Note on a Model of Chinese National Income Determination

Abstract: This note shows that the same model that explains consumption and investment expenditures of China's macro-economy based on annual data from 1952 to 1982 remains valid for explaining Chinese data from 1978 to 2006.

JEL classification: E1, E2

1. Introduction

Chow (1985) explains the two major components, consumption and investment, of real national income in China in the period 1952 to 1982. This note shows that the same model can explain China's national income from 1978 to 2006 (section 2) and extends the theory to include the effects of net exports on consumption and investment (section 3).

2. Reexamination of a model of Chinese national income determination in 1952-1982

The model of Chow (1985) starts with the national income identity $Y_t = C_t + I_t$ where Y_t, C_t, and I_t denote respectively national income, consumption and investment in year t in constant prices. X_t = exports – imports is omitted as a component of Y_t because during the sample period 1952-1982 this variable is less than half of one percent of Y, except for 1982 when it equals 1.6 percent.

Consumption C is determined by the permanent income hypothesis of Hall (1978), namely, as a random walk with drift. To determine investment desired capital stock K* is assumed to equal a constant plus aY, and actual change in capital stock $K_t - K_{t-1}$ is assumed to equal a fraction b of the desired change in capital stock or $b(K^*_t - K_{t-1})$. Substituting the linear function of Y for K* in this equation and solving for K_t give K_t = const. + $abY_t + (1- b) K_{t-1}$. Since gross investment I_t is defined as $K_t - (1- d)K_{t-1}$ where d is the annual rate of depreciation, one can subtract $(1- d)$ times the equation for K_{t-1} from the above equation for K_t to obtain an equation for investment

$I_t = K_t – (1-d) K_{t-1}$ = const. + $ab[Y_t – (1-d)Y_{t-1}] + (1-b) I_{t-1}$.

Given a small rate of depreciation which is equal to about 0.04 for the capital stock in China, investment I_t depends on the rate of change in output Y according to the accelerations principle.

I have now estimated this model using Chinese data from 1978 to 2006. Data on Y=GDP, C, I and X = exports – imports (measured in 100 million RMB) in nominal terms are presented in Table 1. To obtain these variables in constant prices I have divided them by a price index. The price index, also presented in Table 1, is the ratio of Y in nominal terms to Y in real terms. The consumption and investment equations are estimated by the method of two-stage least squares. In the first stage Y_t is estimated by a regression on C_{t-1}, I_{t-1}, X_t and X_{t-1} to yield, with X assumed to be exogenous,

(1) $Y^*_t = 140.8(116.4) + .8841(.0604)\ C_{t-1} + 1.4254\ (.0951)\ I_{t-1} - .4815(.2616)\ X_t + 1.4073(.2883)\ X_{t-1}$ $R^2 = 0.9996$; $s = 273.4$

The number in parentheses after each coefficient is its standard error. The variables are measured in 100 million RMB in 1978 prices, with the price index in 2006 equal to 4.598 as shown in Table 1.

In the second stage of two-stage least squares I have estimated the consumption function

(2a) $C_t = 218.86 + 1.067(.074)\ C_{t-1} – 0.0051(.0371)Y^*_t$ $R^2 = 0.9985$; $s = 271.24$

This result confirms the permanent income hypothesis of Hall perfectly since the coefficient of C_{t-1} is almost exactly 1 and the coefficient of income Y is almost equal to zero. Given the result (2a) I have dropped the variable Y^*_t and reestimated the consumption function to obtain

(2) C_t = 226.05(91.78) + 1.0570(.0079) C_{t-1} R^2 = 0.9985; s = 266.08

The investment function is

(3a) I_t = -399.04(139.79) + 2.4149(.6470) Y^*_t – 2.2861(.6281) Y_{t-1} + .2233(.2369) I_{t-1}
R^2 =.9968; s= 327.4

Note that the coefficient of Y_{t-1} is opposite in sign and slightly less in magnitude (because of the rate of depreciation) to the coefficient of Y^*_t. This confirms the accelerations principle that investment depends on the rate of change in income.

Given the coefficients of Y^*_t and Y_{t-1} in equation (3a) to be almost equal in magnitude I replace these variables by the variable (Y^*_t – Y_{t-1}) to obtain the investment function

(3) I_t = -186.23(120.84) + 1.7782(.6513)(Y^*_t-Y_{t-1}) +.6866(.1589) I_{t-1}
R^2 = .9960; s = 359.28

Chow (1985) reported results similar to equations (2) and (3) obtained by using Chinese annual data from 1952 to 1982. In the consumption function the coefficient of lagged consumption was almost equal to one and the coefficient of income was zero. In the investment equation the coefficient of Y_{t-1} was negative and slightly less in magnitude than the coefficient of Y and these variables were replaced by their difference as in equation (3). The results showed that the coefficient of this difference in the investment equation was smaller than 1.7782. A possible explanation is that before 1978 the ratio *a* of capital stock to output was smaller and the adjustment coefficient *b* for capital stock to reach equilibrium was also smaller. It is remarkable that the same theories of consumption and investment are applicable to China in the period 1952-1982 and the period 1978-2006.

