



RELATIONSHIP BETWEEN SOLAR POWER POLICIES AND THE STOCK PRICES OF SOLAR ENERGY COMPANIES

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Abstract

Amid escalating global climate change and environmental awareness, nations worldwide, including Taiwan, are accelerating renewable energy development. This study reviews Taiwan's solar policy evolution and assesses its impacts on solar concept stock prices. Using regression analysis on Taiwan Economic Journal (TEJ) data, we examine whether policy implementation and solar power growth positively influence stock prices, while accounting for external factors like international crude oil and gold prices. Findings offer investor insights and empirical evidence to guide Taiwan's renewable energy policymaking for sustainable industry growth.

Keywords

Solar Power Policies, Solar Energy, Stock Prices

1. Introduction

In light of intensifying global climate change and heightened environmental awareness, the development of renewable energy has emerged as a priority policy for governments worldwide. Renewable energy refers to resources derived from natural processes that are continuously replenished, such as solar, hydropower, wind, geothermal, and biomass energy. Unlike wind, hydropower, and geothermal energy, which are subject to stringent geographical and environmental constraints, solar energy is limited only by the availability of solar irradiation. Consequently, as an inexhaustible and clean source, solar energy has gradually become a cornerstone of national energy transition strategies.

On Earth Day, April 22, 2024, U.S. President Biden announced a capital allocation of \$7 billion specifically targeting solar energy development across states and tribal regions. This initiative aims to ensure that both the government and residential sectors benefit from solar power generation. Such measures not only advance renewable energy technologies but also facilitate the structural transition of the energy mix and mitigate greenhouse gas emissions.

In China, the government released the 13th Five-Year Plan for Renewable Energy, establishing a target of 10.5 GW of solar photovoltaic (PV) capacity by 2020. The plan prioritizes the comprehensive promotion of distributed PV, the orderly construction of utility-scale solar plants, and the development of solar thermal power demonstration projects tailored to local conditions. Furthermore, it emphasizes the diversification of solar thermal applications and the continuous reduction of the Levelized Cost of Energy (LCOE) for solar PV. Meanwhile, the South Korean government announced on March 28, 2021, an investment of 561 billion KRW into the solar and wind sectors. The first scheme, the 2021 New and Renewable Energy Financial Support, actively leverages underutilized assets—such as industrial facilities, buildings, and parking lots—to expand renewable energy supply. The second scheme, the 'Resident Participation Fund,' incentivizes public adoption of solar installations by providing financial returns to

residents through bonds, equity participation, and direct funding, thereby enhancing the willingness of the populace to deploy solar power generation systems.

In addition to the policies and subsidies implemented by the aforementioned nations, Taiwan's Legislative Yuan enacted the Renewable Energy Development Act in May 2009. This landmark legislation serves as the country's first legal framework specifically designed to promote renewable resources, including solar, wind, and biomass energy.

To accelerate the energy transition, the Executive Yuan launched the New Energy Policy on September 17, 2016, initiating both energy transition and electricity market reform to stimulate the growth of emerging green industries.

Upon her first inauguration in 2016, President Tsai Ing-wen proposed the '2025 Nuclear-Free Homeland' policy. This initiative mandates the gradual phase-out of nuclear power and the aggressive development of renewable energy to foster environmental sustainability. The policy sets a target for renewable energy to account for 20% of the total energy mix. Specifically, the solar PV development plan aims to achieve an installed capacity of 20 GW through the deployment of both ground-mounted and rooftop systems, while the target for offshore wind power is set at 5.6 GW.

Following her re-election in 2020, President Tsai introduced a long-term roadmap for 2030, raising the renewable energy target to 30% of the total mix. Under this revised plan, the target for solar PV installed capacity is increased to 30 GW, and the goal for offshore wind power is elevated to 13.1 GW.

To justify these strategic directions, taking Taiwan as a case study to weigh the specific advantages and limitations of each energy source, an analysis of power generation efficiency reveals a complex landscape. Although Taiwan possesses 80% of the world's optimal offshore wind sites, factors such as high construction costs and geopolitical complexities have escalated development expenses. Consequently, these barriers have significantly hindered the attraction of foreign investment.

Furthermore, hydropower and geothermal energy face significant accessibility challenges within Taiwan, limiting the feasibility of large-scale capacity deployment. In contrast, solar energy—through the promotion of both rooftop and ground-mounted systems—has reached a stage of technological and operational maturity. As of 2023, solar power accounted for 48% of the total renewable energy generation, underscoring its pivotal role in the national energy portfolio.

The primary objective of this study is to investigate the correlation between solar power generation and the stock performance of solar energy companies. By doing so, this research seeks to provide a comprehensive understanding of how Taiwan's renewable energy policies and market dynamics influence the valuation of solar concept stocks.

