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Analyzing the Crowding-out Problems of Taiwan

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This paper examines the crowding-out hypothesis of Taiwan, under which, the policy problem of Taiwan are evaluated. To account for the effect of underlying regime change such as financial openness, a Markov regime-switching framework is employed. Evidence from Taiwan indicates that government spending on investment, instead of that on goods and services, substitutes for private consumption since 1990, which renders unconvincing the policy plea for expansionary government investment since financial openness.

I. Introduction

This paper investigates the relationship between change in private consumption and increase in government spending. The existence of substitutability, or crowding-out, usually renders unconvincing the plea for expansionary fiscal policy. Crowding-out effect is largely related to the means used to finance an increase in government spending. If taxes are used to finance an increase in government spending, then this multiplier is called the *balanced-budget multiplier*, reflecting the fact that the fiscal action has no impact on the size of the government's budget deficit or surplus. In this case, consumers reduce consumption spending to be able to pay the higher taxes. The decrease in consumption demand partially offsets the increase in government spending reducing the size of the multiplier. The offset is only partial because not all the financing for extra taxes comes from reducing consumption. Some comes from reducing saving, which is not a component of aggregate demand.

Moreover, the multiplier process usually assumes that government sells bond to finance an increase in its spending, in this case, extra crowding out comes about in two ways: Firstly, it raises the rate of interest. To sell bonds the government must make them attractive, so it must raise the interest rate. The higher the interest rate crowds out all components in aggregate demand. Secondly, when the bonds mature, interest and principal must be paid to the bondholders. According to the Ricardian equivalence, people would expect that future taxes would be higher because of this and react by increasing saving to build up a reserve so that those anticipated higher taxes can be paid without disrupting future consumption levels.

Bailey (1971) first formally documents the idea that there may be a degree of

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substitutability between government spending and private consumption; Barro (1981) incorporated it into a general model to examine the direct effect of government purchases of goods and services on consumption utility. Kormendi (1983) and Aschauer (1985) applied the permanent-income approach and find a significant degree of substitutability between private consumption and government spending for the United States. Ahmed (1986) estimated the effects of UK government consumption in an intertemporal substitution model and finds that government expenditures tend to crowd out the private consumption. Recently, Aiyagari *et al.* (1992) and Baxter and King (1993) explore the effect of government spending shocks on various economic aggregates in a one-sector neoclassical growth model with constant returns to scale and variable labor supply. They find that increases in government spending significantly led to a decline in private consumption. Amano and Wirjanto (1997) test this hypothesis by estimating the intra-temporal substitution elasticity about 0.9, assuming that a representative consumer maximizes his lifetime utility by consuming two goods.

Some empirical studies have found different results. In terms of a neoclassical model with increasing returns to scale and monopolistic competition, Devereux *et al.* (1996) examined the impact of government spending shocks and found that an increase in government consumption generates an endogenous rise in aggregate productivity. The increase in productivity raises the real wage sufficiently that there is a substitution away from leisure and into consumption. Thus, an increase in government expenditures leads to an increase in private consumption. Karras (1994) examines the change of private consumption in response to increases in government spending across a number of countries and finds that public and private consumption are better described as complementary rather as substitutes.

However, it is not clear why either substitutability or complementarity would best describe the relationship between private consumption and government spending. It must be borne in mind that the above-mentioned conventional inferences are heavily dependent upon the untested underlying assumptions of time-invariance of time-series process with no changes in structure. Even so, regime changes and structural breaks are both economically and empirically relevant, and can severely affect the properties of inferential procedures. In light of this, we propose a Markov-switching model to examine this issue. The methodology of this paper differs itself from the previous researches in one important way: we explicitly take into account the regime-switching property of the parameter vector where the relationship between government spending and private consumption is determined by transition probabilities.

This paper is organized as follows. Section II develops a theoretical model. Section III analyzes basic time series properties. Section IV proposes a Markov-switching model and empirical results are presented. Section V discusses some explanations for the empirical results. Section VI concludes.

Quarterly data derived from AREMOS/QNIA are used. AREMOS is a public database compiled by the Ministry of Education, Taiwan, R.O.C.. The sample period extends from 1961:01 to 1998:03, and seasonality is adjusted by ratios to moving average multiplicatively. The private consumption includes consumer spending on goods and services. All per capita variables are obtained by dividing the aggregate measure by total population.

In addition, we disaggregate total government expenditure into spending on goods and services (*gc*), and investment (*gk*).

