

# The Dynamics Analysis and Simulation of the Macro Economic Behavior of Taiwan's Invigorating Economy Consumption Voucher

Wen-Chin Wei\*

## Abstract

Given the severe global economic downturn, countries are using a variety of possible economic policies to try to help their economies recover. This study adopts system dynamics from the dynamic perspective to investigate how Taiwan's decision to issue time-limited consumption vouchers will influence macro economical behaviors. The simulation led to following primary results. First, in regard to the highest marginal propensity to consume ( $MPC = 0.3$ ) and the lowest substitution rate of consumption ( $SR = 0.6741$ ), the distribution of the consumption voucher will generate the biggest multiplier coefficient (0.6830) and  $Y$  (GDP). Second, as  $SR$  increases by 1%, the multiplier effect decreases by 0.44%. Third, the contribution percentages of consumption vouchers on the first, second, third, and the accumulated total of these three quarters of private consumption in 2009 ranged from 2.13-2.55, 0.25-0.30, 0.19-0.22, and 0.86-1.02 of a percentage, respectively. Meanwhile, the contribution percentage of consumption vouchers in the first, second, third and the accumulated total of these three quarters of GDP in 2009 ranged from 1.36-1.63, 0.15-0.18, 0.11-0.13, and

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0.51-0.61 of a percentage, respectively. Fourth, when the government adopts a constant budget policy, the increased distribution of consumption vouchers will not deteriorate the economy even though the government expenditure — but not private investment — is squeezed out. Finally, when the government does not stick to the constant budget policy, the evidence indicates that the expansion of the distribution of consumption vouchers will not squeeze out government expenditures. The policy implication is that the distribution of consumption vouchers will yield a multiplier effect, which will further stimulate effective demand and contribute to Taiwan's depressing economy. The possible crowding-out effects resulting from the consumption vouchers can be ignored, suggesting that the consumption voucher policy may ultimately be accepted as an effective approach to stimulate the economy.

**Keywords:** System Dynamics, Consumption Voucher, Multiplier Effect

**JEL Classifications:** C61, E21

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Wen-Chin Wei

## I. Introduction

The recent global financial tsunami has led to the deflation of the finance industry's credit and reduced business investments. Meanwhile, Taiwan's central bank has dropped interest rates six times in a row, but no significant predicted outcome has occurred. As a result, the public has continued to deflate its consumption, and firms have cut down on their investments; the public expenditure expansion policy has been too slow to save the bad situation (Zhang, 2009). Therefore, Taiwan's government distributed consumption vouchers on January 18, 2009, to spur private consumption in order to bring positive benefits for economic growth — at least in the short term.

In order to borrow from other countries' experiences, this review examines literature related to consumption coupons. Prior literature has focused on the marginal propensity to consume (MPC) of the coupon, the probability to start eating goods, additional consumption ratio, the replaced consumption effect, and the contribution to a person's consumption. For instance, Hori et al. (2002) used the Kolomogorov-Smirnov Test to demonstrate that the MPC out of the coupon ranged between 0.2 and 0.3 in the first month the coupons were distributed. However, families who received coupons spent less in subsequent months; as a result, the MPC fell to 0.1. The potential reason may be that people do not respond to small and irregular income changes. Other research has examined how to increase consumption, such as that of

agricultural commodities. For example, farmers' markets can effectively increase low-income seniors' consumption of agricultural commodities. Indeed, Kunkel (2003) used a survey approach and found that 89% of respondents had the intention to eat more fruits and vegetables after joining the South Carolina Seniors Farmers' Market Nutrition Program. Fang and Rizzo (2009) studied the Chinese government's decision to issue vouchers to ration cigarettes without informing the public that smoking was unhealthy. The researchers used a chi-square test and logistic regression to find that 46% of males and 39% of females became new smokers after the vouchers were issued. Thus, China's voucher policy had the unintended consequence of encouraging smoking, particularly among women. Furthermore, in Japan's 1999 "shopping coupon" program, Li (2009) used a survey approach to determine that the additional consumption ratio was 32% and the replaced consumption effect for vouchers was 68%. However, the survey results suggested that only 0.1% of personal consumption was created by Japan's 1999 "district promote coupon" as it could be exchanged for cash; hence, the multiplier effects significantly declines (Zeng, 2009a). Participants in a farmers' market nutrition program in Washington, DC, increased 61% (with previous experience) and 40% (without previous experience) (Racine et al., 2010). This empirical evidence was obtained through an analysis of variance and multiple logistic regression, which indicated that the MPC of consumption is about 0.2-0.3, declining to 0.1 in subsequent months, whereas the replaced consumption reached a high of 68%. Meanwhile, fruit and vegetable coupons offer a useful instrument for stimulating demand among low-income farmers while tobacco vouchers encourage people to start smoking, especially women from a low social economical status.

Based on these results, it is imperative to conduct a comprehensive and in-depth analysis and assessment of the policy effects (multiplier effect) of issuing consumption vouchers on macro-economy behaviors (e.g., private consumption, private investment, GDP) as a basis for developing further economical development planning. Theories such as national income, crowding effect, multiplier effect, and private savings and investments are used to support the arguments covered in the proposed model. The system modeling methodology of system dynamics is well suited for addressing the dynamic complexity that characterizes consumption vouchers' economic issues. The system dynamics approach relies on computer simulation

models to portray the processes of accumulation and feedback and may be tested systematically to define effective policies for overcoming macro economic problems (Homer and Hirsch, 2009). Therefore, the current study will use system dynamics. Compared to general economical analysis approaches, system dynamics can deal effectively with the feedback effect (loop) and dynamic analysis. Moreover, it can easily perform simulation under system structure relationships when one or more variables change individually and simultaneously.

