

Article

Did the Consumption Voucher Scheme Stimulate the Economy? Evidence from Smooth Time-Varying Cointegration Analysis

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Abstract: Background: The stimulus coupon plan is one of the economic relief plans used to boost Taiwan's slumping economy in the aftermath of the COVID-19 pandemic outbreak. In order to obtain prior information to understand whether or not the stimulus coupon plan would effectively revive the economy in advance, the purpose of this study is to learn lessons from Taiwan's consumption voucher scheme initiated during the 2007–2009 global financial crisis through evaluating the effect of the consumption voucher scheme on private consumption expenditure. **Methods:** The smooth time-varying cointegration analysis was applied to estimate the income elasticity of consumption, indicating the individual's reaction to consumption vouchers in terms of private consumption expenditure, and then the multiple structural change model was estimated to identify endogenous regime changes of the income elasticity of consumption. **Results:** We found that the income elasticity of consumption dramatically decreased after 2007Q1, a period that covered the subprime mortgage crisis in 2007–2009 and the time of issuance of the consumption vouchers in 2009. **Conclusions:** We concluded that Taiwan's consumption voucher scheme might have had either no or little effect on stimulating the economy, so policymakers should be cautioned concerning the potential ineffectiveness of the stimulus coupon plan in the future.

Keywords: consumption voucher; absolute income hypothesis; life cycle income hypothesis; permanent income hypothesis; time-varying cointegration; structural change model; COVID-19

1. Introduction

The recent COVID-19 pandemic outbreak has put the world into a great lockdown due to the enforcement of necessary quarantines and social distancing practices used to control the spread of the pandemic, and the subsequent massive collapse in economic activities reminisces us that a sharp increase in the unemployment rate and devastating losses in business were incurred during the 2007–2009 global financial crisis period [1]. Consequently, countries around the world continue to implement economic relief plans to stimulate their economies during the COVID-19 pandemic outbreak. Taiwan, maintaining its outstanding record of being one of the few nations that do not suffer from the community spread of the COVID-19 pandemic [2], is not exceptional. In fact, Taiwan's government plans to provide NT\$40 billion (US\$1.33 billion) worth of stimulus coupons in a bid to boost the consumer's spending in the aftermath of the COVID-19 pandemic outbreak, and the design of this stimulus coupon plan will guarantee that all Taiwanese residents (regardless of their age and income status) obtain consumption vouchers worth NT\$3000 (US\$100) for each NT\$1000 (US\$33.33) spending on goods and services in Taiwan [3]. Although this stimulus coupon plan was announced

to be implemented in July 2020 [3], the Taiwan government actually has no definite timeline to put this plan into effect due to the ongoing outbreak of the COVID-19 pandemic. It is very important to address that this stimulus coupon plan resembles the so-called Taiwan's consumption voucher scheme; a fiscal policy intended to boost the slumping economy during the 2007–2009 global financial crisis period. Therefore, the purpose of this study is to learn lessons from Taiwan's consumption voucher scheme initiated during the 2007–2009 global financial crisis through evaluating the effect of the consumption voucher scheme on private consumption expenditure. In this way, we would obtain some prior information to understand whether or not the future stimulus coupon plan would effectively revive the economy in advance.

Taiwan's consumption voucher scheme was implemented at the beginning of 2009 in response to the economic downturn, resulting from the 2007–2009 global financial crisis. This scheme distributed consumption vouchers worth NT\$85.7 billion (US\$2.86 billion), approximately 0.68% of 2008 Taiwan's GDP (Gross Domestic Product), to all Taiwanese citizens and their foreign spouses [4]. Each eligible recipient, regardless of age and income, was notified to collect consumption vouchers from January 18 to April 30, 2009. The vouchers were issued in two denominations, NT\$500 (US\$16.67), and NT\$200 (US\$6.67), with each recipient receiving six vouchers worth NT\$500 (US\$16.67), and three vouchers worth NT\$200 (US\$6.67), amounting to NT\$3600 (US\$120). This amount contributes approximately to 1.05% of the annual per capita household income [4]. To promote circulation of the consumption vouchers, these consumption vouchers are "time-limited" and "use-it-or-lose-it" consumption vouchers that could be used to purchase any kind of goods and services with the exceptions of purchasing financial products, repaying loans, paying utility bills (water, electricity, and other public utility bills) and payments due to government entities (taxes, fines, and official fees). However, there was no change allowed for purchases smaller than the denominations of the consumption vouchers. Neither could the vouchers be exchanged for cash nor deposited into a bank account. Only merchants with valid business registrations would have been able to redeem the vouchers and should have received reimbursement for the vouchers before October 31, 2009. Merchants without business registrations could still use them to purchase materials from upstream firms or for final consumption. All the vouchers expired on September 30, 2009.

It seems that the Taiwanese consumption voucher scheme had a wide-ranging benefit in bolstering domestic consumption in terms of the sharp business growth recorded by hypermarkets, department stores, 3C merchants, and other retail outlets in January, 2009 [5,6]. According to business statistics from the Directorate-General of Budget, Accounting, and Statistics (DGBAS), retail sales per capita and food and restaurant spending per capita in January, 2009 were NT\$13,067 (US\$435.57), and NT\$1318 (US\$43.93), respectively, which were higher than those (NT\$13,051 (US\$435.03), and NT\$1268 (US\$42.27)) at the same period in the previous year [7]. Although business statistics showed that Taiwan's consumption voucher scheme might be able to bolster economic performance as predicted by the Keynesian absolute income hypothesis, it should be noted that consumers would not be predicted to change their consumption behavior in response to an anticipated but temporary change in their income based on the forward-looking consumption hypothesized by either the life cycle of the permanent income hypothesis [8]. These arguments lead us to carefully investigate the impact of Taiwan's consumption voucher scheme on the change of private consumption.

