Full Length Research Paper

The determinants of industrial accidents in the Malaysian manufacturing sector

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This study analyzes the determinants of industrial accidents across 44 four-digit manufacturing industries in Malaysia from 1993 to 2008 through the business cycle and structural approaches. The results of pooled ordinary least square and fixed-effects estimations revealed that industrial accidents in Malaysian manufacturing sector were negatively influenced by firm size and positively influenced by business cycle. Consistent with the findings of previous studies in other countries, the empirical evidence of this study supports the pro-cyclical behavior of injury rates in manufacturing industries towards business cycle. The analysis demonstrates that both structural and cyclical variation effects are important determinants of industrial accidents in Malaysia.

Key words: Industrial accident, cyclical variation, structural characteristics, occupational safety and health act.

INTRODUCTION

Studies on the incidence of industrial accidents or injuries can be grouped into three approaches, namely: business cycle, labor market and structural approaches. The business cycle approach to workplace injuries provides explanations as to how injury rates may be expected to vary over the course of the economic cycle (Kossoris, 1938; Leigh 1985; Robinson and Shor, 1989). These studies support pro-cyclical relation, showing that the number of accident tends to increase during economic upswings and vice versa. Nevertheless, this approach does not explicitly consider the interaction of choices made by employers between safety and profits and the choices of employees between safety and wages in determining the risk of an accident. This give rise to the second approach, the market oriented approach to industrial accident as proposed by Chelius (1974), Oi (1974), and Sider (1985). Their studies relate the injury rate to the market factors, such as wage and government control. In general, their analysis shows that, under firm’s optimization, occupational accident is determined by wage level and employers’ incentives in accident prevention. However, the impact of government intervention through tax and compensation benefit is inconclusive.

The third approach focused on structural effect of the industry such as workers characteristics, firm size, and mechanization or capital intensity in the production process (Oi, 1974; Cooke and Gautschi, 1981; Viscusi, 1986; Currington, 1986). Demographic differentials in work injury rates could have been generated by several structural forces. If other things being equal, (such as type of industry, occupation, firm size and safety of the work site), certain workers are innately more liable to be involved in industrial accidents (Oi, 1974). Despite the three approaches, it is often assumed that the causes of accidents vary across sectors (Coleman, 1981). A survey report by Centers for Disease Control and Prevention (1993) on fatal injuries in the United States (U.S.) during 1980 to 1989 shows that the largest number of fatalities occurred in the construction sector, followed by transportation, manufacturing, and primary economic sectors.

A large body of existing empirical analysis on industrial accidents focused on manufacturing and construction sectors. This is due to their natural hazard and both sectors are found to be highly responsive to the business cycle, particularly in mature capitalist economies as well as those in transition towards industrialized economies (Robinson and Shor, 1989; Davies et al., 2009).

With the vision of becoming an industrialized economy
by the year 2020, Malaysia has started its Industrialization effort since 1960s. Industrialization has been an integral part in the Malaysian development strategies and manufacturing sector has shown to be one of the important backbones and a major contributor to the Malaysian economy. The share of manufacturing sector to Gross Domestic Product (GDP) increased significantly from only 12.2% in 1970 to 30.1% in 2010. Apparently, this sector has been the major sector in creating employment opportunities. In 1970, employment in the manufacturing sector represented only 9.4% of total employment (Malaysia, 1976). In line with the industrialization process, the share of employment in the manufacturing sector increased over the years. As at 2010, the share of employment in the sector has increased to 27.8% (Malaysia, 2010).

It is often the case that rapid expansion of manufacturing industries during economic expansion is associated with large employment of new workers and new technologies, machineries and equipments. While the application of new technologies would expose new hazards to the workers, hiring new worker might as well pose higher risk of accident as they are not accustomed to the hazard of workplace environment. Therefore, a study of workplace injuries in Malaysian manufacturing sector is particularly relevant since it would contribute to a greater understanding of factors that determine industrial accidents in the sector.