This study focuses on answering several questions. First, when the government adjusts policy variables (e.g., the distribution volume of consumption vouchers, government expenditures), how do they influence  $Y$  (GDP)? Second, to what extent will the multiplier of consumption vouchers be influenced by the substitution rate of consumption vouchers? Third, will the distribution of consumption vouchers lead to the crowding effect of private investment and government expenditures, thereby leading to negative impacts for the economy? The main findings are as follows: the simulation result shows that, in regard to the highest marginal propensity to consume ( $MPC = 0.3$ ) and the lowest substitution rate of consumption ( $SR = 0.6741$ ), the distribution of the consumption voucher will generate the biggest multiplier coefficient (0.6830) and  $Y$  (GDP). As  $SR$  increases by 1%, the multiplier effect decreases by 0.44%. The simulation results show that the contribution percentages of consumption vouchers for the first, second, third, and the accumulated total of these three quarters of private consumption in 2009 ranged from 2.13-2.55, 0.25-0.30, 0.19-0.22, and 0.86-1.02 of a percentage, respectively, while the contribution percentage of consumption vouchers for these periods' GDP ranged from 1.36-1.63, 0.15-0.18, 0.11-0.13, and 0.51-0.61 of a percentage, respectively. In addition, the possible crowding-out effects by the consumption vouchers can be ignored. As such, the empirical evidence suggests that Taiwan's issue consumption vouchers achieved the predicted short-term spur in economic growth without resulting in crowding-out effects.

The rest of this study is organized as follows. First, the paper will examine the background of Taiwan's distribution consumption vouchers and related issues. Next, the study will discuss the model and its causal structure, followed by a description of the model validation and calibration. The discussion will then examine the policy design and analyze the

scenarios, followed by a presentation of the policy analysis. Finally, the conclusions will be drawn and policy implications discussed.

## **II. The Background for Taiwan's Distribution Consumption Vouchers and Related Issues**

The recent strict financial distress has affected various industries, financial institutes, and traditional industries, leading to stagnated deflation. In addition, Taiwan's consumer confidence index (consisting of price level, invested stock time-point, domestic economy prospective, employee chance, and durable goods time-point) dropped 48.95 points, to its lowest position since 2001, while its pain index (an important indicator used to study people's lives based on unemployment and inflation rates) rose to 7% (Zhang, 2009). These situations lead to an important question: When the world no longer has consumption, what kind of situation will emerge? In light of the fact that various countries' central banks have dropped their interest rates to increase their money supply, no significant predicted outcome has occurred. For example, Taiwan's central bank dropped interest rates six times until it reached 2.125%—the lowest rate level in the last five and a half years. As the interest rate closed in on zero and the public continued to limit consumption, firms reduced investments and public expenditures became too slow to save the bad economic situation (Zeng, 2009a).

Taiwan's ratio of unpaid debt balance to GDP is only 39.4%, which is low compared to that of other countries (e.g., Japan, 173%; the US, 73.2%; the UK, 58.7%; France, 72.5%). To stimulate the economy, many countries have engaged in unprecedented investment projects. The ratio of investment to GDP is 8.2% in the US, 14.3% in Japan, 8.6% in Korea, and 14.0% in Mainland China; in Taiwan it is 6.3%, indicating that Taiwan's debt management system is appropriate (Zhou, 2009). Recently, international institutes pessimistically forecasted Taiwan's 2009 GDP growth rate to be 2.5% (IMF), 1.7% (Asia Bank), and –2.9% (The Economist). In addition, Taiwan's accumulated debt reached 50% of the GDP. Taiwan relies primarily on

trade; indeed, its private consumption accounts for 60% of its GDP, making it important to maintain a stable domestic market (Chen, 2008; Dai, 2008; Du, 2009). According to Xu and Wang (2009), the most significant relational factor influencing Taiwan's GDP is private consumption, implying that stimulating Taiwan's economy would require increasing private consumption. Based on such evidence, Taiwan has considered implementing consumption vouchers.

Taiwan issued a limited-period consumption voucher on January 18, 2009, based on special consumption articles and supported by a special budget (from issuing Treasury bills); the coupons had to be spent by September 30, 2009. For social effectiveness purposes, everyone was granted 3,600 NT dollars in coupons; in this way, lawmakers avoided adopting a family-based coupon, which would incur the moral hazard of defining an individual family unit. The non-wealth-exclusive article was adopted to avoid excessive audit costs and selective issues stemming from qualified versus non-qualified groups, which constitute hostile positions (Wang, 2009b). The consumption voucher can neither be exchanged for cash nor changed; it can only be used to purchase commodities. Shops receiving consumption vouchers must have a registered business so that they can deposit the coupon into the bank account center in exchange for cash. Those who have not registered yet cannot deposit any consumption vouchers into the account center in exchange for cash, although they can use them to purchase materials from upstream firms or for final consumption (Zhang, 2009). Taiwan's consumption voucher was estimated to have stimulated at least a 20% consumption growth (Zeng, 2009b) and contributed to economic growth rates ranging from 0.28% to 0.43% (Council for Economic Planning and Development of Taiwan Government, CEPD, 2009). From the micro-level view, the single issue of consumption vouchers will generate a larger consumer substitute effect than income effect; however, after multiple issuances, the income effect will exceed the substitute effect, resulting in a marginal utility decrease effect, thereby shaking the basis for issuing consumption (Chen and Zhou, 2009).

### III. Model Framework and Description

System dynamics considers the flow, stock variables, and recursive relationship (loop) from a systematic view to analyze complex issues. Flow variable refers to the volume flows into (and out of) one stock variable per time unit. Stock variable refers to the accumulated quantity during one period. System dynamics is different from the logic of simple falsificationism in several ways. System dynamics deals with a feedback loop that expresses the interaction between cause and effect; in simple falsificationism, an effect could not influence the cause. In system dynamics, the feedback loop between the cause and effect means that the effect influences the cause. In other words, the causality is recursive. The current study will employ the system dynamics approach to establish this complex network of feedback and intertwine the causality relationship among related economic variables (i.e., private consumption, private investment, government expenditure, multiplier effect, export, import, and  $Y$ ) driven by the issuing of consumption vouchers. Furthermore, the number of consumers who use consumption vouchers for purchase will be considered.