II. The Model

In this section, the theoretical model is developed using Hall's (1978) Euler equation method. Hall's model is based on the first-order conditions of a representative consumer's intertemporal optimization. The appealing feature of Hall's approach is that the resulting Euler equations do not require the specification of all future variables relevant to household decisions. Assuming an effective consumption function (Christiano and Eichenbaum (1992)) specified below

$$C^* = C_i + \alpha G_i \tag{1}$$

where C_t^* is the real per capita effective consumption, C_t is the real per capita private consumption, G_t is the real per capita government spending, and α is the parameter measuring the relationship between them.

$$\text{Max.} \quad E_0\left[\sum_{t=1}^{\infty} \beta^t U(C_t^*)\right] \tag{2}$$

$$\text{S.t.} \quad A_{t+1} = \left\{A_t + Y_t - C_t^* - (1-\alpha)G_t\right\} \cdot (1+r) \tag{3}$$

where E_0 is the expectations operator based on information of period 0. β is a discount factor. Equation (3) is the budget constraint, where A_t is the real financial assets net real government debt at the beginning of period t, and r is a time invariant real rate of interest. Finally, assuming that U is increasing and concave in its arguments, and that $\partial U(0)/\partial C^* \rightarrow \propto$. As in Barro (1989) and Christiano and Eichenbaum (1992), a function of G can be added to the utility function so that the government consumption's marginal utility becomes positive. Hence, the Lagrangean function for the optimization problem is given by

$$E_0\left[\sum_{t=1}^{\infty} \beta^t U(C_t^*) + \lambda_t \cdot \left\{A_{t+1} - (1+r) \cdot \left[A_t + Y_t - C_t^* - (1-r) \cdot G_t\right]\right\}\right] \tag{4}$$

where λ_t is the Lagrange multiplier associated with the budget constraint equation above, which measures the marginal utility of wealth. The first order necessary conditions for period t include the following equations.

$$\partial U_t / \partial C_t^* = \lambda_t \tag{5}$$

$$E_0[\beta(1+r)\lambda_{t+1}] = \lambda_t \tag{6}$$

for $t = 1, 2, \ldots$, where $\partial U_t / \partial c_t^* = \partial U_t(c_t^*) / \partial c_t^*$. Substituting Equation (5) for λ_t and λ_{t+1} into Equation (6), the Euler equation between periods t and $t+1$ can be derived below:

$$E_0[\beta(1+r)\cdot(\partial U_{t+1}/\partial U_t)]=1 \qquad (7)$$

To investigate the empirical implications of the model, we assume that the change in marginal utility is negligibly small over time, so that Equation (7) can be written as $E_0 C^*_{t+1}=[\beta(1+r)]^{\sigma}\, C^*_t$, where $\sigma = U'(C^*)/\{C^*\cdot U''(C^*)\}$ is the intertemporal elasticity of substitution. The relationship below is derived:

$$C^*_{t+1}=\gamma\, C^*_t \qquad (8)$$

In terms of Equation (1), Equation (8) can be rewritten as

$$C_t+\alpha G_t=\gamma(C_{t-1}+\alpha G_{t-1})+v_t \qquad (9)$$

Table 1 Nonlinear Estimation of Equation (8): $C_t+\alpha G_t=\gamma(C_{t-1}+\alpha G_{t-1})+v_t$

	Coefficient	Std. Error	t-Statistic	Prob.
α	–0.137	0.0874	–1.568	0.12
γ	0.999	0.0022	447.32	0.00
Akaike info criterion	–5.942			
Schwarz criterion	–5.895			
Durbin-Watson statistic	2.367			
Null Hypothesis: $\gamma=1$	F-statistic=0.019 (0.89)			

To further the analysis of Equation (9), we have to estimate γ. Table 1 summarizes the nonlinear least square estimation outcomes, and $\gamma=1$; hence Equation (9) is reduced to the equation below

$$\Delta C_t=-\alpha\Delta G_t+v_t, \qquad v_t \sim i.i.d \qquad (10)$$

Let lower cases represent the first-order difference of the logarithm of each series, then the econometric form of Equation (10) is written as a linear combination of parameters α_0 and α_1 below.

$$c_t=\alpha_0+\alpha_1 g_t+\zeta_t \qquad \zeta_t \sim i.i.d. \qquad (11)$$

where $c_t=\ln C_t-\ln C_{t-1}=\Delta\ln C_t$, $g_t=\ln G_t-\ln G_{t-1}=\Delta\ln G_t$; and $\alpha_0=\dfrac{\ln\gamma}{\phi}$, $\alpha_1=-\dfrac{\eta}{\phi}$.

