

A model for national income determination in Taiwan

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Abstract

Following Chow (1985 and 2010) and using annual data from 1951 to 2010 for Taiwan this paper estimates a consumption function based on the permanent income hypothesis and an investment function based on the accelerations principle. The data support the permanent income hypothesis Friedman (1957) whereas the permanent income hypothesis of Hall (1978) was supported in Chow (1985 and 2010). The accelerations principle is strongly supported, as in the case of China. An explanation why the two economies have different consumption functions is given.

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This paper presents a simple econometric model to determine national income in Taiwan consisting of a consumption equation and an investment equation, following Chow (1985, 2010 and 2011). The consumption function is based on the permanent income hypothesis and the investment equation is based on the accelerations principle. In section 1 the consumption equation is estimated and found to satisfy the permanent income hypothesis of Friedman (1957). In section 2 the investment function is found to satisfy the accelerations principle. In the model of Chow (1985) for China, the consumption function satisfies the permanent income hypothesis of Hall (1978) instead. Section 3 provides an explanation why the consumption functions of the two economies are different.

1. Estimation of the Consumption Function

The consumption and investment equations are estimated by the method of two- stage least squares, with data given in Table 1 and found in the Statistical Yearbook of the Republic of China, various issues. The three structural equations include (1) the national income identity $Y = C + I + X$, with Y , C , I and X denoting real GDP, consumption, investment and exports minus imports respectively; (2) a consumption function linear in $C(t-1)$ and Y and (3) an investment function linear in Y , $Y(t-1)$ and $I(t-1)$. The endogenous variables are C , I and Y ; the predetermined variables are X , $Y(t-1)$, $C(t-1)$ and $I(t-1)$.

In the first stage, Y^* is estimated by regressing Y on the predetermined variables using 60 annual observations from 1951 to 2010 to yield:

$$Y_t^* = 88802.5(39053.3) + 1.354(.223)Y_{t-1} - .2584(.2552)C_{t-1} - .5116(.2290)I_{t-1} - .2470(.2067)X_t$$

$$R^2 = 0.9979; s = 2.0e+05 \quad (1)$$

The number in parentheses after each coefficient is its standard error. In the second stage of two-stage least squares I have estimated the consumption function

$$C_t = 24106.1(17986.2) + .641(.0892) C_{t-1} + .2756(.0621) Y^*_t \quad R^2 = 0.9992; s = 88650 \quad (2)$$

Note that the coefficient of Y^* is significant, contradicting the permanent income hypothesis of Hall (1978) which states that the consumption function is a random walk with drift. Equation (2) is consistent with Friedman's permanent income hypothesis as shown below.

The consumption function of Friedman (1957) states that consumption C is proportional to permanent income, $C = a Y_p$ where permanent income is determined by adaptive expectations as follows:

$$Y_p = bY(t) + (1-b)Y_p(t-1) = bY(t) + b(1-b)Y(t-1) + b(1-b)^2Y(t-2) + \dots$$

Under adaptive expectations permanent income is a weighted mean of current income Y and permanent income of the preceding period with weights b and $(1-b)$ respectively. By repeated substitutions of lagged Y 's for lagged Y_p backward in time Y_p equals to the right-hand side of the above equation. When this expression is substituted into consumption function we obtain

$$C_t = a [bY_t + b(1-b)Y_{t-1} + b(1-b)^2Y_{t-2} + \dots]$$

$$C_{t-1} = a [bY_{t-1} + b(1-b)Y_{t-2} + b(1-b)^2Y_{t-3} + \dots]$$

which imply

$$C_t = abY_t + (1-b)C_{t-1}$$

From our estimated equation (2), $ab = .2756$ $1-b = .6410$ or $b = .3590$ and $a = .2756/.3590 = .7677$. The estimate .7677 for a, the fraction of national income devoted to consumption, is reasonable.

According to the permanent income hypothesis of Hall (1978), the coefficient of C_{t-1} equals 1 and the coefficient of Y^* should be zero. This hypothesis was confirmed by Chow (1985, 2010, 2011). Section 3 will explain why the data for Taiwan and for China support different versions of the permanent income hypothesis.

