unemployment rate and the inventory index. That is, if the PMI rises, it means that the economy will rise, thus, industrial production and producer prices also rises as shown in the empirical results. On the other hand, unemployment rate and manufacturing Inventories Index showed a reliable result that they declined due to the expansion of the economy. Following the introduction, we examine the theoretical background and previous researches in Chapter 2 and Chapter 3 in detail, and then we explain the models and variables of this study. Chapter 4 discusses the empirical analysis. Section 5 describes the conclusions.

2. Background and Literature Review

Markit, which oversees the PMI about 30 countries around the world, completes the survey of the questionnaires centered on major items and analyzes the results until the middle of each month. The survey subjects are divided into manufacturing, service and construction. The questions, focusing on the five items of the US PMI mentioned above, for purchasing managers are similar to each industry. The survey item should be answered with the reasons that whether the business situation compared with that of the previous month will be improved, deteriorated, or maintained .

The economic indicators related to this study indicate that the IPI, which indicates the symbolic value scale of industrial production, is the indicator of the change in industrial production level and economic fluctuation of a country. That is, the status of the real economy can be known by the IPI indicating the increase and decrease activity of the production result. Generally, an increase in production means that the economy is improving, while a decrease in production means that the economy is deteriorating. Korea's IPI is surveyed every month for mining, manufacturing, electricity and gas industries. The PPI shows the price fluctuations of goods and services sold, and it is an indicator of economic trends. Monthly investigation and calculation of item-specific index are performed in the same way as raw material prices and consumer price index, so that the rise in raw material prices will cause producer price to rise, and it will reflect consumer price index. In addition, the rise in the PPI implies that the economy is recovering and growing. The unemployment rate decreases when the economy rises and employment increases. The manufacturing inventory index is also rapidly declining as inventories are speedily exhausted when the business cycle is growing rapidly.

Today prominent scholars are studying actively the PMI and economic indicators. The PMI has many researches related to variables like the IPI. Also scholars have studied the relation between GDP and PMI (Bretz, 1990; Kauffman, 1999; Lindsey & Pavur, 2005; Afshar, 2007; Giannone et al., 2008). Dasgupta and Lahiri (1993) argue that the PMI is an independent force that explains changes in real GNP and IPI in the manufacturing sector. As for the US and Japan, various economic analyses on economic indicators are conducted using PMI (Stock & Watson, 2002a, b; Tsuchiya, 2012). Baberjee and Marcellino (2006) studied the need for the PMI as a leading indicator of the US inflation and GDP growth. Muller (2013) argues that the US PMI is more predictive of real GDP than that of Switzerland. On the other hand, the Swiss PMI is more suited to non-manufacturing index explanation. Lahiri and Monokroussos (2013), who conducted the previous study on the US GDP forecasts with the US PMI, gave the motivation for making the Swiss non-manufacturing index, and it concluded that the trend of PMI was coincided closely with the GDP growth rate.

There are also the studies on the PMI by each country or region. Gerlach (2011) analyzed the European Central Bank's (ECB) interest rates and the PMI. The sharp decline in the interest rates of the ECB during the financial crisis reflects both the severe deterioration of the economic situation and the shift in response to the ECB. Conesa et al. (2015) found that it was possible to make early forecasts of economic activities through micro-payment data. For the analysis of the retail payment system, they compared the GDP forecasting performance from the Spanish national system data, and the data of the settlement system contributed significantly to the prediction of GDP.

Some studies have analyzed the PMI and domestic economic indicators. Kim (2014) has studied the response to the impact on the supply of money and the expectation of change in purchasing managers in the semiconductor market. In addition, using the Structural Vector Auto Regression (SVAR) model, the manufacturing PMI could explain the response to semiconductor shipments.