Although some categories of government spending, for example, free school lunch, are close substitutes for private spending, others (like spending on transportation) are probably complementary. And for many substitutability and complementarity coexist. Spending by the Food and Drug Administration may decrease private spending on drug and food inspection, but it also increases private spending of them because of risk reduction. That is, careful interpretation is required to argue that the expansionary fiscal policy is ineffective from aggregate data analysis. Because government spending can be broken into several budget categories, it is unfair to say that spending in education and other welfare expenditure will be less effective in stimulating the economy, because their budgetary purposes are not to be economic stimuli.

In light of this, Equation (11) is estimated by three empirical forms with respect to two categories of government spending.

Model 1: Real per capita private consumption on real per capita total government spending, denoted by *g*.
Model 2: Real per capita private consumption on government spending on goods and services, denoted by *gc*.
Model 3: Real per capita private consumption on real per capita government investment, denoted by *gk*.

III. Analyzing Time Series Properties

Since the empirical equation is Equation (11), we test for stationarity of each variable by different null hypotheses. Table 2 presents the ADF (Dickey and Fuller (1981), Said and Dickey (1984)) and the *Z*-test (Phillips and Ouliaris (1990)) for the null hypothesis of unit root. The *Z*-test has the same asymptotic power as the standard ADF that allows for conditional heteroskedasticity in the errors and modifies the augmented Dickey-Fuller test by using the autocovariances of the errors to compute the spectrum at frequency zero. To compare the results with different null hypothesis, we employ the *G*-statistic proposed by Park and Choi (1988) and the KPSS (Kwiatkowski *et al*. (1992)) to test the null hypothesis of no-unit-root. Table 3 summarizes the results. That all series are stationary is unambiguously accepted.

Table 2 Tests for Stationarity

	ADF	Z_a	Z_t	G	KPSS	
					Level	Trend
c	–6.15	–33.42	–7.65	1.26	0.109	0.101
g	–7.63	–31.12	–5.96	1.56	0.101	0.099
Gc	–5.21	–24.24	–9.88	1.69	0.123	0.011
Gk	–8.11	–33.96	–7.82	0.98	0.091	0.019

Note: The critical values for ADF at 1%, 5%, 10% significance level are –4.0437, –3.4508, and –3.1505 (MacKinnon (1991)); those for Z_a and Z_t tests are –27.61, –20.84, –17.62, and –4.005, –3.461, –3.155 (Phillips and Ouliaris (1990)); for G-statistic, they are 6.63, 3.84, and 2.71. For the level model of KPSS tests, they are, 0.347, 0.463, and 0.739, and for the trend model, they are 0.119, 0.146, and 0.216.

Table 3 LS Estimation Results

Variables	Model 1	Model 2	Model 3
a_0	0.0097	0.0094	0.011
	(0.001, 6.85)	(0.0014, 6.834)	(0.0014, 7.63)
Δg	0.0497		
	(0.041, 1.21)		
Δgc		0.0986	
		(0.044, 2.197)	
Δgk			−0.02
			(0.016, −1.276)
ARCH(1)	0.995	0.629	1.33
AIC	–5.612	–5.641	–5.613
SBC	–5.564	–5.593	–5.565
Adjusted R^2	0.013	0.041	0.0055
Durbin-Watson	2.367	2.13	2.56
F	1.477	2.29	1.63

Note: Standard errors and *t*-statistics are in the parentheses.

Table 3 reports the least square estimation results of the three models of Equation (11). Reading across Table 3, we have three important implications:

First, although there is no ARCH effect, except Model 2, the goodness-of-fit statistics show that the data does not fit the models appropriately. For example, R^2 and F are too small to show good fit.

Second, hardly can we find any evidence supporting the substitutability relationship. Although there is negative coefficient in Model 3, it is insignificant. Only in Model 2 do we find significant parameter estimate. Overall, we find that there is substantial crowding-in effect. That is, government spending is complementary to the private consumption.