While local governments have aggressively promoted renewable energy and facilitated the large-scale deployment of solar photovoltaic (PV) systems, the specific impact of these initiatives on stock prices remains an area of ambiguity. Therefore, this study employs a systematic empirical framework to scientifically elucidate the impact of solar energy policies on solar stock prices, providing valuable insights for investment decision-making.

Specifically, this study aims to address the following objectives:

1. To examine whether the implementation of national solar energy policies—which drives substantial public and private installations and subsequently increases the operating revenue of solar firms—exhibits a statistically significant positive correlation with the stock prices of solar concept companies.
2. To determine whether an increase in total solar PV power generation demonstrates a statistically significant positive correlation with the stock prices of solar concept companies.

2. Literature Review and Hypotheses Development

2.1 Overview of Renewable Energy Policy Implementation in Taiwan

To address environmental issues and extreme weather patterns caused by global warming and climate change, nations worldwide have established policies aimed at achieving net-zero emissions and carbon neutrality as part of their sustainable development goals. On April 22, 2021, President Tsai Ing-wen announced Taiwan's "2050 Net-Zero Emissions" target at the RA100 Infrastructure of the Next Decade—2022 Sustainable Design Action Summit. This initiative seeks transformation across four key dimensions: energy, industry, lifestyle, and society, with renewable energy serving as a core pillar. Prior to this, the Executive Yuan enacted the "Renewable Energy Promotion Plan" on October 27, 2016, committing to a goal where renewable energy would account for 20% of total electricity generation by 2025. Notably, solar

photovoltaic (PV) capacity was targeted to reach a high proportion of 66.3%, including a short-term target (by 2010 [sic]*) of 6.5 GW and a long-term target (by 2025) of 20 GW.

By the end of 2016, Taiwan's total power generation capacity was 264,108 MW, with solar PV accounting for only 1,109 MW, or approximately 0.42% of the total. To enhance the proportion of renewable energy, the Ministry of Economic Affairs (MOEA) implemented the "Two-Year Solar PV Promotion Plan" from 2017 to 2018, achieving a cumulative installed capacity of 1.7 GW by December 2018. Building on this foundation, the "Solar PV 6.5GW Goal Plan" was launched for 2020. The original plan aimed for incremental capacities of 1.5 GW and 2.2 GW in 2019 and 2020, respectively; these targets were later revised on February 17, 2020, to 1.5 GW and 2.5757 GW. The government expected to drive the installation of solar PV facilities through three primary strategic axes. Chen (2023) documented that the inauguration of the President on May 20, 2016, and the subsequent promotion of energy policy transformation, had a significant positive relationship with abnormal returns for solar energy stocks in Taiwan. Lin (2019) utilized event study methodology and found that the announcement of energy policies in Taiwan generated positive abnormal returns for the renewable energy industry. Similarly, Zhan (2017) found that the impacts of positive and negative environmental policy events differ; specifically, the implementation of positive environmental policies showed a significant positive correlation with price volatility in Taiwan's solar energy sector.

The first axis of the "Solar PV 6.5GW Goal Plan," labeled "Industrial Parks," involved installing solar PV on rooftops within industrial zones and export processing zones under the MOEA, as well as science parks under the Ministry of Science and Technology. According to the Renewable Energy Development Act, major electricity consumers are required to install a certain proportion of power generation facilities to fulfill their Corporate Social Responsibility (CSR). The second axis, "Agrivoltaics, Aquavoltaics, and Livestock-Solar Symbiosis," encouraged the installation of solar PV on the roofs of livestock facilities, Taiwan Sugar Corporation's agrivoltaic demonstration zones, and fishery-solar projects in Tainan and Chiayi, provided that agricultural production remained unaffected. The third axis, "Joint Promotion by Central and Local Governments," involved local governments facilitating the conversion of specific areas—such as land-subsidence zones in Donggang, Jiadong, and Fangliao in Pingtung County, and available land in Tainan City—into dedicated solar zones. This strategy aimed to actively develop unused land resources and generate renewable energy. Collectively, these three axes added 1,667.7 MW of capacity, representing a 64.75% achievement rate for new installations. In 2020, Taiwan's total power generation was 280,000 MW, with solar PV accounting for 6,075 MW. The share of solar PV rose to approximately 2% of total generation, a slight increase of 1.58 percentage points.