Previous studies that evaluated the effectiveness of fiscal policy in revitalizing the economy (such as Taiwan's consumption voucher scheme, Japan's shopping coupon program, and the US's tax rebate policy, etc.) focused on how the consumer responds to an anticipated but temporary increase in income. Some studies suggested that such fiscal policy, due to increasing temporary income, would increase the demand for consumption and simulate aggregate demand [4,9–18]. Other studies suggested that temporary increases in income lead to proportionately smaller increases in consumption than permanent increases in income, a conclusion positing a skeptical view of the effectiveness of the temporary income shock policy [8,19–25]. The lack of consensus by the previous studies leads us

to re-evaluate the effectiveness of Taiwan's consumption voucher scheme, a fiscal policy set in motion during the 2007–2009 financial crisis period in Taiwan.

In fact, Taiwan was not the only country to utilize consumption vouchers to promote consumption, and in turn, bolster economic growth. In March 1999, the consumption vouchers type of fiscal policy (termed as the Japanese shopping coupon program) was adopted by the Japanese government to revive the slumping economy. This program distributed a total of 620 billion-yen (US\$6 billion) worth of coupons to 31 million Japanese. The qualified recipients, including those whose families with children under the age 15 and the elderly (aged 65 and over) population received “time-limited” and “use-it-or-lose-it” shopping coupons worth 20,000 yen (US\$200) [23]. The regulations for the Japanese shopping coupon program differed from Taiwan's consumption voucher scheme in various ways: First, the nature of the Japanese shopping coupon program was regional, and it intended to stimulate regional economies. Second, the main purpose of the Japanese shopping coupon program was to reduce the economic burden on the younger generation through subsidizing children and the elderly, and in turn, the regional economies could be invigorated through the expansion of consumption expenditure [23]. Taiwan's consumption voucher scheme, on the other hand, was national and universal in nature and focused on the national economy in the hopes that consumer spending would improve the overall economy.

Due to the nation-wide and universal nature of the program, Taiwan's consumption voucher scheme initiative in 2009 posed some difficulties for policy evaluation. All citizens benefited from this fiscal policy; therefore, we did not have a control group. Thus, the standard methodology for policy evaluation based on the difference-in-differences analyses was not suitable for the current study. The other standard approach to evaluate the economic policy effectiveness is to compare pre- and post-policy outcomes through assessing time-series variation. Nevertheless, such an approach may not be valid, because the timing of the policy effect is usually unknown due to the pre-announced effect or the lagged effect in policy intervention. In addition, the consumption voucher scheme may possibly generate a smooth transition of private consumption. In order to evaluate the effectiveness of Taiwan's consumption voucher scheme, we first applied the time series approach based on the smooth time-varying cointegration analysis proposed by Park and Hahn [26] to investigate the dynamic change of income elasticity of consumption, which indicates the individual's reaction to consumption vouchers, and then the Bai and Perron's multiple structural change model [27] was used to identify endogenous regime changes of income elasticity of consumption. Our approach was appropriate for evaluating fiscal policy that aimed to change the regime of the individual's reaction to consumption vouchers. It follows that a test for instability of income elasticity of consumption would provide a flexible framework for testing a range of hypotheses commonly posed in policy evaluation. In this study, if income elasticity of consumption was found to be significantly different in the regime of issuing the consumption vouchers from those in other regimes, one would conclude that consumers may be sensitive to a change of consumption due to a temporary increase in income. The interpretation of our results is closely related to the empirical results presented in a line of the literature devoted to testing either the life cycle or the permanent income hypothesis (i.e., consumers will not change their consumption in response to a temporary change in their income) [8,19–25] against the Keynesian absolute income hypothesis (i.e., any increase of income will impact consumption positively) [4,9–18].

The remainder of the paper is organized as follows: Section 2 introduces the materials and methods of this study. Section 3 presents our empirical results. Section 4 discusses the empirical findings. Section 5 presents our conclusions.

2. Materials and Methods

2.1. Methods

Previous studies on the relationship between private consumption expenditure and other macroeconomic variables via conventional time series models have to deal with the unit root property

involved in a long period of time series in order to validate the statistical inference. One of the most frequently used methods to render a valid inference for the time series model is the so-called cointegration analyses [28]. Despite the popularity of the cointegration analyses, the assumption of time invariant coefficients imposed in the conventional cointegration approach is not likely to be valid. This is particularly true when the time series data cover a long period of time. Many studies on estimating the consumption function argued that the predictive failure of the consumption function is associated with parameter instability caused by structural shock, seasonality, or parameter variation [29]. In addition, Song and his colleagues [30] highlighted three reasons for using the time-varying parameter model to estimate consumption function. First, the well-known Lucas critique provides a theoretical foundation to predict the phenomenon that consumers modify, not only their behavior in response to the economic policy change but also their expectation of the economic model deliberated relevant to prior economic policies [31]. Second, adjustments in some unobservable elements of economic variables such as expectations and permanent income will cause structural change in the data-generating process (DGP). Third, it is not possible to construct a flawless specification of an economic DGP, so the potential risk of mis-specifying econometric models renders another validation for the application of the time-varying parameter type of time series models.

With this backdrop, the time-varying elasticity of consumption to income, revealing the individual's reaction to consumption vouchers over a period of time, was estimated by the smooth time-varying cointegration (STVC, hereafter) model. The STVC model was introduced by Park and Hahn [26] and involved many appealing features. For example, the STVC model included all the samples to estimate the consumption function in contrast to previous studies using ad-hoc splitting samples into different time spans to cope with the structural changes of private consumption expenditure [32], and it followed that the estimators generated by the STVC model reveal a higher efficiency than those created by conventional cointegration models. In addition, the time-varying specification imposed on the STVC model was able to identify the possible turning points of the estimated parameters in the private consumption function, allowing us to obtain some insight of the transition of private consumption spending during our study period. Furthermore, it is important to address that the conventional cointegration model was a special case of the STVC model, and the latter model gave two formal tests to evaluate whether our DGP was consistent with the time invariant or time-varying long-run relationship [26,33,34]. Finally, in comparison to the conventional error correction model (ECM, hereafter) only allowing one lag of error correction term, the ECM generated from the STVC model was more flexible in terms of more than one lag of error correction term included in the estimation process [35]. Specifically, the STVC model proposed by Park and Hahn [26] could be written by

$$C_{qj} = \beta_0 + \alpha_q + \beta'_{qj} X_{qj} + \varepsilon_{qj} = \beta_0 + \alpha_q + \beta_{1(qj)} Y_{qj} + \beta_{2(qj)} R_{qj} + \beta_{3(qj)} W_{qj} + \varepsilon_{qj} \quad (1)$$

