2025-1457 IJOI
https://www.ijoi-online.org/

International Journal of Organizational Innovation

EXPLORING THE RELATIONSHIPS AMONG STOCK MARKET, ECONOMIC GROWTH, AND INCOME INEQUALITY IN TAIWAN USING QUANTILE MEDIATION ANALYSIS

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Abstract

The relationship between the stock market and income inequality is widely acknowledged; however, whether economic growth mitigates or exacerbates this relationship remains an open question. To address this, we apply an innovative quantile mediation analysis to examine the dynamic interactions among the stock market, economic growth, and income inequality in Taiwan from 1976 to 2023. Our study offers two pivotal findings. First, we find no direct relationship between the stock market and income inequality across any quantile of income inequality. Second, while a mediating effect of economic growth is observed at the 0.1 to 0.7 quantiles, this effect diminishes at higher quantiles above 0.8. These results suggest that policymakers should emphasize growth-oriented strategies to effectively reduce income inequality.

Key words: quantile mediation analysis, stock market, economic growth, income inequality, quantile regression

Introduction

Income inequality remains a critical issue in contemporary economics, attracting extensive scholarly study due to

its profound implications for social stability and public policy. Research has identified a variety of factors influencing income inequality, with several closely tied to the stock market. Zietz and Zhao (2009) observed that stock market booms in the U.S. tend to widen the income gap between stockholders and non-stockholders. Hou et al. (2018) demonstrated that while capital raised through stock markets can mitigate inequality, high market turnover intensifies it. Li and Ouyang (2018) highlighted that unequal participation in capital markets enables wealthier individuals to allocate a larger share of their income to investments, thereby exacerbating inequality. Van Lear (2021) emphasized that stock market booms over the past four decades have significantly contributed to rising inequality.

The relationship between the stock market and economic growth has been the subject of extensive research, with numerous studies identifying a generally positive correlation, often accompanied by unidirectional or bidirectional causal links. For instance, Marques et al. (2013) employed vector autoregressive models to investigate Portugal's data from 1993 to 2011, uncovering a bidirectional causal relationship that underscores the critical influence of stock market dynamics on the broader economic structure. In a similar vein, Pradhan (2018) analyzed the G-20 economies and found evidence of both unidirectional and bidirectional causality, reflecting the intricate and multifaceted interaction between stock market development and per capita economic growth. Likewise, Jiang (2019) reported strong yet variable comovements between stock market performance and economic growth in the United States, providing further confirmation of the significant and evolving connection between these two factors.

Moreover, studies by Nolan and Maître (2008), Rubin and Segal (2015), Bouincha and Karim (2018), and Vo et al. (2019) highlight the intricate relationship between income inequality and economic growth. Economic expansion is frequently accompanied by rising income inequality, driven by the forces of globalization. As a result, many nations grapple with the challenge of fostering growth while ensuring a more equitable distribution of income.

Much of the existing literature has focused on two-variable relationships, but research exploring the interplay among three variables remains scarce. This study addresses this gap by examining the interconnected relationships among stock market development, economic growth, and income inequality, offering insights into how these factors collectively influence income disparities.

This study proposes an innovative methodological framework that departs from conventional research by combining mediation analysis with the quantile regression approach introduced by

Koenker and Bassett (1978). Specifically, it examines the influence of the stock market on income inequality in Taiwan over the period 1976 to 2023, considering both direct effects and indirect effects mediated through economic growth, across different levels of conditional income inequality. One of the primary advantages of employing the quantile regression model lies in its robustness, as it does not depend on stringent assumptions regarding the error terms (Koenker, 2005). In contrast to ordinary least squares regression, which only captures the average effect of explanatory variables on the dependent variable, quantile regression provides estimates across the entire conditional distribution, including the median and other quantiles. This enables a more nuanced analysis of how explanatory variables affect the dependent variable at various points along its distribution. By addressing gaps in the existing literature, this study contributes meaningful insights into the complex relationships linking the stock market, economic growth, and income inequality.

