ESTIMATING AND INTERPRETING CHINESE CONSUMPTION FUNCTIONS

Yue Chim Richard Wong

Department of Economics
The Chinese University of Hong Kong
Shatin, Hong Kong
Tel.: (852) 602-6424   Fax.: (852) 603-5245

December 1988

I. INTRODUCTION

The relation between aggregate consumption or aggregate savings and aggregate income, generally termed the consumption function, was first formulated into an economic concept by Keynes (1936). After more than fifty years, theoretical interest in and empirical work on the consumption function has continued unabated. On the theoretical level two major developments occurred in the 1950's. Modigliani and Brumberg (1954) formulated the life-cycle hypothesis and Friedman (1957) the permanent income hypothesis to account for empirical anomalies in the data. More recently, Hall (1978) has developed and tested the stochastic implications of these two hypotheses by incorporating the rational expectations mechanism. Reflecting these theoretical developments are also innovations in econometric techniques that have been used to test these hypotheses.

As a result of the growing availability of data from China in recent years it is possible to test various hypotheses of the consumption function. Given the uncertain quality of Chinese data interpretation of the results can be a major problem. Fortunately the consumption function is a sufficiently well formulated construct that makes testing relatively easy when compared to other aggregate behavioral functions. Furthermore, the data required for such a study are also quite minimal. Such a study may be interesting to economists outside China for understanding either Chinese consumption behaviour or the applicability of neoclassical economic theory to China, and to Chinese economists as an illustration of how econometrics and economic theory can be used to estimate and interpret economic data from China using the consumption function as a vehicle. In so doing I hope to demonstrate the usefulness and relevance of neoclassical economic research methodology in the study of Chinese economic behavior.

II. DATA DESCRIPTION

Based on published data available in various issues of the Statistical Yearbook of China it is possible to make use of three different sets of data: first, aggregate time series of national income and output accounting statistics for the years 1952-1985; second, aggregate cross-sectional provincial income and output accounting statistics for the years 1983 and 1984; and third, provincial level aggregates of peasant household income and expenditure annual survey statistics for the years 1981-1985. We shall refer to these three sets of data as datasets: 52-85, 83-84, and 81-85, respectively.

The first two types of data are identical except for the level of aggregation. The choice of definitions of variables to be used poses some conceptual problems because they are not comparable to standard definitions used in non-socialist countries.

Consumption includes two categories: personal and public consumption for which definitions are not available. After consulting Chinese economists I am led to believe that public consumption is more akin to government consumption expenditures and is not an object of individual choice. The problem, however, is to what extent is personal consumption a choice variable in China. If there is little difference in this respect between personal and public consumption then there is reason to add the two together and to treat the sum as a single total consumption variable.[1] On eclectic grounds we analysed both personal consumption, PC, and total consumption, TC.

Income includes three categories: national income, NI, gross output value of agriculture and industry, GO, and total product of society, TP. Each of these variables suffers from problems of double counting and omissions, especially, the last two variables. All three measures are in real values and are deflated by the implicit price deflator reported in the data source.[2]

Note also that for the provincial dataset 83-84, only the 1984 data includes both personal and public consumption. It is, however, possible to construct the 1983 personal consumption data for each province based on a set of ratios available in the Statistical_Yearbook_of_China_1986 (pp.558).

Dataset 81-85 is based on annual household expenditure and income surveys of peasant households for the years 1981-85. The observations are provincial aggregates. By working with aggregate data we remove measurement problems associated with individual level variations. Note, however, that consumption and income in this dataset is not definitionally comparable to those based on national income and output accounting statistics. Indeed the survey information may be closer to our desired definitions for income and expenditure.

III. THE KEYNESIAN CONSUMPTION FUNCTION

(1) General Issues

Keynes (1936) postulated that current consumption expenditure is a highly dependable and stable function of current income. He termed it a "fundamental psychological rule of any modern community that, when its real income is increased, it will not increase its consumption by an equal amount," and stated somewhat less definitely that "as a rule,.... a greater proportion of income...(is) saved as real income increases." Put in mathematical form we have,

(1) $c_t = c_o + c_1 Y_t, \quad c_o>0,\ 1>c_1>0.$

where C_t and Y_t are real consumption and income at time t, c_1 is the marginal propensity to consume, and $(c_o/Y_t)+c_1$ is the average propensity to consume which is greater than the marginal propensity to consume.

