Does the Volatility of Stock Market have an Impact on Social Security? An Empirical Study Based on American Stock Index and Crime Data from 1068 Counties

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Abstract—The stock market is a barometer and wind vane of the country's social economy. Therefore, the volatility of the stock is closely related to the stability of our society. Based on the data of the American stock market and crime from 2005 to 2018, this study aims to find out whether the volatility of the stock market has an impact on residents' criminal behaviors by regression method. The results indicate that the stock market volatility has a significant impact on residents' crimes, especially on violent crimes, but it makes no major impact on property crimes. Meanwhile, the stock market volatility demonstrates a delayed effect on crime. However, the per capita income (PCI) and its growth rate have no considerable effect on crime rate. The findings in our study can be beneficial for the formulation and implementation of social security policy.

Keywords- Stock market volatility; society security; crime rate; econometrics; regression analysis

1 INTRODUCTION

At the beginning of 2020, the COVID-19 epidemic swept across the world, imposing a huge impact on both the economy and people's lives, especially in the United States. Since 2020, the United States economy has continued to decline, with tremendous volatility in the financial market and stock market, as well as great turbulence in the social security.

According to the Commerce Department, the U.S. economy suffered its worst period ever, with the gross domestic product (GDP) falling at an annualized rate of 5% in the first quarter of 2020, and shrinking by 31.4% in the second quarter. The negative growth of GDP and economic recession led to a series of economic and social problems. For example, as a barometer of the country's economy, the stock market plummeted during this period. Since March 2020, the U.S. stock market circuit breaker four times. Consumer and business spending collapsed as many industries including restaurants, cafeterias, factories and stores were shut down and the unemployment rose rapidly due to COVID-19. In April 2020 the unemployment rate increased

ICIDC 2022, June 17-19, Qingdao, People's Republic of China

DOI 10.4108/eai.17-6-2022.2322632

to the peak point of 14.7%. Although it had gradually decreased to 7.1% by May 2021, it was still higher than the 3.5% level in December 2019 (pre-COVID-19). On the other hand, according to the report of the U.S. COVID-19 and Crime Commission and other agencies, the number of homicides in 2020 in the U.S. increased by 30% compared with the previous year, the incidence of gross assault increased by 6%, and the shooting incidents climbed by 8%.

Considering the correlation of economic conditions and crime, this research aims to discover the relationship between the stock market and the public order. The volatility of the stock market, especially the sharp rise and fall of the stock price, causes the residents to suffer economic losses, which increases their psychological burden on the economy, and thus brings in more criminal incidents and affects the social security.

Our research is based on a large number of relevant research and analysis into the influence of social security on the stock market. We use multiple regression models (empirical research) to analyze data of all counties in the United States in a total of 14 years (2005-2018), covering crime data, population data, unemployment rate data, and data from the stock market. The results show that the stock market volatility has a significant positive effect on violent crimes, with the effect being still significant after controlling for heteroscedasticity, whereas it makes no major impact on property crimes. The study also indicates that it has a delayed effect on crime rates. Nevertheless, income has no moderating effect on crime. We believe that the impact of stock market volatility on crime is highly related to the effect on consumer confidence amid the overall economic situation, but changes in income are not the direct cause of the impact on crime rates.

This research is of great significance since it is the first exploration on the relationship between stock market volatility and crime. Prior to this study, there was only one paper revealing the impact of stock market on crime. Huck [1] examined the impact of stock market regression on crime rate. In Huck's study, the stock returns can reflect the change of stock value over a period of time, and directly reflect the gains or losses of investors**.** Therefore, they will lead to changes in investors' psychology, further inducing the occurrence of crimes. However, the stock returns cannot represent the volatility of the stock over a period of time. Compared with the stock returns, volatility can better reflect the uncertainty of the stock market. Investors may lose confidence (the decline of consumer confidence index) because of the market uncertainty, which leads to the occurrence of crime. Thus, we look at the volatility of the stock market to further explore its social effect on crimes.

This study contributes to the interdisciplinary study of the financial market and sociology, and also provides empirical evidence for the research in this direction. The evidence may have a certain guiding effect on the government's supervision and policy of the financial market. Thus, future research can explore the fundamental mechanism of the stock market's influence on crime rate.

2 LITERATURE REVIEW

In this section, we comb through the relevant literature about the influence of stock market volatility on crimes from three perspectives, including the causes and influences of crimes, the

factors affecting stock market volatility, and the relationship between stock market volatility and crimes.

2.1 Causes and influences of crimes

A crime is an act that seriously endangers society and violates the criminal law, which is punishable by the judiciary authority. Therefore, the research on crime is particularly important for the stability of a country. The Chinese researcher Wu [2] discovered that the greater the urban-rural income gap was, the higher the social crimes rate reached. Furthermore, Tan & Zhang [3] suggested that there was a dynamic nonlinear effect between the urban-rural income gap and criminal crime rate in China. In England, Draca & Machin [4] found that the rise in crime might be resulted from falling wages of unskilled workers through data from police forces in England and Wales between 1975 and 1996. And Soares [5] studied the relationship between development and crime. Using victim survey data and official data, Soares et al. concluded that income inequality had the strongest correlation with crime. Besides, Burnham et al. [6] explored the link between inner-city crime patterns and suburban income growth. Based on the data from 318 counties in the United States for the time span 1982-1997, they pointed out that violent crime seemed to negatively impact the immediate suburbs (with a less negative impact away from central cities) and income growth had no major effect on property crime. To sum up, many researchers have supported the idea that the economy has a huge impact on crime.