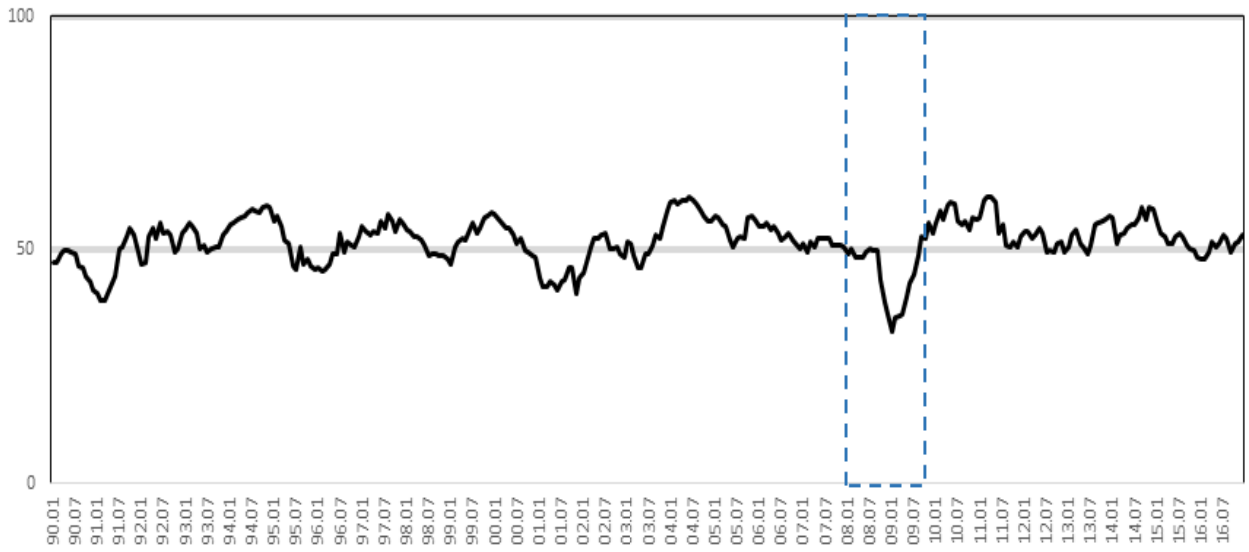
This study is different from previous researches on the existing PMI and economic index. First, the previous studies, which mainly analyzed the correlation between PMI and GDP or GNP, this study examines the main components of the PMI as new orders, production, employment, supplier delivery, and inventory. It analyzes the impact on the real industrial economy by using the corresponding economic indicators such as IPI, PPI, unemployment rate, and manufacturing Inventories Index. Second, it is the first paper to compare Korea and the US economic indicators based on the world's most influential US PMI. As a result, the impact of the US PMI was confirmed in the US, as well as in Korea which does not actually use the PMI. Third, it is a great differentiating point from the other papers that the effect of the economic indicators on the impact of the PMI was examined and its influence was confirmed by carrying out the empirical analysis with the VECM model.

3. Data and Methodology

3.1. Data

We used the monthly data for 27 years from January 1990 to July 2016. To compare Korea and US industrial economies with the US PMI, we used a total of nine variables such as the Korean and US IPI, PPI, unemployment rate, and manufacturing inventory index including the US PMI. For Korean data, the IPI and the manufacturing inventory Index were obtained from Korea National Statistical Office, and the PPI was gathered from the Bank of Korea. For the US data, the PMI and the manufacturing inventory Index were obtained from ISM (Institute for Supply Management), and the IPI was collected from Federal Reserve Economic Data (FRED). The PPI was obtained from the Bureau of Labor Statistics in the US. In addition, the unemployment rate between Korea and the US was collected by the OECD.

<Figure 1> denotes the trend of the US PMI. The PMI changes from 0 to 100. As the PMI is closer to 0, it denotes that the economy is worse than that of the previous month based on 50, and as the PMI is closer to 100, it shows the better economy. For example, the recession period from the National Bureau of Economic Research (NBER) has the largest fluctuation based on the PMI 50. During this period, the US sub-prime mortgage plunged into a global financial crisis and the economy was in a slump, and the PMI also fell sharply.