Following its proposal in October 2017, the "Green Energy Rooftops for All" policy was officially implemented in March 2018. Managed by local governments, the policy targets the installation of solar panels on the rooftops of private residences and public buildings to utilize space effectively and achieve energy-saving goals. To encourage participation from citizens and enterprises, municipal governments provide subsidies to reduce initial installation costs, allowing participants to complete retrofits without capital outlay. Furthermore, the policy offers a Feed-in Tariff (FiT) rebate of at least 10% to residents and a 3% rebate to local governments to support neighborhood infrastructure. Simultaneously, technical consultations and streamlined administrative services were provided to simplify documentation and procedures, preventing potential participants from abandoning solar installations due to time-consuming bureaucracy. By the end of 2023, Taiwan's total electricity generation reached 282,286 GWh, of which solar PV contributed 12,909 GWh, representing approximately 4.57% of the total. This indicates significant growth in solar power generation driven by national policies. Chen (2023) found that the implementation of subsidy policies by local governments effectively and significantly increased solar installations in those regions. Guo (2008) analyzed the impact of solar industry stock prices on firm performance and found that higher operating revenues for solar companies significantly boosted their stock prices. Based on the foregoing, this study develops the following hypothesis:

H1: The implementation of solar energy policies in Taiwan has a positive impact on the stock returns of solar-related "concept" stocks.

2.2 Factors Influencing the Stock Returns of Solar Energy Concept Stocks

According to Article 1, Paragraph 1 of the "Renewable Energy Development Act" of Taiwan, renewable energy is defined as "energy generated through the direct utilization or processing of solar energy, biomass, geothermal energy, ocean energy, wind power, non-pumped storage hydropower, domestic

general waste, and general industrial waste." Statistics for 2023 indicate that Taiwan's primary source of electricity generation is thermal power—comprising coal-fired, oil-fired, and gas-fired power—which collectively accounts for 83.10% of the total generation. Hsieh et al. (2011) utilized descriptive statistics and regression analysis to examine data from air quality monitoring stations, revealing that ozone and particulate matter (PM) concentrations showed no significant improvement despite emission limits imposed by the Environmental Protection Administration (EPA). Consequently, an increase in the proportion of solar energy could reduce the operation of thermal power plants, thereby mitigating the production of PM_{2.5}. Shiao (2018) employed regression analysis to investigate the relationship between air pollution and the Taiwan stock market, finding a significant negative correlation between PM_{2.5} levels and stock prices. This implies that a reduction in suspended particulates is associated with a rise in stock market performance.

Lee (2013) explored the dynamic causal relationship between economic growth and solar power generation in the G7 industrialized nations (U.S., Japan, U.K., Italy, Germany, France, and Canada) and the E.U. Using cointegration tests, causality tests, and error correction models (ECM), the study documented a unidirectional causal link from solar power generation to actual economic growth in the short term, while a robust bidirectional relationship was identified in the long term. Based on these findings, this study develops its second hypothesis:

H2: Solar photovoltaic (PV) power generation has a positive impact on the stock returns of solar energy concept stocks.

Wang (2011) examined weekly data from 2004 to 2010 to analyze the interactions between solar energy stock prices, international crude oil prices, and gold prices. Through time-series analysis, causality tests, and cointegration tests, the study found a long-term cointegrating relationship between solar energy stock prices and gold prices, as well as a feedback loop between solar stock prices and international crude oil prices. Huang (2011) utilized Structural Equation Modeling (SEM) to incorporate oil and gold prices into a model of Taiwan's solar concept stock prices; the time-series analysis revealed that these stock prices are highly susceptible to fluctuations in gold and oil prices.

Chen (2014) conducted a correlation analysis of global energy funds, the World Energy Index, solar stocks, and international oil prices. Employing unit root tests and Granger causality tests, the study established a causal relationship between solar energy stocks and international oil prices. Specifically, rising international oil prices lead to increases in the stock prices of Taiwanese solar energy concept stocks, with long- and short-term equilibrium relationships existing between the two. Teng (2012) utilized correlation coefficients, Chow tests, and cointegration tests to demonstrate that crude oil prices and industry scale are significant factors affecting the stock price index of the Taiwan solar industry. Hsieh (2006) confirmed a long-term equilibrium relationship between Taiwan's solar concept stock prices and oil prices through cointegration tests, identifying a set of cointegrating vectors. The empirical results further indicated a positive correlation between international crude oil prices and solar concept stocks.

Guo (2008) analyzed the solar industry and firm performance, showing that solar stock prices are influenced by operating performance, with earnings per share (EPS) being the most influential variable. In a study on the impact of operating indicators on stock returns in the solar industry, Wang (2022) used Variance Inflation Factor (VIF) collinearity analysis within the SAS statistical program to filter and remove variables with low correlation to the dependent variable (ensuring $VIF < 10$). Subsequently, stepwise regression (forward selection and backward elimination) was used to exclude variables with lower explanatory power. The empirical results showed that EPS has a significant impact on the stock returns of solar energy concept stocks.

