

ORIGINAL ARTICLE

Investigation into the relationship between fatal work accidents, national income, and employment rate in developed and developing countries

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Abstract

Objectives: Industrial advances, as a result of globalization, causes many threats to the working life. These threats are generally associated with the level of economic development of countries. While threats from industrialization are decreasing in developed countries, developing countries are still faced with these threats. Therefore, this study aims to examine the relationship between fatal work accidents (FWA), and independent variables which are national income (NI) and employment rate (ER) in a number of selected countries.

Methods: In this study the relationship between FWA and independent variables which are NI and ER of 18 developed and developing countries and a region, between 2006 and 2015, was analyzed by applying panel data analysis.

Results: According to panel data analysis, whilst a 1% increase in the NI reduces the FWA rate by 1.1%, a 1% increase in the ER results in an increase of approximately 4% in the rate of FWA.

Conclusions: As a result, there was a negative relationship between the FWA and NI growth and a positive relationship with the ER

KEYWORDS

employment rate, fatal work accident, national income, panel data

1 | INTRODUCTION

Throughout the world work accidents are one of the most important problems of working life. Work accidents affect not only the employee but also the society. State and employers are also affected economically by work accidents. According to the International Labour Organization (ILO) data, every 15 seconds, a worker dies from a work-related accident or disease. Every 15 seconds, 153 workers have a work-related accident.

Everyday, 6300 people die as a result of occupational accidents or work-related diseases—more than 2.3 million deaths per year. About 317 million accidents occur at work annually with many of these resulting in extended absences from work. The human cost of this daily adversity is vast and the economic burden of poor occupational safety and health practices is estimated at 4% of global gross domestic product each year.¹

According to researches, five main factors that related to work accidents can be listed.^{2–20} These factors include;

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1. Employees factor; Many factors related to employee's, such as age, gender, work experience, psychological status, social status, level of education, working order etc can trigger work accidents.
2. State policy factor; The state should determine laws and provisions to prevent work accidents. These laws and provisions should be statutory responsibilities of the employer and the worker. A safe working environment is only possible with well-planned and implemented government policy.
3. Workplace factor; Factors such as the size of the place of work, the type of business, the working conditions, and the ergonomic nature of the place of work may cause work accidents.
4. Economic factor; Unemployment rate, national income per capita, budgets allocated by governments for health, and safety are directly related to work accidents.
5. Employer factor; The employer should not only be focused on the profits of the company but also be responsible for creating an appropriate workplace environment and protecting the employee.

A number of researchers have associated work accidents with employee factors. Work accidents and injuries have been analyzed by gender difference, with some studies showing that occupational injuries and fatal accidents are seen more frequently in men than in women.²⁻⁴ Work accidents are related to age and young workers have a higher injury rate than older workers.⁵⁻⁷ According to some researchers, there is a relationship between work accidents and experience. It is stated that, as experience increases there is a related decrease in business accidents.⁸⁻¹⁰

Researchers have found that occupational and environmental conditions, such as type of business, working hours, shift work, risk management, and establishment size have triggered occupational accidents.¹¹⁻¹⁵

Laws, regulations, and standards are the basis of occupational health. The state should develop robust policies to prevent occupational accidents. There are many studies examining the work safety policies of a number of countries. These studies emphasized that a government's policy related to job security is important in preventing occupational accidents.¹⁶⁻¹⁸

Employers have an important role for creating a safety culture and in the prevention of accidents at work in the workplace.¹⁹

There are some studies that examine the relationship between economic factors and work accidents, but these studies have generally only discussed this in relation to a single country. In these studies, it was observed that there was a decrease in job accidents in developed countries.^{20,21}