Note: The dotted box denotes recession periods of PMI for December 2007 to June 2009 from NBER.

<Figure 1> Trend of Purchasing Managers' Index in the US

3.2. Methodology

According to a study by Engle and Granger (1987), linear combination in abnormal time series variables can be stable. Specifically, the calibrated results in the time series of unit root tests are stable and can be empirically analyzed using the VAR (Vector Auto Regression) model. However, if the cointegration exists, it is better to analyze it with VECM than to estimate VAR which does not show long-term balance relation because the inherent information of time series is lost. As a result of the empirical analysis, VECM with a long-term equilibrium relationship and a short-term dynamic relationship between the PMI and the economic index is used as Equation (1). In addition, we will examine the dynamic effects of the VECM through the impact response function between the PMI and the economic indices.

$$\triangle Y_t = \sum_{i=1}^{k-1} \Gamma_i \triangle Y_{t-i} + \alpha\beta' Y_{t-k} + \Psi + \epsilon_t \quad (1)$$

$\triangle$: first difference operator
Y_t: vector of $p \times 1$ matrix when the variables are I(1)
i: lag order (1, 2, ..., N)
k: maximum of lag order
t: period (1, 2, ..., T)
Γi: $p \times p$ matrix coefficient
$\alpha\beta' Y_{t-k}$: lagged error correction term
α: adjustment parameters
β': cointegration vectors
Ψ: vector of deterministic components
ϵ_t: $p \times 1$ vector of disturbances
p: US PMI, Industrial Production Index, Producer Price Index, Unemployment Rate, Manufacturing Inventories Index in Korea and the US

<Table 1> indicates the descriptive statistics of the variables.

<Table 1> Descriptive Statistics

	Korea IPI	Korea PPI	Korea UR	Korea MII	US IPI	US PPI	US UR	US MII	US PMI
Mean	64.91	82.84	3.46	78.10	89.82	152.50	6.07	45.59	51.83
Median	60.16	80.25	3.30	68.99	94.29	137.70	5.60	45.70	52.40
Min.	20.01	55.00	1.90	33.42	62.71	114.10	3.80	31.00	32.40
Max.	115.00	108.97	8.20	137.70	106.69	208.30	10.00	56.50	61.40
S.D.	30.40	16.08	1.16	29.24	13.51	31.83	1.55	4.31	4.98
N	319	319	319	319	319	319	319	319	319

Note: IPI, PPI, UR, and MII denote separately Industrial Production Index, Producer Price Index, Unemployment Rate, and Manufacturing Inventories Index.

<Table 2> Results of Unit Roots Test

		ADF		PP	
		Level	First Difference	Level	First Difference
Korea IPI	Con.	-1.507	-18.300***	-1.758	-33.009***
	Con. & Trend	-4.433	-18.306***	-5.169	-33.355***
Korea PPI	Con.	-1.875	-9.367***	-2.045	-9.308***
	Con. & Trend	-1.709	-9.542***	-0.960	-9.428***
KR UR	Con.	-1.971	-10.334***	-2.143	-16.547***
	Con. & Trend	-1.970	-10.332***	-2.190	-16.527***
KR MII	Con.	-1.187	-10.762***	-1.219	-16.606***
	Con. & Trend	-2.550	-10.764***	-2.701	-16.599***
US IPI	Con.	-2.013	-8.576***	-1.970	-14.841***
	Con. & Trend	-0.856	-8.693***	-1.103	-14.996***
US PPI	Con.	-0.875	-8.935***	-0.802	-11.920***
	Con. & Trend	-2.079	-8.925***	-2.005	-11.904***
US UR	Con.	-0.912	-9.906***	-1.219	-17.888***
	Con. & Trend	-0.695	-9.942***	-1.072	-17.905***
US MII	Con.	-4.475	-16.321***	-5.619	-27.738***
	Con. & Trend	-5.042	-16.294***	-6.563	-27.687***
US PMI	Con.	-3.955	-10.788***	-4.202	-16.239***
	Con. & Trend	-3.975	-10.769***	-4.231	-16.216***

Notes:
1. IPI, PPI, UR, and MII denote separately Industrial Production Index, Producer Price Index, Unemployment Rate, and Manufacturing Inventories Index.
2. Con., Con. & Trend denote constant, constant and trend separately.
3. ***, **, * denotes 1%, 5%, 10% significant level respectively.