Industrial accidents have been the subject of growing number of academic research since the last three decades. However, large body of research focusing on the causes of industrial accidents is dominated by empirical studies in industrialized countries, such as European countries and the U.S. In Malaysia, existing studies on industrial accident were mainly focused on the issues of the establishment and enforcement of the occupational safety and health act (OSHA) and the evolution of safety related regulations (Jamaluddin, 1994; Rahmam and Sum, 2000; Mansur et al., 2003; Ariffin et al., 2006; Rampal and Nizam, 2006; Lugah et al., 2010; Surienty et al., 2011). Empirical study on industrial accidents in Malaysia, however are still lacking and mostly concentrated on the construction sector (AbdulHamid et al., 2008; Ali et al., 2010; Zakaria et al., 2010). Apart from these studies, Mansur et al. (2011) examine the influence of individual factors and nature of job on accident among workers at port sites. However, to the best of our knowledge, no attempt has been made to specifically investigate factors that influence industrial accidents in Malaysian manufacturing sector. Hence, the objective of our study is to examine the determinants of industrial accidents in the Malaysian manufacturing sector during 1993 to 2008. We specify our empirical model based on two approaches, namely: the business cycle and structural approaches. Difficulties of obtaining data on wage premium and on employees' protection measures for each industry prevent us from incorporating the labor market oriented approach in our model.

The remainder of this paper is structured as follows: an overview of industrial accidents in Malaysia and followed by literature review. Subsequently, this study discusses the model specification and data, which is followed by results and discussion. Finally, this study concludes and offers some policy implications.

OVERVIEW OF INDUSTRIAL ACCIDENT IN MALAYSIA

Tables 1 and 2, respectively present the number of industrial accidents by sectors and by types of accident in Malaysia during 1994 to 2008. There was significant decline in the total number of industrial accidents reported for all sectors, a decrease of 55.30% from 125,506 in 1994 to 56,095 in 2008. Among all sectors, the number of accidents reported for the manufacturing sector has been the highest throughout the period. This reflects workers in the manufacturing sector are exposed to higher accidental risks.

It can be observed that the pattern of accidents reported varies from one sector to another, reflecting the difference of hazard across sectors. As shown in Table 2, 20.60% of total fatal accidents and 37.91% of total disablement accidents in 2008 involved workers from the manufacturing sector. Although there has been significant reduction of total accident in the manufacturing sector, accident cases which caused fatality and disablement shown an increment. Between 1998 and 2008, fatal accidents increased from 256 to 268 cases, while disablement increased from 5,823 to 9,701 cases.

Figure 1 illustrates the trend of industrial accidents in the manufacturing sector reported from 1993 to 2008. Overall, total industrial accidents in the manufacturing sector were on a declining trend, except from 1998 to 2000 which shows an upward trend. An upward trend of industrial accidents during this period was attributable to Malaysian economic recovery from the Asian financial crisis which hit Malaysia in the middle of 1997. The upward and downward trend in total accidents during economic crisis and its recovery partly explain the influence of business cycle over industrial accidents. During economic crisis in 1997, firms tended to reduce both the volume and cost of production in response to decrease in aggregate demand. Reducing production involves the lay-off of newly hired, less experienced and unskilled workers who are normally more vulnerable to accident at the workplace. Hence by running the plants with the experienced and skilled workers during economic recession helps to reduce the number of accident cases reported.

As the economy began to recover in 1998, there was an increase in employment due to increase in production. Increase in employment during economic upswing meant hiring new workers who are not accustomed to the hazards of their new jobs and hence increased the number of accidents reported. After 2000, total accidents
Table 1. Industrial accidents reported by sectors, Malaysia, (1994 to 2008).