In addition, studies have shown that there is a significant negative impact of crime on the development of social economy. For example, Detotto & Otranto [7] claimed that crime could encourage people to consume illegal goods and services. Based on research into the crime data of 25 countries from 1991 to 2007, Goulas & Zervoyianni [8] stated that the increase of crime had an uncertain impact on economic growth.

2.2 The facts that influence stock market volatility

Much efforts have also been made to explore the facts that could influence the stock market volatility. Enamorado et al. [9] argued that drug-unrelated crimes indeed deterred economic growth, through a combined analysis on income data from poverty maps, administrative records on crime and violence, and public expenditures data at the municipal level for Mexico (2005–2010). By using daily stock market return data from July 2001 to October 2006, Laverde et al. [10] found that political uncertainty and crime rate were two critical determinants of stock market return in Colombia.

Meanwhile, researchers have asserted that stock prices could fluctuate depending on people's moods. For example, Hirshleifer & Shumway [11] indicated that daylight would put people in a better mood and positively correlated with the stock market, with a potential for higher stock returns. Contrarily, Edmans et al. [12] claimed that the failure of a local sports home team would lead to low market returns. Emotions [15] and behaviors [16] will also have a certain impact.

2.3 The relationship between the stock market and crime

In spite of the tremendous work towards the influence of crime on the stock market, there are few researches about the impact of stock market on crime [17]. One most important and enlightening study is Huck’s discussion [1] on the social effects of realized stock market returns through micro-level (city/county) data. Using daily reported crime incidents from over 2,500

law enforcement agencies across 27 states from 1991-2012, Huck [1] pointed out that the stock returns positively affected the crime rate during the same period, signifying that the crime rate would rise as the stock returns increase. He also suggested that the market changes had different effects on investors and non-investors, explaining this as evidence supporting (which explained) the envy model that people are generally concerned about their relative wealth compared to others. Huck's study took crime as a manifestation of utility. Namely, crime growth could show the measure of revealed marginal utility growth of heterogeneous consumers in incomplete markets [1]. More specifically, in high-income cohorts the effect increased because investors were more willing to buy stocks due to increased stock market returns, thus reducing the crime rate. But for low-income groups, their relative wealth gap with the high-income groups widened as stock market returns increased, leading to a decline in utility and consequently an increase in crime.

On the one hand, crime is an important factor affecting the volatility of the stock market. The fluctuation of the crime rate indicates that the instability of the regional social security has affected the local economy, leading to the change of investors' purchase of stocks and causing the stock market volatility. On the other hand, the stock market volatility may have a certain influence on the crime rate. Investors or non-investors may have negative and cynical reactions amid the changing stock market, which is an inducing factor of crime and could result in the increase of the crime rate.

On the basis of previous (Huck's) research [1], this study takes another perspective - the effect of stock market volatility on crime - to explore whether stock market volatility will have a significant negative correlation with residents' crimes, which is a widely debated and still controversial public issue. The results will be of great practical importance (in the policy-making of our financial market).

3 EXPERIMENT METHODS, DATA SOURCES AND SAMPLE SELECTION

This study uses several regression models to conduct an empirical study on the relationship between financial market fluctuations and resident crime rate by covering American crime data, S&P 500 index, Dow Jones index data and American population data, and economic indicators from 2005 to 2018.

3.1 Experiment methods

The study applies multiple linear regression as the basic empirical model, and employs panel least square estimation technique to estimate the model.

The benchmark model in this study is set as:

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

$$Crime\ Rate_{i.t} = \beta_0 + \beta_1 * Market\ Volatility_t + X\beta_2 + \gamma_i + \varepsilon_{i,t} \quad (1)$$

In (1), $Crime\ Rate_{i,t}$ represents the crime in county i, year t; $Market\ Volatility_t$ represents the volatility of stock market; γ_i is County fixed effect, and $\varepsilon_{i,t}$ is residual. X in the model represents the control variable matrix. The control variables include the volatility of the S&P 500 Index, the total population of the county, the population over 65, the population under 19, the white population, the female population, the consumer price index, the growth rate of income, the unemployment rate, the growth rate of the economy, etc.