Table 4 Granger Causality Tests

Null Hypothesis	Lags			
	2	4	6	8
G does not Granger cause C	14.09(0.00)	1.82(0.13)	1.64(0.15)	1.34(0.23)
C does not Granger cause G	15.95(0.00)	4.38(0.002)	3.18(0.006)	2.19(0.03)
Gc does not Granger cause C	27.30(0.00)	2.83(0.03)	2.13(0.06)	2.24(0.03)
C does not Granger cause Gc	20.27(0.00)	3.01(0.02)	2.73(0.02)	1.42(0.2)
Gk does not Granger cause C	8.79(0.00)	1.23(0.3)	1.19(0.32)	1.01(0.43)
C does not Granger cause GI	11.26(0.00)	4.15(0.004)	3.24(0.006)	2.33(0.03)

Note: Numbers in the parentheses are critical probabilities of the F-statistic for the null. *G* denotes total government spending; *Gc* denotes government spending on consumption and service, and *Gk* denotes the government investment.

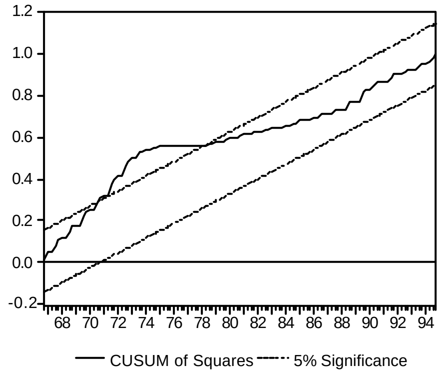

Figure 1 Stability Test of Model 1

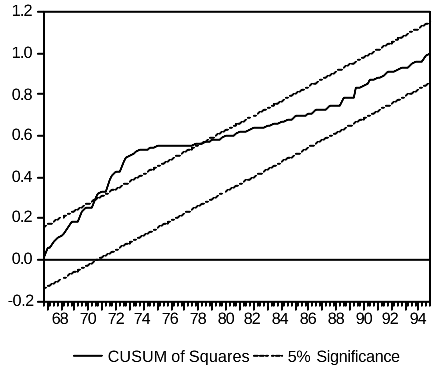

Figure 2 Stability Test of Model 2

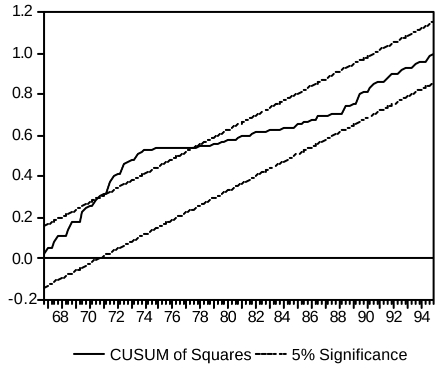

Figure 3 Stability Test of Model 3

According to Graham (1993), Equation (11) is sensitive to the sample period. In light of this, we test for instability using CUSUM statistic and Granger causality. First, Figures 1-3 plot the CUSUM of squares of the three models. Obviously, the three models have strong resemblance to each other, and the structural changes are found around 1970 and 1980. Hence, we continue with presenting a simple dynamic mechanism that could give rise to a Markov-switching relationship. In the next section, we are concerned with the possibility of a more general type of model where the parameter vector is allowed to undergo occasional discrete shifts during the sample period. Second, Table 4 summarizes the Granger causality tests results. To show instability, we conduct this test by taking 2, 4, 6 and 8 lags. Not surprisingly, we find the Granger causality test result is sensitive to the number of lags. The most sensitive one is the null that "government investment does not Granger cause private consumption." This null is significantly rejected when the number of lags is set to 2; when we set 4 lags, the null is accepted. Similar problem is found for the null that total government consumption does not Granger cause private consumption. Therefore, relationship between these variables is subject to change. To motivate the analysis, we continue the Markov-switching regression.

IV. The Markov-switching Model

1. The model

To examine whether there is evidence consistent with regime-switching between private consumption and government spending, the general Markov regime-switching specification of the three models is shown below:

$$c_t = [\alpha_{0,1} S_t + \alpha_{0,2}(1 - S_t)] + [\alpha_{1,1} S_t + \alpha_{1,2}(1 - S_t)] g_t + [\sigma_1 S_t + \sigma_2 (1 - S_t)] \varepsilon_t \tag{12}$$

where $\varepsilon_t \sim i.i.d\ N(0,\ \sigma^2)$ and with unobserved state S_t, which is presumed to follow a two-state Markov chain with transition probabilities p_{ij}. Equation (12) has the following implications with respect to regime change

$$\alpha_0 = \begin{cases} \alpha_{0,1},\ if\ s_t = 1 \\ \alpha_{0,2},\ if\ s_t = 2 \end{cases}, \qquad \alpha_1 = \begin{cases} \alpha_{1,1},\ if\ s_t = 1 \\ \alpha_{1,2},\ if\ s_t = 2 \end{cases}, \qquad \sigma = \begin{cases} \sigma_1,\ if\ s_t = 1 \\ \sigma_1,\ if\ s_t = 2 \end{cases}$$

