

The relation between occupational accidents and economic growth: Evidence from Korea

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Abstract

This study analyzes the impact of occupational accidents on economic growth and labor productivity losses in Korea between January 2008 and July 2018, using the Vector Error-Correction Model (VECM). According to the analysis, the occurrence of occupational accidents was revealed to reduce the number of employed workers and also hinder economic growth. This can be reinterpreted as the reduction of occupational accidents does not cause labor losses in the industry, rather may induce economic growth. Also, the findings discovered that an increase in the number of workers may lead to increase in the probability of occupational accidents in the short term. This suggests that greater number of work-related accidents may occur during the early stages- due to new employees' lack of knowledge related to safety at workplace.

Keywords: Occupational Accidents, Economic Growth, Vector Error-Correction Model(VECM)

1. INTRODUCTION

With various political and systemic efforts to prevent occupational accidents, the overall occurring rate of occupational accidents in Korea has decreased from 0.74% in 1999, to 0.57% in 2020 [1]. However, while the occupational accident rate has decreased overtime, with the population growth and the rapid industrial development in Korea, the number of people injured almost doubled during the period — from 55,405 in 1999 to 108,379 in 2020 [1].

The burden of occupational accidents has been vastly discussed in previous studies in the field [2]. Occupational accidents are detrimental phenomena as they could lead to material and moral damage, and also negatively influence the economy [3]. The social and economic costs include not only the direct costs such as financial assistance to the accident victims, medical expenses, cost for legal services, but also, the indirect costs such as reduced morale among employees, loss of working time, and the company's prestige [4]. Indirect costs are only presumptively measured, as it ranges from 2 to 20 times the direct costs [5].

The most common economic method to estimate economic losses caused by occupational accidents is to adopt the cost-of-illness method which brings together both direct and indirect costs of health outcome [6]. A

review of the cost-of-illness analysis typically includes the value of medical care resources used to treat disease and the losses in productivity in our society resulted from the illness.

In some ways, the cost-of-illness approach has substantial practical values, yet it does not mean that it calculates a complete sum of economic cost related to the events. The estimations only show the financial losses caused by the occupational accidents. However, occupational accidents may have a ripple effect in other areas [7]. For example, a company deficit resulting from major occupational accidents may affect the local economy and labor market. In other words, occupational accidents may lead to changes in economic conditions such as having an influence on the nation's Gross Domestic Product (GDP), unemployment rate, and could also hinder sustainable development [8].

In other words, previous studies using the cost-of-illness approach, have vastly focused only on the estimation of the short-term direct costs, compensation costs, production and sales losses, and material losses that the companies need to bear in the event of occupational accidents —thus, failed to provide substantive evidence on the impact it has on our society or the nation. In the case of Korea, as described above, with the increase in the total number of workers over the past 20 years due to industrial development, the absolute number of industrial accidents has increased. Hence, considering such dynamics of the Korean society, examining how occupational accidents have affected economic growth and the labor force, and conversely, how economic growth has affected the occurrence of occupational accidents, can contribute to setting the directions for employment, labor, and prevention policies in Korea. Therefore, the purpose of the present study is to develop a time series model consisting of industrial accidents, economic growth, and the number of workers in order to analyze the social and economic impact of industrial accidents, which has been an overlooked research area. The VECM (Vector Error-Correction Model) was applied to estimate the shock response function, which allows the investigation of the dynamics of the corresponding variables in response to a shock in each variable. Through this estimation, the study attempts to examine the reciprocal relationship between industrial accidents, economic growth, and the labor productivity.

2. METHOD

2.1 Data

Data from the Korea Occupational Safety and Health Agency was used in this study to obtain the number of workers and occupational accident victims, and the Composite Economic Index was measured based on the data collected by the Korea National Statistical Office. Data gathered between January 2008 and July 2018 were used in the analysis, and the target area for analysis was set nationwide.

For the current study, the quarterly announced economic growth rate parameters were not available as the time series unit of analysis was set to monthly. This study used the Composite Economic Index as a proxy for the economic growth rate. Previous studies in the field have also used Composite Economic Indexes and Industrial Product Index, which are produced on a monthly basis instead of quarterly economic growth rate, as surrogate variables and predictors [9-12].

In fact, from the first quarter of 1990 to the second quarter of 2018, the correlation between the economic growth rate and the change rate in the Composite Economic Index was 0.94, the rate of direction matching was 98.2%, and the paired test of the two indicators failed to reject the null hypothesis that the two indicators were identical. Therefore, it was considered that the use of the Composite Economic Index as a proxy variable for economic growth rate was appropriate.

