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THE RELATIONSHIP BETWEEN ECONOMIC DEVELOPMENT AND FATAL OCCUPATIONAL ACCIDENTS: EVIDENCE FROM TURKEY

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Abstract

Occupational accidents are among the most important issues of the agenda of working life in Turkey recently. Recently the causes and consequences of occupational accidents which are related to human, occupational and environmental factors have received great attention from the researchers but it has been paid little attention to focused on economic factors. The purpose of this paper is to make a contribution to redressing this gap by examining the relationship between fatal occupational accidents and economic development over the period of 1980 to 2012 for Turkey. In this context, bounds testing approach which is also known as autoregressive distributed lag model is performed. The results indicate the existence of positive relationship between gross domestic product per capita and fatal occupational accidents in the short-run while in the long run this turns out to be in a negative way via economic growth and changes in structure of the economy.

Keywords: fatal occupational accidents, economic development, bounds testing approach, Turkey

JEL classification: C22, J28, O10

1. INTRODUCTION

Occupational accidents are among the most important issues of the agenda of working life in Turkey recently. Occupational accidents have an enormous impact on the health of workers and on the economy in general, which is reflected in the death, disability and personal suffering of workers on one hand, and in absence from work, loss of productivity and health costs on the other. Although Turkey has steady growth and economic performance in recent years (the world's 16th and Europe's 6th largest economy), she has very poor track record on occupational accidents. Turkey, covering the period 1995 to 2004 in the EU - 15 countries, has more than seven times the average frequency of fatal occupational accidents and comes third in the world after Russia and India (Ceylan, 2011).

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Recently, in Turkey the causes and consequences of occupational accidents which are related to human factors (e.g. age, race, sex, low motivation, seniority and risk-taking behaviour), and occupational and environmental factors such as hours of work, firm size, shift work, establishment size, risk management and job design have received great attention from the researchers but it has been paid little attention to economic factors (Barlas, 2012; Ceylan, 2012; Colak *et al.*, 2004; Demirbilek and Pazarlıoglu, 2007; Etiler *et al.*, 2004; Kucuker, 2006; Turen and Gokmen, 2014).

Whereas macroeconomic factors such as technological infrastructure, social and cultural development, unemployment and economic growth and the effective labour code are also important determinants of affecting occupational accidents but to our knowledge there are not enough studies which have investigated the impact of macro level factors over a long period of time. Therefore, this paper attempts to make a contribution to redressing this gap by examining the relationship between fatal occupational accidents and economic development over the period of 1980 to 2012. For this purpose, bounds testing approach which is also known as autoregressive distributed lag model (ARDL) is performed. In this context, layout of the paper is as follows: in the next section, theoretical background of the research and relevant studies will be introduced. The third section is devoted to data sources and methodological issues and accordingly we discuss the bounds testing approach which is based on ARDL model to cointegration approach and its applicability to our research. Section four displays the results and main findings of our research, section five is for discussions and the final section we briefly discuss the results of the research and provide some policy recommendations.

2. BACKGROUND

Factors affecting the frequency of occupational accidents that occur in the workplace can be examined in three groups. These are: economic factors such as unemployment, the general economic climate, economic growth, technological infrastructure, social and cultural development levels, and occupational health and safety, environmental and organizational factors such as job design, work environment, work organization and workplace characteristics, personal factors such as monthly earnings, age, gender, motivation, and work experience (Fabiano *et al.*, 2004). According to the studies done on work-related accidents, all the factors mentioned above have impact on occupational accidents but among them the economic factors may be considered the most important especially over the long time periods (Asfaw *et al.*, 2011; Davies *et al.*, 2009; Lander *et al.*, 2016; Nielsen *et al.*, 2015).

