Economic Cost of Work Accidents: Granger Causality Analysis on Turkey with a Panel Data Approach

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ABSTRACT--- ***Significant costs are suffered primarily by individuals and heavy burdens are incurred on businesses and the economy in general due to work accidents. According to the ILO estimates, the total cost of accidents at work has reached to 4% of the Gross World Product (GWP). The production losses and other costs that were suffered as a result of work accidents in Turkey in 2011 are estimated to be as high as TL 34 billion. In this study, the relationship between work-related accidents and gross added value was examined with panel causality analysis using data from 26 regional units for the period between 2004 and 2011. In was determined in conclusion that the number of days of incapacity to work that emerge due to work-related accidents is a statistically significant reason of the gross added value of the region to the economy of the country.***

Keywords--- Work Accidents, Occupational Safety, Panel Causality Analysis

1. INTRODUCTION

The large extent of life and property losses caused by occupational accidents is an important matter well worth investigating. The consecutive mining and other work-related accidents encountered in Turkey in 2014 once again drew attention to the direly significant individual, social, and economic devastations caused by such accidents. The International Labour Organization (ILO) estimates that each year about 2.3 million people die due to work-related accidents. This rate has increased approximately 10% compared to the previous year[1]. According to the same research, an average of 860 thousand occupational accidents occur daily all around the world. The cost of all these is estimated to be about 4% (roughly, $ 1.36 trillion) of the Gross World Product (GWP). These costs are estimated to reach approximately 2.8 trillion US dollars as of the year 2014[2]

In 2013, 2.3% of the total employees had a work-related accident in Turkey[3]. In total, 81.6% of those who had an accident at work were male employees (Turkish Statistical Institute newsletter). According to the fatal accident frequency rates per year calculated by Ceylan (2011)[4], while the EU average is 2,3, this rate is 15.8 in Turkey. An average of 172 occupational accidents occur daily in Turkey. The International Labour Organization (ILO) sources specify that the total cost of accidents at work and occupational diseases varies between 1% and 3% of a country's gross national product (GNP)[5]. Accordingly, the cost of work-related accidents to the economy of Turkey is between 11 and 34 billion Turkish Liras. Even when only the above figures are taken into consideration, the importance of the issue becomes obvious. The purpose of this study is to draw attention to the economic costs of occupational accidents in Turkey and to investigate their impact on national production, which is one of the social costs of accidents at work.

2. THE CONCEPT OF OCCUPATIONAL ACCIDENTS AND WORK ACCIDENTS IN TURKEY

According to the definition made by the International Labour Organization (ILO) and the World Health Organization (WHO) in 1950, occupational health refers to ensuring, maintaining, and developing corporal, mental, and social wellness of workers in all occupations at the highest level[6]. On the other hand, there are many definitions of occupational accidents. The World Health Organization (WHO) defines a work accident as "an unplanned incidence that often results in injuries and damage to machinery and equipment or that leads to downtimes in production" [7]. The International Labour Organization (ILO) defines work accidents as "unexpected and unplanned events that lead to a particular damage or injury". It is defined as “a situation causing damage or injury as a result of an unexpected event"[8].

Today, the rapid increase in the number of industrial workers in industrialized and industrializing countries has brought about certain occupational health and safety issues for employees. Industrialized countries have had to spend considerable efforts on employee health and safety at work in this century. Almost all of these countries strive to keep work accidents and occupational diseases at the lowest level and foster training and controls in this area and they also audit workplaces intensely to ensure that they adopt the required measures with regard to this matter. The general reasons of why the issues of occupational health and safety are gaining growing importance can be grouped under three headings.

These are technical requirements, economic imperatives, and social necessity. In order to be able to explain the importance of the subject with regards to the encountered costs, there is a need to clarify the relationship between employee health-occupational diseases and occupational safety-work related accidents. Multidimensional costs emerge as occupational diseases, when employee health is not given the required importance, and as occupational accidents, when occupational safety is not given the required importance. In other words, the cost of neglecting employee health is occupational diseases whereas the cost of not attaching importance to occupational safety appears to be work-related accidents. Nevertheless, there are certain other costs imposed by work-related accidents and occupational diseases on both the employee and employer as well as on the country's economy at a more macro level.

When calculating the costs of occupational accidents, it is necessary to examine the issue in three parts. These are the costs to employees exposed to accidents, the costs to the company where accident occurred, and the costs to the national economy. These can be outlined as follows:

Direct (Visible) Costs:

- First response, ambulance and treatment expenses,
- Payments for temporary or permanent incapacity to work or death,
- Moral and material compensations paid to the worker or their relatives,
- Indemnities paid to the social security system.