3.2 Data source

The data in this paper are mainly from three sources:

Crime data: FBI official website (https://ucr.fbi.gov/crime-in-the-u.s)

Population data, unemployment rate data, economic data: U.S. Census Bureau (https://www.census.gov/data/tables/time-series/demo/popest/2010s-total-cities-and-towns.html)

Stock market data: Yahoo Finance (https://finance.yahoo.com/)

3.3 Data Processing

The crime data comes from the U.S. Criminal Justice Information Service (CJIS), which provides U.S. law enforcement, national security and intelligence partners with the criminal justice information needed. The data include the yearly number of violent crimes and property crimes in each U.S. County from 2005 to 2018. Under the FBI's Uniform Crime Reporting (UCR) program, violent crimes, as crimes that involve force or the threat of use of force, fall into four categories: murder and non-negligent manslaughter, rape, robbery, and aggravated assault. While the definition of property crimes covers crimes that aim to seize money or property without the use or threat of force against the victim. Crimes including burglary, larceny-theft, motor vehicle theft, and arson fall into the category. To form the balanced-panel data, we have screened 1,068 counties for each of the 14 years. These data are divided into two categories, violent crimes and property crimes, as defined by UCR. We also collect daily data of the Dow Jones Industrial Average and S&P500 stock market price indexes from 2004 to 2018, and calculate the returns and volatility of the two economic indexes. In this paper, volatility is defined as formula (2):

$$Annual\ volatility = standard\ deviation\ of\ daily\ rate\ of\ return \times \sqrt{252} \tag{2}$$

We merge the crime data with the population data by region (county) and time (year), and then merge it with the stock data by time. We define the crime rate data as formula (3):

$$Crime\ rate_{i,t} = Crime_{i,t} \div total\ population_{i,t} \tag{3}$$

Here i is the county and t is the year.

3.4 Sample description

In this study, the crime rate, stock, population and economic data from 2005 to 2018 have been combined, leaving the counties with these common variables and data of all the 14 years. The collated sample is a balanced panel of data covering a total of 1,068 counties spanning 14 years.

Fig. 1 shows the overall trend in the number of crimes in the United States from 2005 to 2018. Panel A shows that the number of violent crimes in the United States reached A peak in 2006, fluctuated repeatedly, and then dropped to the bottom in 2014, and then continued to rise. Panel B shows that the number of property crimes in the United States peaked in 2006 and has continued to decline since. Panel C shows that the average number of violent crimes in the United States began to decline after a sudden rise to a peak in 2007, and continued to rise after falling to a bottom in 2014. Panel D shows a downward trend in the average of property crimes.

Table 1 shows the descriptive statistics of the samples used in this study. Among those violent crimes were murder, rape, arson, robbery, and assault. Property crimes include motor vehicle theft, burglary, and larceny-theft. The growth rate of income is the growth rate of annual income adjusted for inflation. The average number of violent crimes per county per year was 88.8, and the average number of property crimes per county per year was 668.4. The average annual volatility for the S&P 500 is 16%, and the average for the Dow is 15%.