where, Subscripts q and j indicate the quarter $q \in \{1, 2, 3, 4\}$ at year $j \in \{1, 2, 3, \dots, T\}$. C_{qj} is private consumption expenditure per capita (at 2006 price level). $X_{qj} = (Y_{qj}, R_{qj}, W_{qj})'$ signifies a vector for explanatory variables. Y_{qj} , R_{qj} , and W_{qj} denote disposable income per capita (at the 2006 price level), real interest rate (measured by prime lending rate minus the inflation rate), and expected future wealth (measured by the Taiwan stock exchange capitalization-weighted index, hereafter, TAIEX), respectively. α_q denotes the fixed quarter effect to capture the seasonality presented in the private consumption expenditure. β_0 denotes the constant term, and ε_{qj} is the error term. $\beta_{qj} = (\beta_{1(qj)}, \beta_{2(qj)}, \beta_{3(qj)})'$ is a vector for the time-varying parameters corresponding to $X_{qj} = (Y_{qj}, R_{qj}, W_{qj})'$. Specifically, we define a smooth function with a total number of observations (n) as $\beta_{qj} = \beta(t/n) \in [0, 1]$, and the order of observation in the total observation could be delineated by $t = 4(j-1) + q$. The time-varying parameter β_{qj} in Equation (1) could be approximated by the Fourier flexible form function as follows

$$C_{qj} = \beta_0 + \alpha_q + \gamma' X_{kqj} + \varepsilon_{kqj} \quad (2)$$

where, $\phi_i(\lambda) = (\cos 2\pi i\lambda, \sin 2\pi i\lambda)'$, $i = 1, 2, \dots, k$; $\gamma_k = (\gamma'_{k,1}, \gamma'_{k,2}, \dots, \gamma'_{k,2(k+1)})'$; $f_k = (1, \lambda, \phi'_1(\lambda), \dots, \phi'_k(\lambda))'$ with $\lambda \in [0, 1]$; \otimes symbolizes the Kronecker product; $X_{kqj} = f_k(t/n) \otimes X_{qj}$; $\varepsilon_{kqj} = \varepsilon_{qj} + [\beta(t/n) - \beta_k(t/n)]X_{kqj}$; $C_{qj}, \beta_0, \alpha_q, X_{qj}$, and ε_{qj} are defined in the same way as in Equation (1).

Park and Hahn [26] demonstrated that the estimator of β_k (generated by the canonical cointegrating regression (CCR) based on Park [36]) is a consistent estimator of β and its limit distribution is written as follows:

$$M_{nk}^* - 1/2(\Pi(\hat{\beta}_k) - \Pi(\beta)) \xrightarrow{d} N(0, \omega_{*}^2 I_{2d}) \text{ as } n \rightarrow \infty \quad (3)$$

where, $\Pi(\beta) = (\beta(\lambda_1)', \dots, \beta(\lambda_d)')'$, and $\Pi(\beta'_k) = (\beta(\lambda_1)', \dots, \beta(\lambda_d)')$ for λ_i within an interval bounded between 0 and 1, $i = 1, 2, 3, \dots, d$. Total sample size is denoted by n , and a $2d \times 2d$ identity matrix is constructed by I_{2d} . M_{nk}^* represents a matrix by $2d \times 2d$. Park and Hahn [26] symbolized ω_{*}^2 as the conditional long-run variance of the residuals from Equation (2). In this study, the τ^* and τ_1^* testing statistics derived from the Wald-type variable addition tests [26,33,34] were used to test for H_0 : STVC Model versus H_A : No Cointegration (τ^*) and for H_0 : Fixed Coefficient Cointegration Model versus H_A : STVC Model(τ_1^*), respectively. The limit distributions of these two statistics are the chi-square distribution with four degrees of freedom under the null hypotheses are true [33,34]. Once the time-varying long-run relationship between the private consumption expenditure and the macroeconomic variables is justified by our model specification tests, the short-run adjustment towards the long-run equilibrium could be specified by the ECM under the STVC model as follows:

$$\Delta C_t = \theta_0 + \delta_q + \sum_{k=1}^{p1} b_{1k} ec_{t-k} + \sum_{k=1}^{p2} b_{2k} \Delta C_{t-k} + \sum_{k=1}^{p3} b'_{3k} \Delta X_{t-k} + u_t \quad (4)$$

where, Δ is the difference operator, and the error correction term (obtained from Equation (2)) is notarized by ec_t . C_t and X_t are private consumption expenditure per capita and a vector for explanatory variables, respectively. θ_0 and δ_q represent the intercept, and fixed quarter effects, respectively. b_{1k}, b_{2k} , and b_{3k} are parameters. We applied the stepwise regression procedure based on p values less than 10% significance level to select $p1-p3$. The model specification in Equation (4) could accommodate more than one lag of error correction terms that eliminates the multi-collinearity problem between the lags of error correction terms and the lagged differences of other explanatory variables [35].

2.2. Materials

All data were obtained from the macroeconomics statistics database administrated by the Directorate-General of Budget, Accounting, and Statistics [7]. Since the Taiwan fiscal policies such as the public work investment project with total spending of approximately US\$16.38 billion and the consumption voucher scheme using a total of approximately US\$2.08 billion had been executed for a five-year duration from 2009 to 2013 [21], our study period covered data from 1967Q1 to 2013Q4, with a total of 188 quarterly observations. Except for the real interest rate (which was negative for some periods), all variables were transformed into natural logarithms.