The evolution of the unobservable state variable is assumed to follow a two-state Markov chain satisfying: $p_{11} + p_{12} = p_{22} + p_{21} = 1$, where $p_{11} = \Pr(S_t = 1 \mid S_{t-1} = 1)$, $p_{12} = \Pr(S_t = 2 \mid S_{t-1} = 1)$, $p_{21} = \Pr(S_t = 1 \mid S_{t-1} = 2)$, $p_{22} = \Pr(S_t = 2 \mid S_{t-1} = 1)$. The observation can also be thought of as drawing from a mixture of two normal distributions. The state in each period determines which of the two normal densities is used to generate the model. Their correlation is assumed to switch between two regimes according to transition probabilities. For example, when the current relationship is in state 1, there is p_{11} chance for the next correlation to stay in the same regime; when the current correlation relationship is in state 2, there is p_{22} chance for the next correlation relationship to stay in the same regime. The estimation procedure consists of two parts: First, we begin with the unconditional probability of the state of the first observation (Hamilton (1994)). Second, the smoothed probabilities are calculated by using Kim(1994) recursive algorithm, which are also used for weighting data and conducting the regression.

Moreover, we briefly introduce the score-based specification tests. Interested readers are directed to Norden and Vigfusson (1996, pp.26-27) and cited papers for detailed explanations. To test whether there is two regimes underlying the model, the null hypothesis is

$$\mathrm{H}_0\!: \boldsymbol{a}_{0,1} = \boldsymbol{a}_{0,2}\,,\ \ \boldsymbol{a}_{1,1} = \boldsymbol{a}_{1,2}\,, \text{ and } \ \boldsymbol{s}_1 = \boldsymbol{s}_2 \tag{13}$$

White (1987) presents a general score-based tests for Equation (13) in maximum likelihood models that leads to several immediately useful tests in the switching regression context considered above. Given a likelihood function $L(y_t \mid x_t, \boldsymbol{q})$ mentioned previously, $h_t(\boldsymbol{q})$ is simply the gradient of $L(y_t \mid x_t, \boldsymbol{q})$ with respect to $\boldsymbol{q}$. White (1987) construct the general test by listing those l element of $m \times m$ matrix $h_t(\boldsymbol{q}) \times h_t(\boldsymbol{q})'$ that we wish to test in the $l \times 1$ vector $c_t(\boldsymbol{q})$. He then let $\hat{\boldsymbol{q}}$ denote our maximum-likelihood estimate of $\boldsymbol{q}$, and let $\hat{A}$ be the 2×2 subblock of the inverse of the partitioned matrix below. Let A denotes the matrix below

$$\frac{\begin{bmatrix} \sum_{t=1}^{T} h_t(\boldsymbol{q}) \cdot h_t(\boldsymbol{q})' & \sum_{t=1}^{T} h_t(\boldsymbol{q}) \cdot c_t(\boldsymbol{q})' \\ \sum_{t=1}^{T} c_t(\boldsymbol{q}) \cdot h_t(\boldsymbol{q})' & \sum_{t=1}^{T} c_t(\boldsymbol{q}) \cdot c_t(\boldsymbol{q})' \end{bmatrix}}{T} \tag{14}$$

where T is the sample size. In this case, White shows that if the model is well specified, the matrix product

$$\frac{\left[\sum_{t=1}^{T} c_t(\hat{\boldsymbol{q}})\right] \cdot A \cdot \left[\sum_{t=1}^{T} c_t(\hat{\boldsymbol{q}})\right]}{T} \tag{15}$$

will have a $\boldsymbol{c}^2(l)$ asymptotic distribution. The tests of parameters of two regimes follow conventional Wald test statistic formula. Interested readers are referred to Norden and Schaller (1996).

Hamilton (1990) discusses theses tests in the context of Markov mixture of normal distributions model and presents evidence that White's tests tends to over reject the null hypothesis in small samples. Accordingly, all the tests statistics presented below are interpreted using 1% significance level as Hamilton suggested.