3. Effects of net exports on consumption and investment

In the previous section the consumption and investment functions as formulated in Chow (1985) were reestimated using data from 1978 to 2006. Once net exports X_t is introduced into the model, the consumption and investment equations can be revised to include it as an explanatory variable, as I will do in this section.

Let me first reexamined Hall's hypothesis to see if lagged X affects consumption. Adding X_{t-1} in the consumption equation (2) yields the regression

(4) $C_t = 299.73\ (108.57) + 1.0420(.0144)\ C_{t-1} + .2075\ (.1674)\ X_{t-1}$
$R^2 = 0.9986$: $s = 263.38$

The coefficient of X_{t-1} is insignificant and Hall's hypothesis is confirmed.

To incorporate the possible effects of X and X_{t-1} in the consumption and investment equations of a simultaneous equation system that explains the three endogenous variables C_t, I_t and Y_t by four predetermined variables C_{t-1}, I_{t-1}, X_t and X_{t-1} (Y_{t-1} being excluded because it equals $C_{t-1} + I_{t-1} + X_{t-1}$), I reestimate these equations.

For the consumption function I have regressed C_t on the four predetermined variables and Y^*_t and found I_{t-1} and Y^*_t to have t ratios smaller than 0.25. After dropping these two variables the consumption equation is

(5) $C_t = 275.07(106.67) + 1.0462(.0143)C_{t-1} - .2329(.1481)X_t + .4835(.2393)X_{t-1}$
$R^2 = 0.9987$; $s = 255.94$

Similarly for the investment equation I have added X_t and X_{t-1} into equation (3) to obtain

(6) $I_t = -320.27(130.07) + 1.2817(.6195)(Y^*_t - Y_{t-1}) + .8582(.1568)I_{t-1} - .5833(.2189)X_t + .3709(.2955)X_{t-1}$ $R^2 = .9970$; $s = 325.02$

While the accelerations principle is confirmed, the variables X_t and X_{t-1} also contribute to the explanation of investment.

In order to use equations (5) and (6) to explain Y_t I substitute their right-hand sides as functions of the four predetermined variables for C_t and I_t respectively in the national income identity $Y = C+I+X$ to obtain

(7) $Y_t = 135.27 + .8977C_{t-1} + 1.4035I_{t-1} -.4384X_t + 1.3765X_{t-1}$

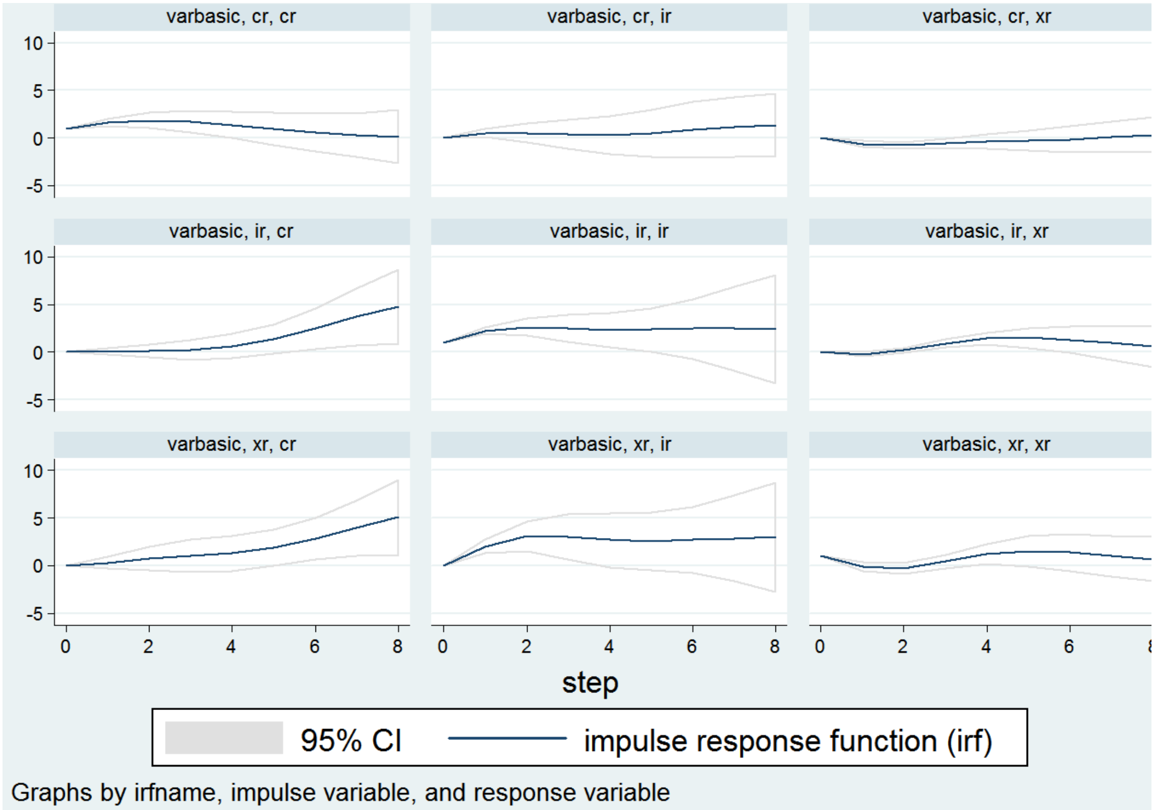
The coefficients in equation (6) based on the consumption and investment equations (5) and (6) are very similar to the coefficients of equation (1) estimated by least-squares. This should be the case because equation (5) is a regression of C_t on the four predetermined variables after dropping two variables with very insignificant coefficients, and equation (6) is a regression of I_t on the same four predetermined variables, after forming linear combinations of these variables in Y^*_t and $Y_{t-1.}$ Therefore, being the sum of equations (5), (6) and $X_t = X_t$ equation (7) should be almost identical with the regression equation (1). In fact the standard error of equation (7), obtained by dividing the sum of squared errors by 28-5 = 23 degrees of freedom, is only 273.7 as compared with 273.4 for equation (1) estimated by least-squares.