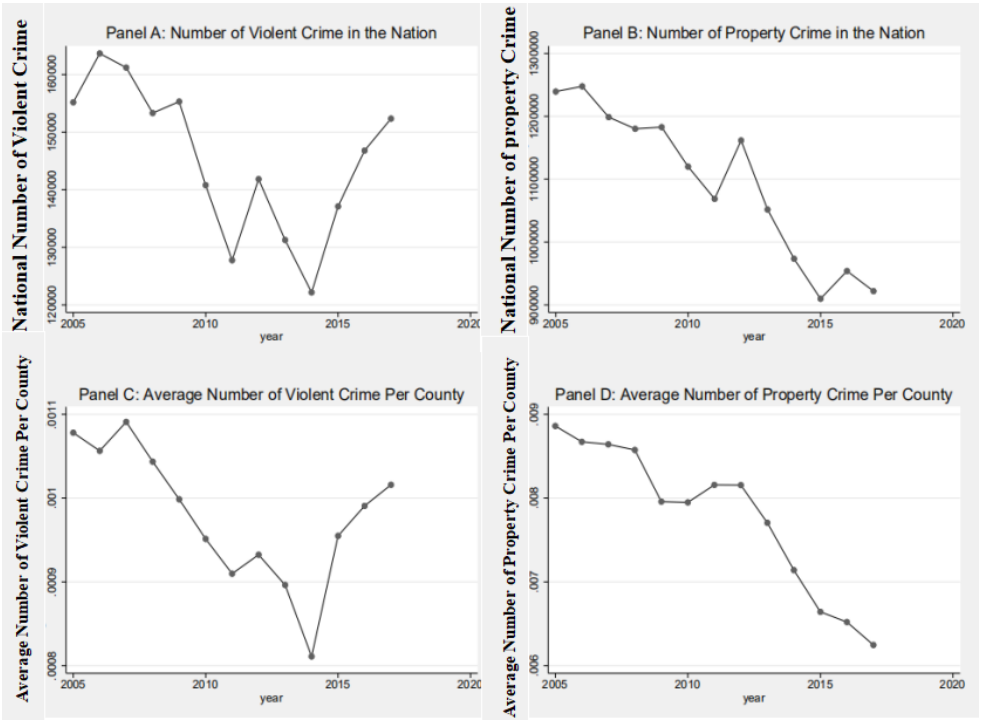

Figure 1. Quantity trends of violent crimes and property crimes

TABLE 1 DESCRIPTIVE STATISTICS

	mean	p50	min	max	sd	count
Violent crime	***88.8441***	***21.0000***	***0.0000***	***9209.0000***	***349.6006***	***21259***
Property crime	668.3999	200.0000	0.0000	55841.0000	2079.1210	21259
Violent crime rate	0.0010	0.0006	0.0000	0.0283	0.0011	21259
Property crime rate	0.0078	0.0061	0.0000	0.2405	0.0068	21259
Murder	1.3314	0.0000	0.0000	168.0000	5.4278	21259
Forcible rape	7.4842	2.0000	0.0000	537.0000	20.0903	21259
Arson	4.8909	1.0000	0.0000	613.0000	20.6317	21259
Robbery	16.3300	1.0000	0.0000	3452.0000	116.9782	21259
Aggravated assault	63.6985	16.0000	0.0000	5463.0000	223.3297	21259
S&P 500 Annual Volatility	0.1664	0.1309	0.0669	0.4097	0.0883	21259
DJIA Annual Volatility	0.1549	0.1261	0.0663	0.3787	0.0789	21259
Total population	116572.3667	34064.0000	61.0000	10163507.0000	366061.0599	21259
Population (>= 65 years old)	15260.1790	5341.0000	9.0000	1343960.0000	42805.7954	21259
Population (<=19 years old)	31640.8176	8754.0000	9.0000	2872418.0000	100975.0484	21259
White population	92385.2237	29341.0000	60.0000	7209524.0000	269861.9679	21259
Female population	59069.2513	17005.0000	30.0000	5153673.0000	185559.3629	21259
Cpi factor	0.4484	0.4427	0.4062	0.5100	0.0310	21259
Income growth per capital	0.0128	0.0114	-0.4459	0.7990	0.0486	21259
Unemployment rate	6.4380	5.8000	1.1000	28.9000	2.7785	21250

4 EMPIRICAL STUDY

4.1 Hypothesis and baseline regression results

The alternative hypothesis of this paper is that stock market volatility has a positive effect on crime rates. Theoretically, volatility in the stock market reflects the uncertainty of the overall economic situation, and affects consumer confidence. First, the economic uncertainty causes instability in consumers' income, thus resulting in their mood fluctuation. Second, the unstable economic condition further weakens consumer confidence and results in irrational behaviors. Both may lead to an increase in the crime rate.

The basic empirical study applies multiple linear regression. Through the principle of least square method, the benchmark model is:

$$crime\ number_{i,t} = \beta_0 + \beta_1 * volatility_t + X\beta_2 + \gamma_i + \varepsilon_{i,t} \quad (4)$$

Equation (4) represents the crime number in county i , year t , where γ_i is County fixed effect, and $\varepsilon_{i,t}$ is residual. X in the model represents the control variable matrix. The control variables include the volatility of the S&P 500 Index, the total population of the county, the population over 65, the population under 19, the white population, the female population, the consumer price index, the growth rate of income, the unemployment rate, the growth rate of the economy, etc.

The S&P 500 Index is a stock index of the 500 listed companies in the United States. It includes more companies as well as more diversified risks, and can reflect broader market changes. In this study, the volatility of S&P 500 is used as the index of stock market volatility. The baseline regression results are displayed in Table 2.

To control the unobservable factors that do not vary with time, the county fixing effect is controlled in the baseline regression. Based on the Panel A baseline regression results in Table 2 (which are also mentioned in other tables), we can observe that for every 1% increase in stock market volatility, the average number of violent crimes in each county increases by 0.271. This finding is consistent with our alternative hypothesis, indicating that stock market volatility does have a negative impact on consumer sentiment and thereby lead to an increase in violent crime.

Panel B in Table 2 shows that stock market volatility has no major influence on property crimes. This phenomenon may suggest that the effect of stock market volatility on crime does not appear to result from changes in consumer income. We test this hypothesis later in the paper.

Our study also demonstrates that stock returns have a significant impact on crimes. The average number of violent crimes will rise by 0.139 as the stock returns increase by 1%. This observation is consistent with what Huck found [1].

According to the envy model [1], with the increase in stock market volatility and continuous investment from investors, the high-income population may get more considerable profits or losses, which possibly lead to rise in crime rate. On the one hand, if high-income people get significant profit from the stock market, the value difference between high-income group and low-income group will expand, which may produce higher crime rate. On the other hand, if high-income people suffer a great loss in the stock market, wage earners' work and life situations would worsen. For example, those in charge of the company may pressure their employees to work overtime or take on more tasks. Such economic situation adds to the psychological burden on the low-income class, thus resulting in an increase of crime rate.

Table 2 (including Panel A & Panel B) shows the basic regression model with a sample range of 14 years from 2005 to 2018. Stock market volatility is the annual standard deviation of the Standard & Poor's 500. The coefficient band of regression results *** is 1% significant, ** is 5% significant, and * is 10% significant. Violent crimes cover murder, rape, arson, robbery, and

assault. Property crimes include motor vehicle theft, burglary, and larceny-theft. The growth rate of income is the growth rate of annual income adjusted for inflation.