2.2 Analytic Model

For the purpose of the present study, the three-variable model consisting of occupational accident (A_t), labor force (L_t), and output (Y_t) were considered. In the past, structural changes have been made continuously from labor-intensive industries to capital-intensive industries, and the numbers of long-term occupational accidents have been reduced as the management of causes have continued to strengthen. However, occupational accidents still continue to take place in many parts of our society, and social losses from these events continue to occur. Thus, this study aimed to analyze the long-term equilibrium relationship among the three variables identified above: occupational accidents; labor force; economic growth; and the impact of each variable on one another.

$$e_t = \ln A_t + \beta_1 \ln L_t + \beta_2 Y_t$$

In this case, e_t stands for the error term; A_t for the number of occupational accidents; L_t for the number of employed; and Y_t for the Composite Economic Index shown by the proxy variable of the output. Here, e_t refers to the error that can deviate from the long-term equilibrium between the victims of occupational accidents, the employed workers, and economic growth. This study intends to apply the vector error-correction model (VECM) to analyze both the short-run dynamic interaction of the variables, and also the dynamics of adjustment back to the long-term equilibrium condition among the variables. Hence, the following equation describes the long-term balance between cointegration and past short-term variation of the vector X that constitutes the model.

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \alpha \beta' X_{t-p} + u_t, u_t \sim N(0, \Sigma_u)$$

$\beta' X_{t-p}$ represents the co-integration relation of endogenous variables, and α represents the adjustment speed at which the endogenous variables approach a long-term equilibrium. Whether a co-integration relationship exists can be confirmed by testing whether the rank of the $\alpha \beta'$ matrix is more than one. This study conducted an impulse response function (IRF) analysis to determine how this shock affects other variables in the event of a shock occurring in each variable. Likewise, the shock response represents the reaction of each variable after k -point for the shock u_t of the t -stage, and can be expressed as follows:

$$\Phi_k \equiv (\phi_{ijk}) = \sum_{s=1}^k \Phi_{k-s} A_s, k = 1, 2, 3, \dots$$

Here, $\Phi_0 = I_n$ and $s > p$ indicates $A_j = 0$. In this case, ϕ_{ijk} is the element of the i th and j column of Π_k , indicating the response at k -point of the i th variable to the impact at t -stage of the j th variable. Since the size of the impact is set to 1 standard deviation of the corresponding variable in the model, there is a limit to intuitively interpreting the analysis results. Alternatively, the variances of each variable can be extracted from the variance-covariance matrix, and the variances can be converted into standard deviations to standardize the impact response function regularly. This study attempted to standardize the magnitude of the impact at 1% as follows, in order to ensure that the results are comparable to each other when the same impact occurs.

$$\hat{\Phi}_k = \frac{\Phi_k}{SD_j}$$

An analysis of the long-term balance between occupational accidents, workers, and economic growth using the Johansen cointegration test was conducted to determine whether there is at least one cointegration vector in the trace and eigenvalue criteria; and whether there is a long-term balance between each variable. Also, we know that both trace and eigenvalue tests show there are at most three cointegrating vectors. In this case, although each time series variable is a non-stationary series in the short-run, as it also conveys information on a possible long-run equilibrium relationship among the variables of interest, the results can be converted into an evaluation of the long-term balance by compensating the noted short-term instability using the error correction terms.

3. RESULTS

According to the IRF results, the occurrence of an occupational accident was analyzed to increase the probability of accident in a relatively high level in the first month, yet appeared to have no significant impact on economic losses in the short term for one to two months. However, the occurrence of an occupational accident was analyzed to have negative impacts on economic growth after three months' timeframe. This suggests that occupational accidents that occur at present do not only affect the current economic growth, but can also have long-term impacts overtime. The results of the current study suggest that the various efforts made by corporations to reduce the occurrence of occupational accidents, including the preparation and provision of protection devices; the elimination of excessive working practices; and occupational safety education, can lead to economic growth in a general sense.

Table 1. Cointegration Test

<i>Number of Cointegrating Relations by Model</i>					
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	2	3	1	2	3
Max-Eig	2	3	1	1	1
<i>Akaike Information Criteria by Rank (rows) and Model (columns)</i>					
0	-15.88612	-15.88612	-15.95529	-15.95529	-15.90921
1	-16.01594	-16.02531	-16.11060	-16.11531	-16.08518
2	-16.03785	-16.04395	-16.12715	-16.13311*	-16.11718
3	-15.94110	-16.03168	-16.03168	-16.11468	-16.11468

The occurrence of occupational accidents was found to decrease the number of employed workers. This result indicates that an occurrence occupational accident may not only lead to a loss of skilled workers, but also a decrease in job seekers' preference to work at such site where an accident had occurred, and thus posing difficulties in retaining manpower required. In addition, it was found that the occurrence of such accidents generally contracts the labor market in Korea, and thus ultimately lead to a decrease in economic growth.