3. Results

3.1. Descriptive Statistics

Table 1 summarizes the descriptive statistics of private consumption expenditure per capita (at the 2006 price level), disposal income per capita (at the 2006 price level), real interest rate (measured by the prime lending rate minus inflation rate), and expected future wealth (measured by TAIEX) over the period of 1967 to 2013. In order to better present these data, we display the trends of all variables used in this study in Figures 1–4. The left vertical axis measures the level of variables (indicated by bold lines). Since all variables (except for the real interest rate) were transformed into natural

logarithms, the right vertical axis measures the level of natural logarithms of variables. As indicated in Figure 1, disposable income showed a continuously increasing trend over the period of 1967–2013 but several turning points mirrored bad years for Taiwan’s economy, such as the recession periods due to the first oil crisis (1974:Q1–1975:Q1), the dot-com bubble recession (2000:Q3–2001:Q3), the Severe Acute Respiratory Syndrome (hereafter, SARS) outbreak (2003:Q1–2003:Q4) and the subprime mortgage crisis (2008:Q1–2009:Q1). Private consumption expenditure, shown in Figure 2, in general, revealed the same trend as disposable income, and some dramatic downturn points appeared during the SARS outbreak (2003Q1–2003Q4) and the subprime mortgage crisis (2008Q1–2009Q1). Not surprisingly, Figure 3 indicates that all historical events had significant impacts on Taiwan’s stock market, but only some of them (such as the 1st and 2nd oil crises, the SARS outbreak, and the subprime mortgage crisis) generated significant impacts on real interest rate (see Figure 4).

Table 1. Descriptive statistics.

Variables	Description	Mean	Std. Dev	Max	Min
CEXP	Private Consumption Per capita at the 2006 price level (NT\$)	43,916.45	27,186.74	89,336.33	8,358.36
DIP	Disposal Income per capita at the 2006 price level (NT\$)	69,492.07	39,429.60	13,7664.4	14,238.22
TSPI	Capitalization- Weighted Index (Points)	38,63.53	32,88.82	11,294.67	94.67
RIR	Real Interest Rate=Prime Lending Rate-Inflation Rate (%)	4.30	6.57	12.94	−38.60

Note: 1 US\$ = 30 NT\$. The whole sample period starts from 1967Q1 and ends in 2013Q4, resulting in a total of 188 quarterly observations.

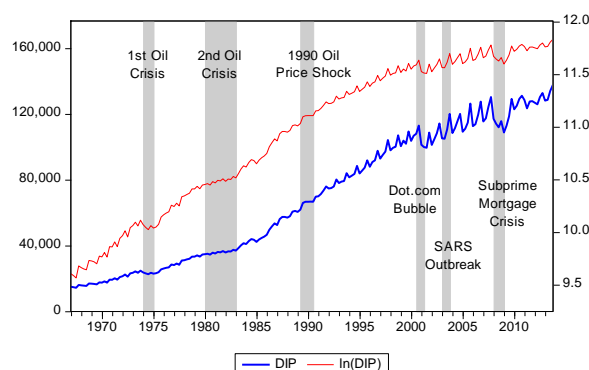


Figure 1. Real disposal income per capita.

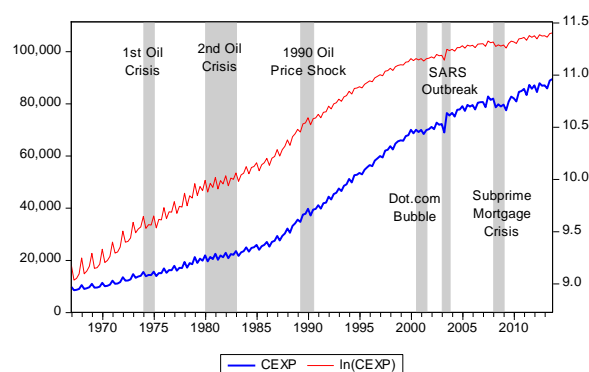


Figure 2. Real consumption per capita.

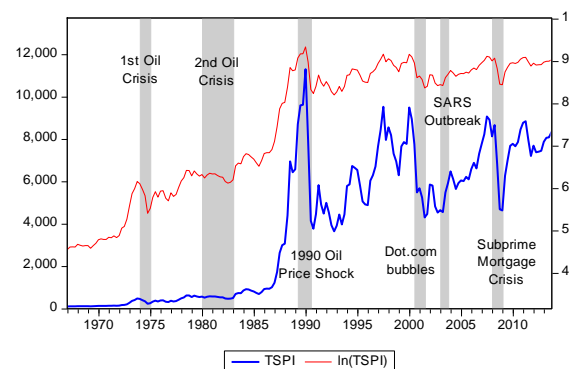


Figure 3. Taiwan stock exchange Capitalization-Weighted Index.

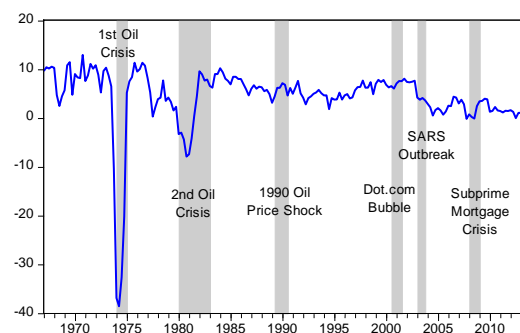


Figure 4. Real interest rate (Prime lending rate minus the inflation rate).

3.2. Unit Root Tests

The results for the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests are displayed in panel (a) of Table 2. We found that no matter which unit root test was chosen, the testing results were in favor of the presence of the unit root in the private consumption expenditure and disposal income. In contrast to the testing results for these two variables, the ADF and PP unit root tests for TAIEX and the real interest rate generated ambiguous results in support of the existence of the unit root. Since we observed several obvious structural changes in TAIEX and the real interest rate in Figures 3 and 4, we adopted two newly developed unit root tests (which are M1 and M2 tests) proposed by Narayan and Popp [37] in order to identify unknown structural breaks. The lags for new ADF tests (M1 and M2) were chosen by the procedure proposed by Hall [38]. As stated by Chen [39], there are several appealing features of these two-unit root tests. First, these two-unit root tests could incorporate two unknown structural breaks under both the null hypotheses of the presence of unit root and the alternative hypotheses of stationary series. Second, the Monte Carlo simulations reported in Narayan and Popp suggested that these two-unit root tests had stable power and could accurately identify true break dates even for small breaks [37]. As showed in panel (b) of Table 2, the structural break points identified by the M1 and M2 tests were consistent with the historical events mentioned in Figures 1–4, and all testing results were in favor of the presence of the unit root in the time series of the TAIEX and the real interest rate. Since the 1st differences of all variables unambiguously suggest the stationarity of all variables used in this study, we confirmed that all variables used in this study belonged to the I(1) series.