2. Estimation of the Investment function

When the investment function is estimated by using both current and lagged income, I find the coefficient of the latter to be negative and of the same order of magnitude as the coefficient of current income, thus confirming the accelerations principle.

$$I_t = -232841.6(57266.5) + 3.1415(.546) Y^*_t - 3.3446(.6046) Y_{t-1} + 1.3971(.2015) I_{t-1} \quad (3)$$

$$R^2 = 0.9793; s = 1.4e+05$$

When the variables Y^* and Y_{t-1} are replaced by their difference the result is excellent:

$$I_t = -81570.96(34760.8) + 1.5471(.2389)(Y^*_t - Y_{t-1}) + .7666(.0441) I_{t-1}$$

$$R^2 = 0.9755; s = 1.5e+0 \quad (4)$$

In conclusion, data for Taiwan support Friedman's permanent income hypothesis for consumption and the accelerations principle for investment.

3. Why data for Taiwan and China support two versions of the permanent income hypotheses

To explain why data for China support Hall's permanent income hypothesis and data for Taiwan support Friedman's version I begin with a restatement of Friedman's permanent income hypothesis. Friedman estimated permanent income $Y_p(t)$ as a variable to explain consumption by the partial adjustment mechanism

$$Y_p(t) - Y_p(t-1) = b(Y(t) - Y_p(t-1)) \quad (5)$$

After observing $Y(t)$ consumers in Taiwan would change their estimate of $Y_p(t)$ by a fraction b of the difference $Y(t) - Y_p(t-1)$ whereas the consumers in China would not. The latter followed the permanent income hypothesis of Hall (1978). Their permanent income in $t-1$ was proportional to $C(t-1)$ by assumption of the permanent income hypothesis. Hence no other data than C_{t-1} that were available in $t-1$ would be useful in estimating $Y_p(t-1)$, or in estimating C_t . The reason is $C_t = a Y_p(t) + u(t)$ by assumption and if only data up to $t-1$ are available the best estimate of $Y_p(t)$ is $Y_p(t-1)$ plus some trend and $Y(t-1) = C(t-1)/a$. Hence by the permanent income hypothesis of Hall (1978)

$$C(t) = a Y_p(t) + u(t) = a[Y_p(t-1) + \text{trend}] + u(t) = C(t-1) + \text{const} + u(t) \quad (6)$$

If the consumers in Taiwan followed Friedman's permanent income hypothesis, they must allow current income $Y(t)$ to influence their estimate of $Y_p(t)$ by equation (5). If only data up to $t-1$ are available they would allow $Y(t-1)$ to influence their estimate of $Y_p(t-1)$ while the Hall consumers in China using only $C(t-1)$ to estimate $Y_p(t-1)$ would not. For the Taiwan consumers to follow (5) data on $Y(t)$ must be informative of their $Y_p(t)$ which determines $C(t)$. This will happen if movement in past $Y(t-k)$ affects movement of current $Y(t)$ substantially. This sufficient condition for the behavior of the Taiwan consumers can be test statistically.

To find out whether movement of past $Y(t-k)$ in Taiwan did affect $Y(t)$, more so than movement of past $Y(t-k)$ affected $Y(t)$ in China, I perform a regression of $\Delta \log Y(t)$ on $\Delta \log Y(t-1)$ using Taiwan data and expect it to have more predictive power than the corresponding regression using data for China. Data on real GDP of China from 1952 to 2008 are taken from the last column of Table 1 of Chow and Wang (2010). The regressions for Taiwan and China are given in equations (7) and (8) respectively.

$$\Delta \log Y(t) = 0.3953(.1219) \Delta \log Y(t-1) + 0.0431(.0095) \quad R^2 = 0.1581 \quad s = .02901 \quad (7)$$

$$\Delta \log Y(t) = 0.3313(.1290) \Delta \log Y(t-1) + 0.0506(.0146) \quad R^2 = 0.1106 \quad s = .07955 \quad (8)$$

The observations for Taiwan using data given in Table 1 of this paper cover the period 1951-2010 while the observations for China cover almost the same period 1952-2008. Regression (7) has a standard error of only .029 for the explanation of the change in log income, while regression (8) has a much larger standard error of .080. The relative magnitudes of these two standard errors confirm our theory for explaining why data for Taiwan support Friedman's version of the permanent income hypothesis and data for China support the Hall version. Changes in real income in Taiwan have been more predictable than in China, leading the Taiwan consumers to use current income to estimate permanent income as specified by the Friedman theory of permanent income to a larger extent than consumers in China.