The Keynesian consumption function is significant in two respects. First, by postulating a psychological principle as the foundation for his theory Keynes departed from standard economic theory and its utility maximization framework. To economists this represented ad hoc theorizing. As a consequence, the acceptance of the Keynesian consumption function by economists was to a large extent made on empirical grounds and there was little attempt to reconcile it with economic theory at the beginning.

Second, a cornerstone of the Keynesian theoretical structure depended on the stability of the consumption relationship with income and on the parametric value of the marginal propensity to consume. A high value would yield large multiplier effects and signal the importance of aggregate demand policies in determining output, employment, and inflationary pressures.

A considerable amount of effort was made by economists to estimate consumption functions from two kinds of data: first, time series data on consumption, savings, income, prices, and similar variables; second, budget data on consumption, savings, and income of individuals and families from sample surveys. Both sources of data seemed at first to confirm Keynes's hypothesis. They found that current consumption expenditure was highly correlated with income, the marginal propensity to consume was less than unity, and the average propensity to consume was greater the marginal propensity to consume, so that the fraction of income saved increased with income.

(2) Application to China

In Table 1 estimates of equation (1) based on the time series dataset 52-85 using different definitions of the income and consumption variables are presented. The first point to notice is that all estimated intercept terms are significantly (i.e., at the 95% level of confidence) positive. Second, all estimated marginal propensities to consume are significantly positive and less than one.

To facilitate comparison across equations it is useful to calculate the elasticity of consumption with respect to income for each estimated equation. These values are given in square-brackets in Table 1. One can see that the elasticity of PC and TC with respect to NI are 0.86 and 0.91. However, those with respect to GO are 0.68 and 0.73, and those with respect to TP are 0.70 and 0.74. These latter estimates are substantially lower than those obtained using NI. This suggests that NI, GO, and TP are not equally good measures of the theoretical concept of real income as used in equation (1). Since, estimates of consumption elasticities with respect to income in most countries tend to be quite high and close to unity, it is reasonable to conjecture that NI is a better proxy for the income variable in Chinese data. As is well known, errors of measurement in the income variable would tend to bias estimated coefficients downwards. In other words, measurement errors are probably less severe in the NI measure.

In Table 2 estimates of equation (1) based on the provincial dataset 83-84 are given for various definitions of the real income variable. The results show that the estimated intercept term is only marginally significantly different from zero when NI is used as the measure of real income, but is significantly different from zero when GO and TP are used. The estimated income elasticity of consumption is again highest, 0.89, in the NI equation. They are, respectively, 0.72 and 0.81 in the GO and TP equations. These results are similar to the findings for the time series data 52-85. This is not surprising since the definitions of the variables are identical and both sets of data are based on aggregated information. Note also that including a dummy variable for year as an additional regressor turns out to be statistically unimportant. These results are not reported in this paper.

We now turn to Table 3 which provides estimates of equation (1) based on the peasant household survey dataset 81-85. The estimates indicate that the intercept term is not significantly different from zero (a result which differs from those reported above). The estimated income elasticity of consumption is 0.95 and is significantly higher than those obtained previously using national income accounting statistics. These results differ from those in Tables 1 and 2 in that they imply the share of consumption expenditures in income constitutes a fixed proportion. In other words, the average and marginal propensities to consume are equal and this is at variance with the Keynesian formulation.

The reason for differences in the estimates based on national income accounting statistics and those on household expenditure and income surveys is probably due to differences in the way the variables are measured. One suspects that the income variable is poorly measured in the national income accounting statistics because of problems in definition and omissions. The consumption variable is also plagued by similar problems, but here the differences between the two sets of data are probably less important. My conjecture is that errors in the income variable are the major cause for the difference in the results and that the household survey data are more reliable. This raises questions as to whether the income variables NI, GO, TP can be used to obtain reliable estimates of macroeconomic behavioral functions.