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture, forestry and fishing</td>
<td>27,268</td>
<td>24,390</td>
<td>13,293</td>
<td>8,796</td>
<td>5,739</td>
<td>3,962</td>
</tr>
<tr>
<td>Mining and quarrying</td>
<td>1,406</td>
<td>763</td>
<td>643</td>
<td>736</td>
<td>541</td>
<td>368</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>68,281</td>
<td>37,829</td>
<td>42,915</td>
<td>33,901</td>
<td>27,066</td>
<td>19,041</td>
</tr>
<tr>
<td>Electricity, gas, water and sanitary services</td>
<td>588</td>
<td>372</td>
<td>592</td>
<td>513</td>
<td>515</td>
<td>524</td>
</tr>
<tr>
<td>Construction</td>
<td>4,536</td>
<td>3,648</td>
<td>4,966</td>
<td>5,113</td>
<td>4,500</td>
<td>3,814</td>
</tr>
<tr>
<td>Trading</td>
<td>9,173</td>
<td>9,248</td>
<td>15,472</td>
<td>13,576</td>
<td>11,783</td>
<td>11,342</td>
</tr>
<tr>
<td>Transportation</td>
<td>4,437</td>
<td>3,276</td>
<td>4,800</td>
<td>4,142</td>
<td>3,653</td>
<td>3,305</td>
</tr>
<tr>
<td>Financial institution</td>
<td>592</td>
<td>367</td>
<td>7,293</td>
<td>6,195</td>
<td>5,386</td>
<td>718</td>
</tr>
<tr>
<td>Real estates, renting and business services</td>
<td>2,830</td>
<td>3,731</td>
<td>6,581</td>
<td>5,617</td>
<td>4,832</td>
<td>4,405</td>
</tr>
<tr>
<td>Total</td>
<td>125,506</td>
<td>89,049</td>
<td>98,281</td>
<td>81,003</td>
<td>68,008</td>
<td>56,095</td>
</tr>
</tbody>
</table>

1 Total accidents reported include total commuting accidents, Source: Labour and Human Resources Statistics (various issues), Kuala Lumpur: Ministry of Human Resource.

Table 2. Types of accidents reported by sectors, Malaysia, (1998 and 2008).

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Fatal accidents</th>
<th>Disablement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture, Forestry and Fishing</td>
<td>69</td>
<td>154</td>
</tr>
<tr>
<td>Mining and Quarrying</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>256</td>
<td>268</td>
</tr>
<tr>
<td>Electricity, gas, water and sanitary services</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Construction</td>
<td>124</td>
<td>102</td>
</tr>
<tr>
<td>Wholesale and retail trade, restaurant and hotel</td>
<td>139</td>
<td>231</td>
</tr>
<tr>
<td>Transportation</td>
<td>83</td>
<td>121</td>
</tr>
<tr>
<td>Financial institution</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Civil service</td>
<td>109</td>
<td>114</td>
</tr>
<tr>
<td>Total</td>
<td>1,135</td>
<td>1,301</td>
</tr>
</tbody>
</table>

1 Total includes fatal accidents and disablement from other services, Source: Labour and Human Resources Statistics (1998) and (2008), Kuala Lumpur: Ministry of Human Resource.

Figure 1. Industrial accidents in manufacturing sector, Malaysia, (1993 to 2008).
in the manufacturing sector were steadily declined. This could be attributed to the remarkable improvement in the safety and health conditions in the workplace. The growing concern among the regulators and employers over the safety and health issues at workplace in Malaysia has led to the introduction of the comprehensive OSHA enacted in 1994 along its related regulations. The legislations that govern issues pertaining to occupational safety and health at the workplace in Malaysia are:

2. Employees Social Security Act 1969.
5. Occupational Safety and Health (control of industrial major accident hazards) Regulations 1996.

LITERATURE REVIEW

An early study on industrial accidents relates its structural nature to the business cycles. Kossoris (1938) was the first researcher who investigated the relationship between business cycle and industrial injuries for the U.S. manufacturing industry for the years 1929 through 1935. He showed that, in general, the trend of injuries frequency rate followed the trend of industrial employment thus provides an early indication of procyclical behavior of industrial accident towards business cycle. Studies by Cooke and Gautschi (1981), Viscusi (1986) and Robinson and Shor (1989) support the procyclical relation showing that the number of accident tends to increase during economic upswings and vice versa. An inference as to why injury rates increase during economic expansion is the increase in employment of new inexperienced workers in the workforce who are vulnerable to accident at their new workplace. A pattern of decrease in injury rates observed by Kossoris (1938) during the Great Depression was related to workers' initiatives to report injuries. Workers tend to avoid reporting an injury, minor injuries in particular, in order to secure their position in the industry.

While the aforementioned studies support the procyclical relation, a study on Finnish manufacturing and construction industries by Saloniemi and Oksanen (1998) during 1977 to 1991 however provides no evidence on the relationship between fatal accidents and business cycle. Similarly, in a study of workplace injury for the United Kingdom from 1986 to 2005 by Davies et al. (2009) found no significant relationship between business cycle and major injury.