4. Empirical Results

4.1. Unit Root Tests Analysis

According to Granger and Newbold (1974), regression analysis with a unit root causes a false statistical error due to an increase in t value, and regression analysis of abnormal state can make a strong correlation in a time series. The presence of unit roots was estimated by Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to confirm such a pseudo-regression phenomenon. As shown in <Table 2>, the time series have unit roots in the level variable, thus the time series have no stationary state. As a result of the unit root tests with the first difference variable, it shows that the time series is stationary because there is no unit root.

4.2. Cointegration Tests Analysis

Cointegration tests should be conducted to account for the information loss that may occur when using the first difference variable. Namely we do the Johansen test for the existence of long-term equilibrium in the time series. The results of the cointegration test show that cointegration exists in the time series from <Table 3>. A statistical error occurs when VAR is used as a stable the first difference variable when there is a unit root in level variable and it is unstable and cointegration exists and is in long-run equilibrium relation. Since the estimated coefficient has bias, this study is analyzed through VECM model instead of VAR.

<Table 3> Results of Cointegration Test

Ho	Trace	5% Critical Value	λmax	5% Critical Value
r=0	393.72	192.89	125.06	57.12
r≤1	268.65	156.00	101.62	51.42
r≤2	167.02	124.24	73.09	45.28
r≤3	93.93*	94.15	31.61	39.37

Note: * denotes the rejection of the null hypothesis at the 5% level.

4.3. Granger Causality Test Analysis

As shown in <Table 4>, the Granger causality test was conducted by Granger (1980) to examine the causal relationship between the US and US economic variables on the US PMI. As a result of the Granger causal test, the PMI rejects the null hypothesis (Ho) if it is significant and adopts the hypothesis. Namely it can be said that “the PMI does granger cause economic indicator variables”. In addition, the effect of economic indicators on the PMI in the opposite direction can also be seen through the Granger causality test.

In the case of the US, the PMI was in a significant Granger Cause relationship with all economic index variables, and the economic index variable was also in a significant Granger causality with the PMI. This implies that the PMI has a close causal relationship between US economic indicators.

In Korea, the PMI was significantly related to all economic indicators except unemployment rate. This means that Korea's economic indicators such as the US economic indicators are also heavily influenced by the US PMI, which is a leading indicator of economic activity.

<Table 4> Results of Granger Causality Tests

	Ho	F-Statistic
Korean Industrial Production Index	PMI ⇏ Korean Industrial Production Index	3.221**
	Korean Industrial Production Index ⇏ PMI	0.935
Korean Producer Price Index	PMI ⇏ Korean Producer Price Index	8.808***
	Korean Producer Price Index ⇏ PMI	0.003
Korean Unemployment Rate	PMI ⇏ Korean Unemployment Rate	0.825
	Korean Unemployment Rate ⇏ PMI	0.178
Korean Manufacturing Inventories Index	PMI ⇏ Korean Manufacturing Inventories Index	3.468**
	Korean Manufacturing Inventories Index ⇏ PMI	0.031
US Industrial Production Index	PMI ⇏ US Industrial Production Index	26.187***
	US Industrial Production Index ⇏ PMI	25.504***
US Producer Price Index	PMI ⇏ US Producer Price Index	9.158***
	US Producer Price Index ⇏ PMI	10.202***
US Unemployment Rate	PMI ⇏ US Unemployment Rate	34.146***
	US Unemployment Rate ⇏ PMI	5.092***
US Manufacturing Inventories Index	PMI ⇏ US Manufacturing Inventories Index	26.187***
	US Manufacturing Inventories Index ⇏ PMI	25.504***

Notes: 1. ⇏ denotes “does not Granger Cause”.
2. 3. ***, **, * denotes 1%, 5%, 10% significant level respectively.