Economic factors, such as economic growth, national income, health and safety expenditures, social and cultural

development, and unemployment are important factors in causing occupational accidents. According to our research, there are not enough studies that have investigated the impact of economic factors over a prolonged period of time. So, this study attempts to address this deficiency by examining the relationship between FWA, NI, and ER over the period from 2006 to 2015 in a number of selected countries. The first step for this purpose involved collecting and compiling data. In the next step, panel data analysis was applied, using the statistical software package Stata version 13.0, to investigate the relationship between FWA and the independent variables including NI and ER

2 | DATA AND METHOD

2.1 | Data

This paper offers a perspective on the relationship between FWA, NI and ER in 18 countries and a region, (Argentina, Australia, Austria, Azerbaijan, Bulgaria, Cyprus, Estonia, Israel, Lithuania, Mexico, Poland, Romania, Russian Federation, Spain, Turkey, Ukraine, the United Kingdom, the United States, and Hong Kong [China]), during the period from 2006 to 2015. The ILOSTAT database has been examined and the countries are evaluated. Eighteen countries and a region with the least missing data in the developed and developing countries were selected. The missing data in the units were estimated and the panel was balanced. Only we estimated the missing data in the FWA data for 1 or 2 years. The missing data are estimated by the command *ipolate* by using STATA 13. All the variables are used as natural logarithmical values in the model. FWA data are taken from the ILOSTAT database period of 2006-2015.²² The ILO data mechanically compiles the reported injuries and diseases from the member states. There can be significant unreported injuries and diseases due to the weak reporting systems, or uncovered industries (for example, agriculture, or informal economy workplaces in several countries). Despite this, the informal data were evaluated by ignoring this limitation. ER and NI (GNI per capita based on purchasing power parity [PPP]) data were obtained from the World Development Indicators²³ database of the World Bank. NI data are in current international dollars based on the 2011 International Comparison Program round.

2.2 | Method

Panel data sets are also known as cross-sectional time series data. They have spatial (N) and temporal (T) dimensions. They constitute of a number of observations over time on a number of cross-sectional units, such as individuals, firms, and countries, allowing researchers to analyze the dynamics of change using short time series data.²⁴

The possibility of modeling more realistic behavioral hypotheses and challenging methodological issues, together with the increasing availability of panel data, have led to the phenomenal proliferation of studies on panel data.²⁵

Under the null hypothesis of time-invariant unobserved heterogeneity, our model for the data is the standard linear panel data model (Equation 1), that is,

$$y_{it} = \alpha_i + X'_{it}\beta + \varepsilon_{it} \quad i = 1, \dots, N; t = 1, \dots, T \quad (1)$$

with i denoting countries and t denoting time. The subscript, therefore, denotes the cross-section dimension, whereas t denotes the time-series dimension. α_i is the error term that is a time-invariant unobservable individual effect (heterogeneity), such as legal regulations, culture, and many other factors. β is the $K \times 1$ and X_{it} is the i th observation on K explanatory variables. ε_{it} is the error term which assumes different values for each individual at each point in time the types of assumptions that are made about α_i distinguish one model from the other. In other words, the distinction between the two models lies in whether the individual-specific time-invariant effects, α_i , are correlated with the regressors or not. In an fixed effects (FE) model, α_i is assumed to be correlated with X_{it} , but an random effects (RE) model is uncorrelated.²⁶

3 | RESULTS

In this section, panel data analysis is applied to investigate the relationship between FWA and the independent variables including NI and ER, with support of the statistical software package Stata version 13.0.

Table 1 presents the descriptive statistics of the log-transformed variables of interest. The second and third columns are the mean and standard deviation for each of the variables and the other columns show the correlation matrix. The unconditional pairwise correlations between the variables are rather small. The correlation between FWA and NI is negative. Before estimating the model, it is necessary to test the assumptions of the cross-section dependency, heteroskedasticity, and autocorrelation in order to find the appropriate estimation method.