Lee, Yahya, and Razzaq (2022) found that temperature has a significant impact on the performance of Chinese solar stocks, leading to price declines in both the short and long term, a result consistent across different market conditions. Chen (2006) investigated factors influencing solar stock prices in Taiwan and identified temperature variation as a critical factor. Rising temperatures can reduce solar power generation efficiency, which in turn adversely affects the stock prices of solar power technology companies.

Hidayat (2020) utilized panel data path analysis to examine stock prices on the Indonesia Stock Exchange, analyzing the link between the Debt-to-Equity Ratio (DER) and stock prices; the study revealed a significant positive impact. To investigate the relationship between DER and stock prices, Kurniasih and Surachim (2019) employed time-series sampling and data analysis, finding that DER significantly

influences stock prices. Widayanti and Colline (2017) used purposive sampling to analyze data from 18 listed companies from 2011 to 2015; their multiple regression analysis found that DER has a significant impact on stock prices.

Liu (2021) analyzed the relationship between stock price volatility and net foreign institutional investment (buy/sell orders) in Taiwan. Using unit root tests, Vector Autoregression (VAR) models, and impulse response analysis on data from January 2001 to December 2020, the study found that foreign institutional trading has a positive impact on Taiwan's stock price volatility. Panigoro (2021) studied the impact of foreign capital flows on stock price volatility in the Indonesian market; empirical regression analysis showed that stock prices trend upward when foreign investors are in a net-buying position and tend to fall when they are in a net-selling position. He and Shen (2014) studied the relationship between foreign capital and local stock prices in the Japanese market using Granger causality tests, finding that changes in foreign institutional trading status can predict market trends: an increase in foreign ownership leads to a rise in stock prices. In summary, changes in foreign institutional positions often determine the direction of stock price movements.

3. Research Methodology

3.1 Variables Description

This study primarily investigates whether government solar energy policies, power generation volumes, and sunshine hours are correlated with the stock prices of solar energy concept stocks. Furthermore, we conduct a granular analysis of stock price performance across the upstream, midstream, and downstream segments of the solar energy supply chain. This section defines the empirical variables employed in this research, with detailed descriptions provided below:

3.1.3 Dependent Variable: Stock Returns of Taiwan's Solar Energy Concept Stocks

This study analyzes listed and over-the-counter (OTC) companies within the Taiwanese stock market. Given the significant variations in absolute stock prices across firms, we employ stock returns rather than raw stock prices as the dependent variable. Furthermore, this study separately examines Upstream Returns, Midstream Returns, and Downstream Returns. This approach allows us to investigate whether the impact of national solar energy policies on stock prices varies according to a firm's position within the industry value chain. The classification of companies in this study is based on the categories defined by the Industry Value Chain Information Platform.

3.1.2 Main Independent Variables

(1) Implementation of Solar Energy Policy (SEP)

This study investigates the impact of Taiwan's national solar energy policies—including the "Two-Year Solar PV Promotion Plan," the "Solar PV 6.5GW Goal Plan," and the "Green Energy Rooftops for All" policy—on the stock prices of solar energy concept stocks. To capture the policy intensity, we define this variable based on the number of policies active during a given period. Specifically, if two policies are implemented simultaneously within a period, the variable is assigned a value of 2; if no such policies are in effect, the value is set to 0.

(2) Generated Energy (GE)

To observe the actual effectiveness of solar energy policies, this study examines the relationship between the total volume of solar photovoltaic (PV) power generation and the dependent variables. Data on solar PV generation were retrieved from the "Power Generation by Fuel Type" section within the Economic Statistics Database System provided by the Energy Administration, Ministry of Economic Affairs (MOEA). The dataset spans from January 2017 to May 2024, utilizing quarterly frequency. The unit of measurement for power generation is GWh (Gigawatt-hours, equivalent to million kWh).

3.1.3 Control Variables

(1) Earnings Per Share (EPS)

Earnings Per Share (EPS) is a critical financial metric used to measure the net profit attributable to each outstanding share of common stock. It serves as a primary indicator for investors to assess a company's investment value and financial health. Furthermore, corporate management typically relies on EPS to determine dividend distribution policies.

(2) Debt-to-Equity Ratio (DER)

The Debt-to-Equity Ratio (DER) is a key financial metric used to evaluate a company's capital structure. It reflects the proportion of debt financing relative to shareholders' equity, thereby helping investors understand the company's capital sources and financial risk profile. A high DER indicates greater financial leverage, which may be associated with higher potential returns but also increased risk. Conversely, a low DER suggests a greater reliance on equity financing and lower financial risk, though it may also imply that the company is underutilizing leverage to enhance returns on equity.