Some studies on relationship between the business cycle and occupational accidents support that the nature of occupational accidents is related to the business cycles; the number of accident tends to increase during economic upswings and decrease during economic downturns (Robinson, 1988; Nichols, 1991). In the USA, injury rates in the manufacturing and construction industries were strongly related to the business cycles; rising with business upturns and declining during the recessions between 1957 to 1982 (Robinson, 1988). Likewise, Nielsen *et al.* (2015, p. 271) examined the relationship between both macroeconomic and industry-specific business cycle indicators, and occupational accidents among construction workers in Denmark during the period 1984-2010 and found pro-cyclical associations between them. Boone and Van Ours (2006) examined the role of the economic cycle from another perspective. According to their view, the share of new or inexperienced workers in the total labour force increases during economic growth and this change may increase the incidence of occupational accidents. In addition, reporting an accident would be expected to increase during expansions due to relatively low unemployment rate. On the other hand, workers facing layoffs during times of high unemployment could refrain from reporting accidents and illnesses.

Moreover, as mentioned by Asfaw *et al.* (2011, p. 3) the effect of the business cycle on occupational injuries could be observed with respect to the composition and utilization of the physical capital of firms. During economic growth, firms work at high capacity to meet demands may schedule less time for proper maintenance of machinery and equipment and this situation could be responsible for high injury rates. V.S. de la Fuente *et al.* (2014) examined the influence of economic crisis on occupational accidents in Spain during 2000-2009, and argued that economic crises appear to provoke a short of "natural selection" in the labour market and only the best adapted tend to remain. Therefore, the probability of workers come across accident is significantly reduced during economic slow-downs.

On the other hand, it is assumed that this so called pro-cyclical relationship has changed with the transition from the industrial sector to services sector especially declining the share of employed people in manufacturing and construction industries (Saloniemi and Oksanen, 1998). In recent years, studies conducted in developed countries show that there is an inverse relationship between economic development and the incidence of work-related accidents. The main reason for this fact is in rising periods with the impact of general prosperity and increase in occupational health and safety measures due to the scientific and technological developments that create new opportunities for the prevention of these hazards and preventive security reduce work-related accidents. On the other hand, economic downturns coincide with job losses and decreasing investments, and fear of unemployment is known to be a risk factor for occupational accidents (Barth *et al.*, 2007).

As previously mentioned, there are many factors that affect occupational accidents and it cannot be said that economic factors are the only reason, in fact work related accidents are the result of a complex interaction of many factors, e.g. employee health, work equipment used, long working hours, carelessness, fatigue, work organization, inability of the receipt of the safety precautions and safety training etc. As revealed in the study of economic growth and occupational injuries in Austria (Barth *et al.*, 2007) many factors mentioned above are already related to overall economic development. It is expected that increasing the development level of a country ensures the social and economic rights of workers and the provision of decent job opportunities for employees. In same manner, in developed countries, occupational safety and health issue are taken more seriously than developing countries. According to the International Labour Organization (ILO), the corresponding average fatal occupational accidents at work per 100,000 employees in developed countries were 4 on average and above 10 in developing countries (Song *et al.*, 2011). For instance, fatality rate per 100,000 workers in Norway, Germany and England were 2, 1.8 and 0.6 on average respectively and while in Turkey, Russia and India 16.8, 12.4 and 27.0 on average respectively (Turkish Statistical Office – Tuik, 2013). As noted by these data it is not surprising that occupational accidents are very common in developing countries which the manufacturing and construction industries are widespread. In addition, it is thought that the rapid and hasty technology transfer in some developing countries is often far too quick to suit, either the individual or the society, threatening a failure to establish appropriate social structures for dealing with occupational health and safety issues (Shanavaz, 1987). Based on the experience in the early years of industrialization of the developed countries occupational accidents seemed to increase at first but with economic growth and investment in training and development and also improved awareness of precaution which led to decrease work related accidents.

