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Stock or stroke? Stock market movement and stroke incidence in Taiwan

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ABSTRACT

This paper investigates the impact of stock market movement on incidences of stroke utilizing population-based aggregate data in Taiwan. Using the daily data from the Taiwan Stock Exchange Capitalization Weighted Stock Index and from the National Health Insurance Research Database during 2001/1/1–2007/12/31, which consist of 2556 observations, we examine the effects of stock market on stroke incidence – the level effect and the daily change effects. In general, we find that both a low stock index level and a daily fall in the stock index are associated with greater incidences of stroke. We further partition the data on sex and age. The level effect is found to be significant for either gender, in the 45–64 and 65≥ age groups. In addition, two daily change effects are found to be significant for males and the elderly. Although stockholdings can increase wealth, they can also increase stroke incidence, thereby representing a cost to health.

Introduction

Recent decades have seen enormous growth in the pursuit of wealth through the purchase of financial stocks, with such activity essentially being based on the possibility of investors accruing a sizeable fortune over a relatively short period of time. In terms of financial assets, high returns are invariably associated with high risk, a factor which is often defined as the 'variance in returns' of such assets.

Holding on to a risky asset is regarded as being more costly than holding on to a safe asset, essentially because the return of a risky asset may well be negative; however, aside from the financial cost of holding on to such risky stocks, there may be other costs which cannot be measured in purely monetary terms, since the pursuit of gains in such a way may also be costly to the health of individual investors. Despite the general recognition of the long-run existence of a positive association between personal wealth and health, any short-run fluctuations in wealth may actually give rise to long-lasting harm to the health of such investors.

An abundance of literature is already available on the relationship between wealth and incidences of stroke, with most of the prior studies concluding that greater wealth is generally associated with lower stroke incidence rates (Ettner, 1996; McClellan, 1998; Meer, Miller, & Rosen, 2003; Smith, 1999; Wu, 2003). The 'wealth effect' on stroke incidence rates is invariably examined using micro-level survey data; however, in the present study, we examine this relationship from a different perspective, using population-based aggregate data to investigate the impact of stock market movements on incidences of cerebrovascular disease.

Incidences of stroke are one of the leading causes of death in developed countries, and indeed, were the third major cause of death in Taiwan in 2009. Furthermore, a number of studies are now suggesting that strokes are set to become the second leading cause of death worldwide as well as one of the leading causes of disability. There are currently approximately 5.5 million deaths worldwide each year as a direct result of stroke, with such attacks resulting in a further 49 million people subsequently suffering from severe disabilities (Berger, Schulte, Stogbauer, & Assmann, 1998; Cox, McKevitt, Rudd, & Wolfe, 2006; van Rossum, van de Mheen, Breteler, Grobbee, & Mackenbach, 1999; Wolf, D'Agostino, Belanger, & Kannel, 1991).

Incidences of stroke place an enormous burden on a country's national health system, mainly as a result of the requirement for ongoing care (Jakovljevic et al., 2001; Saka, McGuire, & Wolfe, 2009; Wolf et al., 1991). This issue has therefore attracted enormous attention, with a considerable number of studies investigating the risk factors associated with stroke, such as smoking, blood pressure, body mass index, cholesterol, diabetes, alcohol consumption, urbanization and socioeconomic status (Boysen et al., 1988; Brown, Guy, & Broad, 2005; Diez-Roux, Link, & Northridge,

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2000; Hart, Hole, & Smith, 2000; Jakovljevic et al., 2001; Jiang et al., 2006; Lin, Lin, Liu, Chen, & Chiu, 2007).

Over recent years, of all of these risk factors, particular focus has been placed on the examination of socioeconomic status and its importance with regard to the impact on incidences of stroke. The majority of the studies examining this factor have tended to use individual-level data from which an inverse correlation is reported between incidences of stroke and socioeconomic status. For example, based upon hospital administration data, with adjustment for risk factors, Hart et al. (2000) found an inverse association between strokes and categories of deprivation. Additionally, based upon panel data from the US Health and Retirement Study, Avendano and Glymour (2008) found that both wealth and income were significant contributory factors to incidences of stroke.

Other studies have focused on the effects of personal economic status as measured by employment status, noting that involuntary job loss can worsen mental health, with the stress from losing one's job subsequently raising incidences of cardiovascular disease (Gallo et al., 2004; Mandal & Roe, 2008).