(3) Foreign Investment (FI)

Foreign Investment refers to institutional investors based outside of Taiwan (Foreign Institutional Investors, or FIIs) that execute trades on the Taiwan Stock Exchange (TWSE) through securities firms. Given the significant impact of foreign capital flows on the Taiwanese stock market, this study employs the average number of shares held by foreign investors as a variable to analyze the influence of foreign investment trends on solar industry stock prices.

(4) Temperature (Tem)

This variable represents the monthly average temperature recorded by various observation stations. As the observation stations of the Central Weather Administration (CWA) are dispersed across Northern, Central, Southern, and Eastern Taiwan, as well as the outlying islands, this study uses the arithmetic mean of these observations as a control variable.

(5) Oil Price (Oil)

Crude oil prices serve as a vital global economic indicator, as oil is a fundamental energy source and raw material for modern industry. Fluctuations in oil prices have profound impacts on the global economy, energy markets, and geopolitical dynamics. Data were retrieved from the Economic Statistics Database System of the Energy Administration (MOEA). To ensure consistency, international crude oil prices are converted into New Taiwan Dollars (TWD) based on the exchange rate of the corresponding period.

(6) Gold Price (Gold)

Gold prices are influenced by various factors, including economic conditions, inflation expectations, geopolitical risks, monetary policies, and market demand. During periods of economic uncertainty or recession, investors often turn to gold as a store of value, driving up prices. In contrast, during periods of economic stability or growth, investors tend to favor riskier assets such as equities. Data for this variable were sourced from the Taiwan Economic Journal (TEJ) database.

3.2 Research Model

In addition to descriptive statistics, this study employs Ordinary Least Squares (OLS) regression analysis to investigate the relationship between Taiwan's solar energy policies and the stock prices of solar energy concept stocks. Lin (2022) examined the determinants of stock prices across the solar industry and found that factors such as firm size and research and development (R&D) expenditures exert heterogeneous effects on stock prices depending on a firm's position in the upstream, midstream, or downstream segments of the supply chain.

Accordingly, this study establishes separate empirical models for each segment. The upstream segment (comprising raw material suppliers, such as silicon wafers and polysilicon) is particularly susceptible to international trade tensions. Notable factors include geopolitical maneuvering between governments, the passage of human rights legislation in the United States, and trade restrictions on exports to the U.S. Given that China controls approximately 90% of global upstream capacity, these geopolitical dynamics are primary drivers of instability in the upstream sector. Consequently, this study conducts a dedicated analysis of upstream stock price performance. The regression equation is specified as follows:

$$UpReturn_i = \beta_0 + \beta_1 SEP_i + \beta_2 GE_i + \beta_3 EPS_i + \beta_4 DER_i + \beta_5 FI_i + \beta_6 Tem + \beta_7 Oil_i + \beta_8 Golden_i + \varepsilon_i$$

The midstream segment of the supply chain is primarily responsible for the manufacturing of solar power devices, serving the critical function of converting raw materials into solar cells and modules, which are subsequently utilized in downstream installations. Under the influence of Taiwan's solar energy policies, the domestic industry has become increasingly reliant on the midstream sector. The operational

performance and stock price fluctuations of these firms directly impact the overall health and stability of the entire solar industry value chain. Therefore, this study conducts a dedicated analysis of the stock price correlations within the midstream segment. This approach aims to assist investors in better understanding the current market dynamics of this link and to provide valuable insights for capital market participants regarding future trends in the midstream solar industry. The regression equation is specified as follows:

$$MidReturn_i = \beta_0 + \beta_1 SEP_i + \beta_2 GE_i + \beta_3 EPS_i + \beta_4 DER_i + \beta_5 FI_i + \beta_6 Tem + \beta_7 Oil_i + \beta_8 Golden_i + \varepsilon_i$$

The downstream segment focuses on the construction of solar energy systems and equipment installation, encompassing both rooftop and ground-mounted solar photovoltaic (PV) systems. Since the government established the "2025 Renewable Energy Development Goals," it has not only driven the domestic installation capacity of solar power but also ensured a stable market share for the domestic solar supply chain. Therefore, this study seeks to independently evaluate whether the surge in power generation installations following policy implementation exerts distinct effects on the downstream industry. The regression equation is specified as follows:

$$DownReturn_i = \beta_0 + \beta_1 SEP_i + \beta_2 GE_i + \beta_3 EPS_i + \beta_4 DER_i + \beta_5 FI_i + \beta_6 Tem + \beta_7 Oil_i + \beta_8 Golden_i + \varepsilon_i$$

3.3 Data Sources

The primary independent variable, Solar Energy Policy (SEP), is constructed based on the implementation periods of Taiwan's "Solar PV 6.5GW Goal Plan" and the "Green Energy Rooftops for All" policy. The other main independent variable, Generated Energy (GE), is compiled from statistical data released by the Economic Statistics Database System of the Ministry of Economic Affairs and the Taiwan Power Company (Taipower). Information regarding solar policy subsidy programs and funding amounts was extracted from various municipal and county-level solar subsidy initiatives, which feature differentiated incentive mechanisms based on the wattage of the power generation installations.