TABLE 2 THE EFFECT OF STOCK MARKET VOLATILITY ON CRIME - BASIC MODEL
PANEL A: THE IMPACT OF STOCK MARKET VOLATILITY ON VIOLENT CRIME

	Violent crime	**Murder**	**Forcible rape**	**Arson1**	**Robbery**	**Aggravated assault**
Stock market volatility	27.471**	0.387	4.656***	3.682***	9.877*	12.552*
	(12.139)	(0.245)	(1.000)	(1.367)	(5.771)	(7.251)
Annual S&P500 returns	13.928**	0.143	0.121	1.824**	6.213**	7.451*
	(6.422)	(0.124)	(0.621)	(0.780)	(3.017)	(3.876)
Total population	0.008*	0.000*	0.000	-0.000	0.006***	0.002
	(0.004)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)
Population greater than 65	0.005**	0.000***	0.001***	0.000	-0.001	0.004***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Population younger than 19	0.008***	0.000***	0.001***	0.000***	0.001	0.006***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
White population	0.001	0.000*	0.000***	0.000**	0.001***	-0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female population	-0.021***	-0.000***	-0.002**	-0.000	-0.012***	-0.007*
	(0.008)	(0.000)	(0.001)	(0.001)	(0.004)	(0.004)
Cpi factor	147.978***	1.006	18.042***	14.718***	29.737***	99.193***
	(29.071)	(0.613)	(4.227)	(3.724)	(10.556)	(18.192)
Income growth per capital	-11.592*	0.081	-5.419***	-1.772**	-2.847	-3.407
	(6.732)	(0.137)	(0.964)	(0.901)	(2.937)	(4.212)
Unemployment rate	-2.047***	-0.041***	-0.246***	-0.232***	-0.685***	-1.074***
	(0.471)	(0.009)	(0.043)	(0.064)	(0.225)	(0.278)
Observations	21250	21250	21250	21250	21250	21250
Adjusted R^2	0.924	0.887	0.742	0.746	0.853	0.936

TABLE 3 THE EFFECT OF STOCK MARKET VOLATILITY ON CRIME - BASIC MODEL
PANEL B: THE IMPACT OF STOCK MARKET VOLATILITY ON PROPERTY CRIME

	Property crime	**Motor vehicle theft**	**Larceny-theft**	**Burglary**
Stock market volatility	31.257	0.190	5.582	25.485
	(98.772)	(14.572)	(68.259)	(22.981)
Annual S&P 500 returns	38.602	8.280	19.930	10.392
	(52.979)	(7.202)	(37.041)	(12.588)
Total population	0.043	0.009	0.020	0.014
	(0.030)	(0.006)	(0.018)	(0.009)
Population greater than 65	-0.046***	0.003	-0.030***	-0.019***
	(0.017)	(0.003)	(0.011)	(0.004)
Population younger than 19	-0.022**	0.005**	-0.017**	-0.011***
	(0.010)	(0.002)	(0.007)	(0.002)
White population	0.014**	0.004***	0.007**	0.003*
	(0.006)	(0.001)	(0.004)	(0.001)
Female population	-0.080	-0.027**	-0.031	-0.022
	(0.059)	(0.011)	(0.035)	(0.016)
Cpi factor	749.032***	200.781***	499.907***	48.344
	(187.898)	(32.832)	(126.020)	(55.285)
Income growth per capital	-115.483**	-13.254*	-63.946**	-38.283***
	(49.604)	(7.790)	(31.695)	(14.538)
Unemployment rate	-2.908	-3.627***	-2.735	3.453***
	(3.662)	(0.608)	(2.418)	(0.914)
Observations	21250	21250	21250	21250
Adjusted R^2	0.883	0.816	0.876	0.891

4.2 Delay effect

In economics, the phenomenon of delay is usually based on the performance of a system that has a lasting effect on an economic outcome [13]. Delay effect analysis is an economic approach in which the dependent variable is affected by its own or the previous level of other variables. The delay effect model in this paper is set as:

$$crime\ number_{i,t} = \beta_0 + \beta_1 * volatility_{t\text{-}1} + X\beta_2 + \gamma_i + \varepsilon_{i,t} \quad (5)$$

Equation (5) represents the crime number in county i, year t, where $volatility_{t-1}$ represents the volatility of stock market in year $t-1$, γ_i is County fixed effect, and $\varepsilon_{i,t}$ is residual. X in the model represents the control variable matrix. The control variables include the volatility of the S&P 500 Index, the total population of the county, the population over 65, the population under 19, the white population, the female population, the consumer price index, the growth rate of income, the unemployment rate, the growth rate of the economy, etc.

This study considers/assumes that stock market volatility may have a delayed effect on crime rates. In other words, it could take time for market volatility in a given year to demonstrate in the consumers' negative emotions or incomes. Therefore, we look at whether crimes in a given year are affected by stock market volatility in previous periods. The results of the impact of the stock market volatility on the crime rate in the previous year are reported in Table 3.

The results show that for every 1% increase in stock market volatility over the previous year, the average number of violent crimes in each county increased by 0.35. In view of this, stock market volatility during the previous year had a major impact on violent crimes. However, stock market volatility of two years ago or even earlier had no significant effect on crime rates. The model also controls county fixation effects to ensure control for unobservable factors that do not vary over time in each county. Combined with previous research findings, this study suggests that stock market volatility not only affect the crime rate of the current year, but also has an anticipated effect on the crime rate of the following year. Thus, the volatility of the stock market has a delayed effect on negative consumer sentiment for about a year.