Table 1 National income and its determinants

Year	Y	C	I	X	P
1951	12.648	11.448	1.779	-579	0.062509
1952	17.623	16.031	2.645	-1.053	0.077864
1953	23.422	21.378	3.230	-1.186	0.094195
1954	25.746	23.804	4.049	-2.107	0.094158

1955	30.685	27.973	4.007	-1.295	0.104062
1956	35.194	32.015	5.538	-2.359	0.113344
1957	41.096	36.778	6.374	-2.056	0.123385
1958	45.990	41.356	7.500	-2.866	0.129279
1959	52.980	47.463	9.798	-4.281	0.137805
1960	63.765	55.775	12.692	-4.702	0.155144
1961	71.389	62.301	14.053	-4.965	0.163373
1962	78.539	68.857	13.799	-4.117	0.166356
1963	88.714	73.684	16.029	-999	0.17112
1964	103.488	83.535	19.178	775	0.1789
1965	114.359	92.080	25.652	-3.373	0.178373
1966	127.675	100.479	26.847	349	0.183162
1967	147.463	114.465	35.983	-2.985	0.191634
1968	171.817	133.885	42.764	-4.832	0.204854
1969	199.154	152.132	48.446	-1.424	0.218498
1970	229.390	171.357	58.147	-114	0.227555
1971	266.594	190.672	69.434	6.488	0.235144
1972	319.573	218.305	81.525	19.743	0.249091
1973	415.111	273.396	119.951	21.764	0.289386
1974	556.303	382.744	216.142	-42.583	0.380713
1975	597.660	436.800	180.166	-19.306	0.388076
1976	717.089	484.156	217.671	15.262	0.410566
1977	840.846	565.639	234.791	40.416	0.434084
1978	1,006.669	661.357	281.356	63.956	0.457755
1979	1,215.395	806.709	395.167	13.519	0.511518
1980	1,519.946	1,031.759	505.941	-17.754	0.596064
1981	1,810.829	1,241.979	532.633	36.217	0.667253
1982	1,941.169	1,353.111	490.261	97.797	0.687827
1983	2,168,143	1,455,987	530,731	181,425	0.709156
1984	2,414,377	1,598,490	562,150	253,737	0.721762
1985	2,517,129	1,698,270	489,140	329,719	0.722689
1986	2,943,997	1,819,992	572,782	551,223	0.760052
1987	3,291,857	2,041,083	729,921	520,853	0.76811
1988	3,488,550	2,342,933	896,435	249,182	0.77068
1989	4,003,227	2,767,709	979,185	256,333	0.802327
1990	4,430,055	3,158,157	1,079,424	192,474	0.83074
1991	4,958,220	3,539,428	1,224,332	194,460	0.861753
1992	5,534,544	3,959,262	1,484,942	90,340	0.895015
1993	6,110,101	4,349,807	1,666,512	93,782	0.925972
1994	6,685,505	4,804,963	1,775,141	105,401	0.942348
1995	7,277,545	5,224,116	1,942,245	111,184	0.96456
1996	7,906,075	5,752,700	1,894,666	258,709	0.992996
1997	8,574,784	6,247,746	2,150,484	176,554	1.021137
1998	9,204,174	6,715,974	2,392,515	95,685	1.059502
1999	9,649,049	6,997,578	2,409,154	242,317	1.04804
2000	10,187,394	7,350,642	2,615,640	221,112	1.045662
2001	9,930,387	7,419,027	1,970,319	541,041	1.036067
2002	10,411,639	7,650,020	2,013,786	747,833	1.031712
2003	10,696,257	7,815,029	2,129,586	751,642	1.02207
2004	11,365,292	8,253,254	2,693,089	418,949	1.023056
2005	11,740,279	8,553,973	2,667,855	518,451	1.010564
2006	12,243,471	8,717,640	2,776,953	748,878	1
2007	12,910,511	9,027,569	2,855,809	1,027,133	0.995462
2008	12,620,150	9,173,629	2,826,311	620,210	0.967407
2009	12,477,182	9,197,343	2,203,436	1,076,403	0.975514

2010	13,603,477	9,555,488	3,077,335	970.654	0.959713
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Source: Statistical Yearbook of the Republic of China, Taipei, Taiwan: Bureau of Accounting and Statistics, various issues.

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