The dependent variables—the stock prices of upstream, midstream, and downstream Taiwanese solar energy concept stocks—were retrieved from the Taiwan Economic Journal (TEJ) database. Control variables, including Earnings Per Share (EPS), Debt-to-Equity Ratio (DER), Foreign Investment (FI), and Gold Price, were also sourced from the TEJ database. Temperature (Tem) data were obtained from the monthly meteorological reports of the Central Weather Administration (CWA). The temperature variable was calculated as the monthly arithmetic mean of observations from 27 stations, distributed across Northern Taiwan (8 stations), Central Taiwan (6 stations), Southern Taiwan (3 stations), Eastern Taiwan (4 stations), and the outlying islands (6 stations). The sampling period for the aforementioned data spans eight years, from January 1, 2016, to December 31, 2023.

4. Empirical Results

4.1 Descriptive Statistics

The sampling period of this study spans from the first quarter (Q1) of 2016 to the fourth quarter (Q4) of 2023. We utilize quarterly closing prices from all trading days within this period as our sample, with the first quarter of 2016 serving as the baseline for calculating returns. Data were retrieved from the Taiwan Economic Journal (TEJ), yielding a total of 1,532 observations.

Table 1: Descriptive Statistics for Dependent Variables

	<i>N</i>	<i>MIN</i>	<i>MAX</i>	<i>Mean</i>	<i>SD</i>
<i>AllReturn</i>	1532	0.035980	11.02769	1.912170	1.617600
<i>UpReturn</i>	419	0.105401	10.11173	1.959544	1.666422
<i>MidReturn</i>	231	0.135422	4.6	1.275597	0.961429
<i>DownReturn</i>	882	0.035980	11.02769	2.056386	1.691200

Table 1 presents the descriptive statistics for the dependent variables, including the returns for the entire solar sector (*AllReturn*), as well as the returns for the upstream (*UpReturn*), midstream (*MidReturn*), and downstream (*DownReturn*) segments. For each variable, the table provides the number of observations (*N*), minimum (*MIN*), maximum (*MAX*), mean (*MEAN*), and standard deviation (*SD*).

Table 2 details the descriptive statistics for the explanatory and control variables, sequentially disclosing the results for policy implementation (SEP), power generation volume (GE), earnings per share (EPS), debt-to-equity ratio (DER), total shares held by foreign investment (FI), temperature (Tem), oil prices (Oil), and gold prices (Gold). The reported statistics include the number of observations (N), minimum (MIN), maximum (MAX), mean (MEAN), and standard deviation (SD).

Table 2: Descriptive Statistics for Explanatory and Control Variables

	N	MIN	MAX	Mean	SD
SEP	1532	0	3	1.593994	0.990966
GE	1532	69.93949	1309.167	508.3887	361.9855
EPS	1532	-13.41	17.29	0.723081	1.764969
DER	1532	0.87	48230.04	263.8106	2225.844
FI	1532	0	3953511	155569	506108.5
Tem	1532	16.32414	27.42667	22.19731	4.158241
Oil	1532	1026.216	3499.345	1996.585	619.275
Golden	1532	36215.16	63879.62	47486.78	8108.74

4.2 Correlation Analyses

Table 3 presents the results of the Pearson correlation analysis between the dependent variable—the stock returns of solar energy concept stocks (AllReturn)—and the explanatory variables. As indicated in the table, the correlation coefficient between AllReturn and the primary explanatory variable, policy implementation (SEP), is 0.095, demonstrating a positive correlation. Furthermore, the correlation between AllReturn and the other primary explanatory variable, generated energy (GE), is 0.423, indicating a moderate positive correlation. Both primary explanatory variables are statistically significant at the 1% level.

Regarding the other control variables, the correlation coefficient for gold prices is 0.404, while the absolute values of the coefficients for the remaining variables are all below 0.4. Specifically, Earnings Per Share (EPS), Oil Price, and Gold Price are significant at the 1% level, while Foreign Investment (FI) is significant at the 10% level. In contrast, the Debt-to-Equity Ratio (DER) and Temperature (Tem) do not reach statistical significance. The following sections will provide a detailed analysis across the upstream, midstream, and downstream segments.