The growing income inequality in Taiwan has become a major social concern. According to the National Wealth Report (2023) released by the Directorate-General of Budget, Accounting, and Statistics after a 30-year hiatus, household wealth disparities continue to widen. From 1976 to 2023, Taiwan's Gini coefficient increased from 0.27 to 0.34, reflecting a deepening gap in income distribution. The growing income gap presents a critical challenge, necessitating further exploration of the factors driving this inequality and the development of strategies to foster more equitable growth. Addressing this escalating inequality forms the central focus of this study.

Literature Review

Stock Market And Income Inequality

The relationship between the stock markets and income inequality is multifaceted, with outcomes varying based on regional contexts, market conditions, and economic structures. For instance, Zietz and Zhao (2009) found that in the United States, stock market booms exacerbate income inequality, particularly by widening the gap between stockholders and non-stockholders. Liu et al. (2017) identified a nonlinear relationship in China, where moderate financial market activity reduces income inequality, especially benefiting rural areas. Similarly, Hou et al. (2018) noted that while capital raised through the stock market can mitigate inequality in China, high market turnover tends to intensify it. Li and Ouyang (2018) emphasized that disparities in capital market participation exacerbate inequality, as wealthier individuals allocate a larger share of their income to investments compared to lower-income groups.

In the 2020s, Van Lear (2021) asserted that stock market booms over the past four decades have been a major

driver of rising income inequality, establishing a unidirectional relationship in which increasing stock prices exacerbate disparities. Similarly, Lee and Siddique (2021) demonstrated that financialization amplifies global inequality, disproportionately favoring wealthier individuals. In the Australian context, Shi, Paul, and Paramati (2022) identified foreign direct investment and trade openness as key factors influencing inequality, while noting that higher per capita income mitigates it. Meanwhile, Dang, Wu, and Korkos (2024) analyzed stock market indicators—accessibility, efficiency, and stability—in BRICS and G7 countries. They found that while the effects on wealth distribution in G7 nations were minimal, the study addressed critical gaps in the literature concerning inequality in BRICS countries. Collectively, these studies reveal the intricate and dynamic interplay between stock markets and income inequality, highlighting how their impacts vary across temporal, regional, and economic contexts.

Stock Market And Economic Growth

The relationship between the stock markets and economic growth has long been a central focus of economic research, typically revealing a positive correlation with both unidirectional and bidirectional causality. Levine and Zervos (1998) demonstrated that the stock market liquidity and banking development significantly enhance economic growth, capital accumulation, and productivity, even after accounting for economic and political factors. Their findings highlighted the complementary roles of banking systems and the stock markets in driving economic progress. Similarly, Liu and Hsu (2006) observed that the stock market development positively influenced Taiwan's economic growth, showcasing the importance of market maturity in economic performance.

Regional studies further highlight the diverse nature of the relationship between the stock markets and economic growth. Marques et al. (2013), for instance, applied vector autoregressive modeling to examine Portugal's economy from 1993 to 2011, revealing a bidirectional causal link between the stock market performance and economic growth. Their findings emphasized the central role of the stock markets within the broader economic framework, while bank financing alone was shown to have a limited effect on growth. Similarly, Pradhan (2018) analyzed G-20 nations and identified both unidirectional and bidirectional causality, underscoring the intricate interplay between the stock market development and per capita economic growth.

The strength and dynamics of this relationship can vary significantly depending on market maturity and economic structures. For example, Jiang (2019) observed strong but fluctuating co-movements between the stock markets and economic growth in the United States, while China exhibited weaker yet

more stable relationships. These variations reflect differences in market maturity, institutional quality, and underlying economic frameworks.

In summary, while stock markets generally facilitate economic growth, the relationship is nuanced and highly context-dependent. Robust policy frameworks are essential to enhance market conditions and ensure efficient capital allocation. By accounting for regional disparities, economic structures, and market maturity, policymakers can promote sustainable economic growth through well-functioning stock markets.

Economic Growth And Income Inequality

The relationship between economic growth and income inequality is complex and multifaceted, especially in developing nations striving to enhance public welfare. Although economic growth is often associated with widespread prosperity, evidence indicates that rapid growth can paradoxically exacerbate income disparities due to the limited efficacy of the trickle-down effect.