IV. THE LIFE-CYCLE AND PERMANENT INCOME HYPOTHESES

(1) General Issues

The psychological foundations of the Keynesian consumption function was always deemed unsatisfactory by many economists because of its departure from the utility maximizing approach of mainstream economic theory. Kuznets (1942) and other economists soon began to discover empirical anomalies in the data. Specifically long aggregate time series data revealed that consumption functions typically had an insignificant intercept term, implying that average and marginal propensities to consume were the same. This departed from the postulated psychological principle proposed by Keynes. However, cross-sectional budget estimates based on individual household survey data consistently indicated a significant positive intercept term. The life-cycle and permanent income hypotheses grew out of attempts to reconcile the empirical anomaly and to provide a utility maximizing framework for the consumption function.

Both Modigliani and Brumberg (1954) and Friedman (1957) used the individual or household as the basic unit of analysis. They postulated that the individual or the household sought to maximize an intertemporal utility function with dated consumption as arguments. The following functional form was typically postulated:

(2) $$\sum_{i=0}^{\infty} (1+\sigma)^{-i} U(C_{t+i})$$

where U is an instantaneous utility function with $U^{'}>0$ and $U^{''}<0$, C_{t+i} is consumption at date t+i, and σ is the rate of time preference. We have assumed that the time horizon is infinite. Although this is not necessary for all the essential results to be discussed later, it simplifies a number of manipulations. One may rationalize the assumption by noting that while individuals are mortals, households as an institution need not be so. Equation (1) is maximized subject to the household budget constraint

(3) $$W_t + \sum_{i=0}^{\infty} (1+r)^{-i} E_tY_{t+i}$$

where W_t is asset wealth at date t, E_tY_{t+i} is expected income at t+i based on information available at date t, and r is the discount rate. Friedman's permanent income is defined as the equivalent constant income stream that would have the same present value as that indicated in equation (3). That is

(4) $$W_t + \sum_{i=0}^{\infty} (1+r)^{-i} E_tY_{t+i} = Y_t^p [1 + (1+r)^{-1} + (1+r)^{-2} + ...]$$
$$= Y_t^p (1+r)/r$$

where Y_t^p is permanent income assessed at date t.

Maximization of equation (2) subject to equation (3) yields first-order conditions for a maximum, which upon manipulation gives

(5) $$EU'(C_{t+i})/U'(C_{t+i-1}) = (1+\sigma)/(1+r)$$

If we assume σ=r, then the planned consumption stream will be smooth and flat. One may choose to write the consumption function as follows:

(6) $$C_t = k\, Y_t^p$$

where k is some constant.

The major implication of such an approach is that consumption is smooth even when income is volatile. The ability to transfer resources intertemporally ensure that this happens. The implication is also consistent with empirical findings that fluctuations in consumption are much less than income.

Such an approach also explains why cross-sectional micro budget estimates of the consumption function tend to differ from time series aggregate studies. At any moment in time, realized income may differ from permanent income, but this transitory component will have no effect on consumption. In aggregate data these errors tend to be washed out so that true estimates of the consumption function can be reliably obtained. However, in micro budget studies transitory components in realized income constitute measurement errors that would bias estimates of the marginal propensity to consume downwards. At the same time, it also artificially generates a significant intercept term in the consumption function.

For estimation purposes permanent income has to be constructed. Friedman proposed that it can be measured as a function of lagged income variables. Implicit in this proposal is the adoption of an adaptive expectations mechanism for assessing permanent income.

(7) $$Y_t^p = \sum_{i=0}^{\infty} \tau_i\, Y_{t-i}$$

where $0<\tau_i<1$ and $\Sigma\, \tau_i=1$. Equation (7) is not practical for estimation purposes, since most data series are finite and short. Applying a Koyck lag structure to equation (7) simplifies the estimation structure significantly. The idea is to impose a lag structure on the coefficients as follows

(8) $$Y_t^p = \sum_{i=0}^{\infty} \tau^i\, Y_{t-i}$$

where $0<\tau<1$. Substituting equation (8) into (6), leads upon manipulation to a simple estimating equation

(9) $$C_t = \tau\, C_{t-1} + k\tau\, Y_t$$

Note that in this equation the instantaneous impact of an increase in Y_t on C_t is $k\tau$ and not k. This leads to a reduced instantaneous multiplier effect. Such an implication differs from the original Keynesian analysis.

(2) Application to China

Table 4 gives estimates of equation (9) using the time series dataset 52-85 with both personal and total consumption (PC, TC) as dependent variables. All the intercept terms are statistically insignificant and suggest that the appropriate estimating equation should not contain an intercept term.