According to the analysis, economic growth did not lead to an increase in occupational accidents. This

result was evident as economic growth led to employment of more workers by increasing flexibility in employment conditions. This can be understood as reducing the labor intensity of workers in the workplace by hiring additional workers with the profit made from the increase in sales. Such reduction in labor intensity is perceived help prevent occupational accidents. However it is worth noting that the increase in the number of workers may lead to an increase in occupational accidents for the timeframe of three months. This suggests that related accidents can occur significantly in the early stages depending on the new workers' level of knowledge regarding safety once employed. In order to prevent accidents caused by excessive workload, thorough management and training are necessary, which needs to be supported by expansion in the government's employment policies. Further, to ensure workers are aware of the ways to prevent occupational accidents, provision of effective occupational safety and health related education must take place as a conventional phase prior to being placed within their worksites.

As a result of the analysis of this study, the magnitude of the shock between each parameter varied greatly with the 1 standard deviation of occupational accident 0.0944, growth 0.0025, and employment 0.0080, and it was considered to be difficult to compare the results. By standardizing the magnitude of the shock, the magnitude of the shock between each variable was shown to be equal, enabling a comparison between the variables, and the results of the analysis were also shown to be intuitive.

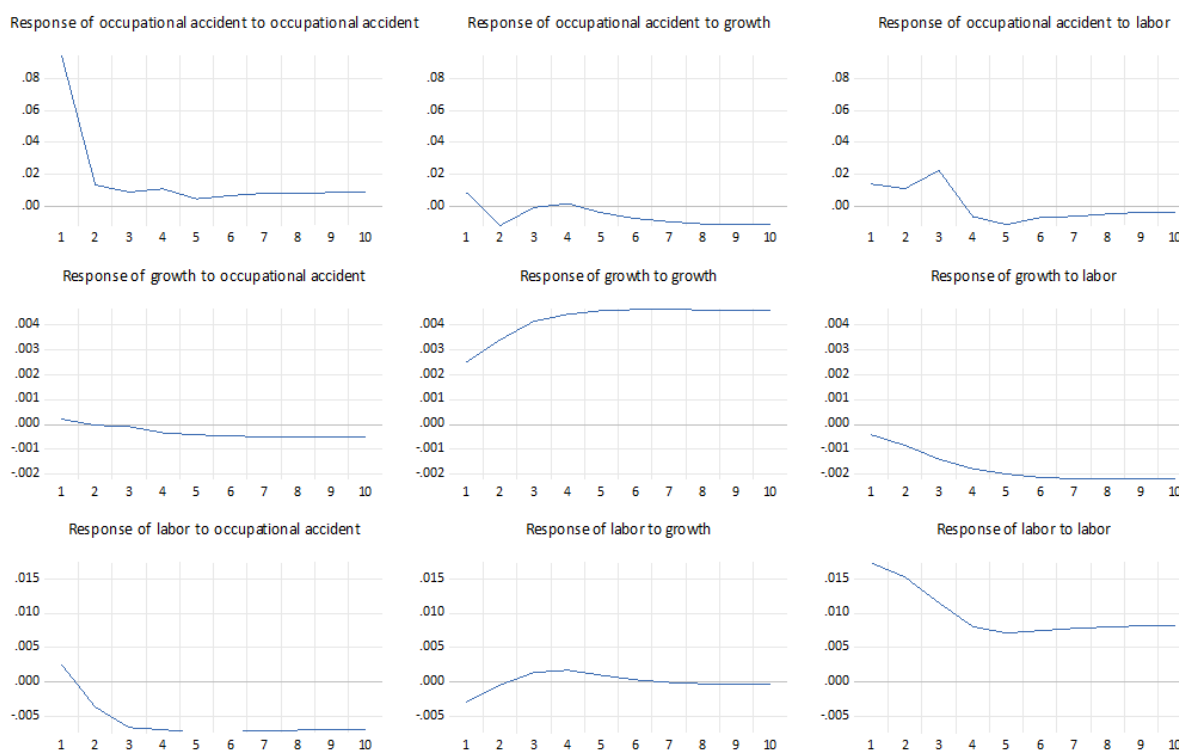


Figure 1. Response to Generalized One S.D. Innovations

According to the analysis, if occupational accidents increase by 0.01%, occupational accidents may increase to about 0.01% in the first month after the event, and 0.0201% after 12 months which is about twice as much, and 0.0312% after 24 months which is about three times the initial timeframe. This result suggests that the occurrence of an occupational accident at present may not only affect the numbers of such event occurring on the present day, but may also affect the result when measured over a long period of time. In the case of

occupational accidents, similar accidents are likely to occur continuously at the same site unless appropriate actions are taken to prevent these issues from reoccurring. If the policy around the occupational accidents prevention works effectively, the value of this cumulative shock response is expected to decrease significantly as compared to the current level.