In the United States, Rubin and Segal (2015) analyzed data from 1953 to 2008 and found that the incomes of wealthier individuals respond more significantly to economic growth than those of lower-income groups. This disparity arises because high earners derive much of their income from investments, which are highly sensitive to economic fluctuations, and from performance-based compensation, such as equity-linked pay. Consequently, economic growth is positively correlated with increasing income inequality. Similarly, Bouincha and Karim (2018) challenged the traditional Kuznets hypothesis, which posits an inverted U-shaped relationship between economic growth and inequality. Their analysis of 189 countries from 1990 to 2015 revealed that economic growth has limited impact on income inequality globally and in developing nations, while it reduces inequality in developed countries. This suggests that the effect of economic growth on inequality is highly context-dependent.

In middle-income countries, Vo et al. (2019) identified bidirectional causality between economic growth and income inequality, suggesting a feedback loop where growth influences inequality, and inequality, in turn, shapes the trajectory of growth.

Overall, while growth has the potential to improve public welfare, its benefits are often unevenly distributed, particularly in contexts where wealthier individuals and regions disproportionately gain. To address these challenges, policymakers must implement strategies that ensure economic growth translates into inclusive development, reducing disparities and fostering equitable societal progress.

Research Methodology

Hsu (2020) introduced an innovative approach that combines mediation analysis with quantile regression, offering a significant advancement over traditional constant-parameter regression models. This methodology allows for the exploration of how relationships between variables differ across various points of the conditional distribution, providing deeper insights into effects at both the lower and upper tails of the dependent variable. For example, Hsu (2021) applied this technique to examine how economic growth mediates the relationship between aggregated renewable energy consumption and CO_2 emissions in Taiwan. Expanding on this research, Hsu et al. (2023) employed quantile mediation analysis to investigate the dynamic interactions among hydropower consumption, economic growth, and CO_2 emissions in Taiwan. Building on these developments, the present study adopts a quantile regression-based mediation framework to analyze the direct and indirect effects of the stock market and economic growth on income inequality in Taiwan, with particular emphasis on the mediating role of economic growth.

Quantile Regression

Koenker and Bassett (1978) introduced quantile regression, a methodology further developed by Koenker (2005) and Koenker and Hallock (2001). This approach estimates conditional quantile functions, enabling analysis of how independent variables influence different points in the distribution of the dependent variable, rather than focusing solely on the conditional mean as in ordinary least squares (OLS) regression. Compared to OLS, quantile regression offers several advantages. It provides a more comprehensive understanding of the dependent variable's distribution and exhibits greater robustness to outliers. Moreover, it remains efficient even when the error terms deviate from normality. Methodologically, quantile regression is closely related to the least absolute deviations approach, as its objective function is based on a weighted sum of absolute deviations, reducing the influence of extreme values on parameter estimates.

$$\min_{\beta} \left[\theta \sum_{\{t: Y_t \geq X_t\beta\}} |y_t - x_t\beta| + (1-\theta) \sum_{\{t: Y_t < X_t\beta\}} |y_t - x_t\beta|\right] \quad (1)$$

Meditation Analysis

Baron and Kenny (1986) introduced a widely utilized framework for examining mediation effects, consisting of four key steps that elucidate the relationships among the dependent variable, mediator variable, and independent variable.

The first step involves estimating the relationship between the independent variable, stock market (SI), and the dependent variable, income inequality (II), as specified in Equation (2). If the coefficient b_1 is statistically significant, it indicates the presence of a direct relationship between SI and II.

$$\text{II} = b_0 + b_1 SI + e_1 \quad (2)$$

The second step examines the association between the independent variable SI and the mediator variable, economic growth (EG), measured by gross domestic product (GDP), as outlined in Equation (3). A statistically significant coefficient $c_1$supports the existence of an initial mediating effect.

$$\text{EG} = c_0 + c_1 SI + e_2 \quad (3)$$

In the third step, the relationship between the mediator variable EG and the dependent variable II is assessed using Equation (4). If the coefficient d_2 is significant, it confirms the presence of a mediated effect.

$$\text{II} = d_0 + d_1 SI + d_2 EG + e_3 \quad (4)$$

Finally, the last step evaluates whether the independent variable SI continues to affect the dependent variable II after accounting for the mediator variable EG, as described in Equation (4). If the coefficient d_1 is not significant, this suggests the existence of complete mediation, where the direct relationship between SI and II disappears once the mediated effect through EG is included. Conversely, if the coefficient d_1 remains significant but is smaller than b_1, it indicates the presence of partial mediation through EG.