All the estimated coefficients for the three measures of income (NI, GO, TP) are very small in magnitude and are statistically significant only for the TP variables. The implied instantaneous marginal propensity to consume is also very small, which is highly implausible.

The estimated coefficients on the lagged consumption variables are all statistically significant. Their estimated coefficients are in the range of 0.85-0.95. These are rather high values and imply implausibly low values of k.

Table 5 gives estimates using the provincial dataset 83-84. Only personal consumption is available for use as the dependent variable. The results are essentially similar to those obtained from time series data. Coefficients on the intercept terms and the income variables are all insignificant. Those on the lagged consumption variables are all significant with estimated coefficient values around 1.1, which is of course implausibly high.

Table 6 gives estimates using the peasant household survey dataset 81-85. The results differ somewhat from those obtained above. The estimated intercept term is still statistically insignificant, however, the coefficients on both the income and lagged consumption variables are now statistically significant with estimated values 0.16 and 0.89, respectively. A significant estimated income coefficient in Table 6 suggests that the surveyed income variable is probably a better measure of income than that obtained from national income accounts. Nevertheless, the low estimated values differ from results obtained in other countries.

The insignificance of the estimated income coefficients in Tables 4 and 5 differs from results obtained by other researchers using datasets from other countries. The low estimated values of τ imply that permanent income is poorly proxied by lagged values of NI, GO, and TP, or that changes in NI, GO, and TP do not lead to any significant changes in the level of permanent income. One is inclined to believe that the results on the whole casts some serious doubts about the usefulness of NI, GO, and TP as measures of income for use in macroeconometric modeling. Another possible explanation is that the estimating equations have been misspecified. In particular, the income variables should not be considered as being fixed but endogenously determined in a larger economic model. This possibility is investigated in the next section.

V. SIMPLE MACRO MODELS FOR CONSUMPTION ANALYSIS

Haavelmo (1953) was one of the first economists to point out that the single equation estimation of the consumption function would be inappropriate if income itself was endogenously determined in a macroeconomic model. Chow (1985) formulated a basic model of the determination of national income for the Chinese economy as follows:

(10) $NI_t = TC_t + I_t$

(11) $TC_t = a_o + a_1 NI_t + a_2 TC_{t-1}$

(12) $I_t = b_1 \; NI_t + b_2 I_{t-1}$

Where I_t is investment, TC_t is total consumption, and NI_t is national income. The structural form of the model represented by equations (10)-(12) may be written in reduced form as

(13) $TC_t = a_o^* + a_1^* TC_{t-1} + a_2^* I_{t-1}$

(14) $I_t = b_o^* + b_1^* TC_{t-1} + b_2^* I_{t-1}$

The reduced form equations express the two endogenously determined variables as functions of the exogenous variables.

Estimates of the above model in both reduced form by ordinary least-squares and in structural form by two-stage least-squares are given in Table 7. For our purposes we are only interested in the structural estimates of the consumption function. The estimated intercept is significantly negative, the estimated coefficient of the national income variable is insignificantly negative, and of the lagged total consumption variable is significantly positive with an estimated value of 1.77 which is implausibly high. Some of the estimates differ from those in Table 4, but the insignificance of the income coefficients are, however, similar in both tables. Chow (1985) also has a similar result. This strengthens our conjecture that the national income measure is inadequate. Note also that the Durbin-Watson statistics of the consumption equation is 0.96, which indicates that there is autocorrelation in the residuals.

Chow's model, however, does not distinguish between personal and public consumption. An extended model may be written as follows:

(15) $NI_t = PC_t + GC_t + I_t$

(16) $PC_t = \alpha_o + \alpha_1 NI_t + \alpha_2 PC_{t-1}$

(17) $GC_t = ß_o + ß_1 NI_t + ß_2 GC_{t-1}$

(18) $I_t = \delta_o NI_t + \delta_1 I_{t-1}$

Where GC_t is public consumption and PC_t is personal consumption. Equation (18) may be interpreted as the permanent income version of public consumption expenditures. A similar formulation was introduced by Alt and Chrystal (1983).