4.2.1 The Impact of Solar Energy Policy on Upstream Stock Returns

Table 4 presents the correlation coefficients between upstream stock returns (UpReturn) and the explanatory variables. The correlation between UpReturn and policy implementation (SEP) is significant only at the 5% level, whereas its correlation with generated energy (GE) reaches significance at the 1% level. These findings suggest that due to the nature of policy subsidies and departmental assistance, the influence of policy on the upstream segment is less potent compared to the midstream and downstream segments, resulting in lower sensitivity to policy implementation. Conversely, an increase in total power generation drives higher demand for raw materials, which in turn impacts upstream stock returns. This observation is consistent with our analytical expectations.

4.2.2 The Impact of Solar Energy Policy on Midstream Stock Returns

The correlation analysis between midstream stock returns (MidReturn) and the explanatory variables is detailed in Table 5. The correlation between MidReturn and SEP is significant at the 1% level, indicating that policy implementation exerts a substantial influence on midstream stock returns. However, the correlation between MidReturn and GE does not reach statistical significance. This suggests that for midstream component assembly manufacturers, policy drivers are more influential than the year-on-year increase in power generation capacity, which may not necessarily translate into a significant impact on stock performance.

Table 3: Pearson Correlation Coefficient Matrix

	AllReturn	SEP	GE	EPS	DER	FI	Tem	Oil	Golden
AllReturn	1.000								
SEP	0.095***	1.000							
GE	0.423***	0.060*	1.000						
EPS	0.323***	0.022	0.123***	1.000					
DER	-0.033	-0.040	-0.063*	-0.027	1.000				
FI	0.054*	0.004	-0.041	0.030	-0.020	1.000			
Tem	-0.014	0.031	0.140***	0.059*	0.016	-0.001	1.000		
Oil	0.315***	-0.008	0.646***	0.093***	-0.029	-0.025	0.086***	1.000	
Golden	0.404***	0.110***	0.885***	0.112***	-0.062*	-0.042	0.004	0.463***	1.000

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4: Pearson Correlation Coefficient Matrix for the Upstream Segment

	AllReturn	SEP	GE	EPS	DER	FI	Tem	Oil	Golden
AllReturn	1.000								
SEP	0.158**	1.000							
GE	0.335***	0.064	1.000						
EPS	0.367***	0.038	0.104*	1.000					
DER	0.235***	0.094	-0.125*	0.038	1.000				
FI	0.052	0.006	-0.080	-0.079	0.077	1.000			
Tem	-0.017	0.040	0.140**	0.083	0.027	0.000	1.000		
Oil	0.268***	-0.005	0.646***	0.050	-0.125*	-0.052	0.088	1.000	
Golden	0.311***	0.115*	0.885***	0.115*	-0.096	-0.080	0.005	0.458***	1.000

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5: Pearson Correlation Coefficient Matrix for the Midstream Segment

	AllReturn	SEP	GE	EPS	DER	FI	Tem	Oil	Golden
AllReturn	1.000								
SEP	0.141*	1.000							
GE	0.348***	-0.040	1.000						
EPS	0.293***	-0.011	0.377***	1.000					
DER	-0.055	-0.108	-0.192**	-0.011	1.000				
FI	-0.345***	0.099	0.001	-0.216***	-0.081	1.000			
Tem	-0.031	0.019	0.143*	0.080	0.039	0.003	1.000		
Oil	0.231***	-0.080	0.661***	0.227***	-0.095	-0.003	0.095	1.000	
Golden	0.371***	0.025	0.883***	0.384***	-0.192**	0.000	-0.017	0.491***	1.000

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6: Pearson Correlation Coefficient Matrix for the Downstream Segment

	AllReturn	SEP	GE	EPS	DER	FI	Tem	Oil	Golden
AllReturn	1.000								
SEP	0.060	1.000							
GE	0.521***	0.086*	1.000						
EPS	0.276***	0.017	0.121***	1.000					
DER	0.300***	0.077*	0.167***	0.189***	1.000				
FI	0.055	-0.004	-0.002	0.142***	-0.036	1.000			
Tem	-0.010	0.030	0.140***	0.049	0.044	-0.002	1.000		
Oil	0.381***	0.010	0.641***	0.112***	0.102**	0.002	0.084*	1.000	
Golden	0.495***	0.133***	0.884***	0.096**	0.170***	-0.004	0.010	0.454***	1.000

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

generation capacity, which may not necessarily translate into a significant impact on stock performance.

4.2.3 The Impact of Solar Energy Policy on Downstream Stock Returns

Table 6 shows the correlation coefficients for downstream stock returns (DownReturn). The results indicate that SEP lacks statistical significance concerning DownReturn. In contrast, the correlation between DownReturn and GE is significant at the 1% level. This implies that while policy implementation may not have a direct material impact, the annual growth in power generation—reflecting an increase in solar installations and service opportunities for downstream providers—significantly and positively affects stock returns. This finding is aligned with the existing literature.