Quantile Meditation Analysis

In this study, we adopt a novel quantile mediation analysis approach proposed by Hsu (2020), which integrates quantile regression with mediation analysis. By combining Equations (1)–(4), we derive Equations (5)–(7), which represent an innovative framework for estimating quantile-specific parameters across various levels of the dependent variable, whether at the upper or lower tails of the distribution. Equations (5)–(7) describe the minimization of a weighted sum of errors within the quantile mediation regression framework.

$$\min_b [\theta \sum |II_t - b_0 - b_1 SI_t| + (1 - \theta) \sum |II_t - b_0 - b_1 SI_t|] \quad (5)$$

$$\min_c [\theta \sum |EG_t - c_0 - c_1 SI_t| + (1 - \theta) \sum |EG_t - c_0 - c_1 SI_t|] \quad (6)$$

$$\min_d [\theta \sum |II_t - d_0 - d_1 SI_t - d_2 EG_t|] + (1 - \theta)[\sum |II_t - d_0 - d_1 SI_t - d_2 EG_t|] \quad (7)$$

Following the guidelines of Baron and Kenny (1986), if the total effect, represented by the coefficient b_1, is significant in Equation (5), and both the coefficient c_1 in Equation (6) and the coefficient d_2 in Equation (7) are also statistically significant, the significance of the coefficient d_1 in Equation (7) can be evaluated. If d_1 is significant but smaller than b_1, this suggests the presence of a partial mediation effect through the mediator variable, EG. Conversely, if d_1 is not significant, this would indicate a complete mediation effect through EG.

Results and Discussions

This study utilizes annual data from Taiwan spanning the period 1976–2023. The variables of interest include income inequality (II, measured by the Gini coefficient), the stock market (SI, measured by TAIEX), and economic growth (EG, measured by real GDP growth rate), all of which are sourced from the Taiwan Economic Journal. For analytical purposes, data on the three variables were standardized.

In this study, we utilized the augmented Dickey-Fuller (ADF) unit root test to evaluate the stationarity of the variables. The ADF test is a widely used statistical method for determining whether a time series is non-stationary (i.e., contains a unit root) or stationary. Ensuring data stationarity is critical for obtaining reliable statistical inferences in time series analysis.

The ADF test results, summarized in Table 1, present the unit root test outcomes for the variables in both their level and first-difference forms. Initially, the ADF test was applied to the level forms of the three variables, and the results indicated that the null hypothesis of a unit root could not be rejected for any of the variables. This finding suggests that the series in their levels are non-stationary.

However, after transforming the data by taking the first differences, the ADF test yielded different results. At the first-difference level, the null hypothesis of a unit root was rejected at the 1% significance level, providing strong evidence that the series become stationary after differencing. Based on these findings, we conclude that the three data series are integrated of order one I(1), meaning they achieve stationarity after first differencing.

Table 1. Results from the augmented Dicker–Fuller (ADF) unit root test.

* Denotes significance at the 1% level.	Level	P-value	First difference	P-value
income inequality(II)	1.5984	0.4754	-7.5189	0.0000*
stock market(SI)	0.1312	0.9396	-9.4401	0.0000*
economic growth(EG)	2.3332	0.9999	-6.0650	0.0000*

Regarding the causal relationship between the stock market and income inequality, and stock market and economic growth in equations 5 and 6, we demonstrate the causality test results in Table 2. The notation of x≠>y means that the variable x does not affect the variable y.

We find some remarkable results as follows. By using a quantile approach, if b_1 is significant, there exists causality running from the stock market to income inequality at distributions (0.1 to 0.7) of income inequality, but no causal relationship at higher distributions (0.8 to

0.9) of income inequality. In other words, there is no direct relationship between the stock market and income inequality at higher distributions of income inequality. Table 3 shows that d_2 is significant by using a quantile approach at Through a quantile mediation analysis, the variable SI also no longer relates to the dependent variable II after the mediator variable EG is controlled at all distributions of income inequality in Table 3. This condition shows that the relationship between SI and II examined under the first condition disappears when the mediated effect transmitted through EG is taken into account. This result evidences the complete mediation because of satisfies all four steps in equations 2 to 4.

any distribution in Equation 7, that is, the mediator variable EG relates to the dependent variable II. This result establishes the second stage of the mediated effect.