A number of related studies have used nationwide aggregate data to examine the relationship between national economic conditions and mortality rates, with the majority of these studies focussing on the analysis of the relationship between unemployment rates and the mortality rates of specific diseases. Unfortunately, however, the use of aggregate-level data in these studies has resulted in rather inconclusive evidence on the health–wealth relationship.

In the earlier studies, it was often suggested that a negative relationship would be found to exist between national economic conditions and mortality risk, with mortality rates being higher during periods of recession (Brenner, 1971, 1975, 1979). However, some of the more recent studies continue to find either a negative or insignificant relationship, whilst others have actually found the relationship to be positive (Gerdtham & Johannesson, 2005; Gerdtham & Ruhm, 2006; Miller, Page, Stevens, & Filipski, 2009; Ruhm, 2003, 2008; Tapia Granados, 2005).

The primary aim of the present study is to examine the impact of changes in wealth on the nationwide prevalence of strokes in Taiwan. We use the stock price index as a measure of personal wealth, although we recognize that this measure is far from perfect. Personal wealth does of course include other types of assets; however, it is extremely difficult to obtain data providing details of such assets, particularly when our overall aim is to measure their value over time.

We therefore propose stock market movements as an appropriate proxy for changes in personal wealth, essentially because financial stocks have become a very common means of managing personal wealth in Taiwan. The arrival of news on daily stock market movements in Taiwan is provided by various mass media sources, such that by the end of 2009, the number of stock accounts in Taiwan had climbed to 15,122,181, a figure which represents about 65 per cent of the island's population. Moreover, the market trading value in 2009 was about 30,118 trillion New Taiwan Dollars, which was nearly 2.4 times of GDP of Taiwan in that year.

Domestic individual investors play a very important role in the Taiwan stock market; indeed, in 2001, contributions to total market transactions were 85 per cent for domestic individual investors, 9 per cent for domestic institutional investors and 6 per cent for foreign institutional investors. Despite the overall weighting of transactions by domestic individual investors having fallen to 72 per cent in 2009, as compared to other types of investors, domestic individuals clearly continue to be the major contributors to stock market transactions in Taiwan.

Data and methodology

Our dependent variable is the number of daily incidences of stroke, with each hospitalization as a result of a cerebrovascular attack (CVA, ICD-9 code 430–437) being counted as one incidence of stroke. The data on strokes in Taiwan are obtained from the National Health Insurance Research Database (NHIRD) provided by the National Health Research Institutes (NHRI). All personal identified were encrypted by the NHRI before release to the public. Because the NHIRD consists of de-identified secondary data released for research purposes, this study was exempt from full review by the institutional review board.

Taiwan implemented its national health insurance (NHI) system in 1995, with the NHIRD containing records of all inpatient and outpatient treatment provided under the system since then. Our selection of NHI inpatient records as the health measure for use in the present study is based essentially upon merit. Firstly, as compared to the outpatient data provided by the NHRI, which are sampling-based, the inpatient records are population-based; thus, the use of inpatient data can help to avoid potential issues of sampling bias. Secondly, we select inpatient care over outpatient care because the former has lower demand elasticity than the latter; thus, hospitalizations are more likely to reflect actual changes in health status (Manning, Newhouse, Duan, Keeler, & Leibowitz, 1987; Ruhm, 2003).

One potential criticism of the use of morbidity, as opposed to mortality, as our health measure, is that individuals may choose to receive medical services during periods of economic expansion essentially because they have more disposable income, or during periods of recession as a result of the lower opportunity costs. However, this concern is greatly reduced in our study as a result of Taiwan's 1995 implementation of the NHI system, since this means that the cost of receiving medical services should not be a major concern.

Our inpatient data covers the period from 1 January 2001 to 31 December 2007, with the original sample providing a total of 2556 observations on daily CVA hospitalization records. There were approximately 230 cases of hospitalization daily attributable to CVA during the sample period. We find that the maximum number of daily CVA hospitalizations was 367 (occurring on 18 February 2002), whilst the minimum number during this period was 94 (occurring on 25 May 2003). For our empirical analysis, the CVA observations are also divided according to gender, age and region.