Indirect (Invisible) Costs:

- The loss of a portion or the entirety of the business, machinery, process, or plant,
- Labor or cost losses as the worker is not engaged in production activities,
- Legal costs (Court expenses)
- The cost brought about by low productivity when hiring a new worker is required,
- The cost of overtime work brought about by the accident,
- The time and cost losses due to the suspension of work in the work section upon the accident,
- The costs of repair or purchase of new machinery due to partial or complete damage to the process, machinery, or workbench,
- Damage to products or raw materials,
- Direct or indirect work slowdowns by employees due to low morale,
- If there is a need to hire new workers, the costs associated with the training delivered to the worker and the time it takes for the new employee to learn the work,
- Wasted time and material losses associated with bureaucratic procedures,
- Losses to be incurred due to failure in timely delivery of purchase orders[9].

In accordance with the basic perspective of the study, only the costs on the economy of the country will be discussed here.

In addition to direct costs they impose to the society as a whole such as those on the social security system and hospital and healing center expenses, work-related accidents also adversely affect the productive capacity of the economy and thereby, lead to the destruction of national resources.Work-related accidents have an inhibitory effect on national development and reduce national prosperity. They lead to the destruction of the country's resources and significantly increase the losses of labor force and working days.

These costs can be summarized as follows:

- Because of direct and indirect costs and expenses associated with occupational accidents, product costs increase and prices rise,
- A decrease in national production occurs,
- They cause an increase in insurance and health expenditures[10].

The following table shows accidents at work in the 2004-2013 period and real GDP values (because the occupational accidents and occupational diseases statistics for 2014 have not yet been published, the data up to 2013 are provided here). Due to the 79 thousand occupational accidents occurred in 2013, the number of lost working days was around 2 million 300 thousand days. About 2.3 of every 100 employees had a work-related accident in the specified year. Despite the increasing importance given to the subject, enactment of a lot of relevant legislations, and increased frequency of related audits, a significant change in the number of accidents that occur is not observed.

Years	Number of Accidents	Incapacity Day Count	GDP (1998:100, 1,000 TL)
2004	80,903	1,778,293	83,485,591
2005	73,923	1,727,827	90,499,731
2006	79,052	1,848,810	96,738,320
2007	80,824	1,876,524	101,254,625
2008	72,963	1,796,831	101,921,730
2009	64,321	1,469,261	97,003,114
2010	63,354	1,455,555	105,885,644
2011	69,227	1,701,928	115,174,724
2012	78,871	1,597,241	117,625,021
2013	79,122	2,357,505	122,388,466

Although a significant decrease has occurred in occupational accidents with the measures taken in recent years, while the average number of fatal occupational accidents per 100 thousand employees is 2.1 for 27 European countries, this figure is as high as 14.3 in Turkey and the fact that Turkey ranks the first among the European countries and the third among all the countries of the world with regards to work-related accidents is a clear proof that we are not still at a sufficient level in terms of job safety.

3. DATA SET AND METEDOLOGY

The work accident statistics compiled from the annual statistics published by the Social Security Organization and regional gross added value data released by the Turkish Statistical Institute were used in the study. The data set consists of 208 observations of 26 regions covering the period between 2004 and 2011.

In this study, the variables of the number of occupational accidents that occurred in the region within the year (ACCIDENT); the number of days of incapacity to work resulting from occupational accidents (DAY); the Regional Gross Added Value (KD, %); and the Regional Gross Added Value (GDP, $) are used.

Before the causality analysis, the panel stability analysis of the data used in the study was performed utilizing the panel unit root test known as the LL (Levin-Lin) method in literature[11].

Three equations are used in the model. The first is an equation not containing a constant (individual specific intercepts) or trend (d_{1t}=Ø), the second is an equation with a constant [d_{2t}=(1)], and finally, an equation that contains both a constant and a trend [d_{3t}=(1,t)]. The basic equation is as follows:

$$\Delta Y_{it} = \delta Y_{it-1} + \sum_{L=1}^{p_i} \theta_{iL} \Delta Y_{it-L} + \alpha_{mi} d_{mt} + \varepsilon_{it} \quad (1)$$

m=1,2,3

After the basic equation above is run, the variables of ΔY_{it} and Y_{it-1} are separately run over ΔY_{it-L} and the error terms are identified.