4.4. VECM Analysis

Optimal lag order should be set before executing the VECM of this study. <Table 5 > shows that lag 3 is set by AIC (Akaike Information Criterion).

<Table 5> Lag Order Selection

Lag	AIC	HQIC	SBIC
0	-17.155	-17.112	-17.048
1	-43.727	-43.299	-42.655
2	-44.469	-43.6553	-42.432
3	-44.476*	-43.277	-41.474

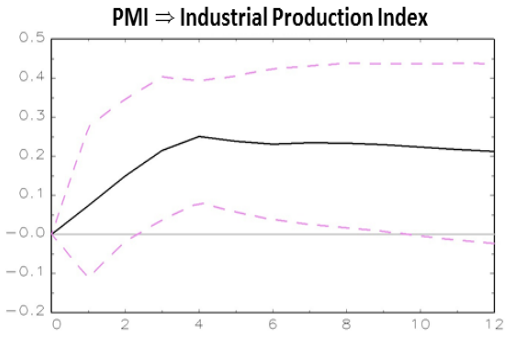
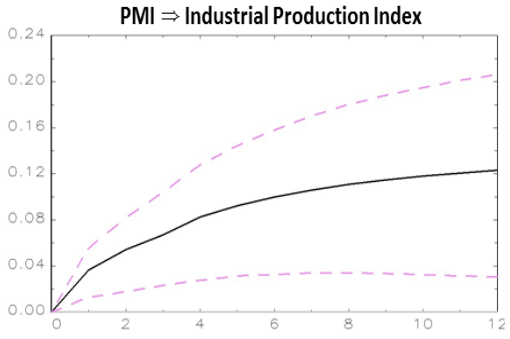
Note: * means lag order selected by the criterion.