It is typically assumed that disturbances in panel data models are cross-sectionally independent. Baltagi²⁶ points out that cross-section dependence caused the standard FE and RE estimators to be consistent, although not efficient, and the

TABLE 1 Descriptive statistics of the log transformed variables

Variable	Obs	Mean	Std. Dev.	FWA	NI	ER
FWA	190	5.47	1.57	1.00		
NI	190	10.07	0.50	-0.12	1.00	
ER	190	4.00	0.10	0.08	0.32	1.00

estimated standard errors are biased. Therefore, several different tests are used to test cross-sectional dependence in panel data analysis. In this study, we used the Pesaran²⁷ cross-sectional dependence (CD) test, based on the average of pairwise correlation coefficients, Friedman's statistic²⁸ nonparametric test, and Spearman's rank correlation coefficient test based on the sum of the squared rank correlation coefficients and proposed by Frees.²⁹ These tests are designed to be the formal statistical procedures to test for cross-sectional dependence in small T, large N. Results are shown in Table 2.

It is seen that the null of no cross-sectional dependence across variables is not rejected in three tests. Since first generation panel unit root tests have the restriction that all cross sections are independent, test results of cross-sectional dependence are very important for the panel unit root tests to be applied in the next part of the study. Due to the absence of the cross-sectional dependence in this study, we used Harris and Tzavalis³⁰ test in order to investigate whether the series are stationary or nonstationary (The number of countries (N) > The number of years [T]).

Table 3 shows that FWA, NI, and ER contain unit root. Therefore, the difference of series is taken. According to the results of Harris and Tzavalis test,³⁰ the first difference of these variables is they are stationary.

After investigating the series, if they were stationary with the Harris and Tzavalis³⁰ test, the panel cointegration test was applied. The results obtained with the panel cointegration test determined which prediction method should be used in panel causality analysis. We used the panel cointegration test of Westerlund,³¹ which has good small sample properties and high power relative to popular, residual based, panel cointegration tests, making inference possible under very general forms of cross-sectional dependence and allows variables

TABLE 2 Cross sectional dependence test results

Test	Statistic Value	P-value
Pesaran	0.79	0.43
Friedman	7.71	0.98
Frees	2.05	Critical values of Q distribution 0.26 for 0.10 0.34 for 0.05 0.52 for 0.01

TABLE 3 Harris and Tzavalis panel unit root test results

Variables	Level		First difference	
	Zt-bar)	P-value	Zt-bar)	P-value
FWA	-1.27	0.10	-16.24	0.00
NI	1.32	0.91	-9.86	0.00
ER	0.44	0.67	-6.25	0.00

that are nonstationary. The test is designed to test the null hypothesis of no cointegration by testing whether the error correction term in a conditional error correction model is equal to zero. If the null hypothesis of no error correction is rejected, then the null hypothesis of no cointegration is also rejected. Since $DH_G = -5.245$ ($P = 1.000$) and $DH_P = -7.458$ ($P = 0.853$) are obtained with the Westerlund³¹ test, where DH_G is the group mean statistics and DH_P is the panel statistics, there is no cointegration at the 5% level of significance.

There are four causality tests, Panel VECM, Canning and Pedroni,³² Emirmahmutoğlu and Köse,³³ and Hurlin and Dumitrescu,³⁴ used in panel data analysis. For the purpose of this study, the method proposed by Hurlin and Dumitrescu³⁴ was used to test the presence of the causality relation between the variables. The testing procedure has a number of advantages as well as it tackles cross-sectional dependence. Firstly, the test has very good properties, even in samples with very small values of T and N. Secondly, the test can be used on statistics based on the cross-sectional average of individual Wald statistics, without estimating any particular panel regression. Thirdly, the method can be employed in unbalanced panels and/or panels with a different lag order of K for each individual.

Table 4 shows that the null hypothesis is not rejected for FWA, at the 5% level of significance, meaning that there is no causality with the NI. However, we found that for NI there is a statistically significant relationship with FWA. Similarly, for ER there is a statistically significant relationship with FWA and the direction also goes the other way.