$$\Delta Y_{it} = \sum_{L=1}^{p_i} \pi_{iL} \Delta Y_{it-L} + \alpha_{mi} d_{mt} + e_{it} \quad (2)$$

$$Y_{it-1} = \sum_{L=1}^{p_i} \pi_{iL} \Delta Y_{it-L} + \alpha_{mi} d_{mt} + \nu_{it-1} \quad (3)$$

In order to eliminate the problem of changing variance in cross-sectional data, the error term series from Equations 2 and 3 are normalized as follows.

$$e'_{it} = \frac{e_{it}}{\sigma' \varepsilon_i} \text{ and } \nu'_{it-1} = \frac{\nu_{it-1}}{\sigma' \varepsilon_i} \quad (4)$$

Then, using the series of new error terms obtained by the above method, the following final equation number 5 is run.

$$e'_{it} = \delta \nu'_{it-1} + \varepsilon'_{it} \quad (5)$$

While the tau statistics to be used for the first model is calculated as in equation 6, a correction as shown in equation 7 is applied for the other models.

$$t_\delta = \frac{\hat{\delta}}{STD(\hat{\delta})} \tag{6}$$

$$t_\delta^* = \frac{t_\delta - N\tilde{T}\hat{S}_N \hat{\sigma}_{\hat{\varepsilon}}^{-2} STD(\hat{\delta})\mu_{m\tilde{T}}^*}{\sigma_{m\tilde{T}}^*} \tag{7}$$

where $\tilde{T} = T - \bar{p} - 1$ represents the average number of observations per cross section, N represents the number of cross observations, and $\hat{S}_N = (1/N)\sum_{i=1}^{N} \hat{s}_i$ shows the standard deviation calculated as such. The $\mu_{m\tilde{T}}^*$ and $\sigma_{m\tilde{T}}^*$ values are the standard values obtained from the study by Levin et al. (2002). The Table critical values are also taken from the table provided in the said study. The unit root test will be performed against the H_0: δ =0 hypothesis. If the coefficient is significantly different from zero, the series in question will be deemed as not containing a unit root and is stable in its level.

The unit root test results of the variables are shown in the following table (Table 1). The series do not contain unit roots and are stable in their levels.

Table 1: Unit Root Test Results

	MODEL	Levin, Lin & Chu t statistics
Days	Constant-free – Trendless	-1.96127**
	With Constant	-17.2304*
	With Constant – With Trend	-16.4647*
Accident	Constant-free – Trendless	-3.75819*
	With Constant	-6.07254*
	With Constant – With Trend	-9.58270*
KD	Constant-free – Trendless	-1.04520
	With Constant	-10.1229*
	With Constant – With Trend	-7.87463*
GDP	Constant-free – Trendless	7.80119
	With Constant	-5.51089*
	With Constant – With Trend	-13.0582*

Days: Number of Days of Incapacity to Work Resulting from Occupational Accidents
Accident: Number of Occupational Accidents
KD: Gross Regional Added Value Per Capita ($)
GDP: Gross Regional Added Value (%)
* Significant at 1%

It is possible to learn about the possible causal relationships between both the cross sections and the time series using dimensional panel data. They have a structure of increasing the degree of freedom with particularly involving a very large number of observations and reducing the linearity between the explanatory variables. That is why; dimensional panel data augment the power of the Granger causality test significantly. Another well known advantage of the grouped cross-sectional units is that they soften the assumption of time stability[12].

The causality analysis results are shown in Table 2. The number of the occurred accidents (ACCIDENT) is a statistically significant cause of the Regional Gross Added Value (GDP). The number of days of incapacity to work resulting from occupational accidents (DAY), on the other hand, is a statistically significant cause of both per capita added value (KD) and the regional added value.

Table 2: Panel Causality Analysis Results

MODEL	χ^2_h	Causality Relationship
ACCIDENT →KD[a]	0.44393	None
ACCIDENT →KD[b]	2.10109	None
ACCIDENT →GDP[a]	21.3081	Exists
ACCIDENT →GDP[b]	10.9220	Exists
DAY →KD[a]	0.02133	None
DAY →KD[b]	8.62618	Exists
DAY →GDP[a]	17.4486	Exists
DAY →GDP[b]	8.96258	Exists

[*]Significant at 1%
[a] 1 delayed, [b] 2 delayed models.

Under the light of the ILO data mentioned in this study, it is obvious that work-related accidents are a significant cost factor for individuals, companies, and the national economy. Minimizing occupational accidents will provide significant contributions both to the national economy and the protection of labor force, the most important source of wealth of the country's economy. A significant relationship between work-related accidents and national production is also supported by the results specified above. However, in order to be able to exactly calculate these costs, further detailed statistics on the subject are required to be published.

4. REFERENCES

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