Oi (1974) analyses various aspects of industrial accidents in the U.S. including the characteristics of workers, labor turnover and establishment size. It appears that over all ages, males were three times as likely to be injured at work as females. As for labor turnover, an increase in the accession rate or new hires of less experienced workers during high employment gives rise to an increase in the overall work injury rate. Injury rates in relation to establishment size exhibit an inverted U-shaped where the smallest and the largest establishments reporting lower injury cases. Lower injury frequency in larger establishments could be explained by lower labor turnover, larger fractions of workers in safer tasks and fewer young males.

Smith (1979) estimates the impact of OSHA inspections on the U.S. manufacturing industry for the years 1972 to 1974. The study finds that injury as it pertains to inspection effect varies across plant-size and hazardous plant categories. Inspection effects were larger and statistically significant for the smallest plant and tend to be greater in the more dangerous plants. Similarly, Smith (1979) suggests that the relationship between firm size and injury rates probably is an inverted U-shaped. One possible explanation to the relationship is that small firms are less hazardous and easily monitored, while large firms, with the advantage of economies of scale are able to apply safety machineries and equipments.

Cooke and Gautschi (1981) examined the impact of OSHA citation activities and plant-specific programs upon changes in the injury rate for 113 Maine manufacturing plants over the period 1970 to 1976. Apart from OSHA citations, other factors included in the study are plant size and business cycle. The study employs the change in the percentage of production workers receiving first payments as a proxy measure of business cycle. They found that both firm size and business cycle were highly significant to injury rates. While firm size influences injury rates negatively, business cycle affects positively. They concluded that OSHA investigation activities have reduced the injury rate substantially for the case of larger firms.

Using a sample of 20 two-digit U.S. manufacturing industries from 1973 to 1983, Viscusi (1986) investigates the impact of OSHA on workplace safety. The independent variables included in the analysis are production workers, female workers and three variables to capture the influence of business cycle, namely the percentage change in the industry’s employment, average weekly work hours and average overtime hours. While
production workers are found to be positively related to accidents, female workers showed the reverse effect. A positive relationship between business cycle and injury rate is only significant for percentage change in the industry’s employment. The results thus support for cyclical relationship between employment and industrial accidents.

Currington (1986) analyses the impact of OSHA standards on injury frequency rates for 18 manufacturing industries in New York from 1964 to 1976. The analysis of the study is performed separately for “all injuries”, “caught in machine”, and “struck by machine” injuries. The independent variables included are unionization, capital intensity, firm size, new hire rate, employment ratio and production workers. All these variables are only significant for “all injuries” except the employment ratio, a proxy measure for cyclical variation. Among the significant variables, firm size is found to be the only variable which affects injury frequency negatively.

Jeong (1997) analyses the characteristics and causes of accidents for Korean manufacturing industry during 1991 to 1994. Analysis of causes of accidents in the study includes firm size, age and work experience. The analysis shows that larger companies tend to have a lower accident rate and adult and less experience workers are more prone to accident. Fabiano et al. (2004) examine the relationship between occupational injuries and types of Italian industry during 1995 to 2000 with a large sample of 2,983,753 firms. They identify four major factors that influenced accident frequency, namely: economical factors, technologies used, organizational factors and human factors and relate these factors to the firm size effect. An inverse relationship between accident frequency and firm size is found in all types of industries. The results of the study suggest that the four factors are unfavorable for small firms which prove to be more liable to high accident frequency.

Previous studies on industrial accidents in Malaysia are mainly focused on the evolution and enforcement of OSHA and level of awareness and knowledge on safety issue among employers and employees (Jamalu’din, 1994; Mansur et al., 2003; Ariffin et al., 2006; Rampal and Nizam, 2006; Lugah et al., 2010). As shown by their studies, safety and health regulations in Malaysia have evolved from very prescriptive legislations to detailed technical provisions and to the one that is more flexible where self-regulations are encouraged under OSHA 1994. Rahmah and Sum (2000) on the other hand, analyze the impact of OSHA on labor market demand in 50 manufacturing firms. The results of cross-sectional analysis of their study show that OSHA has a significant impact on the demand for labour by firms. The impact of OSHA is also different across types of industry where labor-intensive firms were found to be more sensitive towards the regulations. A recent study by Suriyent et al. (2011) investigates the impact of demographical variables (company size, type of organization and years of establishment), management commitment, external support and legislation on occupational safety and health (OSH) implementation in small and medium enterprises (SMEs) in Malaysia. The correlation analysis performed on surveyed data of 35 companies shows that only management and external support were significant to OSH implementation where both variables have positive correlation.