The 0.01% increase in occupational accidents was found to be related to a drop of about 0.0004% in economic growth over the timeframe of one year. If the size of the shock of occupational accidents is converted to 1 percent, the amount will affect economic growth by 0.04 percent for the first year, and will result in 0.1 percent over two years. This suggests that the social impact of occupational accidents is not short-term but long-term, and that the occurrence of occupational accidents at this point may adversely affect the nation's employment situation and economic growth in the long run, which leads to an argument, that there is a serious need for continued efforts to prevent occupational accidents in the workplace.

4. DISCUSSION

Data collected between January 2008 and July 2018 were used in the current study to analyze the relationship between occupational accidents, economic growth, and the labor force. According to the results of the analysis, while the occurrence of occupational accidents does not negatively affect economic growth in the short term, it gradually reduces economic growth over time. Hence, although the investment in reduction of occupational accidents may be perceived to cause financial loss for the companies in the short run, our findings suggest that over time, it helps businesses retain their jobs, improve productivity, and ultimately have a positive impact on economic growth.

Also, the results revealed that an increase in the number of workers could increase the probability of occupational accidents in the short term. This suggests that greater number of occupational accidents can occur in the early stages as a result of the new workers' lack of knowledge around safety guidelines. This also indicates that occupational accidents can cause consecutive accidents. For example, it may be necessary for the companies to find replacements after the loss of workforce due to an occupational accident. If newly hired workers without enough safety training are thrown into the field, they are exposed to higher risk of being involved in an accident. Previous research also concluded that new workers in their first months are more than three times likely to be at risk of a lost-time injury [13]. In fact, more than half of occupational injuries in Korea have occurred among new employees who worked less than six months [14]. This suggests that sufficient occupational accident prevention education should take place prior to being put into practice at industrial worksites, and newly employed workers should be required to complete sufficient training before they can work on sites [15] as safety performance intended to prevent occupational accidents depends significantly on the workers' knowledge and training related to workplace safety.

This quantitative study analyzed the level of economic loss caused by occupational accidents, which have been considered an overlooked area in the field as there have been lack of studies conducted. The results of this study confirmed that occupational accidents can have direct negative effects on the nation's economic growth. These results of the present study therefore support the emphasis placed by the United Nations on preventing occupational accidents to achieve sustainable growth [16]. It suggested that more support and investment are needed to prevent occupational accidents, ultimately, leading sustainable value creation [17].

Based on the monthly time series model, this study used the Composite Economic Index as a proxy variable of the economic growth rate provided on a quarterly basis. This study concluded that the change rate in the Composite Economic Index highly correlated with the economic growth rate, and the level of concordance in direction to be also very high- hence was considered appropriate to be used as a proxy variable. However, since GDP was not analyzed directly, there may be limitations in the analysis, hence once enough data on

occupational accidents is accumulated in the future to allow time series analysis, further research concerning quarterly based analysis is necessary.

Furthermore, for future research, it is necessary to consider the characteristics of the Korean labor market in relation to occupational accidents. Korea is known as a country where the dual structure of the labor market is very firmly established [18]. In other words, movement or entry between the primary market with —good working conditions and high job security— and the secondary market —with poor working conditions and low job security— is rather restricted. For this reason, in Korea, the ‘outsourcing of occupational accident danger’ or ‘risk outsourcing’, a situation in which tasks that are considered dangerous or with higher risk of occupational accidents are transferred to subcontractors, has become a social issue [19]. In a situation in which outsourcing of risk is deeply rooted, large corporations can transfer work that is highly likely to cause accidents to subcontractors to save investment costs for occupational accident prevention, and thus industrial accidents in the secondary labor market continue to occur. In other words, in the case of subcontractors, occupational accidents may lead to losses and diminish the derive for growth. According to the findings of the study, while large corporations can save investment costs in the short term, the overall economic growth of Korea may be hindered, and thus large corporations may also be negatively affected in the end. If future research in the field can reflect these characteristics of Korean labor market, the negative impact of the dual labor market structure and the ‘risk outsourcing’ may be confirmed more concretely.

The current study is at its early stage of occupational accident research using a quantitative approach, and fails to review various topics related to industry. Thus, there is a need for further follow-up research concerning the social costs of severe accidents, the possibility for a chain operation of inter-industry accidents, and inter-industrial and regional spillover

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