According to the national income account, bathtub theory, the crowding out effect, and the multiplier effect, the responded macro economic model will be established by using the system dynamics approach. The national income account indicates that  $Y$  (GDP) =  $C + I + G + (X - M)$ , implying that national income equals private consumption ( $C$ ) plus private investment ( $I$ ), plus government expenditure ( $G$ ), plus net export ( $X - M$ , export – import). Xu and Wang's (2009) empirical evidence verified that the most critical determinant influencing Taiwan's GDP is private consumption. Therefore, issuing consumption vouchers to stimulate private consumption will contribute meaningfully to economic growth (i.e., GDP).

Consumption vouchers will drive the flow variable of consumption to increase the stock variable (represented by a box variable) of the GDP. National income account theory further argues that, as private investments ( $I$ ), government expenditures ( $G$ ), and net exports ( $X - M$ ) increase, the GDP will increase ( $I$ ,  $G$  and  $X - M$  are deemed to be auxiliary variables). Issuing consumption vouchers will induce the increase of consumption demands and raise



consumption confidence as well as promote private investment (Zhang, 2009). The annual rate of change in retail business turnover — a high proportion of which stems from the receipt of consumption vouchers and is closely correlated to private consumption — indicates that its shrinkage dropped from 9.8% in December 2008 to 4.6% in January to February 2009. This shrinkage rebounded to a positive growth rate of 3.9% in September 2009. These statistics demonstrate that the consumption vouchers truly act as a driving force to stimulate private consumption.

In addition, the consumption voucher scheme serves to raise the real GDP of the industry by expanding demand; furthermore, it induces related service industries' (3C, retail, hotel/lodging, tourist recreation) consumption demand, thereby indicating the industry linkage effect (Wang, 2009a). Nearly 80% of the public believe that the consumption voucher will be helpful in stimulating private consumption and revitalizing the economy. The simulation results of the CEPD (2009) demonstrate that — except for the electronic industry — the main beneficiaries are service industries. However, imports drain the  $Y$  of Taiwan. In terms of system dynamics, imports act as the one flow variable that reduces  $Y$ .

According to bathtub theory (or leakage-injection approach to equilibrium GDP), the government's tax revenue is one leakage item; if a government adopts a tax reduction or tax refund, it might have the opportunity to enable the bathtub level to rise. However, if tax refund money is converted into another leakage or savings, the bathtub will remain at its original level. Nowadays, in the shadow of the global financial crisis, the goal of adding tax refund money back into the national bathtub to raise the level is hard to achieve, as proven by the American experience: only 20% of people use tax rebates for consumer spending. In contrast, the population-wide distribution of consumption vouchers can benefit everyone, thereby resulting in an immediate fiscal expansion effect (CEPD, 2009). If consumption vouchers are paid for in cash, the cash might turn into savings. However, the Taiwanese government limited the period of use, stipulating that the coupons must be spent by September 30, 2009. Thus, the consumption voucher could not turn into savings and had to be spent on private consumption to stimulate the economy. In addition, the consumption voucher might lead to the substitute effect, as a number of Taiwanese consumers used the consumption vouchers to make purchases they

already intended to make and saved the planned consumption amount, thereby offsetting the stimulation effect of consumption vouchers. The CEPD-commissioned study took an appropriately conservative approach to set three substitution ratios at 76.06%, 71.5%, and 67.41% (CEPD, 2009).

The crowding-out effect suggests that any economy-stimulating project might crowd out other stimulating items; for example, government expenditures ( $G$ ) might crowd out private investment ( $I$ ). However, Taiwan's consumption voucher had to be spent within a defined time period; thus, it served to raise the real GDP of industry by expanding demand and inducing industrial linkage effects. Under the 71.5% substitution rate, the simulation results indicated that the consumption voucher effect on real GDP by industry was as follows: consumer goods (0.88%); electronic goods (0.63%); transport, storage, and telecommunications (0.63%); educational and medical services (0.43%); and catering and lodging services (1.16%). In other words, apart from the electronics industry, the main beneficiaries were service industries (CEPD, 2009). Determining whether the issuance of consumption vouchers will crowd out government expenditures will be explored through the simulation in the current study.

The scale of consumption vouchers' multiplier effect will substantially influence the predicted effect of stimulating consumption, thereby enhancing GDP growth. The question is, how do we decide the objects of consumption vouchers in order to expand the multiplier effect? Unlike cash, the public will hurry to turn in consumption vouchers, using them to purchase goods/service. Hence, the voucher objects should not be limited in order to increase the turnover rate and expand the multiplier effect as much as possible. Furthermore, many firms and shops that accept the consumption voucher do not go to banks to exchange them, but use them to conduct further consumption, thereby expanding the stimulating effect and promoting the economy (Chen, 2009). Wang (2009a) estimated that the multiplier effects of the consumption voucher is about 1.2. If the multiplier effect is estimated to be 3, the economic growth of 2010 will reach 1% (Nie, 2009).

Over the long term, the Keynesian School insists that consumers' desire will not depend on changes in current revenues, but on changes in future long-term revenues. Therefore, from a long-term point of view, efforts to increase consumers' confidence will change consumers'

consumption mood. Thus, as the consumer confidence index increases, it will bring about positive change for private consumption but will decrease savings. Yet Taiwan's 2008 extra savings rate was 9.1% (savings rate of 29.7% - investment rate of 20.6%), which will negatively influence the consumer confidence index; this extra savings rate will exceed 9.5% (Zhang, 2009). Furthermore, as the misery index (unemployment rate + inflation rate) increases, the public will consume less and make more precautionary savings. As the incremental consumption from consumption vouchers creates a positive flow to  $Y$  (GDP), according to national income account theory, private consumption, private investments, government expenditures, and exports will also result in positive contributions to  $Y$  whereas imports will drain the stock of  $Y$ . In addition, the multiplier effect created by the marginal propensity to consume (MPC), marginal propensity of income to investment (MPI), marginal propensity to import (MPM), and industry linkage effects will positively contribute to  $Y$ . However, the substitution rate of consumption vouchers will be less than the stimulated consumption effect given the number of consumers who use the consumption vouchers for purchases they originally intended to make. Thus, one dynamic simulation model is established and illustrated below.