Table 2. Unit root tests.

(a) ADF & PP	Levels				Differences			
	Demeaned		De-trended		Demeaned		De-trended	
	ADF	PP	ADF	PP	ADF	PP	ADF	PP
ln(CEXP)	−2.051	−1.812	−0.160	−2.485	−3.628†	−31.115†	−4.196†	−38.426†
ln(DIP)	−2.758	−2.661	−0.318	−1.028	−4.054†	−20.983†	−4.968†	−24.223†
ln(TSPI)	−1.502	−1.561	−4.034*	−3.421	−6.541†	−9.617†	−9.709†	−9.858†
ln(RIR)	−5.071†	−3.376*	−5.078†	−3.364	−7.898†	−18.665†	−7.875†	18.839†

(b) New ADF	Levels-M1				Levels-M2 Levels			
	ADF	TB1	TB2	Lags	ADF	TB1	TB2	Lags
ln(CEXP)	−1.426	1975.Q2	2003.Q2	19	−1.577	1975.Q2	2003.Q2	19
ln(DIP)	−1.203	1973.Q4	2000.Q4	8	−4.049	1990.Q3	2000.Q4	8
ln(TSPI)	−3.079	1987.Q1	1990.Q3	18	−4.341	1988.Q1	1990.Q1	7
ln(RIR)	−1.616	1973.Q4	1978.Q1	20	−2.064	1973.Q4	1979.Q2	20
CV5%	−4.136				−5.318			
CV1%	−4.731				−4.714			

Note: all variables are defined the same as for Table 1 but they are transformed into natural logarithms for the unit root tests. “†”, and “*” represent 1% and 5% significance, respectively. The critical values (CV5% and CV1%) were obtained from Narayan and Popp [37]. The lags for new ADF (Augmented Dickey–Fuller) tests (M1 and M2) were chosen by the procedure proposed by Hall [38]. CEXP, DIP, TSPI, and RIR represent private consumption per capita, disposal income per capita, Taiwan stock exchange Capitalization-Weighted Index, and real interest rate, respectively.

3.3. Specification Tests and Short-run Adjustment

The estimated results of the STVC model is displayed in Table 3. Previous studies using the STVC model to describe the time-varying long-run relationship suggested time polynomial terms, t^1 , t^2 , t^3 , and t^4 as the superfluous regressors to test for whether or not the STVC model was consistent with the DGP. As demonstrated in panel (a) of Table 3, the null hypothesis of the fixed coefficient cointegration model was rejected at 1% significance level ($\tau_1^* = 527.49 > 1\%$ critical value), but we failed to reject the null hypothesis of the STVC model ($\tau^* = 2.01 < 10\%$ critical value). The results generated from these two specification tests suggested that there was a time-varying long-run relationship between private consumption expenditure and the selected macro-economic variables such as disposable income, real interest rate, and TAIEX. For the purposes of model comparison, two conventional cointegration tests (namely, Engle–Granger and Phillips–Ouliaris cointegration tests) were estimated to compare with the testing results generated by the STVC model, and we refer any interested readers to the online Supplementary Materials.

Table 3-Panel (b) presents the estimated results of the ECM under the STVC model. We selected lags based on the stepwise regression procedure with p values less than 10% criterion. In general, the estimated model shows a high goodness-of-fit, since approximately 75% of variation ($R^2 = 74.50\%$) in the growth rate of private consumption expenditure could be explained by all explanatory variables included in our ECM, and no first-order serial correlation was detected in residuals of the ECM (Durbin–Watson statistics = 2.1). We find that the growth rate of TAIEX in the previous period is positively related to the private consumption expenditure in the current period. Nevertheless, the growth rates of disposable income and private consumption expenditure in the previous period generate a significantly negative impact on the private consumption expenditure in the current period. Note that the absence of the real interest rate in the selected ECM confirms a low impact of real interest rate on private consumption expenditure in the long-run equilibrium (See Figures 5–7 below). Finally, the estimated coefficients of the two lagged error correction terms (ec_{t-1} , ec_{t-2}) were significantly negative at a 5% significance level. These results were characteristic of the adjustment path over two

periods toward the long-run equilibrium of private consumption expenditure if an external shock of the economics occurred.

Table 3. Results for the Smooth Time-Varying Cointegration (STVC) model.

(a) Model Specification Test	H ₀ : Fixed Coefficient Cointegration Model H _A : STVC Model	H ₀ : STVC Model H _A : No Cointegration
	τ_1^*	τ^*
Test Statistics	527.49	2.01
1% Critical Values	13.28	13.28
5% Critical Values	9.49	9.49
10% Critical Values	7.78	7.78
(b) Results for Error Correction Model		
Variables	Coefficient	t-Statistic
$\Delta \ln(\text{CEXP})_{t-1}$	−0.426	−4.32†
$\Delta \ln(\text{DIP})_{t-2}$	−0.384	−4.99†
$\Delta \ln(\text{TSPI})_{t-1}$	0.046	2.51*
ECt-1	−0.281	−2.38*
ECt-2	−0.228	−2.19*
Dummy Var for 1st Quarter	0.031	4.09†
Dummy Var for 2nd Quarter	−0.055	−7.84†
Dummy Var for 3rd Quarter	−0.027	−1.91
Constant	0.034	5.01†
R ²	74.50%	
Adjusted R ²	73.34%	
Durbin-Watson stat	2.10	

Note: “†”, and “*” represent 1% and 5% significance, respectively. “ Δ ” represents difference operators. CEXP, DIP, TSPI, and EC represent private consumption per capita, disposal income per capita, Taiwan stock exchange Capitalization-Weighted Index, and error correction terms obtained from the smooth time-varying cointegration (STVC) model, respectively.