Our key explanatory variables are based upon the stock price index, which is provided by the Taiwan Stock Exchange Capitalization-weighted Stock Index (TAIEX), with the data being obtained from the Taiwan Stock Exchange (TWSE) website. Two effects of the stock price index are examined in the present study, the first of which is the 'level' effect, whilst the second is the 'daily change' effect; we take the daily close index as the stock market price level, and measure the daily change in the stock index as the percentage change from the open index to the close index on that day. The stock price index level measures the overall macroeconomic status and serves as a proxy of the wealth level. The daily percentage change in stock price index captures the wealth variation in the short run. Previous studies have shown that the stock investors are engaged in short-term trading in some emerging markets. Using a complete individual-level stock trading dataset of Taiwan, Barber, Lee, Liu, and Odean (2009) find that day trading is prevalent in Taiwan – the percentage of day trade to all trades was 23.1% during their study period, 1995–1999. Moreover, they show that the average turnover in Taiwan Stock Exchange was 294% annually. In contrast, the annual turnover in the New York Stock Exchange was about 97%. The statistics indicates that short-term stock trading plays an important role in Taiwan. Thus, the daily effect of stock price change is included in our analysis.

The first observation on the TAIEX in our sample period occurred on 2 January 2001, with an open index level of 4717.49 and a close index level of 4935.28. The final observation on the TAIEX occurred on 31 December 2007, with an open index level of 8450.32 and a close index level of 8506.28. The close index touched its lowest level of 3446.26 on 3 October 2001, and reached its highest level of 9809.88 on 29 October 2007. The greatest daily rise in the TAIEX, at 4.76 per cent, occurred on 16 January 2001, whilst the greatest daily fall, at −5.59 per cent, occurred on 5 May 2004. For those non-transaction days such as weekends and holidays, we set the close index value equal to the previous transaction close index value. It follows that the daily change of stock index for a non-transaction day is zero.

Incidences of stroke are known to have seasonal patterns; indeed it has been documented that the stroke incidence rate is higher on cold days (Chen, Chang, & Su, 1995; Ricci et al., 1992; Sobel et al., 1987). We therefore use dummy variables to control for the seasonal weather effects of different months. Furthermore, day-of-the-week dummies are also included in our analysis, since certain days of the week are also found to affect the stroke incidence rate, with some studies reporting that there were more occurrences of stroke on Mondays (Jakovljevic, 2004; Kelly-Hayes et al., 1995) although this feature was not found to carry over to groups of high socioeconomic status (Jakovljevic, 2004).

The outbreak of 'severe acute respiratory syndrome' (SARS) in 2003 was a significant event which occurred during our sample period, with the Department of Health announcing the first probable case of SARS in Taiwan on 26 April 2003. As the situation worsened, the Taipei Jen-Chi Hospital was temporarily closed down on 29 April 2003 as a result of hospital-acquired infections.

Although the epidemic situation worsened still further in May 2003, it was subsequently brought under control by June, and on 5 July 2003, the World Health Organization removed Taiwan from the list of areas with recent SARS transmissions. Thus, we observe a substantial drop in the number of hospitalizations during this period, a situation which may be attributable to the general avoidance of visiting hospitals in order to reduce the likelihood of becoming infected with SARS. We therefore include a dummy variable to control for the SARS outbreak during this period.

The following equation describes our estimation model, autoregression with exogenous variables (ARX):

$$\mathrm{CVA}_t = \alpha + \beta_1 \mathrm{INDEX}_t + \beta_2 \mathrm{DAYCHG}_t + \beta_3 \mathrm{DAYCHG}_t^2 + \sum_{i=2}^{7} \delta_i D_{it} + \sum_{j=2}^{12} \gamma_j M_{jt} + \theta \mathrm{SARS}_t + \tau \mathrm{Trend}_t + \phi_k \sum_{k=1}^{p} \mathrm{CVA}_{t-k} + \varepsilon_t \quad (1)$$

where CVA_t is the number of hospitalizations attributable to strokes on date t.

INDEX_t is the Taiwan Stock Exchange Capitalization-weighted Stock Index (TAIEX), with our stock index level effect being based upon the estimation of β_1. DAYCHG_t is the daily percentage change in the TAIEX, measured by the log of the close index minus the log of the open index on date t, with our first order daily change effect being based on the estimation of β_2. DAYCHG_t^2 is the squared daily change in TAIEX and is our second order daily change effect based on the estimation of β_3.