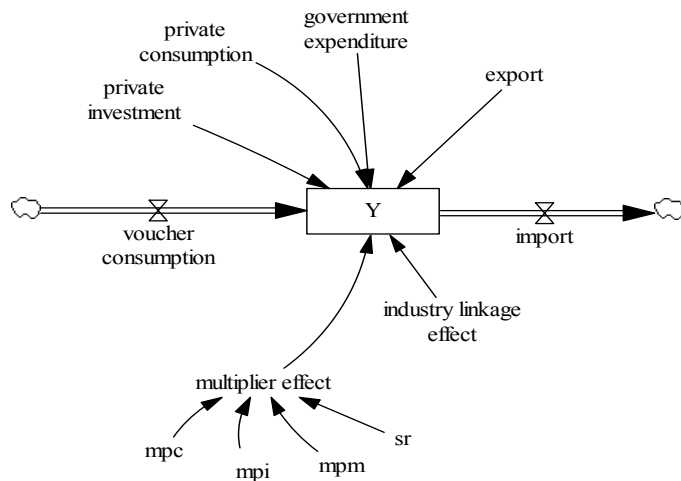


Figure 1 The dynamic analysis and simulation of the multiplier effect of consumption vouchers

According to Academia Sinica's Center for Survey Research's survey results, the total MPC is 32.5% while out of consumption vouchers is 25.7%. In contrast, the MPC of Japan's 1999 shopping coupon program was 0.2-0.3 a month, and only 0.1 over a longer 3- to 4-month interval (Kan, 2010). According to the Directorate General of Budget, Accounting and Statistics, Executive Yuan, Taiwan, the MPI of the consumption vouchers is 21% and the MPM is 30% (Zhang, 2009). The industry linkage effect is assumed to be 1 for service industries (Wang, 2009a). Moreover, the ratio of consumers who used consumption vouchers for purchases they originally intended to make must be taken into account (CEPD, 2009). This substitution rate of consumption vouchers is approximately 0.72 (Kan, 2010). The out-of-voucher MPC is 0.257, and the substitution rate of consumption voucher is 0.72; both will be used as reference values in the current study. The unit of related macro economy variables in formulas (1), (2), and (9) is million NT dollars. The equations related to Figure 1 are illustrated as follows:

Assumptions: In this study, the autonomous consumption and investment are not considered.

$$\begin{aligned} & \text{Voucher consumption} \\ & \text{Units: millions/quarter} \end{aligned} \tag{1}$$

The annual rate of change in retail business turnover is high due to the receipt of consumption vouchers and is closely related to private consumption. Hence, the receipt of consumption vouchers can be perceived as a ratio of business turnover of the consumption vouchers to estimate the quarterly consumption of vouchers (from January 2009 to September 2009).

$$\begin{aligned} & \text{private investments, private consumption, government expenditures, exports, imports} \\ & \text{Units: million} \end{aligned} \tag{2}$$

These five data variables are assumed to be exogenous inputs and are time series inputs

that drive a portion of the model.

$$\begin{aligned} & \text{industry linkage effect} = 1 \\ \text{Units} & = \text{Dmnl (dimensionless, hereafter the same)} \end{aligned} \quad (3)$$

The time when consumption vouchers raise the real GDP of industry by expanding demand and inducing industry linkage effects is one.

$$\begin{aligned} \text{multiplier effect} & = 1/(1 - \text{mpc} + \text{sr} - \text{mpi} + \text{mpm}) \\ \text{Units: Dmnl} & \end{aligned} \quad (4)$$

Based on Keynesian's multiplier theory, international trade as well as consumption vouchers' substitution rate effect is used to derive this multiplier effect. The multiplier effect is equal to one divided by one minus MPC plus SR of consumption voucher minus MPI plus MPM.

$$\begin{aligned} \text{MPC} & = 0.257 \\ \text{Units} & = \text{Dmnl} \end{aligned} \quad (5)$$

MPC represents the marginal propensity to consume.

$$\begin{aligned} \text{MPI} & = 0.21 \\ \text{Units} & = \text{Dmnl} \end{aligned} \quad (6)$$

MPI represents the marginal propensity to invest.

$$\begin{aligned} \text{MPM} & = 0.3 \\ \text{Units} & = \text{Dmnl} \end{aligned} \quad (7)$$

MPM represents the marginal propensity to import.

$$\begin{aligned} \text{SR} &= 0.72 \\ \text{Units} &= \text{Dmnl} \end{aligned} \quad (8)$$

SR represents the substitution rate of consumption, in which the consumer uses the consumption vouchers to make purchases they already intended to make.

$$\begin{aligned} Y &= \text{INTEG} (\text{voucher consumption} * \text{multiplier effect} * (1 + \text{industry linkage effect}) \\ &\quad + \text{private consumption} + \text{private investment} + \text{government expenditure} \\ &\quad + \text{export-import}) \\ \text{Units:} & \text{million} \end{aligned} \quad (9)$$

This defines the level variable ( $Y$ ), integrating it over time. This equation indicates that  $Y$  will accumulate according to the expanding multiplier effect stimulated by voucher consumption plus industry linkage effect, plus the addition of private consumption, private investments, government expenditures, and net exports (export-import).

## IV. Model Validation and Calibration

The system dynamics ( $SD$ ) models, which are causal models, should generate the appropriate behavior for the appropriate reasons. The structural validity of the model results from the descriptive knowledge about the system structure and the comparison of the model behavior with the real system behavior to establish the behavior validity (Liang and Lin, 2008; Qureshi, 2009; Sterman, 2000). The causal structure of the model previously described is grounded in the relevant theoretical and empirical literature, which establishes its structural validity. In the current study,  $SD$  software (Vensim  $DSS$  version 5.9c) is used to perform dynamics simulation, scenario analysis, and policy (scenario) optimization. Such macro variables as  $Y$ , private consumption, private investments, government expenditures, exports, and imports are collected from National Statistics, R.O.C., Taiwan (from first to third quarter 2009); the previous figure provides the simulated values.