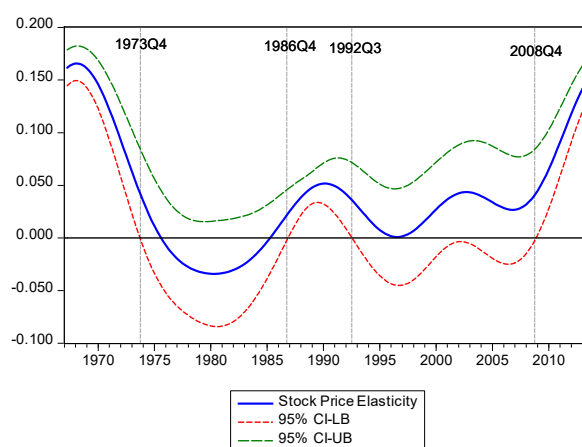


Figure 5. Stock price elasticity.

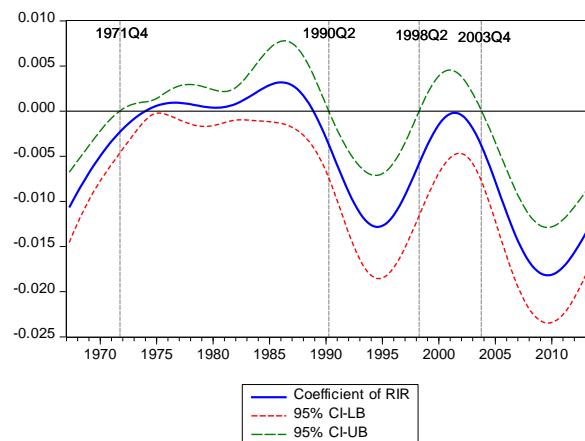


Figure 6. Coefficient of real interest rate.

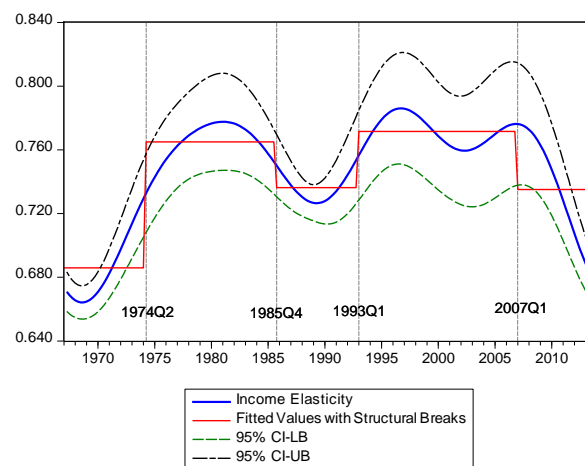


Figure 7. Income elasticity.

3.4. Long-Run Relationship

Figures 5–7 plot the estimated coefficients from the STVC model. The solid and dashed lines represent the estimated time-varying coefficients and 95% confidence interval bands, respectively. As indicated in Figure 5, the TAIEX (serving as a proxy for the expected future wealth) generated a significantly positive impact on private consumption expenditure only in the periods of 1967Q1–1973Q4, 1986Q4–1992Q3, and 2008Q4–2013Q4. The expected future wealth included different types of assets rather than stocks only, so the insignificant relationship between the TAIEX and private consumption expenditure in other periods might have resulted from an imperfect measure of expected future wealth. In addition, the effect of the real interest rate on private consumption expenditure could be interpreted by the substitution effect and income effect. The former means that the real interest is the price of current consumption in terms of future consumption, so an increase of the real interest rate would decrease current private consumption. The latter suggests that the increase in real interest rates actually increases future wealth, leading to an increase in current private consumption. The plot from Figure 6 indicates that the substitution effect dominated the income effect in the periods of 1967Q1–1971Q4, 1990Q2–1998Q2, and 2003Q4–2013Q4. Moreover, Figure 7 shows that the estimated income elasticity of consumption in our observed period was significantly positive but less than one. This result suggests that private consumption is not only of normal goods but also for necessities. The income elasticity of the consumption increased at the beginning of 1969, and reached its first peak at the end of 1980. The income elasticity of consumption started to rebound from 1989, and it reached its second peak in 1996. The third peak of the income elasticity of the consumption appeared

at the beginning of 2007, and a dramatic decrease in income elasticity of consumption was found after 2007, a period covering the subprime mortgage crisis in 2008–2009 and the time of issuance of the consumption vouchers in 2009.

4. Discussion

The concept of forward-looking consumption hypothesized by both the life cycle and the permanent income hypotheses [8] should be applied to the interpretation of the change of income elasticity of consumption across different regimes of time periods (such as before and after the implementation of Taiwan's consumption voucher scheme). Intuitively, we may use a pre-determinate date to compare pre- and post-policy income elasticity of consumption. Nevertheless, there are two reasons suggesting that this approach cannot be justified in evaluating the Taiwanese consumption voucher scheme. First, the timing of the policy effect is usually unknown due to the pre-announced effect or the lagged effect in policy intervention. Second, the income elasticity of consumption fluctuated from 1967 to 2013 (see Figure 7), and its 95% confidence interval includes a certain value (say 0.76, for example) in some periods (such as 1974Q2–1985Q4, and 1993Q1–2007Q1). It follows that we cannot really differentiate the statistically significant change of the income elasticity of consumption from one period to the other periods in Figure 7.

In order to validate the policy evaluation, we estimated the structural change model proposed by Bai and Perron [26] with only a constant term included for the income elasticity of consumption to identify the endogenous structural change over the period of 1967–2013. Table 4-panel (a) presents the results of using the three F type tests (Double maximum, $Sup F$, and Sequential $Sup F$ tests) proposed by Bai and Perron [26] to test the null hypothesis of no structural breaks during the period from 1967–2013. As revealed in Table 4, at least one break in the structural change model was identified by the UD max and WD max statistics, and the $Sup F$ Tests justified four breaks. Specifically, the sequential $Sup F$ statistics ($SupF_T(1|2)$) rejects the null hypothesis of one break in favor of two breaks. The next sequential $Sup F$ statistics ($SupF_T(2|3)$) indicates that the null hypothesis of only two breaks is also rejected in favor of two breaks. The following null hypothesis of the null hypothesis of only three breaks is also rejected by the sequential $Sup F$ statistics ($SupF_T(3|4)$) in favor of three breaks. Finally, the result using the last sequential $Sup F$ statistics ($SupF_T(4|5)$) shows that there is evidence in favor of four breaks of structural change in estimating parameters in the income elasticity of consumption. The fitted income elasticity of consumption based on the structural change model was also plotted in Figure 7.