3. DATA AND METHODOLOGY

3.1 Data

It is a well-known fact that statistics which are concerning the occupational injuries cover the workers whom are insured by any social insurance institution and therefore most of the fatal or nonfatal occupational injuries are above the official estimates. So in this paper by considering the fact that nonfatal occupational accidents are less reported than fatal occupational accidents and data accessibility concerning nonfatal occupational accidents channelize us to examine the nexus between fatal occupational accidents and economic development for Turkey. Due to availability of data for fatal occupational accidents we examine this nexus over the period of 1980-2012.

According to Resolution adopted by the 16th International Conference of Labour Statisticians (1998), a case of fatal occupational injury is defined as "… the result of an occupational accident where death occurred within one year from the day of the accident." In this context, annual data for cases of fatal occupational injuries in absolute terms (thousands) is disaggregated by economic activity and sex, gathered from ILOSTAT database of the ILO for 1980-2012 based on the calculations of the Turkish Social Security Institution (SSI). In order to analyse the effect of economic development on fatal occupational injuries, some control variables that are thought to represent economic development are adopted. As an indicator for the scale of economics, real Gross Domestic Product (GDP) per capita is used. Annual time series data set GDP per capita (US $) are obtained from World Development Indicators (WDI) database of the World Bank and measured by constant prices in 2005. As one of the most important determinant of economic growth, human capital index is used and data regarding with human capital index is collected from updated version of Penn World Table (version 8.0) (Feenstra *et al.*, 2013). This index is calculated in the form of schooling year and returns to education (Barro and Lee, 2013; Psacharopoulos, 1994).

Table no. 1 – List of Variables

Variables	Abbreviation	Description	Period	Source
Gross Domestic Product per capita	LGDPC	Natural log of GDP per capita (US $), 1980-2012	Annual	WDI
Fatal occupational accidents	LFATAL	Natural log of cases ending with fatal occupational accidents, 1980-2012	Annual	ILOSTAT
Human capital index	LHC	Based on schooling year and returns to education natural log of index value, 1980-2012	Annual	Penn World Table
Average working hours	LAWH	Natural log of working hours in average, 1980-2012	Annual	Penn World Table

Finally, average working hours is thought to be an important determinant of fatal occupational injuries, since the average duration of workers increases the risk for occupational incidents. The data for this variable is also obtained from Penn World Table (version 8.0) based on the average working hours of persons engaged in any job and hours worked vary between 1380 and 2800 hours, with richer countries working relatively fewer hours. Data set for human capital index and average working hours cover for 1980-2010 and for missing values data set was interpolated. On the other hand, all variables drawn on the empirical analysis are transformed into the natural logarithmic form. In this context, list of variables and relevant descriptive statistics for the variables identified above are exhibited in Table no. 1 and Table no. 2 respectively. Mean of fatal occupational accidents during the sample period is 1233.72 while maximum and minimum values are 1776 and 702 respectively. Strikingly minimum value of fatal occupational accidents is observed in 2012 when GDP per capita reaches its maximum. Jarque-Bera statistics for each variable indicate that series are normally distributed by not rejecting the null hypothesis of normality as the calculated statistics are insignificant.

Table no. 2 – Descriptive Statistics

Descriptive Statistics	LGDPC	LFATAL	LHCB	LAWHB
# of Observations	33	33	33	33
Mean	5745.92	1233.72	2.0347	2026.42
Maximum	8483.33	1776.00	2.3565	2163.91
Minimum	3700.79	702.00	1.6548	1877.35
Standard Deviation	1404.47	275.43	0.2099	90.03
Skewness	0.3798	-0.0482	-0.0451	-0.0994
Kurtosis	2.1130	2.1182	1.9804	1.7632
Jarque-Bera (p-value)	1.8752 (0.3915)	1.0818 (0.5822)	1.4404 (0.4866)	2.1575 (0.3400)

Source: authors' estimations.