Several studies have attempted to examine the causes of industrial accidents in the construction sector in Malaysia (AbdulHamid et al., 2008; Ali et al., 2010, Zakaria et al., 2010). Through analysis made on surveyed data, they show that the main causes of accident at construction sites are workers’ negligence, failure to obey the work procedures, work at high elevation, operate equipments without safety devices, poor site management and low skill and knowledge.

A study on accidents at port sites by Mansor et al. (2011) focuses on two common dimensions of workplace accidents, namely individual and job related factors. Using 177 surveyed samples, correlation test results show that stress and fatigue, unsafe action, machinery and tools, design of workplace, training procedures are the significant factors that contribute to workplace accident.

MODEL SPECIFICATION AND DATA DESCRIPTION

This study analyzes the determinants of industrial accidents in 44 Malaysian manufacturing industries during the period from 1993 to 2008. The structure of our data set which contains both cross-sectional and time series satisfies the balanced panel data estimation technique. Using panel data with a large number of data points and high degree of freedom helps to reduce the multi-collinearity problem (Hsiao, 2003). To identify which character of our data set belongs to, either fixed or random, the Hausman specification test is first performed. The test results suggest that the industry-specific effects are fixed and the general fixed-effects model is presented as follows:

\[
Y_{it} = \alpha_i + \beta_i X_{it} + \mu_{it}
\]

(1)

where \(Y_{it}\) is the dependent variable, \(i\) is entity, \(t\) is time, \(\alpha_i\) is the entity-specific intercept and \(\beta_i\) is the coefficient for independent variable, \(X_i\) and \(\mu_{it}\) is the error term. Based on the general fixed-effects model, we rewrite Equation 1 into the following specification:

\[
IR_{it} = \alpha + \beta_1 \log S_{it} + \beta_2 \log K_{it} + \beta_3 PW_{it} + \beta_4 F_{it} + \beta_5 CV_{it} + \mu_{it}
\]

(2)

Where:

- \(IR\) = The injury rate
- \(S\) = Firm size
- \(K\) = Capital intensity
- \(PW\) = Percentage of production workers in the industry
- \(F\) = Percentage of female workers in the industry
- \(CV\) = Cyclical variation
- \(\alpha\) = Industry-specific intercepts
- \(\beta\) = Coefficient for each independent variable;
- \(\mu\) = Error term
- \(i\) = Industry
- \(t\) = Year
The injury rate, as a proxy for industrial accidents, is measured by the percentage of accidents reported per worker employed. Firm size is measured by employees per establishment and capital intensity is measured by the value of fixed assets per worker where these two independent variables take the natural logarithm form. Production workers and female workers are respectively measured as a percentage of total employment. The cyclical variation variable is measured by the percentage change of total employment in the manufacturing industries.

Most studies on occupational accidents and business cycle support the existence of pro-cyclical relationship where the number of accidents tends to increase during economic upswings and reduce during economic recession (Kossoris, 1938; Leigh, 1985; Robinson and Shor, 1989). Thus, we expect a positive relationship between injury rates and cyclical variation. Similarly, capital intensity, production worker, and female worker are expected to have positive influence over the injury rates. As for firm size, a negative relationship with injury rate is expected in the sense that larger firms are better in controlling accidents among workers as compared to smaller firms (Cooke and Gautschi, 1981; McVittie et al., 1997).

Three types of industrial accidents are included in the study, viz. fatal accidents, permanent disability and temporary disability. Data on industrial accidents were obtained from annual report published by social security organization (SOCSO). The annual survey of manufacturing industry, published by the Department of Statistics, provides data on total employees, fixed assets and total establishments for each industry. Unpublished data of production workers in manufacturing plants were obtained from the Department of Statistics. We precede the analysis of this study by estimating our balanced panel data using pooled ordinary least square (OLS) method and compare the results with those under Equation 2 specification which is the fixed effects model.