Table 4-Panel (b) displays the estimated income elasticity of consumption with four structural breaks. The four break dates captured by Bai and Perron's methodology were at 1974Q2 (the first oil crisis period), 1985Q4 (a period following the second oil crisis), 1993Q1 (a period following the 1990's oil price shock), and 2007Q1 (a period prior to the subprime mortgage crisis). These break dates separate our observed period into the five regimes. Compared to the income elasticity of consumption in the first regime (1967Q1–1974Q2), it significantly increased from 0.686 (95% CI = [0.679, 0.692]) to 0.765 (95% CI = [0.760, 0.770]) in the second regime (1974Q2–1985Q3), reflecting the fact that Taiwanese were optimistic about the future economy due to Taiwan's economic recovery from the first oil crisis. The income elasticity of consumption in the third regime (1985Q4–1992Q4) was 0.736, lower than that in the second regime (1974Q2–1985Q3) because of pessimistic anticipation that Taiwan's economic activity would be severely affected by the 1990 oil price shock. The time span of the fourth regime covered the period of 1993–2006, a period during which Taiwan's government applied for a WTO (World Trade Organization) membership. With there being more optimism regarding the future economy during this period than during the previous period, the elasticity of consumption in the fourth regime (1993Q1–2006Q4) went up to 0.772 (95% CI = [0.767–0.776]), which is statistically the same level as in the second regime (1974Q2–1985Q3) due to the overlapping 95% confidence intervals (CIs) of the elasticity of consumption for these two regimes. Note that Taiwan's government announced and implemented Taiwan's consumption voucher scheme during the period of 2008Q4 to 2009Q3

and that the time span of the fifth regime (2007Q1–2013Q4) actually covered the period of issuing consumption vouchers in Taiwan. Surprisingly, the income elasticity of consumption did not go up but dropped down to 0.735 (95% CI = [0.728–0.742]), which is statistically the same level as in the third regime (1974Q2–1985Q3) due to the overlapping 95% CIs of the elasticity of consumption for these two regimes. This result needs to be carefully interpreted.

Table 4. Results for structure breaks.

(a) Tests for Structure Breaks		Statistics	5% Critical Values
Double Maximum Tests	UD max	250.93	8.88
	WD max	252.02	9.91
Sup F Tests	$SupF_T(1)$	250.93	8.58
	$SupF_T(2)$	160.82	7.22
	$SupF_T(3)$	134.08	5.96
	$SupF_T(4)$	138.06	4.99
	$SupF_T(5)$	114.85	3.91
	$SupF_T(0 1)$	250.93	8.58
Sequential Sup F Tests	$SupF_T(1 2)$	30.58	10.13
	$SupF_T(2 3)$	29.78	11.14
	$SupF_T(3 4)$	45.08	11.83
	$SupF_T(4 5)$	7.15	12.25
	# of Breaks	4	
(b) Estimates for Parameters			
Periods	Coefficient	95% CIs	Break Points
1967Q2–1974Q1	0.686	[0.679, 0.692]	—
1974Q2–1985Q3	0.765	[0.760, 0.770]	1974Q2
1985Q4–1992Q4	0.736	[0.730, 0.743]	1985Q4
1993Q1–2006Q4	0.772	[0.767, 0.776]	1993Q1
2007Q1–2013Q4	0.735	[0.728, 0.742]	2007Q1
R ²	73.91%		
Adjusted R ²	73.34%		

Note: The upper bound of breaks (M) and the trimming percentage of samples were set to be 5%, and 15%, respectively. The number of breaks was chosen on the basis of the sequential test statistics $SupF_T(l+1|l)$, $l = 0, 1, 2, 3, 4$ using a 5% significance level.

It was reported that over 91% of the consumption vouchers (representing NT\$76.23 billion or US\$2.50 billion) had been distributed before the 2009 Lunar New Year holidays (January 25, 2009), a week after the first day of issuance of consumption vouchers [5]. Approximately 32% of the consumption vouchers had been reimbursed by February 5, 2009 (right after the end of the 2009 Lunar New Year holiday, see [5] for details). In addition, Kan and his colleagues [4] reported that more than 99% of eligible recipients collected their consumption vouchers, and 87% of them had used consumption vouchers or had consumption vouchers at their disposal by the end of May in 2009. These reported statistics indicate that the period of greatest impact of Taiwan's consumption voucher program on consumption appeared during the period from 2009Q1 to 2009Q2. In fact, starting from 2009Q4 to 2010Q2, Taiwan's economic growth rate was higher than 9% [7], a sign of economic prosperity. Nevertheless, we find that Taiwan's consumption voucher scheme may have had no impact on consumption since the income elasticity of consumption in the fifth regime dropped down to 0.735, lower than that of the fourth regime (0.772), during which the negative impact of the 2007–2008 global financial crisis on the economy was realized.

From the microeconomic point of view, the issuance of consumption vouchers may create both a (temporal) income and an (inter-temporal) substitute effect. In the case of an income effect, less than for a substitute effect, the extra-spending due to the consumption vouchers would be offset by reduced

spending in the future. It was reported that Taiwan's consumption voucher scheme crowded out about three-quarters of private spending [4]. Such a high substitute effect would result in a multiplier effect of less than one, a result that has been justified by a recent dynamic simulation study and CGE (Computable General Equilibrium) analysis on the impact of Taiwan's consumption vouchers scheme on stimulating the economy [15,20]. Based on the empirical results from the current study and many others, we may conclude that Taiwan's consumption voucher scheme may have had a temporary impact on promoting consumption, and this policy intervention may not possess adequate cost-benefit.