## V. Scenario Design

### A. MPC and substitution rate (SR) of consumption vouchers' combination designs

The *SD* model seeks to characterize the behavior pattern of variables of interest dynamically over time, which shows how they have evolved and might develop given the continuity of current trends. Such a characterization is called “reference mode” (Sterman, 2000). Reference modes can refer to past or future behaviors and can represent what is expected to happen, what is feared will happen, and what is hoped will happen (Ventana System Inc., 2003). The current values' trend of MPC and the consumption vouchers' substitution rate are called reference values. The *MPC* of 0.257 is assumed to be a reference value because it is out of vouchers and more feasible; it also ranges from 0.1, 0.2, to 0.3. Meanwhile, the *SR* of 0.72 is used as a reference value ranging from 0.6741, 0.7150, to 0.7606. Therefore, three different MPCs (0.1, 0.2, and 0.3) and three different *SR*s constitute nine different scenarios; the resulting multiplier coefficients are simulated and presented in Table 1 (Kan, 2010). The substitution rate of consumption vouchers (*SR*) represents the ratio of consumers who used consumption vouchers for purchases they originally intended to make (CEPD, 2009). Thus, *SR* has to be deducted in order to calculate the net effect of the multiplier coefficients of consumption vouchers. Multiplier effects obtained in this manner are less than one, which can be verified as *SR* increases lead to the decrease of multiplier coefficients (fourth column of Table 1). In addition, voucher consumption, private consumption, private investments, government expenditures, exports, and imports are set as exogenous data variables and time series that will be imported to drive the model. They exist as quarterly data series (ranging from first quarter 2009 to third quarter 2009), based on 2006 prices, from National Statistics, R.O.C. (Taiwan).

Table 1 Scenario number, multiplier coefficients, and Y

Scenario no.	MPC	Substitution rate of consumption bouchers (SR)	Multiplier coefficients	$\Delta C_1$	$\Delta C_1/C_1(\%)$	$\Delta C_1/Y_1(\%)$
1	0.3	0.7606	0.6449	44,347	2.40	1.54
2	0.3	0.7150	0.6644	45,688	2.48	1.59
3	0.3	0.6741	0.6830	46,967	2.55	1.63
reference	0.257	0.7200	0.6439	44,278	2.40	1.54
4	0.2	0.7606	0.6058	41,658	2.26	1.45
5	0.2	0.7150	0.6230	42,841	2.32	1.49
6	0.2	0.6741	0.6393	43,962	2.38	1.53
7	0.1	0.7606	0.5712	39,279	2.13	1.36
8	0.1	0.7150	0.5865	40,331	2.19	1.40
9	0.1	0.6741	0.6009	41,321	2.24	1.43

Table 1 Scenario number, multiplier coefficients, and Y (continue)

Scenario no.	$\Delta C_2$	$\Delta C_2/C_2$ (%)	$\Delta C_2/Y_2$ (%)	$\Delta C_3$	$\Delta C_3/C_3$ (%)	$\Delta C_3/Y_3$ (%)	$\Delta C_{13}$	$\Delta C_{13}/C_{13}$ (%)	$\Delta C_{13}/Y_{13}$ (%)
1	5,159	0.29	0.17	3,946	0.21	0.12	53,452	0.97	0.58
2	5,315	0.30	0.17	4,065	0.22	0.12	55,068	1.00	0.59
3	5,464	0.30	0.18	4,179	0.22	0.13	56,610	1.02	0.61
reference	5,151	0.29	0.17	3,939	0.21	0.12	53,368	0.97	0.58
4	4,846	0.27	0.16	3,706	0.20	0.11	50,210	0.91	0.54
5	4,984	0.28	0.16	3,812	0.20	0.12	51,637	0.93	0.56
6	5,114	0.28	0.17	3,911	0.21	0.12	52,987	0.96	0.57
7	4,570	0.25	0.15	3,495	0.19	0.11	47,344	0.86	0.51
8	4,692	0.26	0.15	3,588	0.19	0.11	48,611	0.88	0.53
9	4,807	0.27	0.16	3,676	0.20	0.11	49,804	0.90	0.54

Notes: 1.  $C_i$  represents the private consumption of quarter  $i$ , 2009. ( $i = 1, 2, 3$ )

$Y_i$  represents the GDP of quarter  $i$ , 2009. ( $i = 1, 2, 3$ )

$\Delta C_i$  represents the net contribution from the consumption vouchers for quarter  $i$ , 2009. ( $i = 1, 2,$



3)

$\Delta C_i/C_i(\%)$  represents the contribution percentage of consumption vouchers in the quarter  $i$  private consumption, 2009. ( $i = 1, 2, 3$ )

$\Delta C_i/Y_i(\%)$  represents the contribution percentage of consumption vouchers in the quarter  $i$  GDP, 2009. ( $i = 1, 2, 3$ )

$\Delta C_{13}$  represents the accumulated net contribution from the consumption vouchers for quarter 1 to quarter 3, 2009.

$C_{13}$  represents the accumulated private consumption from quarter 1 to quarter 3, 2009.

$Y_{13}$  represents the accumulated GDP from quarter 1 to quarter 3, 2009.

2. Unit of  $C$  and  $Y$ : million NT dollars.

## B. Crowding-out effect scenario design

To test whether the government's increase in consumption voucher distribution will squeeze out private investments and government expenditures, thereby benefiting or damaging the economy, two policy scenarios are set. First, when the government adopts a constant budget policy, it compensates for the incremental budget on consumption vouchers by decreasing government expenditures. More specifically, when 83,729 million NT dollars in increases occur in the distribution of consumption vouchers, the government will compensate for this by decreasing the same amount of government expenditures (i.e., policy 2). The simulation result of this constant budget policy (policy 2) is shown in Figure 3. Second, when the government does not stick to the constant budget policy, the incremental budget of 83,729 million NT dollars for the distribution of consumption vouchers will not be compensated by the same amount of government expenditures. The simulation result of the second scenario is depicted in Figure 4.