D_{it} is the day-of-the-week dummies, with Monday representing the reference day, and M_{jt} is the month dummies with January representing the reference month. SARS_t is equal to 1 if the observation is within the SARS outbreak period (26 April 2003–5 July 2003), otherwise 0. We include autoregressive terms to control for residual autocorrelation and determine the number of lags, p, based on the Bayesian Information Criterion (BIC). The lags of the daily change term may be included in the model since the impact on health may appear with time lag. We have estimated the models with three lags of the daily change effect. However, we only find limited significant coefficients in all estimations (pooled and subgroups). Moreover, the BIC prefers the model without the daily change lags in all cases. Therefore, we do not include the lags of the daily change effect. The empirical analysis in this study is performed under EViews 6. The summary statistics of all of the variables are presented in Table 1.

Estimation results

We present the estimation result of our model with autoregressive order one, three and four in Table 2. Although inclusion of more autoregressive terms increases the R^2, it also leads to less degrees-of-freedom in estimation. We set the maximum number of lags equal seven and select the model with three autoregressive terms based on the BIC. The last row of Table 2 reports the F-statistic and the result indicates the coefficients are jointly significant. Both the level effect and the daily change effect are found significant. The level effect is found to be negative, thereby indicating that a bear market increases incidences of stroke; the first order daily change effect is also negative, thereby implying that downward daily stock market movements also increase incidences of stroke; the second order daily change effect is found to be positive, thereby indicating that great daily index movements increase incidences of stroke in a quadratic way.

The level effect is found to be highly significant ($p < 0.001$), with the estimate of −4.396. This suggests that a 1000 point reduction in the stock market index leads to a daily increase of approximately 4.396 hospitalizations for occurrences of stroke. We can also obtain the index elasticity of stroke from the estimates. A 1000 point change in the stock market is about a 17% change off the mean. A 4.396 incidence decrease in hospitalization is about a 1.9% decrease off the mean. Therefore, the index elasticity of stroke is around 0.1.

Daily stock market movements are found to have a negative effect whilst the squared daily changes are found to have a positive effect on incidences of stroke. This implies that the relationship between daily market movement and incidence of stroke is not only linear. The greater daily movement, regardless upwards or downwards, also increase stroke incidence. It indicates that when the stock market index went down by 1 per cent within a single day, there was an increase of approximately 1.581 (=1.002 + 0.579)

Table 1
Statistics summary.

	Mean	S. d.	Min.	Max.
Dependent variables				
CVA	230.38	41.97	94	367
CVA_M	134.22	25.94	62	220
CVA_F	95.99	19.37	32	164
CVA_65	147.17	28.98	49	239
CVA_4564	70.30	14.34	30	128
CVA_2544	11.54	4.28	2	31
Independent variables				
INDEX	6.11	1.27	3.45	9.81
DAYCHG (%)	−0.09	0.98	−5.59	4.76

The data are from 2001/1/1 to 2007/12/31 and consist of 2556 observations. CVA is the daily number of hospitalizations owing to cerebrovascular accidents (ICD9CM code 430–437). CVA_M and CVA_F are the numbers of CVA hospitalization for male and female, respectively. CVA_65, CVA4564, and CVA_2544 are the numbers of CVA hospitalization for three age groups. The independent variables of interest are the stock market index divided by 1000 (INDEX) and the daily stock market index percentage change (DAYCHG). For concise representation, we omit the statistics of the dummy variables for weekdays, months, and SARS.

Table 2
Stock market and stroke incidence for all population.