2. Empirical Results

Table 5 presents the ML approximation results of three Markov-switching models. Model 1 reports the estimation results of private consumption on total government spending. It identifies two regimes of the same signs. Total government spending does not substitute for the private consumption; instead, it “crowds in” the private consumption. The transition probability indicates that if the state of current period is in the first regime, there is 97.1% chance to stay in the same state next period. And if the state of current period is in the second regime, there is 98.01% chance to stay in the same state next period. According to the transition probabilities, hardly can we judge which regime dominates over time. The limiting probability that the relationship will be in regime 1 at any given time is 0.029, and regime 1 is expected to persist for 34.5 quarters, on average. The relationship will be in regime 2 at any given time is 0.0199, and regime 2 is expected to persist for 50 quarters, on average.

Model 2 reports the estimation results of private consumption on government spending on goods and services. Two regimes with different signs are identified. However, the α_1 parameter estimate of the second regime is insignificantly negative, we do not accept it. Hence, the substitutability hypothesis is also rejected by Model 2 in favor of the alternative that the government spending on goods and services “crowds in” private consumption. The transition probability indicates that if the state of current period is in the first regime, there is 97.5% chance to stay in the same state next period. And if the state of current period is in the second regime, there is 96.7% chance to stay in the same state next period. Similarly, the transition probabilities do not inform us which regime dominates over time. The limiting probability that the relationship will be in regime 1 at any given time is 0.025, and regime 1 is expected to persist for 40 quarters, on average. The relationship will be in regime 2 at any given time is 0.033, and regime 2 is expected to persist for 30.3 quarters, on average.

Table 5 ML Estimates of Parameters for Two-Regime Markov-switching Regressions

	α_0	α_1	p_{ii}	σ
Model 1: Total Government Spending H$_0$: $\alpha_{0,1} = \alpha_{0,2}$, $\alpha_{1,1} = \alpha_{1,2}$, and $\sigma_1 = \sigma_2$ Wald Test Statistic = 38.43 (0.00) ~$\chi^2(6)$ AIC= –8.236				
Regime 1	0.434 (0.014, 30.95)	0.26 (0.048, 5.47)	0.971 (0.34, 5.5)	0.012 (0.0013, 9.28)
Regime 2	0.5087 (0.021, 24.07)	0.17 (0.07, 2.505)	0.9801 (0.40, 5.66)	0.017 (0.002, 11.07)
Model 2: Government Consumption H$_0$: $\alpha_{0,1} = \alpha_{0,2}$, $\alpha_{1,1} = \alpha_{1,2}$, and $\sigma_1 = \sigma_2$ Wald Test Statistic = 37.65 (0.000) ~$\chi^2(6)$ AIC= –8.583				
Regime 1	0.3537 (0.011, 32.85)	0.8782 (0.053, 26.25)	0.975 (0.322, 6.076)	0.012 (0.001, 9.023)
Regime 2	0.5698 (0.021, 16.51)	–0.0837 (0.117, –0.718)	0.967 (0.35, 5.267)	0.015 (0.0017, 8.638)

Table 5 (Continued)

	α_0	α_1	p_{ii}	σ
Model 3: Government Investment				
H_0: $\alpha_{0,1} = \alpha_{0,2}$, $\alpha_{1,1} = \alpha_{1,2}$, and $\sigma_1 = \sigma_2$		Wald Test Statistic = 67.08 (0.00) $\sim\chi^2(6)$		
AIC= –8.236				
Regime 1	0.49 (0.0075, 64.68)	0.186 (0.071, 2.62)	0.973 (0.35, 5.502)	0.0123 (0.001, 9.287)
Regime 2	0.59 (0.009, 63.94)	–0.257 (0.084, –3.06)	0.989 (0.404, 5.666)	0.0179 (0.0016, 11.07)

Note: Standard errors and *t*-statistics are in the parentheses.

Model 3 reports the estimation results of private consumption on government investment. Two regimes with different signs are identified. In sharp contrast to previous outcomes, the substitutability relationship is found. α_1 of regime 1 is significantly positive and α_1 of regime 2 is significantly negative at 1 % significance level. Hence. Regime 2 substantially implies a substitutability relationship between private consumption and government investment, which supports the crowding-out hypothesis. The transition probability indicates that if the state of current period is in the first regime, there is 97.3% chance to stay in the same regime next period. And if the state of current period is in the second regime, there is 98.9% chance to stay in the same state next period. The limiting probability that the relationship will be in regime 1 at any given time is 0.027, and regime 1 is expected to persist for 40 quarters, on average. The relationship will be in regime 2 at any given time is 0.011, and regime 2 is expected to persist for 90 quarters, on average. Therefore, it would be clear that regime 2 (the crowding-out regime) has stronger persistence, which exerts dominant effect on the relationship over time.