Table 3 shows the basic regression model with a sample range of 14 years from 2005 to 2018. Stock market volatility is the annual standard deviation of the S&P500. The coefficient band of regression results *** is 1% significant, ** is 5% significant, and * is 10% significant. Violent crimes cover murder, rape, arson, robbery, and assault. Property crimes include motor vehicle theft, burglary, and larceny-theft. The growth rate of income is the growth rate of annual income adjusted for inflation.

TABLE 4 THE EFFECT OF STOCK MARKET VOLATILITY ON CRIMES OF THE NEXT YEAR

	Violent crime	**Murder**	**Forcible rape**	**Arson1**	**Robbery**	**Aggravated assault**
vol_gspc_annual_lag	31.589***	0.299*	10.789***	3.925***	6.441	14.060***
	(8.808)	(0.173)	(0.900)	(1.009)	(4.123)	(5.297)
Annual S&P 500 returns	0.173	-0.042	-2.504***	-0.003	1.533	1.187
	(4.517)	(0.081)	(0.445)	(0.484)	(2.332)	(2.505)
Total population	0.008*	0.000*	0.000	-0.000	0.006***	0.002
	(0.004)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)
Population greater than 65	0.005**	0.000***	0.001***	0.000	-0.001	0.004***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Population younger than 19	0.008***	0.000***	0.001***	0.000***	0.001	0.006***

	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
White population	0.001	0.000*	0.000***	0.000**	0.001***	-0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female population	-0.021***	-0.000***	-0.002**	-0.000	-0.012***	-0.007*
	(0.008)	(0.000)	(0.001)	(0.001)	(0.004)	(0.004)
Cpi factor	151.250***	1.040*	19.055***	15.112***	30.420***	100.735***
	(29.137)	(0.615)	(4.232)	(3.739)	(10.558)	(18.231)
Income growth per capital	-10.877	0.074	-4.681***	-1.711*	-3.146	-3.125
	(6.970)	(0.140)	(0.988)	(0.915)	(3.060)	(4.325)
Unemployment rate	-2.417***	-0.042***	-0.467***	-0.273***	-0.675***	-1.233***
	(0.488)	(0.009)	(0.046)	(0.068)	(0.227)	(0.291)
Observations	21249	21249	21249	21249	21249	21249
Adjusted R2	0.924	0.887	0.743	0.746	0.853	0.936

4.3 Mediating effect

Mediating effect analysis is an important step to test whether a variable becomes a mediating variable and to what extent it plays a mediating role. In this study, we also conduct a mediating effect analysis in order to explore the fundamental mechanism of the impact of stock market volatility on crime rate.

Firstly, this study discusses whether regional economic growth rate (measured by per capita income growth rate) and regional economic status (measured by per capita income growth rate) are the factors of the impact of stock market volatility on the crime rate. The regression model is as follows:

$$\begin{aligned} crime\ number_{i,t} &= \beta_0 + \beta_1 * volatility_t \\ &+ \beta_2 * volatility\ rate_t \times Growth\ rate\ of\ \ per\ capita\ income_{i,t} \\ &+ \beta_3 \times Growth\ rate\ of\ \ per\ capita\ income_{i,t} + X\beta_4 + \gamma_i + \varepsilon_{i,t} \end{aligned} \tag{6}$$

In Equation (6), $crime\ number_{i,t}$ represents the crime in county i, year t, where γ_i is County fixed effect, and $\varepsilon_{i,t}$ is residual. X in the model represents the control variable matrix. The control variables include the volatility of the S&P 500 Index, the total population of the county, the population over 65, the population under 19, the white population, the female population, the consumer price index, the growth rate of income, the unemployment rate, the growth rate of the economy, etc.

The results of the test of per capita income growth rate are reported in Table 4. We find that the per capita income growth rate has no significant adjustment effect on stock market fluctuations and crime. Table 5 provides the results of the per capita income mechanism test. It shows that

per capita income has no remarkable mediating effect as regarding the impact of stock market fluctuations on crime. Considering that the influence of per capita income may be non-linear, and to verify the jealousy model [1], we conduct a group regression test. Specifically, we divide the counties into three groups, from the highest to lowest per capita income, and perform a baseline regression for each group. The regression results are reported in Table 6, suggesting that there is no major mediating effect of regional income. In other words, the impact of stock market volatility on the crime rate is not significantly different in regions with varied income levels. To summarize, we hold that per capita income (growth) or the change of investors' economic conditions do not seem to link the impact of the volatility of the stock market on crime rates. Conversely, the uncertainty of investors resulting from assessing the market situation seems to be the root cause [14][8].