	ARX(1)	ARX(3)	ARX(4)
C	307.595*** (5.466)	305.959*** (5.836)	305.610*** (5.960)
INDEX	−4.728*** (0.953)	−4.396*** (1.029)	−4.276*** (1.058)
DAYCHG	−0.974* (0.390)	−1.002* (0.396)	−0.957* (0.392)
DAYCHG^2	0.588** (0.201)	0.579** (0.195)	0.578** (0.192)
Tuesday	−35.061*** (1.616)	−35.106*** (1.618)	−35.110*** (1.618)
Wednesday	−37.693*** (1.651)	−37.695*** (1.613)	−37.703*** (1.616)
Thursday	−41.467*** (1.702)	−41.456*** (1.650)	−41.421*** (1.646)
Friday	−37.118*** (1.736)	−37.122*** (1.694)	−37.112*** (1.681)
Saturday	−74.960*** (1.576)	−74.977*** (1.547)	−74.985*** (1.544)
Sunday	−113.177*** (1.706)	−113.188*** (1.697)	−113.196*** (1.695)
February	1.542 (4.761)	1.681 (4.960)	1.497 (5.025)
March	2.692 (3.784)	2.921 (4.041)	2.820 (4.127)
April	−4.252 (3.824)	−4.023 (4.021)	−4.248 (4.091)
May	−11.813** (3.792)	−12.093** (4.062)	−12.227** (4.147)
June	−9.875* (3.842)	−10.144* (4.077)	−10.444* (4.148)
July	−15.491*** (3.777)	−15.129*** (3.996)	−15.146*** (4.073)
August	−14.450*** (3.816)	−14.116*** (4.041)	−14.264*** (4.117)
September	−14.906*** (3.734)	−13.868*** (4.007)	−13.896*** (4.091)
October	−11.765** (3.773)	−11.898** (4.048)	−11.944** (4.136)
November	−2.906 (3.632)	−2.321 (3.880)	−2.532 (3.962)
December	10.387** (3.756)	9.979* (3.961)	9.723* (4.019)
SARS	−48.579*** (7.598)	−46.411*** (7.853)	−45.836*** (7.939)
Trend	0.005** (0.002)	0.005** (0.002)	0.005* (0.002)
AR(1)	0.245*** (0.033)	0.206*** (0.028)	0.203*** (0.029)
AR(2)		0.110*** (0.022)	0.105*** (0.021)
AR(3)		0.078*** (0.020)	0.068*** (0.020)
AR(4)			0.047* (0.023)
R^2	0.7369	0.7427	0.7433
BIC	9.0495	9.0341	9.0352
F-statistic	308.16***	291.75***	281.18***

The number in the parenthesis is the Newey–West Heteroskedasticity Autocorrelation Consistent (HAC) standard error.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

in the number of hospitalizations for occurrences of stroke on that day. Note that the daily change effect was asymmetric due to the second order effect. If the stock market index went up by 1 per cent within a single day, there was a decrease of approximately 0.423 (=−1.002 + 0.579) in the number of stroke hospitalizations on that day. Moreover, the daily effect increased in quadratic manner when market went down: when the stock market index went down by 2 per cent within a single day, there was an increase of approximately 4.32 (=2.004 + 2.316) in the number of hospitalizations due to stroke on that day. The effects of stock index do not seem great in magnitude despite they are highly statistically significant in some cases. It may result from the health measure used in the study. An alternative measure can the number of stroke outpatient utilization but the national-wide outpatient dataset is not available to us. According to Chiu and Lien (2003), the number of stroke outpatient utilization is about 13 times of that of inpatient utilization based on the data of a medical center.

Our analysis exhibits significant weekday variations in occurrences of stroke; indeed, we find a significant Monday effect, similar to the prior studies (Jakovljevic, 2004; Kelly-Hayes et al., 1995). Using Monday as the reference day, we find that there were approximately 35.106 fewer hospitalizations for stroke on Tuesdays, 37.695 fewer on Wednesdays, 41.456 fewer on Thursdays, 37.122 fewer on Fridays, 74.977 fewer on Saturday, and 113.188 fewer on Sunday.

A seasonal (month) effect on occurrences of stroke is also discernible, with the number of hospitalizations for stroke increasing significantly during cold months (November–April); this is again consistent with the prior studies (Chen et al., 1995; Ricci et al., 1992; Sobel et al., 1987). The month effect is found to be most pronounced in December, when there were 9.979 more daily hospitalizations for stroke than in January. Finally, the number of daily hospitalizations for stroke during the period of the SARS outbreak was reduced by an average of about 46.411. Overall, there is a clear and significant upward time trend, which suggests a general increase in the number of occurrences of stroke between 2001 and 2007.