The specification tests are summarized at each panel of Table 5. The critical values of $\chi^2(6)$ at 10%, 5%, and 1% significance level are, respectively, 7.78, 9.49, and 13.3. Obviously, the null hypothesis of model misspecification is rejected at least 1% significance level, and support the alternative that the model is appropriately described by Markov-switching.

The next section offers several explanations to this finding.

V. Discussions

To sum up, there is one important policy implication: The substitutability hypothesis holds only when the regressor is government investment. Government spending on goods and services does not crowd out, or substitute for, the private consumption. Government investment implies the coexistence of both effects: crowding-in and crowding-out. The dominant impact of crowding-out effect would make the government spending multiplier smaller than it is anticipated. Figure 4-6 present the inferred probabilities of state 1. To simplify the discussion, we examine Figure 6 which plots the inferred *posterior* probabilities of regime 1 of Model 3.

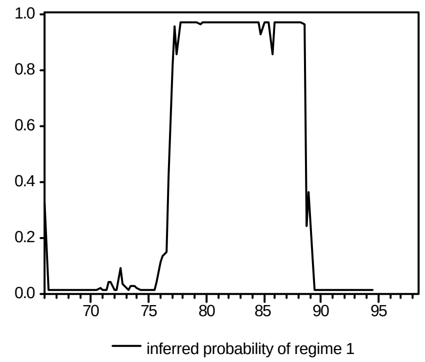

Figure 4 Inferred Probabilities: Model 1

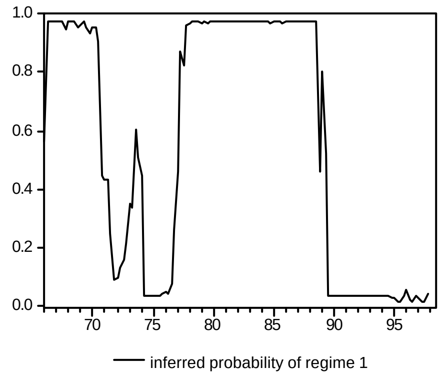

Figure 5 Inferred Probabilities: Model 2

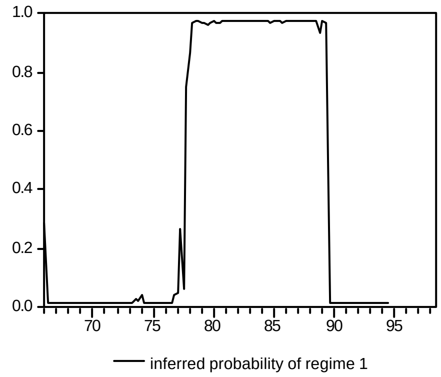

Figure 6 Inferred Probabilities: Model 3

In Figure 6, there are two periods that crowding-out (substitutability) has dominant effect on the relationship. The first period is a range from 1990 to now, the second period is that before 1980. The dominant crowding-in effect took place between 1980 and 1990. There are two possible explanations for the first dating of crowding-out regime.[1]

The first explanation is related to the level of employment. The multiplier process causes an increase in government spending, or any other exogenous increase in spending, to have a greater ultimate effect on the nominal level of income through price increases, real income increases, or both, depending on where the economy is relative to full employment. Although we have no empirical evidences to show whether the 1990s is a high-employment era, it is known that Taiwan exhibits a strong consumption propensity and high saving rate in the 1990s (see Table 6).

Table 6 Disposable Income, Final Consumption and Savings, NT$

Year	Disposable Income	Final Consumption	Savings Rate, %
1964	28591	25381	11.23
1970	44486	40929	8.00
1975	101821	86849	14.87
1980	233112	179687	23.17
1985	320495	246277	23.52
1990	520147	370323	28.80
1994	769755	545987	29.07

Source: *Report of the Survey of Family Income & Expenditure in Taiwan Area of Republic of China*, 1997. Directorate-General of Budget, Accounting and Statistics, Executive Yuan, Taiwan, R.O.C..