Table 3 presents a summary of the descriptive statistics of the variables used in this study. During 1993 to 2008, the average injury rate among the sample manufacturing industries was approximately 3.90% ranging from a minimum of 0 to a maximum of 54.86%. The lowest and the highest injury rate came from tanneries and leather finishing industries and metal and wood working machinery manufacturing, respectively. Based on the cut-off point of 120, on average, the Malaysian manufacturing industries can be classified as capital intensive or heavy industry (UNIDO, 1985; Fatimah and Saad, 2004). The mean for total production worker and female worker were 57.86 and 21.33%, respectively. The average cyclical variation was 5.60% throughout the period of study.

### RESULTS AND DISCUSSION

The regression results for three different model specifications are reported in Table 4. The second column of the table shows the results from pooled OLS estimates, which is Model 1. As shown in Model 1, firm size, capital intensity and cyclical variation are the significant variables under pooled OLS. R-squared value for pooled regression is lower than that of Models 2 and 3 whereby only 25% of variation in dependent variable can be explained by the explanatory variables included in the model. Models 2 and 3 are the fixed-effects estimation results. Under this specification, we treat Model 2 as the reference model. In Model 3, production workers (PW) is excluded to isolate the possible influence of this variable over female workers (F) resulting from our measurement method.

The results of this study reveal a strong negative relationship between firm size (S) and injury rate (IR) as the sign of the coefficient and its level of significance are consistent under the three models. This finding is consistent with the theory (Oi, 1974; Smith, 1979) and supports the empirical findings of previous studies (Cooke and Gautschi, 1981; McVittie et al., 1997). It turns out that the larger the firm, the lower the injury rates. This could be attributed to a proper safety precaution practiced by larger firm or adoption of safety machinery and equipments.

The coefficient for capital intensity (KI) is positive and highly significant under pooled OLS (Model 1) and consistent with the findings of Currington (1986). However, this variable appears to be insignificant under the fixed effects method. One possible explanation for the difference is that the variation among industries in terms of capital intensity is not an important factor that causes the injury rates to vary across the sample industry.

Production workers (KI) and female workers (F) are found to have positive influence over injury rates (IR) and only significant under fixed-effects estimation. Our finding with respect to production workers is consistent with Viscusi (1986). The result is justifiable as production workers are those who are directly involve in firms operation and having direct contact with machineries and equipments. Hence, increase in the fraction of production workers in manufacturing plants would increase the injury rates. In contrast, Viscusi (1986) found a negative relationship between female workers and industrial accidents where he expected that higher fraction of female workers involve less physical effort and pose lower risk.

A positive sign of female workers in this study leads us to draw a number of inferences. A common explanation is

<table>
<thead>
<tr>
<th>Variables</th>
<th>IR</th>
<th>S</th>
<th>KI</th>
<th>PW</th>
<th>F</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>3.90</td>
<td>134.21</td>
<td>120.63</td>
<td>57.86</td>
<td>21.33</td>
<td>5.60</td>
</tr>
<tr>
<td>Median</td>
<td>1.99</td>
<td>75.80</td>
<td>73.76</td>
<td>65.06</td>
<td>17.40</td>
<td>3.06</td>
</tr>
<tr>
<td>Maximum</td>
<td>54.86</td>
<td>1399.63</td>
<td>1367.41</td>
<td>92.17</td>
<td>75.20</td>
<td>136.61</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.00</td>
<td>1.51</td>
<td>1.76</td>
<td>0.13</td>
<td>0.00</td>
<td>-83.87</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>5.50</td>
<td>202.49</td>
<td>174.46</td>
<td>21.26</td>
<td>18.20</td>
<td>23.65</td>
</tr>
</tbody>
</table>

**Table 3. Descriptive statistics.**

- IR: Injury Rate
- S: Firm Size
- KI: Capital Intensity
- PW: Total Production Worker
- F: Female Worker
- CV: Coefficient of Variation

The results of this study reveal a strong negative relationship between firm size (S) and injury rate (IR) as the sign of the coefficient and its level of significance are consistent under the three models. This finding is consistent with the theory (Oi, 1974; Smith, 1979) and supports the empirical findings of previous studies (Cooke and Gautschi, 1981; McVittie et al., 1997). It turns out that the larger the firm, the lower the injury rates. This could be attributed to a proper safety precaution practiced by larger firm or adoption of safety machinery and equipments.