The structural form of the extended model represented by equations (15)-(18) may be written in reduced form as

(19) $PC_t = \alpha_o^* + \alpha_1^* PC_{t-1} + \alpha_2^* GC_{t-1} + \alpha_3^* I_{t-1}$

(20) $GC_t = ß_o^* + ß_1^* PC_{t-1} + ß_2^* GC_{t-1} + ß_3^* I_{t-1}$

(21) $I_{t-1} = \delta_o^* + \delta_1^* PC_{t-1} + \delta_2^* GC_{t-1} + \delta_3^* I_{t-1}$

The reduced form equations express the three endogenous variables as functions of the exogenous variables.

Estimates of the extended model in reduced form using ordinary least-squares and in structural form using two-stage least-squares are given in Table 8. Again our interest is only in the two structural consumption functions. The intercept terms and the coefficients of the national income variable are both statistically insignificant. Those for the lagged consumption variables are both significantly positive. In particular the point estimates for personal consumption is 0.83 which is not too different from those obtained in Table 4. The coefficient for public consumption is 1.11. Both estimates are implausibly high. Note that the Durbin-Watson statistics in the personal and public consumption functions are 1.33 and 2.07, respectively, indicating that there is autocorrelation in the residuals in the consumption equation.

The analysis in this section suggests that taking into account the possible endogeneity of the income variable has little effect on the major conclusions put forth in the previous section. A second interesting conjecture which can be advanced on the basis of a comparison between the basic model and the extended model is that it is meaningful to construct a model that distinguishes between personal and public consumption. In particular, the estimated coefficients of the personal consumption functions are different in the two models.

VI. STOCHASTIC APPROACH TO THE LIFE-CYCLE AND PERMANENT INCOME HYPOTHESES

(1) General Issues

A crucial point to note about the technique used by Ando and Modigliani and also Friedman to construct expected income is that it is backward looking when in fact it should be forward looking. Hall (1978) examined the implications of adopting the appropriate assumption that expectations about future income are themselves forward looking and are formed in accordance with the rational expectations hypothesis. This amounts to assuming that agents will process at time t all available information concerning current wealth and income and future earnings in order to arrive at their assessment of permanent income. Similarly in period t-1, agents would process all information available at that time to form an assessment of permanent income. The two assessment will differ if new information become available between time t and time t-1. From equation (3) we obtain

(22) $$E_{t-1}Y_t^p = [r/(1+r)]\,(E_{t-1}W_t + \sum_{i=0}^{\infty} (1+r)^{-i} E_{t-1}Y_{t+i}$$

Consequently,

(23) $$Y_t^p - E_{t-1}Y_t^p = [r/(1+r)]\,(W_t - E_{t-1}W_t + \sum_{i=0}^{\infty} (1+r)^{-i}[E_tY_{t+i} - E_{t-1}Y_{t+i}]$$

The right hand side of equation (23) is a forecasting error which according to the rational expectations hypothesis of unbiasedness is 0. Hence,

(24) $$Y_t^p - E_{t-1}Y_t^p = u_t$$

where $E_{t-1}u_t = 0$. Equation (24) can be modified by noting that permanent income was earlier defined as a constant stream so that (25) $Y_{t-1}^p = E_{t-1}Y_t^p$

Substituting Equation (23) into (22) yields

(26) $$Y_t^p - Y_{t-1}^p = u_t$$

or $$Y_t^p = Y_{t-1}^p + u_t$$

Substitution for Y_t^p using Equation (6) gives

(27) $$C_t = k\,Y_{t-1}^p + k\,u_t$$

Since $C_{t-1} = k\,Y_{t-1}^p$, therefore

(28) $$C_t = C_{t-1} + k\,u_t$$

In other words, consumption expenditure follows a random walk. This analysis leads to two striking results. First, the best predictor of next period's consumption is current consumption expenditure. Second, the stability of the economy in response to demand shocks is questioned. According to the rational expectations hypothesis, the receipt of new information will lead to a reappraisal of permanent income immediately. At low real rates of interest the discount factor will be quite small, so that the response of permanent income to new information may be quite large. The response of consumption will depend on the dynamic properties of income innovation.

The validity of equation (28) can be empirically tested by estimating the equation below

(29) $C_t = q_o + q_1 C_{t-1} + q_2 X_{t-1}$

where X_{t-1} is a vector of variables known in period t-1. A test that all the coefficients in q_2 should all be 0 can be performed.