The results based upon the separation of the data by gender are presented in Table 3, from which we can see that the level effect of the stock index is negative for both males and females, but that the daily change effects are significant only for males. A 1000 point fall in the stock index is found to have increased hospitalizations for stroke by 2.772 for men, and by 1.821 for women. A 1 per cent fall in TAIEX within a single day is associated with an increase of 1.302 in number of stroke hospitalizations. In contrast, neither daily change effects are found to be significant for women. The patterns of the day-of-the-week effect and the month effect are similar to those found in the estimation for the full population sample. A point worth noting, however, is that whilst the upward time trend is highly significant for males, it has no significance for females.

These effects are further examined by different age groups in Table 4, which reveals that all the level and daily change effects are found to be significant for the elderly group. A 1000 point reduction in the stock index is found to have increased hospitalizations for stroke by 3.588 amongst the elderly, whilst a 1 per cent fall in the stock index within a single day is found to have increased hospitalizations for stroke for the same group by 1.026. Amongst the 45–64 age group, we find significance only for the level effect, and not for the daily change effects.

Neither the level effect nor the daily change effect is found to have significant impacts on occurrences of stroke for the 25–44 age

Table 3
Stock market and stroke incidence for data partitioned on gender.

	Male	Female
C	174.666*** (3.435)	132.298*** (3.002)
INDEX	−2.772*** (0.624)	−1.821*** (0.520)
DAYCHG	−0.604* (0.306)	−0.410 (0.220)
DAYCHG^2	0.428** (0.148)	0.101 (0.100)
Tuesday	−18.399*** (1.183)	−16.670*** (0.929)
Wednesday	−20.341*** (1.147)	−17.359*** (0.921)
Thursday	−22.377*** (1.193)	−19.027*** (0.935)
Friday	−20.403*** (1.201)	−16.700*** (0.936)
Saturday	−43.785*** (1.143)	−31.178*** (0.894)
Sunday	−65.193*** (1.164)	−48.051*** (0.955)
February	1.540 (3.077)	−0.108 (2.229)
March	2.260 (2.221)	0.178 (2.151)
April	−1.723 (2.353)	−2.931 (2.076)
May	−4.500* (2.241)	−7.751*** (2.083)
June	−3.245 (2.343)	−7.197*** (2.065)
July	−6.803** (2.265)	−8.875*** (2.055)
August	−5.568* (2.259)	−9.037*** (2.073)
September	−6.135** (2.320)	−8.522*** (1.985)
October	−4.220 (2.246)	−7.812*** (2.094)
November	0.118 (2.271)	−3.148 (1.961)
December	6.064** (2.213)	3.504 (2.112)
SARS	−27.606*** (4.335)	−19.979*** (3.568)
Trend	0.005*** (0.001)	0.001 (0.001)
Lag number selected by BIC[a]	3	4
BIC	8.372	7.883
F-statistic	189.64***	158.01***

The number in the parenthesis is the Newey–West Heteroskedasticity Autocorrelation Consistent (HAC) standard error.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.
Note that the pooled sample is the sum of men and women, so the coefficient for the level effect of the pooled sample is close to the sum of the coefficients of both genders. i.e., −4.4 ≈ (−2.77) + (−1.82). The difference may partly result from different model specification – 3 lags in men's estimation and 4 lags in women's estimation.
[a] We set the minimum number of lags equals 0 and the maximum number of lags equals 7.

Table 4
Stock market and stroke incidence for data partitioned on age.