3.2 Methodology

Developed by Pesaran *et al.* (2001), the nexus between fatal occupational accidents and economic development is examined by bounds test approach within autoregressive distributed lag model (ARDL). The statistic underlying the procedure is the Wald or F-statistic in a generalized Dickey-Fuller type regression, which is used to test the significance of lagged levels of the variables under consideration in a conditional unrestricted error correction model (UECM). This procedure has several advantages over alternatives such as the Engle and Granger (1987) two-step residual-based procedure for testing the null of no cointegration or the system-based reduced rank regression approach pioneered by Johansen (1988) and Johansen and Juselius (1990). The first main advantage is that bound test approach is applicable irrespective of whether underlying regressors are purely I (0), purely I (1), or mutually cointegrated. Second, the UECM is likely to have better statistical properties than the two-step Engle and Granger (1987) method because, unlike Engle and Granger (1987) method, the UECM does not push the short-run dynamics into the residual terms. The other major advantage of the bounds test approach is that it can be applied to studies that have a small sample size compared to its counterparts indicated above (Narayan and Narayan, 2004).

In order to examine the nexus between fatal occupational accidents and economic development in Turkey, we construct the following model:

$$lfat_t = \alpha_0 + \alpha_1 \lg dp_t + \alpha_2 lawh_t + \alpha_3 lhc_t + \varepsilon_t \quad (1)$$

where small t represents the time dimension (year) under each variable and small l shows each variable to be transformed into the natural logarithmic form. In this equation, dependent variable is the number of fatal accidents (thousands) and represented by $lfat_t$. Independent variables are real GDP per capita (US $), average working hours, and human capital index which are denoted as $\lg dp_t$, $lawh_t$ and lhc_t respectively in Equation no. 1. Last term in Equation no. 1 ε_t represents the disturbance term which follows a standard normal distribution. Finally, α_0 is drift parameter while α_1, α_2 and α_3 are coefficients to be estimated for GDP per capita, average working hours and human capital index respectively.

The bounds test approach in this paper consists of three steps. In the first step, based on unrestricted error correction model (UECM) bound test is performed in order to search for cointegration relationship among the series regardless of whether they are stationary at the same level or not. In this context, based on UECM cointegration relationship will be examined by the following equation which is adopted from Equation no. 1.

$$\begin{aligned}\Delta lfat_t = \alpha_0 + \sum_{i=1}^{n}\alpha_{1i}\Delta lfat_{t-i} + \sum_{i=0}^{n}\alpha_{2i}\Delta \lg dp_{t-i} + \sum_{i=0}^{n}\alpha_{3i}\Delta lawh_{t-i} + \sum_{i=0}^{n}\alpha_{4i}\Delta lhc_{t-i} \\ + \alpha_5 lfat_{t-1} + \alpha_6 \lg dp_{t-1} + \alpha_7 lawh_{t-1} + \alpha_8 lhc_{t-1} + \varepsilon_t\end{aligned} \quad (2)$$

In this equation n represents the lag length, Δ represents difference operator, sub-indices t-i and t-1 represents the lag orders respectively. Null hypothesis of no cointegration among the variables is tested against the alternative and in this context two sets of critical values for F-test in which upper and lower bounds are provided for purely I (1), purely I (0) or mutually cointegrated regressors are developed (Pesaran *et al.*, 2001). If calculated F statistics exceeds upper bound, then null hypothesis of no cointegration is rejected and variables are said to be cointegrated.

Secondly, if cointegration relationship is found through the estimation of Equation no. 2, our main model presented by Equation no. 1 would be estimated by the following ARDL (m, n, p, q) specification.

$$lfat_t = \alpha_0 + \sum_{i=1}^{n}\alpha_{1i} lfat_{t-i} + \sum_{i=0}^{m}\alpha_{2i} \lg dp_{t-i} + \sum_{i=0}^{m}\alpha_{3i} lawh_{t-i} + \sum_{i=0}^{m}\alpha_{4i} lhc_{t-i} + \varepsilon_t \quad (3)$$