The variables which have been used in X_{t-1} in previous studies in the estimation of equation (29) have included lagged values of consumption, income, assets, real interest rates, and inflation rates. The results of most of these studies are encouraging but not completely in favor of the Hall hypothesis. The most significant and consistent result is that the lagged one period consumption variable accounts for almost all the variation in predicting future consumption even when the coefficients in q_2 are not all zero. This suggests that equation (28) is a good approximation of consumption behavior.

(2) Application to China

Empirical estimation of equation (29) using Chinese data has the problem that there are very few suitable variables that are available for use in X_{t-1}. From results in the previous two sections, one is led to believe that using lagged income variables will be a weak test of the validity of the Hall hypothesis because the income variable is poorly measured so that the coefficients are automatically biased towards zero.

This means that the best available test would be to use lagged consumption values. Here again the problem is that there is no assurance that these values are measured properly in the Chinese data because of definitional problems. To the extent that it is measured with error, equation (6) will have to be replaced by

(30) $C_t = k Y_t^p + e_t$

where e_t is a white noise. Using equations (22) and (26) we can eliminate Y_t^p, to obtain

(31) $C_t - C_{t-1} = k U_t + e_t - e_{t-1}$

The composite error term can be written as a moving-average error term of order 1. Consequently,

(32) $C_t - C_{t-1} = \phi_t - m \phi_{t-1}$

where m is a constant and ϕ_t is a random error. Equation (32) is an ARIMA (0,1,1) model and differs from the ARIMA (0,1,0) model in equation (28).

Note that if the MA error term is not allowed for in the estimation equation, then lagged values of consumption could appear significant, since the MA error term can be approximated by lagged terms in consumption. This can be seen by rewriting equation (32) using the lag operator L

(33) $(C_t - C_{t-1})/(1-mL) = \phi_t$

Recall that $1/(1-x) = 1 + x + x^2 + ...$, equation (33) can be written as

(34) $(C_t - C_{t-1}) (1 + mL + m^2L^2 + ...) = \phi_t$

or $C_t - C_{t-1} = -(m + m^2L + ...) (C_{t-1} - C_{t-2}) + \phi_t$

This means that a test of the validity of the Hall hypothesis rests on distinguishing between whether $(C_t - C_{t-1})$ is a MA(1) process or some other higher order AR process which does not resemble equation (34). Unfortunately with only 34 annual observations it will not be easy to determine which model fits the consumption data better.

Table 9 gives test statistics for selecting the best ARIMA model in fitting the logarithmic value of personal consumption per capita for 1952-85. A variety of statistical tests are used to help us select the best model. The models are estimated in both the first-difference form and the level-form by maximum likelihood method.

The t-tests applied to each individual AR and MA parameter in the various models show that all of the first-order roots are statistically significant. These include the AR(1) and MA(1) roots in models with log personal consumption per capita in both first-difference form and level-form.

The minimal final prediction error (FPE) criterion due to Akaike (1969) is at a minimum value of 1.808 when an AR(1) model in first-difference form is fitted to the data. When the level-form is used the minimum FPE value of 2.263 is obtained in an AR(3) model. The former model is the preferred one in this instance.

The minimal Akaike Information Criterion (AIC) developed by Akaike (1974) also indicates that the best fit is obtained with a minimum value of -114.37 in an AR(1) model in first-difference form. When levels are used the best fit is obtained with a minimum value of -104.35 when an AR(3) model is used.

The minimal Schwartz Bayesian Criterion (SBC) developed by Schwartz (1978), which usually favors a low order model when the series is short, also indicates that the best model is an AR(1) model when the first-difference form is used and an AR(3) model when the level-form is used. The respective estimated minimum values are -111.37 and -98.24.

The estimates in Table 9 show that a MA(1) model applied to per capita log personal consumption also seems to fit the data reasonably well. But they are generally inferior to a high-order AR model. A declining FPE with higher orders of the AR model is usually indicative of a MA process. The evidence show that the estimated FPE is U-shaped for AR models estimated in first-difference form and in level-form.

In all the estimated models there is evidence that the first-difference form is preferred to the level-form as measured in terms of the FPE, AIC, and SBC criteria. However, the estimates appear to reject the hypothesis that per capita log personal consumption follows a random walk process in favor of an AR(1) process in first-difference form. On this evidence one may apparently reject the Hall hypothesis for China.