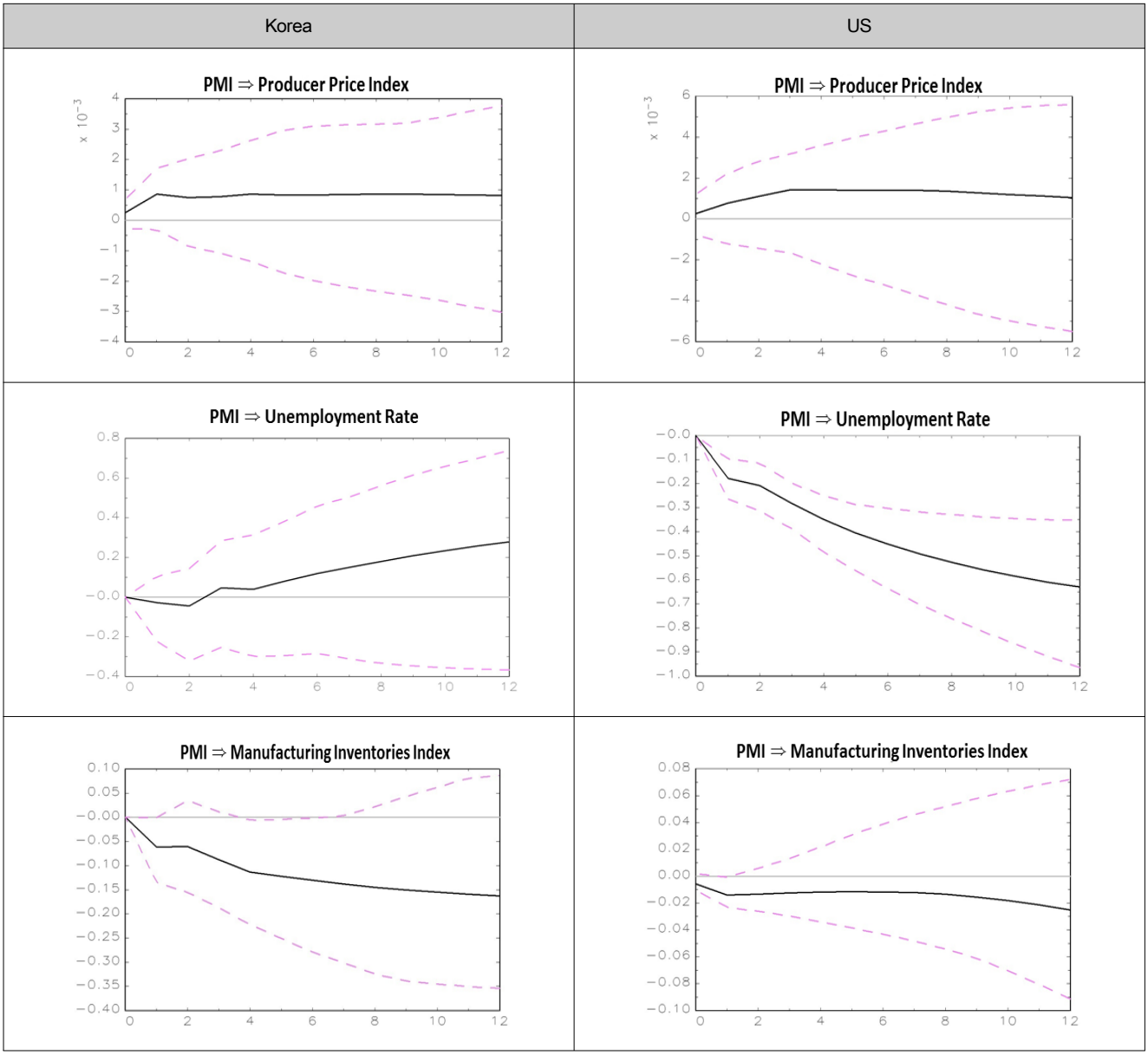
As shown in <Table 6>, the VECM of lag 3 shows that the US PMI has a close correlation with the economic indicators of Korea and the US. In Korea and the US, IPI and PPI were positively correlated with the US PMI, but unemployment rate and manufacturing inventory index were negatively correlated with the US PMI. This implies that when the PMI rises, the economy improves. As the production increases, the IPI and the PPI increase, and as the economy grows, the employment rate increases and the unemployment rate decreases. The manufacturing Inventories also decline as it is quickly exhausted. The result of the VECM is supported by this.

<Table 6> Estimation Results of VECM

	Coefficient
Korea Industrial Production Index	0.145* (0.087)
Korea Producer Price Index	0.018** (0.009)
Korea Unemployment Rate	-0.177** (0.081)
Korea Manufacturing Inventories Index	-0.175 (0.0322)
US Industrial Production Index	0.025*** (0.009)
US Producer Price Index	0.032** (0.015)
US Unemployment Rate	-0.094** (0.037)
US Manufacturing Inventories Index	-0.275*** (0.026)

Notes: 1. 3. ***, **, * denotes 1%, 5%, 10% significant level respectively.
2. Standard deviations are in parentheses.

Korea	US
	



Note: The solid line denotes the impulse response. And the dotted lines denotes 95% confidential interval.

<Figure 2> Response Results to Impulse of Purchasing Managers' Index

4.5. Impulse Response Analysis

After the cointegration test for time series variables, the response function of the PMI to the economic indicators of Korea and the US was examined through the VECM for each variable (Benkwitz et al., 2001). In <Figure 2>, it shows the impact of PMI on the US and Korean economic variables. The response to the shock can be divided into Korea and the US as follows.

4.5.1. Impulse Response Analysis in Korea

The response of IPI to the impact of the PMI is rising steadily in the positive direction from the beginning. The PPI has also been moving upward in the direction of the positive from the beginning and has maintained a gentle condition. In the case of the unemployment rate, it falls in the direction of the negative in the beginning, and it rises in the direction of the positive from the second period and has a gentle upward curve. In addition, the manufacturing inventory

Index has been falling in the direction of the negative from the beginning.