In Equation no. 3, n and m represent corresponding lag lengths, t-i shows the ith lag of corresponding variable, ε_t represents the disturbance term and the variables are the same as defined for above equations. In the final step, error correction model would be setup to identify the existence of short-run relationship among the variables. In this context Equation no. 4 displays the error correction model.

$$\Delta lfat_t = \alpha_0 + ec_{t-1} + \sum_{i=1}^{m}\alpha_{1i}\Delta lfat_{t-i} + \sum_{i=0}^{n}\alpha_{2i}\Delta \lg dp_{t-i} + \sum_{i=0}^{n}\alpha_{3i}\Delta lawh_{t-i} + \sum_{i=0}^{n}\alpha_{4i}\Delta lhc_{t-i} + \varepsilon_t \quad (4)$$

where ec_{t-1} represents the error correction term with one lag, m is the optimal lag length for dependent variable while n is the optimal lag length for corresponding independent variables. Indicated above for Equation no. 2, all variables exempt from error correction term enter into the regression as the first differences are taken and Δ denotes difference operator. Finally, t-i represents the lag order for relevant variable and ε_t represents the disturbance term as it is expressed for above equations.

Fatal occupational accidents might be affected in a different way both in the long run and short run. But in overall considering our basic model specified by Equation no. 1, fatal occupational accidents should be inversely related by GDP and human capital which indicates that the rise in GDP causes to stimulate firms to invest for security in work places. For human capital there are many proxies in the existing literature on economic growth but most of them refer to the significance of health and educational status. As the educational attainment of workers increases and increase in healthy working places should minimize the risk of fatal accidents in work places. As the average working hour increases it is likely to detriment the concentration of workers in the work place which in turn may cause the fatal accidents.

4. RESULTS

Stated in previous section, the nexus between economic development fatal occupational accidents would be examined by the bounds test approach to cointegration. In order to investigate the presence of cointegration relationship among the variables specified by Equation no. 2, it is important to identify whether the series are stationary at same order or not to decide appropriateness of bounds test and accordingly augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) type unit root tests (including intercept and time trend) performed respectively. Table no. 3 displays the results of unit root tests and according to the results all variables except GDP are stationary at level. Nevertheless, all series become stationary (including GDP) by taking the first differences since the calculated statistics are significant at 1 % significance level which is demonstrated by each test. Since the stationarity order of the series are different, it is inappropriate to perform cointegration methods developed by Engle and Granger (1987), Johansen (1988) and Johansen and Juselius (1990) which require the stationary of series at same order. In this context, it is plausible to employ bounds test approach to cointegration which is confirmed by the results of unit root tests.

Table no. 3 – Unit Root Tests

Variables	ADF Test		PP Test	
	Level	1st Dif.	Level	1st Dif.
LGDP	-3.1139	-6.1332*	-3.1831	-7.4428*
LFATAL	-3.6030**	-4.6914*	-3.3098***	-7.0833*
LAWH	-6.2381*	-5.3913*	-6.2381*	-34.2284*
LHC	-5.0316*	-6.4226*	-7.3144*	-13.6504*

,,*** indicates the significance levels at 1 %, 5% and 10 % respectively. Both intercept and time trend is included. Lag length is selected by Schwarz Bayesian Criteria (SBC).*

Source: Authors' estimations.

Since cointegration relationship among the variables is estimated by UECM framework specified by Equation no. 2, selection of optimal lag length without bearing autocorrelation among residuals of UECM is also an important issue to identify. Based on Schwarz Bayesian Criterion (SBC), as we deal with annual time series data we determine the maximum lag length to be 5 and the results in Table no. 4 shows that optimal lag length is selected to be 2 at which autocorrelation among the residuals do not exist.

Table no. 4 – Optimal Lag Length Selection

Lag Order	SBC	$\chi^2_{BG}(2)$
1	0.3428	11.6416*
2	0.0007	5.9541
3	-1.2693	13.7369*
4	-4.3846	20.7876*

,,*** indicates the significance levels at 1 %, 5% and 10 % respectively.*
Abbreviations: SBC-Schwarz Bayesian Criterion; χ^2_{BG} *(1): Breusch-Godfrey serial correlation test*

Source: Authors' estimations.