There may be a number of reasons why the Hall hypothesis is apparently rejected. First, on empirical grounds one may question the quality of the data used. In particular, the reporting of aggregate economic statistics was seriously distorted during the period of the Great Leap Forward and in its aftermath. This means that the simple inclusion of a MA error structure is insufficient to correct for errors in variables. One possibility would be to include a dummy variable for the years 1959-1962 as an explanatory variable when estimating the consumption model. Table 10 present estimates of four sets of models. While the first-differenced dummy variable is significantly negative in all the models, the FPE, AIC, and SBC criteria indicate that the best model is still the differenced AR(1) model.

Second, on theoretical grounds one may believe that there may be less opportunity for intertemporal smoothing of consumption in China because of the absence of credit market institutions. The significance of this factor is difficult to assess a priori. But if this is the case, one would also expect that income and price shocks would have an impact on consumption. To test this we included lagged values of log national income per capita and of the rate of inflation as explanatory variables. Table 11 reports the estimated results when only the one-period lagged values of income and inflation are separately included. All of the coefficients of the income and inflation variables are statistically insignificant. We also experimented with longer lags for the income and inflation variables but the results were unchanged. The general insignificance of the income and inflation coefficients suggests that difficulties in consumption smoothing arising from income and price shocks may not be the reason why the Hall hypothesis is rejected.

The fact that consumption follows an AR(1) process in first-differences in China means that there is persistence in the observed consumption series. One possible explanation may simply be problems with the quality of the data. Since Chinese consumption data does not separately identify durables and non-durables, the lumpy consumption of durables may give rise to observed persistence in the consumption series.

(3) Consumption Response and Income Innovation

It should be noted that the insignificance of the effect of lagged income on consumption in the Hall model should not be interpreted to mean that changes in income will not affect consumption. This issue is explored in this section. It is demonstrated how the effect of changes in income on consumption in such a model can be estimated.

The Hall hypothesis leads to the prediction that the output response of the economy to demand shocks can be either very large or very small. This is in contrast to the Keynesian implication of large responses and the Modigliani and Brumberg and Friedman implication of small responses. Empirically, the volatility of income and output is usually greater than consumption, and this has traditionally been used as evidence in favor of the life cycle and permanent income hypotheses. The introduction of rational expectations into the life cycle and permanent income hypotheses upsets this view. In particular, if innovations in income is permanent rather than temporary then its predictions about the relative volatility of income and consumption could contradict observed facts. This paradox was first noted by Deaton (1986).

To understand this point recall that in the life cycle and permanent income models C_t is set at a level that households believe is sustainable indefinitely. This implies that C_t differs from C_{t-1} only when something happens to income at the start of period t that was not anticipated in period t-1, when C_{t-1} was set. If the interest rate is fixed then the only source of uncertainty is labor income. We can write

(35) $$(C_t - C_{t-1})/k = r/(1+r) \sum_{i=0}^{\infty} (1+r)^{-i} [E_tY_{t+i} - E_{t-1}Y_{t+i}]$$

The expression $[E_tY_{t+i} - E_{t-1}Y_{t+i}]$ is the revision in household's expectation about future labor income due to the new information available in period t, but not in period t-1. The right hand side of equation (35) is the annuity value of the revisions to the outlook for current and future income. Equation (35) can be substantially simplified if the following proportionality assumption is made:

(36) $E_tY_{t+i} - E_{t-1}Y_{t+i} = \mu_i (Y_t - E_{t-1}Y_t)$

for i=1,2,3.... Also, let $\mu_o=1$. Now substitute equation (36) into (35) to obtain

(37) $(C_t - C_{t-1})/k = \Gamma (Y_t - E_{t-1}Y_t)$

where

(38) $$\Gamma = r/(1+r) \sum_{i=0}^{\infty} \mu_i/(1+r)^i$$

Γ is the annuity value of a $1 innovation in income. Large values of Γ imply that innovations in income would induce large consumption responses.

It can be shown that if Yt follows an AR(1) process

(39) $Y_t = u + vt + \phi Y_{t-1} + \varepsilon_t$

we then have

(40) $$\Gamma = r/(1+r) \sum_{i=0}^{\infty} [\phi/(1+r)]^i$$

$$= r/(1+r-\phi)$$

Estimates of r and ϕ would permit us to calculate Γ. Equation (39) is known as the trend stationary model in the literature. If ϕ=1 and v=0 then we have

(41) $Y_t = u + \varepsilon_t$

which is the random walk model. Clearly the implied values of Γ using equation (40) would be different under the two models. For low values of r, the differences can be very large even if the estimated value of ϕ
is very close to 1.