TABLE 5 MEDIATING EFFECT OF STOCK MARKET VOLATILITY ON CRIME - PER CAPITA INCOME GROWTH RATE

	Violent crime	**Murder**	**Forcible rape**	**Arson1**	**Robbery**	**Aggravated assault**
S&P 500 Annual Volatility	27.570**	0.388	4.655***	3.673***	10.065*	12.462*
	(12.176)	(0.246)	(0.999)	(1.367)	(5.798)	(7.265)
Stock volatility × Income growth per capital	-45.887	-0.578	0.657	4.238	-87.559	41.593
	(102.753)	(1.812)	(11.043)	(12.536)	(54.837)	(56.584)
Income growth per capital	-3.292	0.185	-5.538**	-2.539	12.992	-10.931
	(18.100)	(0.338)	(2.481)	(2.630)	(9.183)	(10.449)
Annual S&P 500 returns	13.643**	0.140	0.125	1.850**	5.668*	7.710*
	(6.650)	(0.127)	(0.651)	(0.810)	(3.151)	(3.981)
Total population	0.008*	0.000*	0.000	-0.000	0.006***	0.002
	(0.004)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)
Population greater than 65	0.005**	0.000***	0.001***	0.000	-0.001	0.004***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Population younger than 19	0.008***	0.000***	0.001***	0.000***	0.001	0.006***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
White population	0.001	0.000*	0.000***	0.000**	0.001***	-0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female population	-0.021***	-0.000***	-0.002**	-0.000	-0.012***	-0.007*
	(0.008)	(0.000)	(0.001)	(0.001)	(0.004)	(0.004)

Cpi factor	147.733***	1.003	18.045***	14.741***	29.269***	99.416***
	(29.088)	(0.613)	(4.215)	(3.740)	(10.588)	(18.198)
Unemployment rate	-2.041***	-0.041***	-0.246***	-0.233***	-0.675***	-1.079***
	(0.471)	(0.009)	(0.043)	(0.065)	(0.225)	(0.279)
Observations	21250	21250	21250	21250	21250	21250
Adjusted R^2	0.924	0.887	0.742	0.746	0.853	0.936

Table 4 shows the regression model of mediating effect, and the sample range is from 2005 to 2018. Stock market volatility is the annual standard deviation of the Standard & Poor's 500. The coefficient band of regression results *** is 1% significant, ** is 5% significant, and * is 10% significant. Violent crimes cover murder, rape, arson, robbery, and assault. Property crimes include motor vehicle theft, burglary, and larceny-theft. The growth rate of income is the growth rate of annual income adjusted for inflation.

Table 5 shows the regression model of mediating effect, and the sample range is from 2005 to 2018. Stock market volatility is the annual standard deviation of the Standard & Poor's 500. The coefficient band of regression results *** is 1% significant, ** is 5% significant, and * is 10% significant. Violent crimes cover murder, rape, arson, robbery, and assault. Property crimes include motor vehicle theft, burglary, and larceny-theft. Income growth is the increase in annual income adjusted for inflation.

TABLE 6 MEDIATING EFFECT OF STOCK MARKET VOLATILITY ON CRIME - PER CAPITA INCOME

	Violent crime	**Murder**	**Forcible rape**	**Arson1**	**Robbery**	**Aggravated assault**
S&P 500 Annual Volatility	59.792	-0.148	-3.985	13.225**	24.934	38.991
	(46.514)	(0.632)	(4.001)	(6.015)	(22.870)	(25.117)
Interaction	-0.002	0.000	0.001**	-0.001	-0.001	-0.002
	(0.003)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)
Percap_income_adjusted	0.002***	0.000	0.000***	0.000***	0.000	0.002***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Unemployment_rate	-1.805***	-0.038***	-0.178***	-0.220***	-0.676***	-0.914***
	(0.456)	(0.009)	(0.044)	(0.065)	(0.218)	(0.271)
Percap_income_growth	-25.200***	-0.106	-9.114***	-2.565**	-3.493	-12.487**
	(7.821)	(0.157)	(1.096)	(1.002)	(3.397)	(4.899)
Return_gspc_annual	13.372**	0.139	0.030	1.765**	6.140**	7.063*
	(6.414)	(0.125)	(0.620)	(0.783)	(3.016)	(3.871)
Total population	0.007*	0.000*	0.000	-0.000	0.006***	0.001
	(0.004)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)
Population greater than 65	0.005**	0.000***	0.001***	0.000	-0.001	0.004***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)

Population younger than 19	0.008***	0.000***	0.001***	0.000**	0.001	0.006***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
White population	0.001	0.000*	0.000***	0.000**	0.001***	-0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female population	-0.020***	-0.000***	-0.002**	-0.000	-0.012***	-0.006
	(0.008)	(0.000)	(0.001)	(0.001)	(0.004)	(0.004)
Cpi factor	195.881***	1.602**	29.994***	17.974***	32.831***	131.453***
	(33.703)	(0.685)	(4.562)	(4.003)	(12.513)	(21.086)
Observations	21250	21250	21250	21250	21250	21250
Adjusted R^2	0.924	0.888	0.742	0.746	0.853	0.936

TABLE 7 MEDIATING EFFECT OF STOCK MARKET VOLATILITY ON CRIME - REGIONAL INCOME

	Violent crime in high-income regions	**Violent crime in middle-income regions**	**Violent crime in low-income regions**
S&P 500 Annual Volatility	21.27	0.692	-21.59
	(15.70)	(15.90)	(54.05)
S&P 500 Annual returns	39.40	58.90**	41.10
	(27.83)	(29.01)	(113.1)
Total population	0.00446	0.0207***	0.0100*
	(0.00738)	(0.00503)	(0.00561)
Population greater than 65	-0.000989	0.00451**	0.00321
	(0.00320)	(0.00201)	(0.00313)
Population younger than 19	-0.00181	0.00813***	0.00651***
	(0.00346)	(0.00196)	(0.00218)
White population	-0.00133	-0.00225*	0.00227**
	(0.00488)	(0.00116)	(0.000975)
Female population	-0.00786	-0.0452***	-0.0250**
	(0.0146)	(0.00964)	(0.0113)
Cpi factor	57.37*	58.76***	265.8***
	(33.85)	(20.36)	(58.92)
Income growth per capital	-18.28**	-13.72*	-16.39
	(7.983)	(7.775)	(13.09)
Unemployment rate	-0.418	-1.699***	-3.313**
	(0.363)	(0.360)	(1.683)
constant	8.146	113.4***	-243.0***
	(45.04)	(22.56)	(77.23)
Observations	6,647	6,626	6,602
R-squared	0.779	0.959	0.926