Having decided the optimal lag length, in the following step we proceed to examine the presence of cointegration relationship among the series by performing bounds (F-test) test and the relevant results exhibited in Table no. 5. In Table no. 5, while I (0) represent lower bound, I (1) represent upper bound respectively according to 90 %, 95 % and 99 % confidence intervals (Pesaran *et al.*, 2001). Table no. 5 reveals that since the calculated F-statistics fall above the upper bound at 90 % confidence interval, it would be stated that cointegration relationship among the series does exist.

Table no. 5 – Bounds Test for Cointegration Relationship

Critical Value Bounds for F-Statistics							
k	**F-Stat. (p-val.)**	**90 % Level**		**95 % Level**		**99 % Level**	
		I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
3	3.2710 (0.0365)	2.37	3.20	2.79	3.67	3.65	4.66

Note: k indicates the number of explanatory variables. For critical values see Pesaran et al. (2001), Table CI (iii) on p. 300.

Source: authors' estimations

On the other hand detection of cointegration relationship among the series leads us to estimate long run relationship by ARDL model. In specifying the proper ARDL model, we adopt the approach proposed by Kamas and Joyce (1993). According to this setting, regression is performed to lags of dependent variable through maximum lag length specified to be 5 since we deal with annual time series data that is mentioned above for estimation process of UECM and then lag length that meets the minimum SIC condition is selected for dependent variable as optimal. Afterwards, selected optimal lag for dependent variable is held constant to specify optimal lag lengths for each independent variable by constructing regressions between dependent variable and each independent variable with all possible lag lengths. Then, lag lengths that meet minimum SIC condition is selected for each independent variable as well. In this context Equation no. 1 is estimated by ARDL (2, 3, 0, 1) model and results are displayed in Table no. 6.

Upper part of Table no. 6 shows the estimated coefficients of ARDL (2, 3, 0, 1) model while bottom part is devoted to the long-run coefficients obtained by ARDL (2, 3, 0, 1) model. Estimation results of long run coefficients regarding GDP and human capital index are both negative and significant at 10 % and 1 % significance levels respectively which indicate the existence of inverse relationship with the fatal occupational accidents while average working hours do not have any impact on fatal occupational accidents since relevant coefficient is insignificant. Coherent with our expectations, negative sign of GDP indicates that in the long run as the country gets richer firms tend to invest new technologies to mitigate the accidents at work place. Although human capital is proxied by different measures such as educational attainment, achievement to better health conditions, etc., workers that are endowed with advanced capabilities do have minimum risk in suffering the fatal accidents at work place. In this context, the sign of human capital index accrues consistently through our expectations by which verifying the inverse relationship with fatal occupational accidents. Not surprisingly, in recent years with the rapid growth process of the Turkish economy and accordingly improvement in the living standards of people in overall generate deterrent impact on the incidence of occupational accidents. On the other hand, diagnostic check results show that there is no serial correlation, heteroskedasticity among residuals and residuals are also normally distributed. Ramsey's RESET test results yield that our functional form is correctly specified.