According to the results of Hurlin-Dumitrescu³⁴ panel causality test in Table 4, taking into account the direction of the determined relationship, the model is shown in Equation 2.

$$FWA_{it} = \beta_0 + \beta_1 NI_{it} + \beta_2 ER + \varepsilon_{it} \quad (2)$$

In this panel, there were not cointegration and cross-sectional dependence but heteroskedasticity ($\chi^2 = 1003.25$ $P = 0.000$) and autocorrelation (Durbin-Watson: 1.270, Baltagi-Wu LBI: 1.563) were found so we used Arellano, Froot, and Rogers estimator which allows heteroskedasticity and autocorrelation in order to fit a model. Once we decided that we have a panel data model and not a pooled ordinary least squares (POLS), based on a poolability test, we had to choose between the FE and RE model. For that, we applied the Hausman test ($\chi^2 = 2.24$, $P = 0.326$) which suggested that a RE model would be more appropriate to describe our data. Results of Arellano,³⁵ Froot,³⁶ and Rogers³⁷ estimation are given in Table 5 and fitted model is shown in Equation 3.

$$FWA_{it} = -1.19NI_{it} + 4.19ER_{it} \quad (3)$$

TABLE 4 Dumitrescu-Hurlin panel causality test results

	W statistics	Z-bar statistics	P-value
FWA→NI	0.94	-0.18	0.86
NI→FWA	5.84	6.91	0.00
FWA→ER	3.68	3.55	0.00
ER→FWA	3.27	2.92	0.00

TABLE 5 Results of Arellano, Froot, and Rogers estimation

	Coef.	S.E	P-value
NI	-1.19	0.17	0.00
ER	4.19	0.68	0.00
Cons	0.62	2.68	0.82

In Table 5, it is shown that constant coefficient is not statistically significant but coefficients of NI and ER are statistically significant. According to this, while a 1% increase in the NI reduces the working accident by 1.19%, a 1% increase in the ER increase of 4.19% in the working accident.

As a result, it has been observed that NI levels of countries are related to FWA. The increase in the FWA due to the increase in the ER will be inevitable.

4 | DISCUSSION

The studies are very limited which associate fatal occupational accidents with economic indicators such as gross domestic product and national income.^{20,21} In this manuscript, panel data analysis showed the relationship between fatal working accident and the independent variables including NI and ER. While a 1% increase in the NI reduces the FWA by 1.19%. Similarly, Li et al (2011) showed that economic fluctuation would influence occupational safety on national level in their study.

The consequences of occupational accidents not only affect the family but also affect the employers, the society in which they live, and the economy of the country. It also has a global influence in the world.

FWA are induced because of the fact that there is insecure in working method and working conditions, employees are not trained enough for work safety, employers do not give importance to work safety, or lack of personal protective equipment.^{38,39} The importance of economic and technological developments are obvious in removing these situations that cause FWA. Due to the restrictions from economic and technological development, there exist many work safety problems that still need to be resolved. Fortunately, developing and developed countries have clearly put forward some potentially effective suggestions for work safety to guide the work safety actions.

Development of occupational safety culture in countries will play a significant role in making for these countries sustainable development and help locate an effective safety solution to solve work safety problems. Countries should extend the application of work safety achievements, implement scientific, and social demonstration projects related to work safety. Furthermore, in order to lessen FWA, the cause of work accidents should be identified via analyses and assessments, necessary measures should be taken and audits should be used to see if the measures are implemented effectively or not by government.

ACKNOWLEDGMENTS

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

DISCLOSURE

Approval of the research protocol: N/A. Informed consent: N/A. Registry and the registration no. of the study/trial: N/A. Animal studies: N/A.

CONFLICT OF INTEREST

There are no conflicts of interest between authors.

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How to cite this article: Kahraman E, Akay Ö, Kılıç AM. Investigation into the relationship between fatal work accidents, national income, and employment rate in developed and developing countries. *J Occup Health*. 2019;61:213–218. <https://doi.org/10.1002/1348-9585.12021>