## VI. Policy Analysis

### A. Analysis of different MPC and SR combinations

The model was simulated based on the assumptions of the nine scenarios described in Table 1. The focus of these simulations is to analyze the impact of the distribution of consumption vouchers on  $Y$  through the multiplier effect under different  $MPC$  and  $SR$  combinations. Moreover, the crowding effect will be examined through simulation. The simulation result of scenario 3 indicates that the highest  $MPC$  (0.3) and lowest  $SR$  (0.6741) will generate the biggest multiplier coefficient (0.6830); this result outperforms any scenario — even the reference one. This finding suggests that, when the  $MPC$  is highest, it should be combined with the lowest  $SR$ ; at this point, the distribution of consumption vouchers will yield the maximum multiplier effect and generate the greatest  $Y$ . The evidence also indicates that, by maintaining the same  $MPC$ , the increased substitution rate of consumption vouchers will reduce the multiplier effect. For instance, when the  $MPC$  is maintained at 0.3 and the substitution rate of consumption vouchers increases from 0.6741 to 0.7606, the multiplier coefficients will decrease from 0.6830 to 0.6449. More specifically, when  $SR$  increases by 1%, the multiplier effect will decrease by 0.44%. Similar results can be found using other  $MPC$  levels.

The receipt of consumption vouchers contributed to the high ratio of the annual rate of change in retail business turnover and was closely correlated to private consumption (CEPD, 2009). The receipt of consumption vouchers as a ratio of retail business turnover was used to calculate the ratio of consumption vouchers used during the first three quarters of 2009. These three ratios of consumption vouchers used during the first three quarters of 2009 are 82.95%, 9.65%, and 7.38% respectively. First, multiplying the ratio of consumption voucher used in the first quarter of 2009 (82.95%) by the amount of consumption vouchers (82.9 billion) and the multipliers with different scenarios, the contribution from the consumption vouchers for the first quarter 2009 ( $\Delta C_1$ , fifth column of Table 1) could be determined. Second, the contribution

of the consumption vouchers ( $\Delta C_1$ ) was divided by the first quarter 2009 private consumption ( $C_1$ ) and multiplied by 100% to obtain the contribution percentage of consumption vouchers in the first quarter 2009 private consumption ( $\Delta C_1/C_1(\%)$ , sixth column of Table 1). Third, the contribution of the consumption vouchers for first quarter 2009 ( $\Delta C_1$ ) was divided by  $Y_1$  (first quarter 2009 GDP) and multiplied by 100% to generate the contribution percentage of consumption vouchers in the first quarter 2009 GDP ( $\Delta C_1/Y_1(\%)$ , seventh column of Table 1). The same procedures are performed for second and third quarters 2009, and the estimated results are presented in Table 1 (cont.). Finally, the accumulated net contribution from the consumption vouchers ( $\Delta C_{13}$ ) is obtained by summing  $\Delta C_1$ ,  $\Delta C_2$ , and  $\Delta C_3$ ; the accumulated private consumption for the first three quarters of 2009 ( $C_{13}$ ) is obtained by summing  $C_1$  to  $C_3$ ; and the accumulated GDP for the three quarters 2009 ( $Y_{13}$ ) is obtained by summing  $Y_1$ ,  $Y_2$ , and  $Y_3$ . The contribution percentage of consumption vouchers in the accumulated total of these three quarters of 2009 for private consumption is obtained by dividing  $\Delta C_{13}$  by  $C_{13}$  and multiplying by 100%. Meanwhile, the contribution percentage of consumption vouchers for the GDP in the accumulated total of these three quarters in 2009 is obtained by dividing  $\Delta C_{13}$  by  $Y_{13}$  and multiplying by 100%. These two categories of numbers are presented in the last two columns of Table 1 (cont.).

In order to examine the dynamic behavior of Taiwan's consumption coupon program for private consumption and the accumulated effect (stock effect), the individual effect from the first through third quarters and the accumulated effect of these three quarters in 2009 will be investigated. Japan's 1999 shopping coupon program increased private consumption by 0.1% (Li, 2009); meanwhile, the estimation results of this study show that the contribution of consumption vouchers on private consumption during the first to third quarters as well as the accumulated total of these three quarters in 2009 ranged from 2.13-2.55, 0.25-0.30, 0.19-0.22, and 0.86-1.02 of a percentage, respectively. The lower multiplier effect of Japan's 1999 shopping coupon program might stem from the fact that it was subject to those under the age of 15 and over 65 by local governments based on restriction regulations. In addition, only registered firms could accept the coupon, thereby decreasing its multiplier effect greatly.

CEPD (2009) and Zhang (2009) estimated that Taiwan's consumption voucher scheme

contributed approximately 0.28-0.43 and 0.64 of a percentage to the economic growth rate in 2009, respectively. However, the current study's estimation indicates that the contribution percentage of consumption vouchers to GDP during the first to third quarters as well as the accumulated total of these three quarters in 2009 ranged from 1.36-1.63, 0.15-0.18, 0.11-0.13, and 0.51-0.61 of a percentage, respectively. These results are slightly different from those of prior literature, which might be due to the fact that the substitution rate and the industry linkage effect of consumption vouchers were considered in this study.

In view of these findings, several points should be considered to increase consumption vouchers' MPC and decrease their SR in order to raise their contribution to GDP. First, firms should be encouraged to offer discounted promotions (like product mix). Second, the public should be encouraged to purchase Taiwan-made goods to promote the closer industry linkage effect, thereby creating a greater multiplier effect. Third, the public should be encouraged to spend the consumption voucher as soon as possible; if deferred or spent by batch, it will deteriorate the multiplier effect. Fourth, employees' bonuses, dividends, lottery prizes, cash payments, or departmental coupons can all be replaced by consumption vouchers. Finally, shortening the usage period of consumption vouchers will decrease their substitute rate, thereby increasing new consumption (Wang, 2009b).