4.3 Regression Analyses

4.3.1 The Impact of Solar Energy Policy Implementation on Stock Returns

Extant literature suggests that policy interventions exert a quantifiable influence on stock prices. This study further explores whether such impacts vary according to a firm's position within the supply chain. Based on regression analysis using classifications from the Industry Value Chain Information Platform, the results in Table 7 find that policy implementation has a significant impact on the stock returns of the aggregate sector (All), upstream, and midstream segments, with coefficients of 0.105, 0.183, and 0.177, respectively. All three coefficients are statistically significant at the 1% level. These results support Hypothesis 1 for the aggregate, upstream, and midstream segments, although the effect on the downstream segment did not reach statistical significance.

4.3.2 The Impact of Solar Power Generation on Stock Returns

This study also examines whether the growth in solar power generation influences the stock returns of solar-related firms. While Lee (2013) identified a bidirectional relationship between economic growth and solar power generation in G7 nations, our empirical results show that power generation significantly impacts aggregate and downstream stock returns, with coefficients of 0.001 for both, significant at the 1% level. Furthermore, the upstream segment shows a coefficient of 0.001, significant at the 5% level. However, the midstream segment did not exhibit a significant response. These findings regarding the impact on aggregate, upstream, and downstream returns are consistent with Hypothesis 2.

4.3.3 The Impact of Other Explanatory Variables on Stock Returns

Regarding Earnings Per Share (EPS), we observe a significant positive correlation with the stock returns of the aggregate, upstream, and downstream segments, with coefficients of 0.251, 0.320, and 0.162, respectively (all significant at the 1% level). This aligns with the findings of Guo (2008).

For the Debt-to-Equity Ratio (DER), a significant positive correlation is observed in the upstream and downstream segments, with both coefficients at 0.005 (significant at the 1% level). Foreign Investment (FI) exhibits a significant positive correlation with aggregate, upstream, and midstream stock returns. Conversely, Temperature (Tem) and Oil Prices (Oil) show a significant negative correlation with aggregate, upstream, and downstream returns. Finally, Gold Price demonstrates a significant positive relationship with both aggregate and downstream solar stock returns.

Table 7: The Impact of Solar Energy Policy on Stock Returns across Upstream, Midstream, and Downstream Segments

	AllReturn	UpReturn	MidReturn	DownReturn
SEP	0.105*** (0.004)	0.183*** (0.009)	0.177*** (0.002)	-0.002 (0.961)
GE	0.001*** (0.000)	0.001** (0.017)	0.000 (0.455)	0.001*** (0.000)
EPS	0.251*** (0.000)	0.320*** (0.000)	0.086 (0.147)	0.162*** (0.000)
DER	0.000 (0.852)	0.005*** (0.000)	0.000 (0.916)	0.005*** (0.000)
FI	0.000*** (0.004)	0.000** (0.035)	0.000*** (0.000)	0.000 (0.174)
Tem	-0.028** (0.002)	-0.042** (0.015)	-0.014 (0.330)	-0.030*** (0.009)

Oil	0.000** (0.002)	0.000** (0.026)	0.000 (0.491)	0.000*** (0.007)
Golden	0.000* (0.016)	0.000 (0.977)	0.000 (0.130)	0.000** (0.010)
N	1532	419	231	882
R ² _{adj}	0.271	0.316	0.274	0.362
F-stat	72.256	25.177	11.862	63.584

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

5. Conclusions and Policy Implications

Based on our regression analysis, we find a significant positive relationship between the implementation of national solar energy policies and the stock returns of solar energy concept stocks. Specifically, an increase in the number of active policy initiatives is associated with higher stock returns within the sector. These findings align with empirical evidence previously documented in regions such as the United States, Germany, the United Kingdom, France, Japan, Italy, Canada, and the European Union. This study demonstrates that Taiwan exhibits consistent results. Although the magnitude of impact varies across the upstream, midstream, and downstream segments of the supply chain, the overall direction of the influence remains positive and consistent.

Under the government's strategic planning and policy implementation, the development of renewable solar energy has significantly enhanced the maturity of the industry in Taiwan. These efforts not only address environmental protection goals but also mitigate the challenges posed by energy scarcity on the island. This undoubtedly represents a transformative direction for Taiwan's energy policy. However, as the infrastructure for solar power in Taiwan reaches maturity and the era of equipment depreciation and replacement approaches, whether these factors will exert different impacts on the stock returns of solar energy concept stocks remains a compelling question for future research.

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