Table no. 6 – ARDL (2, 3, 0, 1) Model

Depended variable : $LFATAL_t$					
Variables	**Coefficient**	**t-stat.**	**Variables**	**Coefficient**	**t-stat.**
C	6.4076	1.3218	$LGDPC_{t-2}$	-1.3416	-1.4891***
$LFATAL_{t-1}$	0.4024	2.3060**	$LGDPC_{t-3}$	-1.2927	-2.0007***
$LFATAL_{t-2}$	-0.0128	-0.0870	$LAWH_t$	0.2087	0.3536
$LGDPC_t$	1.0558	1.4466	LHC_t	-0.8344	-3.6340*
$LGDPC_{t-1}$	1.3025	1.6281	LHC_{t-1}	-0.8575	-3.3662*
Long Run Coefficients and Diagnostics					
Variables	**Coefficient**	**t-stat**	**Diagnostics**	**Statistics**	
C	10.9591	1.0476	R^2	0.82	
LGDPC	-0.4720	-1.7350***	F-Stat. (p-value)	7.5587 (0.000)*	
LAWH	0.3570	0.3617	$\chi^2_{BG}(1)$	0.3465 (0.556)	
LHC	-2.8223	-1.8187*	$\chi^2_{WHITE}(1)$	12.3835 (0.335)	
			$\chi^2_{RESET}(1)$	1.5374 (0.231)	
			$\chi^2_{JBN}(2)$	0.2677 (0.874)	

,* indicates the significance levels at 1 % and 10 % respectively. For the explanation and abbreviations of variables see Table no. 1. Abbreviations: C-constant. Test statistics are as follows: R^2: coefficient of determination; χ^2_{BG} (1): Breusch-Godfrey serial correlation test; χ^2_{WHITE} (1): White heteroskedasticity test; χ^2_{RESET} (1): Ramsey's RESET test for functional form; χ^2_{JBN} (2): Jarque-Bera test for the normality of residuals. The p-values of the relevant statistics are shown in the parenthesis.*

Source: Authors' estimations.

Short run relationship based on error correction form among the variables is examined through the estimation of ARDL (2, 1, 0, 1) model by applying the same methodology as discussed for long run relationship and the results are exhibited in Table no. 7. Error correction term in Table no. 7 is the one period lag of residuals obtained by estimating the ARDL (2, 3, 0, 1) model which indicates the resilience or adjustment speed to the shocks that come from dependent variable in the long run and the sign of this term should be negative and statistically significant. In line with the expectations, the coefficient of error correction term (EC_t) which is -0.8970 and statistically significant at 1 % significance level indicates that the shock that comes from fatal accidents will converge to the equilibrium path quickly at a rate of almost 90 % in one period spam. All variables including the dependent variable enter into the regressions with first differentiated forms as it is specified by Equation no. 4. According to results, average working hours do not have any impact on fatal occupational accidents while human capital index displays inverse relationship with the fatal occupational accidents through our expectations as in the long run. The sign of coefficient for human capital index is negative and statistically significant at 1 significance level. It is striking that unlike in the case of long run, in the short run GDP and fatal occupational accidents are positively related as the sign of the coefficient of GDP by one lag is positive and statistically significant at 10 % significance level. Finally, diagnostic test results reveal that either functional form of our model is correctly specified or residuals do not exhibit serial correlation and heteroskedasticity.

Table no. 7 – Error Correction Model

Dependent Variable: $DLFATAL_t$				
Variables	**Coefficient**	**t-stat.**	**Diagnostics**	**Statistics**
C	-0.0719	-2.1202**	R^2	0.70
EC_t	-0.8979	-3.2260*	F-stat.(p-value)	7.6852 (0.000)*
$DLFATAL_{t-1}$	-0.0074	-0.0572	χ^2_{BG} (1)	2.9108 (0.233)
$DLFATAL_{t-2}$	-0.3019	-3.0065*	χ^2_{WHITE} (1)	6.8164 (0.448)
$DLGDPC_t$	0.7384	1.1758	χ^2_{RESET} (1)	1.0513 (0.316)
$DLGDPC_{t-1}$	1.7532	2.7772**	χ^2_{JBN} (2)	0.7417 (0.690)
$DLAWH_t$	-0.3961	-0.8694		
$DLHC_t$	-0.8248	-4.4079*		

,* indicates the significance levels at 1 % and 10 % respectively. In front of each variable capital D shows the first differences of each variable. For the explanations and abbreviations of each variable see Table no. 1. Abbreviations: C-constant; EC-error correction term. Test statistics are as follows: R^2:coefficient of determination; χ^2_{BG} (1): Breusch-Godfrey serial correlation test; χ^2_{WHITE} (1): White heteroskedasticity test; χ^2_{RESET} (1): Ramsey's RESET test for functional form; χ^2_{JBN} (2): Jarque-Bera test for the normality of residuals. The p-values of the relevant statistics are shown in the parenthesis.*

Source: Authors' estimations.

