



# The association between attempted suicide and stock price movements: Evidence from Taiwan



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## ABSTRACT

This study is the first comprehensive analysis to investigate the potential association between stock market fluctuations and attempted suicide events as measured by self-inflicted injuries treated in hospitalization. Using nationwide, 15-year population-based data from 1998 through 2012, we observe that the occurrences for the hospitalizations of attempted suicides are apparently predicted by stock price movements. A low stock price index, a daily fall in the stock index, and consecutive daily falls in the stock index have been shown to be associated with increased risk of hospitalization in patients with attempted suicide. More specifically, stock price index is found to be significant impact on attempted suicide in the 45–54 age groups of both genders, whilst daily change is significant for both genders in the 25–34 and 55–64 age groups and accumulated change is only significant in female aged 25–44 and above 65. On the basis of the results, relevant organizations should consider the suicidal factors that relate prime-working-age and near-retirement-age people to better carry out specific suicide prevention measures, and, meanwhile, encourage those people to pay less attention towards daily stock price movements.

## 1. Introduction

The incidence of suicide in Taiwan and globally is an important public health issue over the last decade, and its influence on the entire society is still increasing. The World Health Organization (WHO) recently estimated that 804,000 people worldwide died by suicide during 2012, representing approximately 11.4 per 100,000 persons, or one death every 40 s (WHO, 2014). In the past decades, suicide mortality rates in Taiwan had been steadily rising from 7.6 per 100,000 populations in 1995, reached its highest level of 19.3 per 100,000 populations in 2006, and then declined to 15.7 per 100,000 populations in 2015. Over 3600 suicide deaths occurred in 2015, making suicide 11th among the leading causes of death (Ministry of Health and Welfare, 2015). In 2008, during the “Great Recession”, over 4100 people died by suicide, presenting a suicide rate of 15.2 per 100,000 populations, and pushing suicide the ninth leading cause of death. In response to this public health threat, greater insight into the complexity of suicidal behavior can help facilitate the development of effective prevention efforts.

Identifying the major predictive factors for suicide should help in devising effective social and policy initiatives for suicide prevention.

Suicidal behavior has been viewed as a multifaceted clinical phenomenon shaped by many factors. Epidemiological studies have shown many risk factors: age (Gunnell et al., 2003), gender (Lin and Lu, 2008), psychiatric history (Weiser et al., 2015; Smith et al., 2015), area (Singh and Siahpush, 2002; Tiesman et al., 2015), interpersonal relationships (Ping et al., 2003; Brent and Mann, 2006), marital status (Yeh et al., 2008; Yip et al., 2015), socioeconomic factors (Rehkopf and Buka, 2006; Knipe et al., 2015), season/climate (Lee et al., 2006; Bramness et al., 2015), ethnicity (Liu et al., 2011), disaster (Ohto et al., 2015), unemployment (Fountoulakis et al., 2013; Breuer, 2015), business cycles and economic recession (Luo et al., 2011; Reeves et al., 2012; Norstrom and Gronqvist, 2015).

Among these risk factors, economic conditions have drawn considerable attention in recent years, because of the recent rash of financial crises. An economic crisis encompasses the state of affairs provoked by a sudden and severe economic recession. During economic recession certain individuals may have an increased risk for suicide, because of the sudden deterioration in their social status and their difficulties in adjusting to the gap between their expectations/demands and their ability to realize them, particularly when society fails to help those individuals readjust.

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A growing body of empirical work has considered how economic conditions are associated with suicide. Most research on the impact of economic fluctuations on suicide in the last century conducted their studies in Western societies, and the findings vary between countries with different economic and social conditions. For example, rising unemployment rates are associated with increases in suicide rates in the United States (Ruhm, 2000), Italy (Preti and Miotto, 1999), Australia (Berk et al., 2006), Spain (Granados, 2005), New Zealand (Blakely et al., 2003), Japan (Granados, 2008), and many European Union countries (Economou et al., 2008). Nevertheless, the association between unemployment conditions and suicide rates is a counter-cyclical variation in the United Kingdom (Boor, 1980) and Germany (Neumayer, 2004), and even non-existent in Scotland (Crombie, 1989).

In respect of an economic crisis, the literature notes mixed results of any association with the suicide rate. Some suicide studies focusing on an economic crisis report that suicides increased rapidly in the United States during the Great Depression (Tapia Granados and Diez Roux, 2009; Stuckler et al., 2012; Phillips and Nugent, 2014) and in South Korea, Japan, and Hong Kong after the outbreak of the Asian economic crisis (Kim et al., 2004; Chang et al., 2009). Others present that the suicide rate has declined during times of economic crisis in Finland and Sweden (Stuckler et al., 2009; Hintikka et al., 1999).