The second explanation is related to the relative ineffectiveness of expansionary fiscal policy in a flexible exchange rate regime, as indicated by the standard Mundell-Fleming theory, which argues that, given imperfect capital mobility, the ability of expansionary fiscal policy to affect aggregate demand is related to the flexibility of exchange rate. Under flexible exchange rate regimes, expansionary fiscal policy can stimulate aggregate demand, but it also raises interest rate which is supposed to reduce domestic private investment. The intuition behind these theoretical results is straightforward and can be found easily (see Krugman and Obstfeld (1997, pp.499-503)). A stronger version of this perspective was first documented by Mundell and Fleming in the early 1960s, Barro (1990, ch.12-14) rigorously analyzes this issue, and McKibbin and Sachs (1991) develop a dynamic version of the Mundell-Fleming approach and concluded that, given floating exchange rate, commercial policy would be less effective in improving U.S. trade deficit.

During the past decades, the foreign exchange market of Taiwan has experienced a structural transition from fixed to flexible regime. On October 10, 1978, Taiwan announced to terminate fixed exchange rate, and the foreign exchange market began to operate formally on February 1, 1979. The second financial liberalization began with the late 1980s, the domestic foreign exchange market has been further liberalized up to now. For instance, Figure 7 shows that the spot exchange rate has larger fluctuation since the mid-1980s.

1. See Shirley (1983) and Gustav (1992) for relevant discussions.

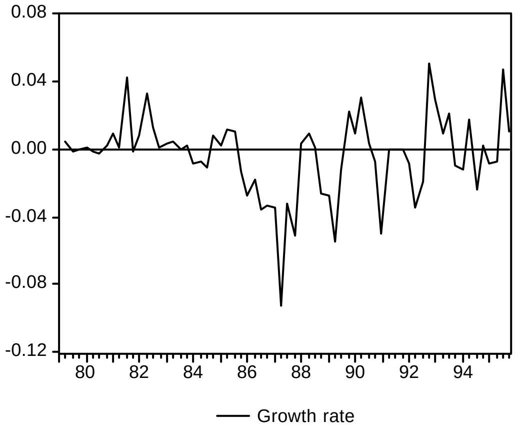

Figure 7 Spot Exchange Rate

Explanations to the second crowding-out dating of government investment have many possibilities. First, the government investment during this period was mainly focused on the expansion of national defense and the state-owned enterprises, which largely transferred private consumption to the army. Second, up to 1970s, the economy of Taiwan was confronted with three severe problems: budget deficit, inflationary pressure, and confidence problems. The budget deficit was due to the growing fiscal spending on economic reconstruction since the World War II. The inflation pressure was related to two oil crises and increasing fiscal spending. The confidence problem was rooted in the political struggle between Taiwan and communist China, especially the ending of diplomatic relationship with U.S. in 1978, which negatively affected the confidence of Taiwan residents. These problems could adversely affect the multiplier effect of expansionary government investment on private consumption.

Between 1970 and 1990, government investment was mainly related to infrastructure construction, the typical example is the Ten Great Economic Constructions. Hence, it might be the reason why the crowding-in effect dominates. The rationale is simple: Aschauer (1989a, 1989b, 1990) shows that if infrastructure construction turns down, then total factor productivity turns down slightly later. The point is that the infrastructure construction will provide a service which minimizes cost; for example, the telecommunication system improves information technology and enhances production efficiency and more highway saves time spent in traffic and so on.

In this section, I attempt to explain the results from the experiences of Taiwan's economic development. However, careful interpretations are required. Because at any point of time, the explanations are not mutually exclusive, but reflect the synthesis of different forces.

VI. Conclusion

The crowding-out phenomenon describes the process whereby an increase in government spending decreases other components of aggregate demand, thus reducing the government spending multiplier effect on stimulating aggregate demand. During the multiplier process, several factors crowd out aggregate demand. Financing an increase in government spending by increasing taxes or by selling bonds to the public causes crowding out forces to reduce the magnitude of the multiplier. Although financing by printing money may avert crowding out effect temporarily, it will cause inflation and raise the interest rate in the future. However, whether the increase in national income is due to the increase in the money supply or the increase in government spending is still a debatable issue. This paper indicates that the existence of dominant crowding-out effect renders unconvincing the Keynesian plea for expansionary public investment of Taiwan since 1990s.

There are two modifications which could be made to improve the conclusion in the future. Firstly, as discussed in previous section, to extend this issue to more government spending categories can be helpful to this research issue. Secondly, although Graham (1993) argues that real disposable income is an important factor in this modeling, however, partly because of the lack of quarterly data on Taiwan' s real disposable income, and partly because of not to complicating the convergence of maximum likelihood computation and making this research too lengthy, this paper does not include this variable. Both are left as a research in the future.

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