4.5.2. Impulse Response Analysis in the US

The response of the US IPI to the impact of the US PMI has been on the rise in the positive direction from the beginning. The PPI has also been moving upward in the direction of the positive from the beginning and has maintained a gentle condition. In the case of the unemployment rate, the rate of decline in the direction of the negative from the beginning shows that it is continuously falling. In addition, the manufacturing inventory Index has been falling in the direction of the negative from the beginning.

4.5.3. Comparative Analysis of Impact Response between Korea and the US

The impact of the US PMI on the economic indicators of Korea and the US is summarized as follows. In the case of IPI and PPI, both Korea and the US are continuously rising in the same direction. On the other hand, the unemployment rate response to the impact of the PMI in both Korea and the US initially proceeded in the negative direction, but soon Korea was shifted in the positive direction. However, since the US is steadily falling in the negative direction, the US is more influenced by the impact of PMI than Korea. In the case of the manufacturing inventory Index, both Korea and the US are going down in the direction of negative from the beginning, and both Korea and the US are receiving the same influence on the impact of PMI continuously.

5. Conclusions

This study is to investigate the effects of the US PMI on Korea and the US with the IPI, the PPI, the unemployment rate, and the manufacturing Inventories Index from January 1990 to July 2016. This paper is an empirical analysis using VECM. As a result of Granger causality analysis, this paper found that the PMI had a great influence on economic indicators both Korea and the US. In the case of US economic indicators, both had a significant Granger causality relationship with the PMI in both directions. In addition, in the case of Korea, the US PMI was found to be significant in the Granger causality relationship with the other economic indicators excluding the unemployment rate. The differentiation from the previous studies implies the following. First, this study differs from the previous studies in that the PMI is a leading indicator and its effect on GDP and GNP is mainly explained. The data are used to analyze the impacts on the actual industrial economies in Korea and the US by using the PMI and the IPI, the PPI, the unemployment rate, and the manufacturing inventory Index. Specifically, as can be seen from the results of the impact response, both the IPI and the PPI were positively correlated with both Korea and the US. Both countries were in the same trend. IPI and PPI were found to be positively related to the US PMI. On the other hand, both the unemployment rate and the manufacturing inventory Index tend to fall in the early stages. However, in the unemployment rate, unlike the case of Korea, the US continues to decline in the negative direction, and the influence of the PMI is higher than that of Korea. On the other hand, in the case of the manufacturing inventory Index, both Korea and the US declined in the direction of the negative, indicating that both Korea and the US are affected by the impact of the PMI. The effect of the PMI on Korea and the US economic variables through the impact response has a characteristic that we have learned through this study. Second, it is the first paper to compare and analyze the economic indicators of Korea and the US based on the US PMI, which has a strong influence as a leading indicator of economic indicators. Through this study, we could confirm the ripple effects of the US PMI for the US, as well as in Korea which does not actually use the PMI. Third, it is a differentiating point from other papers that VECM model is used to analyze the response of the economic indicators to PMI shocks, and confirms that the influence is not only in the US but also in Korea. In other words, the analysis of the economic variables for the PMI by the impulse response through the VECM model shows that the overall effect is similar to that for Korea and the US in the same direction. In addition, the forecasts of economic indicators through this study can be confirmed by considering other economic indicators. For example, if the empirical analysis is applied to the exchange rate or the stock price, various forecast results can be obtained, and the ripple effect of the PMI on the economy can be confirmed. In the next period, it is necessary to select specific industries such as the distribution industry and examine the relation to the PMI in detail. For example, it is necessary to study the effect of the PMI on industries such as the distribution industry through stock prices, exports and imports of the relevant industries.

Finally, this is a very rare study in which the US PMI affects economic indicators such as IPI, PPI, unemployment rate, and manufacturing Inventories Index. In this study, we can observe the importance of the PMI carefully and predict the future, which can contribute to the economic development of firms and countries.

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