## **B. Analysis of crowding-out effect**

Using the findings of Wang (2009a) and Qureshi (2009) to investigate micro economic behavior (see Figure 2), it can be inferred that increases in  $Y$  (GDP) will bring about positive contributions to the per capita GDP, thereby generating positive benefits to private savings and subsequently positively influencing private investments. Ultimately, it will have a positive influence on  $Y$  (GDP). In this analysis, private consumption is defined as  $0.7$ \*per capita GDP, private saving is  $0.3$ \*per capita GDP, and private investment is  $0.21$ \*private savings (Zhang, 2009).

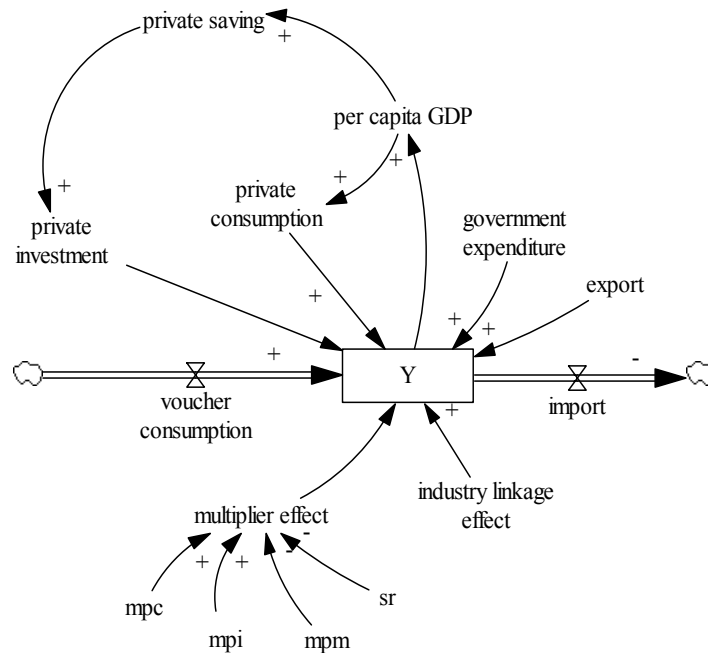


Figure 2 The dynamic analysis and simulation of the multiplier effect of consumption vouchers

In Figures 3 and 4, the horizontal axis represents the time bound of the model (from 2009 to 2012); the units of time is a yearly quarter. To compare changes in trends of government expenditures, private investments and  $Y$  dynamically over time, these three variables are illustrated in the same figure. Meanwhile, the figure on the vertical axis represents the units of above three macro variables, respectively. The figure on the vertical axis should be read from the first (second, third) number of each group and from down to up. When the government adopts a constant national budget policy, increases in the distribution of consumption vouchers will shrink the scale of government expenditures. The base run in Figure 3 represents a run performed with constants at their original values. Next, line 2 represents the run performed with the reduced government expenditures for financing the distribution of consumption

vouchers. Figure 3 shows that increasing the incremental distribution of consumption vouchers will not deteriorate the economy ( $Y$ ) despite the fact that the government expenditures are squeezed out (as policy 2 shows). In addition, private investments are not significantly squeezed out by the expansion of consumption voucher expenditures; this result echoes the questionnaire survey's results (CEPD, 2009).

However, if the government does not stick to one constant budget policy, as in Figure 4, the expansion of the distribution of consumption vouchers will not squeeze out government expenditures. Therefore the level of government expenditures will not be influenced by the distribution of consumption voucher uses, as indicated by line 3. The principal reason for this outcome is that, during the distribution period of consumption vouchers, not only was there no increase in the overall level of the domestic interest rates representing financing costs, but those rates also actually trended downward continuously, meaning a suppressing effect on effective demand did not occur (CEPD, 2009). Therefore, in the long run, as Figure 4 shows, the  $Y$  indicates one growth trend.

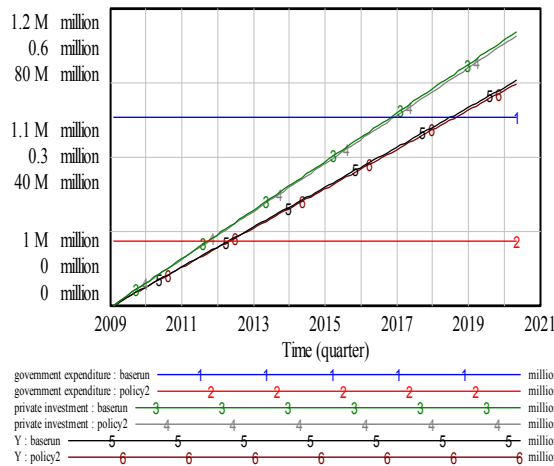


Figure 3 Government expenditure, private investment, and  $Y$

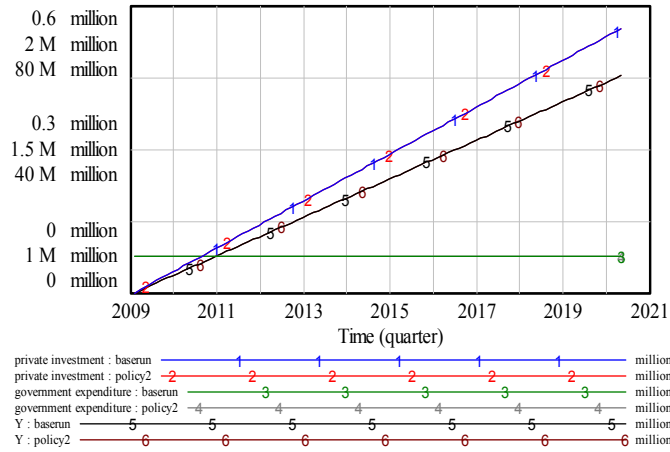


Figure 4 Private investment, government expenditures and Y

### C. Optimization: scenario analysis

To maximize the multiplier effect of the distribution of consumption vouchers, important alternative scenario variables ( $MPC$  and  $SR$ ) were chosen to maximize the integral of the payoff — a measure numerically stating how good the simulation is. The payoff collapses the entire model over the entire time period of the simulation into a single number. In Figure 5, the base run is conducted using constants at their original values ( $MPC = 0.257$ ,  $SR = 0.72$ ). Optimization involves the simulation results after establishing parameters with maximum and minimum bounds for  $MPC$  (from 0.1 to 0.3) and  $SR$  (from 0.67 to 0.72) (Kan, 2010). The optimization process indicated that the value for the maximum multiplier of the distribution of consumption is 0.6849 (where  $MPC = 0.3$  and  $SR = 0.67$ ), as line 1 shows; at this combination point, the payoff value is 7.7911, whereas the multiplier coefficient using the original values is 0.6439 (where  $MPC = 0.257$ ,  $SR = 0.72$ ), as line 2 indicates.