The coefficient for capital intensity (KI) is positive and highly significant under pooled OLS (Model 1) and consistent with the findings of Currington (1986). However, this variable appears to be insignificant under the fixed effects method. One possible explanation for the difference is that the variation among industries in terms of capital intensity is not an important factor that causes the injury rates to vary across the sample industry.

Production workers (KI) and female workers (F) are found to have positive influence over injury rates (IR) and only significant under fixed-effects estimation. Our finding with respect to production workers is consistent with Viscusi (1986). The result is justifiable as production workers are those who are directly involve in firms operation and having direct contact with machineries and equipments. Hence, increase in the fraction of production workers in manufacturing plants would increase the injury rates. In contrast, Viscusi (1986) found a negative relationship between female workers and industrial accidents where he expected that higher fraction of female workers involve less physical effort and pose lower risk.

A positive sign of female workers in this study leads us to draw a number of inferences. A common explanation is
to relate accident to the natural characteristics of women which physically are less capable of performing some tasks (Lin et al., 2008). Industrialization would normally result in increase participation of women in manufacturing industries and most of them are assigned the same tasks as performed by men. In addition, workplace and machinery designs are usually designed to fit male’s capacity (Taiwo et al., 2008). Hence, these factors would expose female workers to the similar risks faced by male workers, but the impact would be different as far as women physical anthropology is concerned.

Our result for business cycle (CV) impact on industrial accident is consistent with pro-cyclical relation in previous studies (Kossoris, 1938; Leigh 1985; Cooke and Gautschi, 1981; Robinson and Shor, 1989). The coefficient for cyclical variation remains positive and significant under the three different estimations, suggesting that business cycle is an important determinant of injury rate in the Malaysian manufacturing sector.

**CONCLUSION AND POLICY IMPLICATION**

This paper sought to analyze the determinants of industrial accidents in the Malaysian manufacturing sector during the period 1993 to 2008. Adopting the structural and business cycle approach, our panel data was tested using pooled OLS and fixed-effects estimation method. The explanatory variables included in the analysis of this study are generally significant to injury rates and consistent with the findings of existing studies.

The most robust findings of this study are that industrial accidents were negatively influenced by firm size and positively influenced by cyclical variation. Consistent with previous studies, this study found that large manufacturing firms are more capable of controlling accidents at workplace as compared to small firms. This reflects greater level of awareness on OSH matters among large firms. Efforts by employers from SMEs in Malaysia in promoting safety and health in the workplace are still lacking (Rampal and Nizam, 2006) possibly due to low awareness over OSH requirements (Suriency et al., 2011). Under OSHA 1994 (Section 30), every employer shall establish a safety and health committee at the place of work if there are 40 or more persons employed. Lack of law enforcement on smaller firms is possibly the underlying factor that they are less sensitive towards OSH issues. Therefore, to improve safety at workplace in Malaysian manufacturing industries, higher priorities should as well be given to small firms through supplementary and special inspection to ensure that small firms apply the appropriate safety and health standards and codes of practices.

Similarly, focus of safety regulations should as well be given to reduce business-cycle-related injuries. Since business cycle is an unpredictable phenomenon, advanced preventive efforts towards potential accidents among workers during economic upswing might be useful.
to reduce accidental risks in industries. Preventive measures may include training programs and technical skills education. In Malaysia, there have been concerted efforts among government agencies to prepare the Malaysian youths with relevant skills, knowledge and experience through vocational and technical schools, polytechnics and industrial training institutions. On the employers’ side, hiring safety machineries and equipments as well as safety devices will further help to reduce the risks of getting injured at workplace.

The results of this study also reveal that production workers and female workers in manufacturing plant are equally significant for injury rates. It is generally known that production workers, either male or female, are those who directly perform the operation in the plants and have a direct contact with machinery and equipments. Poor working attitude, inadequate knowledge and experience, and poor supervision by the management are among the factors that place them into accidental risks. Therefore, improved training programs and enforcement of compliant safety regulations should be the priorities by both the employees and employers.

This study has shown that industrial accidents in Malaysia are generally attributed to both business cycle and structural factors. Hence, it suggests the importance of OSHA enforcement and its compliance to codes of practices among manufacturing industries in Malaysia. Our study is limited by some measures which were not able to be included in the analysis, such as compensation, level of workers’ knowledge, workers' experience and other relevant factors. We leave these limitations to be improved in future in-depth analysis.

REFERENCES