	65≥	45–64	25–44
C	204.667*** (4.151)	86.649*** (1.942)	13.634*** (0.653)
INDEX	−3.588*** (0.717)	−0.921* (0.374)	−0.065 (0.117)
DAYCHG	−0.633* (0.288)	−0.314 (0.228)	−0.104 (0.076)
DAYCHG^2	0.393** (0.138)	0.122 (0.105)	0.011 (0.035)
Tuesday	−22.550*** (1.215)	−10.277*** (0.791)	−1.894*** (0.327)
Wednesday	−23.693*** (1.241)	−11.506*** (0.783)	−2.083*** (0.302)
Thursday	−25.470*** (1.228)	−13.322*** (0.780)	−2.103*** (0.301)
Friday	−23.624*** (1.222)	−10.999*** (0.814)	−1.893*** (0.311)
Saturday	−48.588*** (1.209)	−21.399*** (0.746)	−4.077*** (0.303)
Sunday	−74.282*** (1.215)	−32.724*** (0.818)	−5.325*** (0.289)
February	−0.282 (3.451)	1.355 (1.550)	0.314 (0.423)
March	0.200 (2.925)	2.153 (1.310)	0.237 (0.346)
April	−5.010 (2.835)	0.588 (1.393)	−0.071 (0.350)
May	−11.523*** (2.932)	−0.421 (1.258)	−0.144 (0.354)
June	−11.227*** (2.938)	0.710 (1.253)	0.489 (0.405)
July	−14.515*** (2.922)	−1.229 (1.244)	0.022 (0.390)
August	−14.256*** (2.931)	−0.804 (1.213)	0.553 (0.349)
September	−15.265*** (2.751)	0.104 (1.307)	0.652 (0.389)
October	−15.004*** (2.851)	1.943 (1.270)	1.191** (0.383)
November	−8.695** (2.873)	4.262*** (1.196)	1.689*** (0.410)
December	−0.778 (2.834)	8.458*** (1.211)	2.154*** (0.418)
SARS	−32.856*** (5.664)	−12.646*** (2.086)	−1.726*** (0.433)
Trend	0.003* (0.001)	0.002** (0.001)	0.000 (0.000)
Lag number selected by BIC[a]	3	2	0
BIC	8.458	7.529	5.621
F-statistic	232.08***	109.35***	24.65***

The number in the parenthesis is the Newey–West Heteroskedasticity Autocorrelation Consistent (HAC) standard error.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.
[a] We set the minimum number of lags equals 0 and the maximum number of lags equals 7.

group. However, the day-of-the-week effect, month effect and SARS effect are all found to exist in each of the three age groups, with the month effect being found to be stronger for the elderly group. It is again readily noticeable that the time trend has significance for the elderly group, but not for the other age groups.

Our result suggests that stock index has stronger effects on male and elder people and it urges us to investigate the effects based on the data divided by both gender and age. Table 5 shows that all three effects are significant only in the elderly male group. The level effect is significant in the elderly female group and in the mid-age male group. Comparing Table 3 and Table 5, we find that the significant effects for male are mainly driven by the elder males. Moreover, we find that the significance of two daily effects of the elderly group (in Table 4) is mainly driven by the elder males (in Table 5) since both daily effects are insignificant for the elder females.

Table 5
Stock market and stroke incidence for data partitioned on both age and gender.

Male	M65≥		M45–64		M25–44	
Index	−2.075***	(0.433)	−0.624*	(0.263)	−0.145	(0.091)
DAYCHG	−0.426*	(0.215)	−0.132	(0.165)	−0.073	(0.063)
DAYCHG^2	0.301**	(0.108)	0.078	(0.064)	0.015	(0.028)
Lags	3		0		0	
F-statistic	143.20***		78.27***		16.01***	
Female	F65≥		F45–64		F25–44	
Index	−1.645***	(0.382)	−0.339	(0.181)	0.075	(0.063)
DAYCHG	−0.235	(0.190)	−0.183	(0.134)	−0.014	(0.044)
DAYCHG^2	0.073	(0.088)	0.033	(0.062)	−0.010	(0.021)
Lags	4		0		0	
F-statistic	117.82***		51.36***		10.22***	

For concise presentation, we only report the coefficients of the level and daily change effects for each subgroup.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Discussion

Our empirical results reveal that stock price movements clearly have effects on incidences of stroke. Firstly, the level effect of the stock market index on stroke hospitalizations is found to be significantly negative; that is, when the stock market index is at a low level, incidences of cerebrovascular disease are found to be relatively high. In general, a 1000 point fall in the TAIEX increases the number of daily stroke hospitalizations by 4.396. Secondly, daily movements in the stock price are also found to affect incidences of stroke. A fall of 1 per cent in the TAIEX within a single day increases daily hospitalizations for stroke by 1.582; this result is in line with the general view that a reduction in wealth is detrimental to health status. Thirdly, a fall in TAIEX within a day increases daily stroke hospitalizations in a quadratic way. A 2 per cent fall within a single day leads to an increase of approximately 4.32 in the number of hospitalizations due to stroke on that day.