Table 6 shows the regression model of mediating effect, and the sample range is from 2005 to 2018. Stock market volatility is the annual standard deviation of the Standard & Poor's 500. The coefficient band of regression results *** is 1% significant, ** is 5% significant, and * is 10% significant. Income growth is the increase in annual income adjusted for inflation.

We have studied the impact of stock market volatility on consumer confidence index, and the results are reported in Table 7. The equation is as follows formula (7):

$$comsumer\ confidence\ index_{i,t} = \beta_0 + \beta_1 * volatility_{t-1} + X\beta_3 + \gamma_i + \varepsilon_{i,t} \quad (7)$$

The sample covers 14 years from 2005 to 2018. Stock market volatility is the annual standard deviation of the Standard & Poor's 500. The coefficient band of regression results *** is 1% significant, ** is 5% significant, and * is 10% significant.

We find that stock market volatility has a considerable negative effect on consumer confidence index in Table 8. For every 1% increase in stock market volatility, the consumer confidence index decreases by 0.1.

We also analyze the impact of the consumer confidence index on crimes, with the results reported in Table 9. The formula (8) is as follows:

$$national\ crime\ number_t = \beta_0 + \beta_1 * annual + X\beta_2 + \varepsilon_t \quad (8)$$

TABLE 8 IMPACT OF STOCK MARKET VOLATILITY ON CONSUMER CONFIDENCE INDEX

	Index
Annual S&P 500 Volatility	-10.218***
	(0.414)
Income growth per capital	2.936***
	(0.478)
Annual S&P 500 returns	30.405***
	(1.020)
Total population	-0.000
	(0.000)
Population greater than 65	-0.000
	(0.000)
Population younger than 19	-0.000
	(0.000)
White population	-0.000
	(0.000)
Female population	0.000
	(0.000)
Cpi factor	170.431***
	(0.876)
Unemployment rate	0.459***
	(0.014)
Observations	20465
Adjusted R^2	0.739

TABLE 9 IMPACT OF CONSUMER CONFIDENCE INDEX ON CRIMES

	National Number of Violent Crime
Annual consumer confidence index	-123.508***
	(19.902)
Income growth per capital	-29185.168***
	(1307.639)
Total population	0.084***
	(0.016)
Population greater than 65	0.163***
	(0.014)
Population younger than 19	0.100***
	(0.010)
White population	-0.019***
	(0.002)
Female population	-0.229***
	(0.031)
Cpi factor	241156.948***
	(4364.110)
Unemployment rate	-1072.623***
	(25.373)
Observations	20465
Adjusted R^2	0.448

The sample covers data from 2005 to 2018. Stock market volatility is the annual standard deviation of the Standard & Poor's 500. The coefficient band of regression results *** is 1% significant, ** is 5% significant, and * is 10% significant.

We find a significant negative correlation between fluctuations in consumer confidence and violent crimes. For every 1% increase (decrease) in the annual consumer confidence index, the number of violent crimes in the country decreases (increases) -1.23. To conclude, the consumer confidence index is one of the important factors affecting the relationship between the stock market and crime, which further supports the inference above.

On the other hand, our results indicate that income is not a mechanism for the effect of market volatility on violent crimes, which is consistent with the discussion that stock volatility has no major effect on property crimes. According to the findings of Goulas & Zervoyianni [8], the correlation between violent crime rate and economic growth is determined by macroeconomic uncertainty, which can be exactly reflected in the volatility of the stock market.

5 CONCLUSION

In conclusion, upon investigating American crime data across 14 years, the research has discovered that stock market volatility makes a significant positive impact on violent crimes, whereas it does not considerably affect property crimes. Moreover, the stock market volatility has a delay effect on violent crimes. From our study, the main reason is that the stock market

volatility influence consumers' confidence in the economy and their psychological condition, which cause higher crime rate.

Our research is one of the few studies on the impact of stock market volatility on crime rate, and contributes to the intersection of financial market and social science. It paves the way for future work on the mechanism of the stock market's influence on crime rate. One limitation of this study, however, is that the crime types only include murder, rape, arson, robbery, aggravated assault, motor vehicle theft, burglary, and larceny. The future study could cover more crime types such as fraud, gambling and bribery, thus to obtain more detailed results. Besides, continued efforts are needed to distinguish and fully explore the influences of regional economic growth rate, per capita income growth rate and other factors on different income groups. Lastly, as psychological changes of consumers are one of the important reasons for criminal behaviors, future study can target the changing psychology of consumers amid different economic conditions, and its consequences and causes as well.

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