One puzzling result in equations (1) and (7) is that the effect of net exports X_t on output Y_t is negative. However, if we use a VAR model to explain C, I and X rather than using a simultaneous equation model to explain C, I and Y and treating X as an exogenous variable, both C and I have positive impulse responses to an exogenous shock of X in periods 1 to 8 as given in Figure 1 and have zero response in the current period by definition. The VAR was estimated from the data given in Table 1 using the “varbasic” command of STATA that chose two lags.

In conclusion I have found that the permanent income hypothesis of Hall (1978) to explain consumption and the accelerations principle to explain investment are well supported by Chinese macro data for the periods 1952-1982 and 1987-2006 as well. This is one example of the applicability of economic theory to the Chinese economy. Other examples can be found in Chow (2007).

.

Figure 1 Impulse Responses from VAR for C, I and X with Two Lags



References

All China Data Center, 2009, "Foreign Trade and International Cooperation: Total Imports and Exports" , *China Yearly Macro-Economic Statistics (National).*

Chow, Gregory C. 1985 "A model of Chinese national income determination," *Journal of Political Economy*. 93, pp. 782-792.

________________ 2007 *China's Economic Transformation*, 2nd edition. Blackwell, 2007.

Hall, Robert E. 1978 "Stochastic implications of the life-cycle-permanent income hypothesis: theory and evidence," 86, pp. 971-87.

Table 1 Data on China's National Income and its Determinants

Year	Y	C	I	X	p
1978	3605.6	2239.1	1377.9	-11.4	1
1979	4092.6	2633.7	1478.9	-20	1.054896
1980	4592.9	3007.9	1599.7	-14.7	1.098124
1981	5008.8	3361.5	1630.2	17.1	1.137733
1982	5590	3714.8	1784.2	91	1.164813
1983	6216.2	4126.4	2039	50.8	1.168049
1984	7362.7	4846.3	2515.1	1.3	1.201187
1985	9076.7	5986.3	3457.5	-367.1	1.305023
1986	10508.5	6821.8	3941.9	-255.2	1.387854
1987	12277.4	7804.6	4462	10.8	1.453304
1988	15388.6	9839.5	5700.2	-151.1	1.63712
1989	17311.3	11164.2	6332.7	-185.6	1.769711
1990	19347.8	12090.5	6747	510.3	1.904878
1991	22577.4	14091.9	7868	617.5	2.035682
1992	27565.2	17203.3	10086.3	275.6	2.175614
1993	36938.1	21899.9	15717.7	-679.5	2.558603
1994	50217.4	29242.2	20341.1	634.1	3.075886
1995	63216.9	36748.2	25470.1	998.6	3.490539
1996	74163.6	43919.5	28784.9	1459.2	3.722223
1997	81658.5	48140.6	29968	3549.9	3.750238
1998	86531.6	51588.2	31314.2	3629.2	3.685385
1999	91125	55636.9	32951.5	2536.6	3.605819
2000	98749	61516	34842.8	2390.2	3.604115
2001	108972.4	66878.3	39769.4	2324.7	3.672308
2002	120350.3	71691.2	45565	3094.1	3.717834
2003	136398.8	77449.5	55963	2986.3	3.829693
2004	160280.4	87032.9	69168.4	4079.1	4.088025
2005	188692.1	97822.7	80646.3	10223.1	4.358183
2006	221170.5	110413.2	94103.2	16654.1	4.598263

Sources: Y=GDP, C, I and X= exports - imports in nominal terms, measured in 100 million RMB, are found in Table 3-15 of *China Statistical Yearbook 2007.* The price index p is the ratio of Y in nominal terms and Y in real terms, the latter given in Table 3-4 of *China Statistical Yearbook 2007*.