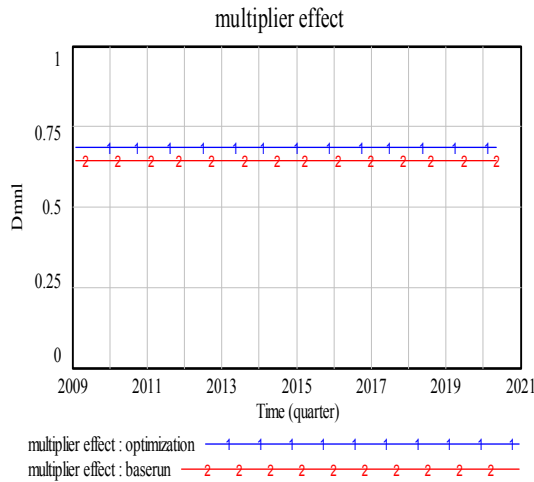


Figure 5 The multiplier effect of consumption vouchers

In addition, when  $MPC$  rises from 0.1 to 0.3, it leads the per capita GDP to increase; hence, private consumption and private investment increase as well. On the other hand, when  $MPI$  rises from 0.21 to 0.4, private consumption and private investment rise to equivalent results. As  $MPC$  rises by 1%, private consumption increases by 0.00000288 million NT dollars and  $Y$  by 0.00000087627 million NT dollars.

## VII. Conclusions and Policy Implications

This study developed a system-based simulation model to examine the dynamics of voucher consumption,  $Y$  (GDP), government expenditures, private investments and private consumption, and the multiplier effect in Taiwan. Several findings were outlined. First, associated with the highest  $MPC$  (0.3) and lowest  $SR$  (0.6741), the distribution of consumption vouchers will generate the largest multiplier coefficient (0.6830) and  $Y$ . Second, when the substitution rate of consumption vouchers increases by 1%, the multiplier effect decreases by



0.44%. Third, the contribution percentages of consumption vouchers on private consumption during the first through third quarters as well as the accumulated total of these three quarters in 2009, ranged from 2.13-2.55, 0.25-0.30, 0.19-0.22, and 0.86-1.02 of a percentage, respectively. Meanwhile, the contribution percentage of consumption vouchers on GDP during the first through third quarters as well as the accumulated total of these three quarters in 2009 ranged from 1.36-1.63, 0.15-0.18, 0.11-0.13, and 0.51-0.61 of a percentage, respectively. Fourth, when the government adopts a constant national budget policy, the increase of the distribution of consumption vouchers will not deteriorate the economy even though government expenditures — but not necessarily private investments — are squeezed out; such a result echoes the questionnaire survey's results (CEPD, 2009). Fifth, when the government does not stick to a constant budget policy, the evidence indicates that the expansion of the distribution of consumption vouchers will not squeeze out government expenditures because, during the distribution of consumption vouchers, not only is there no increase in the overall level of the domestic interest rates, but there is also no occurrence of a suppressing effect on effective demand. Furthermore, in the long run, the evidence indicates that  $Y$  displays one growth trend. Finally, the optimization process found that the values for the maximum multiplier of the distribution of consumption is 0.6849 (where  $MPC = 0.3$  and  $SR = 0.67$ ). The policy implication of these conclusions is that the distribution of consumption vouchers will — to some extent — yield a multiplier effect to stimulate effective demand, thereby benefiting Taiwan's depressed economy. Moreover, the government does not need to worry about possible crowding-out effects, which may be brought about by the consumption vouchers as the distribution consumption vouchers can be regarded as one effective way of stimulating the economy.

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# 臺灣發行經濟消費券之動態分析及 總體經濟行為模擬

魏文欽\*

## 摘要

面臨嚴峻全球經濟不景氣下，各國家莫不採取各種經濟政策企圖使其景氣回溫。本文使用系統動力學從動態觀點探討臺灣發行限期使用消費券，將如何影響總體經濟行為？研究模擬結果顯示：第一，當最高邊際消費傾向 ( $MPC = 0.3$ ) 搭配最低消費券替代率 ( $SR = 0.6741$ ) 時，將產生最大的乘數效果為 0.6830 及國內生產毛額。第二，當消費券替代率增加 1% 時，乘數效果將下降 0.44%。第三，估計消費券對第一、二、三季及前三季累積民間消費支出的貢獻分別介於 2.13-2.55、0.25-0.30、0.19-0.22 與 0.86-1.02 百分點間；而對第一、二、三季及前三季 GDP 的貢獻分別介於 1.36-1.63、0.15-0.18、0.11-0.13 與 0.51-0.61 百分點間。第四，當政府採取固定預算政策時，消費券替代率的增加，縱然使政府支出被排擠，亦不致導致經濟惡化，再者，私人投資將不致為消費券的增加所排擠。最後，當政府不採取固定預算政策時，模擬結果顯示：擴大消費券發行，將不會排擠政府支出。本研究之政策意涵如下：發行消費券將產生乘數效果以刺激有效需求，為低迷的臺灣景氣帶來效益。發行消費券可能產生的排擠效果可予以忽略，同時發行消費券政策可被視為刺激經濟的有效方法。

關鍵詞：系統動力學、消費券、乘數效果

JEL 分類代號：C61, E21

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