5. DISCUSSION

Based on bounds test approach, estimation of ARDL model to investigate the nexus between fatal occupational accidents and economic development indicate that in contrast to long-run, variation of economic growth has positive effect on occupational accidents in short-run. This result is not surprising because the Turkish economy has been going through a large structural transformation from agriculture to industry and services since the 1980s. As it is mentioned by Fabiano *et al.* (2004, p. 588) historical experiences of the developed countries show that a pro-cyclical relation is supported by the results of different researchers before 1970s. On the other hand, after 1970s, as Saloniemi and Oksanen (1998) found that there is no significant nexus between fatal accidents and business cycle in Finnish construction and manufacturing industries between 1977 and 1991.

According to Atiyas and Bakis (2013, p. 10) a steady decline in the share of agriculture was steeper in the 2000s relative to the 1990s; agriculture's share of total employment was 47% in 1988 to nearly 26% in 2010. On the other hand, there is a steady corresponding increase in the share of employment in services from less than 40 to over 55% in the same period. The increase in the employment share of industry has been less dramatic; it has increased from about 16% in the late 1980s to about 20% in mid-2000 and has remained there. Unsar and Sut (2009) analysed the results of occupational accidents between the years 2000 and 2005 in Turkey and they stated that occupational accidents are mostly seen in the sectors of manufacture, construction, textile industry and coal mining, while fatal and permanent disabilities have started to decrease since 2002. In addition, Asfaw *et al.* (2011) examined the association between the business cycle and the incidence of workplace injuries during the period of 1976 to 2007 across five industry sectors and found that mining, construction and manufacturing injury rates were most sensitive to the business cycle. Likewise Davies *et al.* (2009) provide evidence of pro-cyclical association between business cycle and injury rates in the UK, and the strongest affects were found within the construction and manufacturing sectors.

6. CONCLUSIONS

In the present study we explored the long-term relativity between economic development and fatal occupational accidents over the period of 1980 to 2012 for Turkey which exerts as a developing country. Our results indicate that there is a negative interdependence between fatal occupational accidents and GDP between 1980 and 2012 which is observed for the cases of developed countries. It seems that economical booming with high level of GDP, as a measure of welfare, increasing investment in new technologies and improving working conditions would make occupational accidents decrease, and economical depression would make occupational accidents increase. In addition, it is found that average working hours do not have any impact on fatal occupational accidents. However, human capital index which is calculated in the form of schooling year and returns to education displays inverse relationship with the fatal occupational accidents. As it is expected investment in human capital is considered a strong predictor of economic growth and leads to prevent occupational accidents and diseases.

On the other hand, short term results support the traditional way of pro-cyclical relation between fatal occupational accidents and economic development in Turkey. This could be the reason of structural and social change of occupations and industries during the whole period. As is well known that construction, coal mining, and manufacturing involve high risk due to its production process and labour intensive characteristics. In future we can expect a slow decrease in the rate of occupational injuries due to change from an industrial society to a service society in Turkey. However, it seems that economic cycles determine the rate of occupational injuries at least in the short run. Therefore, especially in the construction, manufacturing and coal mining sectors we need to be aware of the strong association between business cycle and occupational accidents and take necessary precautionary safety measures during the period of economic slow-downs. Further research should be carried out on occupational injuries in specific industries, sectors or economic activities to find out their sensitivity to the economic development over the long term. Meanwhile, an inverse parallelism between the economic development and the trend of fatal occupational accidents points out that the government should give importance to the awareness about occupational health and safety and improve working conditions of workers specifically during economic downturns.

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