The results of the effects of the stock market on income inequality are different from the previous results. Applying the quantile mediation analysis, we find stock market affects income inequality through the full mediation effect of economic growth for the period of 1976-2023 and there is no direct relation between the stock market and income inequality, which is different from the previous empirical findings. Moreover, by using a quantile regression and mediation analysis, we find stock market affects income inequality through the full mediation effect of economic growth at

Table 2. Results from stock market to income inequality and from stock market to growth at different quantiles.

	SI ≠> II		SI ≠> EG	
Quantile	b_1	P-value	C_1	P-value
0.1	0.6640	0.0000*	0.7200	0.0000*
0.2	0.7582	0.0000*	0.8509	0.0000*
0.3	0.8689	0.0000*	0.8591	0.0000*
0.4	0.9385	0.0000*	0.9047	0.0000*
0.5	1.0334	0.0000*	0.9618	0.0000*
0.6	0.9521	0.0000*	1.0259	0.0000*
0.7	1.1251	0.0000*	1.0893	0.0000*
0.8	0.7925	0.2367	1.1435	0.0000*
0.9	2.22E-16	1.0000	1.1827	0.0000*

* Denotes significance at the 1% level.

below 0.7 distributions of income inequality. However, at above 0.8 distributions of income inequality, there are no direct and indirect (mediation) effects from the stock market on income inequality in Taiwan.

Table 3. Results from stock market and growth to income inequality at different quantiles.

	SI ≠> II		EG ≠> II	
Quantile	d_1	P-value	d_2	P-value
0.1	-0.4507	0.2935	1.3072	0.0043*
0.2	-0.6021	0.1660	1.4354	0.0020*
0.3	-0.5039	0.2434	1.3323	0.0036*
0.4	0.0133	0.9636	0.8264	0.0014*
0.5	0.0963	0.7599	0.8036	0.0022*
0.6	-0.0250	0.9345	1.0267	0.0001*
0.7	0.0747	0.7631	1.0847	0.0001*
0.8	-0.1620	0.4927	1.3587	0.0000*
0.9	-0.5009	0.3747	1.2857	0.0003*

* Denotes significance at the 1% level.

Conclusions and Policy Recommendations

This study examines the impact of the stock market on income inequality in Taiwan, with economic growth considered as a mediating variable. To ensure robust results and gain deeper insights, quantile mediation regression was employed to estimate the median of the conditional distribution of the dependent variables. Both the direct and indirect effects of the stock market on Taiwan's income inequality were analyzed.

This study yields two key conclusions. First, no direct relationship was identified between the stock market and income inequality, suggesting that stock indices alone do not contribute to widening income disparities. This aligns with the findings of Dang, Wu, and Korkos (2024). Second, the empirical results indicate a mediating effect of economic growth within the 0.1–0.7 quantile range, while this effect diminishes at higher quantiles above 0.8. These findings underscore the importance of implementing growth-oriented policies to effectively address and reduce income inequality.

The findings of this study diverge from prior research (e.g., Zietz and Zhao, 2009; Lee and Siddique, 2021; Van Lear, 2021). Using quantile mediation analysis, the study demonstrates that the stock market influences income inequality solely through the mediating role

of economic growth over the period 1976–2023, with no direct link between the stock market and income inequality. This contrasts with earlier studies, such as Rubin and Segal (2015), which suggested that economic growth often exacerbates income inequality, largely driven by stock market dynamics. The present findings challenge such conclusions.

The study underscores the importance of policies that foster economic growth while addressing income inequality. It highlights the intricate relationship between economic expansion and income inequality, urging policymakers to implement strategies that promote inclusive growth. To achieve this, policies must address the uneven distribution of economic gains, ensuring that growth benefits all sectors of society rather than reinforcing existing disparities.

Notably, this study focuses exclusively on Taiwan and does not account for other potential contributors to income inequality. Future research could apply this methodology to other countries and investigate additional factors influencing income inequality, offering a more comprehensive understanding of this complex issue.

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