This gives rise to the question of how stock market movements affect incidences of stroke. One possible answer is that a reduction in wealth can often lead to depression, a condition which is already documented as being a high risk factor for stroke (Glymour, Maselko, Gilman, Patton, & Avendaño, 2010; Jonas & Mussolino, 2000). The level effect is found to be significant for both males and females whilst the daily change effects are found to be significant only for males. One potential reason for this significant daily change effect primarily affecting men is the fact that men participate in the stock market much more actively than women. Some researchers have also documented differences between men and women in terms of their attitude towards money; for example, Prince (1993) argued that men were more prone to feelings of greater competence in their management of finances and were therefore likely to take greater risks in order to amass wealth. From their analysis of survey and brokerage records, Lewellen, Lease, and Schlarbaum (1977) found that men spent more time and money on financial analysis, and also engaged in more transactions. Barber and Odean (2001) similarly examined a stock brokerage dataset, comprising of transactions by over 35,000 households, and found that men traded 45 per cent more than women. Thus, both the psychology and health status of men are more likely to be affected by daily stock market movements given that men engage far more actively in stock transactions than women.

The second order daily change effect is found positive in the pooled sample and in the male and elderly subgroups. Combined with the negative first order daily change effect, it implies that a fall on stock price has a larger impact on stroke incidences than a rise. This asymmetric effect may result from loss aversion, a property of prospect theory – the utility impact from a loss is greater than that from an equivalent gain (Kahneman & Tversky, 1979; Tversky & Kahneman, 1991). Loss aversion has been observed in various markets such as stock markets, housing markets, and wine markets (Barberis & Huang, 2001; van Dijk & van Knippenberg, 1998; Genesove & Mayer, 2001).

We also divide the inpatient records by age groups, and find that all the level effect and the daily change effects of the stock market are significantly negative on incidences of stroke for those people in the 65≥ age group. A significant level effect is also found for those people in the 45–64 age group, although the daily change effect is found to be insignificant. By comparison, for those in the 25–44 age group, no significance is discernible for either of the effects.

Our results indicate that age is crucial to the impact of the stock market on incidences of stroke, which is hardly surprising, since age itself is an important risk factor for stroke; thus, if stock movements do increase incidences of stroke, this should have the

greatest effect on the elderly. Another possible reason is that most people in the 65≥ age group are retired and have no income from work, such that their main source of income may well be the returns from financial investments, such as pension funds. If the stock market performs poorly, there will be a general reduction in their wealth, which could lead to higher stress levels and greater depression, thereby resulting in higher incidences of stroke.

There are some inherent limitations of this study which should be taken into consideration. Firstly, the NHIRD contains no information on the socioeconomic variables of patients. Socioeconomic status has consistently been found to be an important factor in health status (Cox et al., 2006), and it is possible that people of high status may be resistant to stock market volatility since they are more likely to have access to other sources of income. It would be interesting to investigate this issue further, but this will require combinations of data from various sources.

Secondly, since we are using aggregate data, the variations in individual risk factors potentially contributing to incidences of stroke are ignored; nevertheless, it is possible that some personal risk factors are associated with the stock market index. For example, involuntary job losses increase occurrences of stroke (Gallo et al., 2004), and the unemployment figure is likely to be higher in bad economic times, which are associated with low stock market index levels. However, this concern will mainly affect the stock price level effect, given that employment status usually persists for a considerable period of time. Thirdly, it is possible that causal direction does not run from daily stock price change to stroke incidences – they can be both affected by a common factor. For example, bad news regarding to economic prospects may affect stock prices and stroke incidences concurrently. It would be interesting to examine the issue further while the task may require more datasets.

Conclusions

This study is believed to be the first of its kind to examine stock market impacts on incidences of stroke. We find that both a low stock index level and a daily fall in the stock index are associated with greater incidences of stroke. The level effect is found to be significant for either gender, in the 45–64 and 65≥ age groups. In addition, two daily change effects are found to be significant for males and the elderly.

In order to reduce incidences of stroke, policymakers in Taiwan could try to reduce economic insecurity in retirement by establishing a stable pension system or enhancing opportunities for people to accumulate assets prior to retirement. Furthermore, less attention on daily stock market movements should be encouraged, particularly for elderly male residents. Although stockholdings can increase wealth, they can also increase incidences of stroke, thereby representing a cost to health.

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