Our conclusion is consistent with a large body of evidence showing that consumers would not respond to a temporary change of income [8,19–25]. For example, Hsieh and his colleagues used the difference-in-differences estimation procedure to investigate the effects of Japan's shopping coupon program implemented in the spring of 1999 [23]. Similar to Taiwan's consumption voucher scheme investigated in this study, the program was also a nation-wide and non-cash consumption stimulating policy. Hsieh and his colleagues found that the households that received more coupons spent less in subsequent months, and thereby, this significant inter-temporal substitute effect resulted in Japan's shopping coupon program being ineffective in changing consumption [23]. Furthermore, our conclusion also provides some insights for the potential ineffectiveness of the stimulus coupon plan that would be implemented in the aftermath of the COVID-19 pandemic outbreak. We argued that the more sophisticated mechanisms of the future stimulus coupon plan used to stimulate the slumping economy should be made to minimize the inter-temporal substitute effect but to maximize the temporal income effect. One mechanism designed to minimize the inter-temporal substitute effect could be to put some restrictions on stimulus coupons that cannot be used to hoard daily necessities, and the other mechanism designed to maximize the temporal income effect would be the enlargement of the ratio of the number of coupons obtained from consumers' purchases to their out-of-pocket payments for goods and services.

It is important to note that a recent announcement made by the Taiwan government for the implementation of the stimulus coupon plan showed both similarities and dissimilarities between the recent stimulus coupon plan and the 2009 consumption voucher scheme. The same as the 2009 consumption voucher scheme, the stimulus coupons (based on the new stimulus coupon plan) are also "time-limited" and "use-it-or-lose-it" coupons (valid for six months only), and they could be spent on any kind of goods and services, except for online shopping, taxes, fines, official fees, cigarettes, insurances, stocks, pension, credit card bill, gift vouchers, and any money deposits [40]. In contrast to the 2009 consumption voucher scheme where a total value of NT\$3600 (US\$120) consumption vouchers were delivered to Taiwanese in the form of paper vouchers without any restriction, the new stimulus coupon plan requires that Taiwanese residents have to pay NT\$1,000 (US\$33.33) to claim a total value of NT\$3000 (US\$100) coupons, and these coupons could be delivered by both paper and electronic forms to meet the needs of different age groups [40]. These main differences of the new stimulus coupon plan from the 2009 consumption voucher scheme are likely to be a powerful force driving residents in Taiwan to spend extra money on their consumption that would minimize the inter-temporal substitute effect of the new stimulus coupon plan. In addition, many local governments and commercial organizations in Taiwan also planned to respond to the new stimulus coupon plan with various promotions by increasing the consumer's economic incentive to spend the amount of money beyond the value of their coupons that is expected to maximize the temporal income effect of the new stimulus coupon plan [41].

Moreover, the COVID-19 pandemic outbreak impacts economies worldwide, and this study investigates the effectiveness of an important economic stimulus policy executed by the Taiwan government in response to an unexpected economic recession during 2007–2009. Learning lessons from previous economic stimulus policies in Taiwan, this study provided valuable information to address new solutions of the ongoing economic impacts due to the COVID-19 pandemic outbreak around the world. These solutions are not only useful to sustain the development of society during the ongoing COVID-19 pandemic outbreak, but they also could be applied to those countries intending

to use a similar fiscal policy to stimulate their economies in the aftermath of the COVID-19 pandemic outbreak. It follows that our study fits into the scope of this special issue of Sustainability.

Finally, although we used the most rigorous methodology in conducting this research, three limitations in this study have to be addressed. First, approximately 99% of recipients had received their consumption vouchers and 87% of recipients had used them within four months after the date of issuing the Taiwan consumption vouchers [4], so the quarterly data used in this study may average to the monthly change of private consumption expenditure resulting from the Taiwan's consumption vouchers scheme. Second, Taiwan has a small and open economy and we cannot filter out the international trade links. As one reviewer addressed that "even if the customers spend the vouchers in local shops buying local goods and using home-grown services, there is always an import component". Based on our conclusion of no or little effect of the Taiwan's consumption vouchers scheme on Taiwan's economy, it is important to further examine whether or not the economic stimulus goes to foreign economies. In order to evaluate the effect of international trade links on the effectiveness of Taiwan's consumption vouchers scheme, more detailed data for the classification of the private consumption expenditure is necessary. The unavailability of this type of data prevents further investigation of this issue. We demand more detailed data for future studies. Third, from the perspective of the policy evaluation, a result of no structural break could be used to support the conclusion of no policy effect. Nevertheless, one should be cautious when concluding on policy effectiveness when a structural break in the parameters of regression has been proved due to the limitation in pre-post policy evaluation research without any control groups. Therefore, the micro-data, incorporating individual characteristics, and consumers' behavior in reaction to consumption vouchers, should be used to further evaluate the effectiveness of Taiwan's consumption vouchers scheme in the future.

5. Conclusions

This study investigated the effect of a natural experiment on Taiwan's consumption voucher scheme undertaken by the Taiwanese government in the spring of 2009. Under this scheme, the Taiwanese government delivered consumption vouchers worth NT\$3600 (US\$120) to all citizens and their foreign spouses, regardless of income or age. The consumption vouchers could purchase most goods and services with limited restrictions, and had to be used (redeemed) within a certain time limit. We investigated the effect of this scheme by estimating the income elasticity of consumption (a measure of the individual's reaction to consumption vouchers in terms of private consumption expenditure) based on the STVC model [26], and the multiple structural change model [27] to identify whether there exists a structural break of income elasticity of consumption during the study period. Although the multiple structural change model did capture a structural break during the period of issuing consumption vouchers in Taiwan, the income elasticity of consumption decreased after 2007Q1, evidence supporting the assertion that Taiwan's consumption voucher scheme may have had no effect on stimulating the economy. Our conclusion not only mirrored Hsieh and his colleagues' findings that Japan's shopping coupon program (another nation-wide non-cash consumption stimulating policy) had little success in invigorating the economy [23] but also provided valuable evidence for the potential ineffectiveness of the stimulus coupon plan that would be implemented in the aftermath of the COVID-19 pandemic outbreak. The subtler design of the stimulus coupon plan should be made not only to reduce the inter-temporal substitute effect but also to increase the temporal income effect.

Supplementary Materials: The following are available online at <http://www.mdpi.com/2071-1050/12/12/4895/s1>. This section consists of results for two conventional cointegration tests (namely, Engle–Granger and Phillips–Ouliaris cointegration tests) that used to compare with the testing results generated by the STVC model.

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