Economic conditions may exert an influence on suicides by acting at multiple levels. Not only does economic fluctuation cause a change in the burden of the economy on an individual, but it also affects access to and the quality of social safety nets, e.g., job placement, subsidies for household bills, and other cash equivalents for food. Economic changes or business cycles, consisting of economic expansions and recessions, are generally measured using changes in real gross domestic product, unemployment, industrial production, and wholesale and retail sales, yet these important economic indicators may nonetheless be removed from the everyday experience of individuals. Alternative measures, such as wage levels, hours worked, consumer confidence, and stock market fluctuation, might more adequately capture the economic insecurity experienced by populations during times of economic crisis. We therefore propose stock market movements as an appropriate proxy for changes in economic conditions, essentially because drops in the value of stocks can and often do announce the multiplication of business failures with the consequential loss of jobs. In other words, fluctuations of stock markets price can more adequately capture the economic insecurity experienced by a population during times of economic adversity (Nandi et al., 2012; McInerney et al., 2013; Cotti et al., 2015).

Attempted suicide is itself a serious mental health and social problem and is significantly associated with the risk of completed suicide (Isometsa and Lonnqvist, 1998). However, most epidemiologic studies focus on completed suicide rather than attempted suicide and intentional self-injury. Consequently, previous epidemiologic studies of suicide do not reflect the patterns of “suicide cases” seen in hospitals, where such patients are much more likely to represent a suicide attempt. Moreover, a hospital visit related to deliberate self-harm is a positive predictor of future completed suicide. Any new knowledge of hospital patients who have attempted suicide and self-inflicted injury may encourage the development of tailored and effective models for clinical and preventive implications.

The major aim of this study is to provide empirical evidence to comprehensively demonstrate how changing economic conditions impact overall and age-specific suicide attempts in Taiwan from 1998 to 2012. We use the stock market price index as a measure of economic fluctuation. People may have no direct or indirect financial interest in the stock market, and thus whatever the mechanism is, it cannot work through all personal portfolios, or at least not entirely so. However, for much of the time during an economic cycle, stock market fluctuations do reflect investors' and the public's feelings or perception of the health of the economy. In other words, the stock market is the most watched indicator for not only of the present situation, but also of the future. For

example, during the collapse of Lehman Brothers when the Taiwan stock market was falling rapidly, it was reasonable enough for people to have dire fears about the future, and those fears were heavily intensified by mass media, sending highly correlated interpretations of negative financial events to a large segment of the population. Our study provides evidence on the mechanisms linking the stock market to attempted suicide and intentional self-injury by examining the relationship between stock market fluctuations and daily hospitalizations owing to attempted suicide.

## 2. Methods

This study uses data from the National Health Insurance Research Dataset (NHIRD), published by the National Health Research Institute in Taiwan, covering the years 1998–2012. The NHIRD is currently one of the largest and most comprehensive nationwide population-based datasets available in the world, covering over 97% of Taiwan's 23 million citizens, and includes all claims data from the National Health Insurance (NHI) program, which was implemented in 1995 as a means of providing comprehensive coverage of all inpatient and outpatient care. The NHI system has a unique combination of characteristics that include universal coverage, a single-payer system (with the government as the sole insurer), and comprehensive benefits coverage. The NHI data are therefore more complete compared to data from other countries that lack universal medical insurance.

In this study we choose hospitalization records of suicide and self-inflicted injuries, because they are population-based, and such patients who poison by solid or liquid substance and gas, or injure by hanging, suffocation, drowning, or jumping from high places are more likely to represent a suicide attempt. Our data are from 1 January 1998 to 31 December 2012, whereby hospitalization for suicide, self-inflicted injury and undetermined-intent injury are defined by the *International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM)* code of E950 to E959 and E980 to E989 in the primary diagnosis field, with the original sample providing a total of 5479 observations on daily attempted suicide hospitalization records. There are approximately 21 cases of hospitalization daily attributable to attempted suicide during the sample period.

For the research on the attempted-suicide implications of the stock market, we measure stock performances using the level of the Taiwan Stock Exchange Capitalization-weighted Stock Index (TAIEX). The first observation on the TAIEX in our sample period occurred on 3 January 1998, with a closing index value of 8159.11, after falling 28.16 points. The final observation on the TAIEX occurred on 28 December 2012, with a closing index value of 7699.5, after rising 51.09 points. The global financial crisis that began in the summer of 2008 saw a rise in the domestic unemployment rate from 3.8% in April 2008 to 6.1% at its peak in August 2009, as well as a collapse and subsequent recovery in the stock market - the TAIEX on 16 September 2008 fell 295.83 points (−4.89%), the time of the Lehman Brothers bankruptcy, and then fell further to the lowest value of 4089.93 on 20 November 2008.

In light of the evolution of both the stock price index and attempted suicide hospitalization, as depicted in Fig. 1, we applied the Hodrick–Prescott (HP) filter to decompose log monthly average stock index and log monthly aggregated attempted suicide hospitalization into a trend and a cyclical component (Hodrick and Prescott, 1997). The figure shows that the long-term trend patterns between stock market price and suicide attempts show a strongly negative association. Hospitalizations from attempted suicide increased as the stock index went into a downward trend, however, when the stock index increased after 2004, hospitalized admissions still continued to go down.

The relationship between stock market prices and attempted suicide has been understudied, perhaps because it is not easily addressed in cross-sectional data. Exploring the link between stock prices and attempted suicide also requires relatively high frequency time-series data. We present three reasons for choosing the TAIEX. First, the TAIEX

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