If Y_t follows an AR(2) process then we have

(42) $Y_t = u + vt + \sigma_1 Y_{t-1} + \sigma_2 Y_{t-2} + \varepsilon_t$

which may be rewritten as

(43) $Y_t - \phi_1 Y_{t-1} = u + vt + \phi_2 (Y_{t-1} - \phi_1 Y_{t-2}) + \varepsilon_t$

where ϕ_1 and ϕ_2 are the autoregressive roots of Y_t obtained by solving $\phi^2 - \sigma_1\phi - \sigma_2 = 0$. We then have

(44) $\Gamma = r/(\phi_1-\phi_2) [\phi_1/(1+r-\phi_1) - \phi_2/(1+r-\phi_2)]$

Equation (42) is also a trend stationary model. If ϕ_1=1 and v=0 then we have

(45) $Y_t = u + \phi_2 Y_{t-1} + \varepsilon_t$

which is an AR(1) model in first-differences. Again for low values of r, the difference in the estimated values of Γ between the two models can be very significant even for small differences in the estimated values of ϕ_1 and ϕ_2.

Since the data series for China is relatively short it will be almost impossible to determine which type of model fits the data better. Consequently it may be difficult to determine whether income innovations in China are permanent or transitory. A similar problem also exists with data in other countries. The maximum likelihood estimates of a variety of ARIMA models for the logarithmic value of national income per capita based on equations (39), (41), (43), and (45) are given in Tables 12 and 13. Table 12 reports the estimates using the level-form and Table 13 reports those using the first-difference form.

From Table 12, according to the minimal FPE, AIC and SBC criteria the best trend stationary models are the trended AR(2) model and the trended ARMA(1,1) model. For r=.02 the implied value of Γ is .1095 for the trended ARMA(1,1) model, which is the lowest value of Γ found for all the estimated models. The value of Γ cannot be calculated for the trended AR(2) model because the coefficients resulted in complex roots. The estimated AR and MA roots in both of these models are all found to be statistically significant.

From Table 13 the best difference stationary models according to the same criteria are the untrended MA(1) model and the untrended AR(1) model. Again for r=.02 the implied values of Γ are 1 and 1.3575, respectively. In these two models the estimated MA root is statistically significant but the AR root is not.

The estimated range of values of Γ for the various models confirm our conjecture that it is empirically difficult to determine the responsiveness of consumption to income. It is also difficult to determine which model fits the data better.

VII. CONCLUSION

In this paper we have attempted to apply three separate hypothesis about consumption behavior to Chinese data. The first model due to Keynes fits the data well. Theoretically the model is not entirely satisfactory. When applied to Chinese data it clearly shows that national income is a better measure than total product of society and gross output value of agriculture and industry in approximating output or income. But all these national income and output accounting data appear to be inferior to those obtained through household income and expenditure surveys.

The second model due to Modigliani and Brumberg and Friedman also fits the data very well. The most important result to note here is that when lagged consumption is introduced as an explanatory variable the current income variables usually become totally insignificant. Results obtained elsewhere typically show that there is some decline in the significance of the current income variable, but never to the extent indicated in our results. It suggests that there may be some very serious problems in the measurment of the income variable which is not evident when only the Keynesian type approach is used. These conclusions are not altered when the consumption estimates are obtained by estimating a complete macroeconomic model.

The third model due to Hall is essentially the second model with the additional assumption of rational expectations. Given that Chinese data do not use the same definitions as those implied by the theoretical constructs, the results have to be interpreted with great care. The estimated results provide evidence against the applicability of the Hall hypothesis to China. But the reason for this does not appear to be the inability of households to smooth consumption in the presence of income and price shocks. The problem appears to be associated with the poor quality of the data used. The difficulty was not resolved even after a number of attempts were made to correct for errors of measurement in the variables. It is postulated that the inclusion of durables in the consumption data may be the cause for the observed persistence in the consumption series.

The main lessons to be learnt from the above exercise is that ad hoc econometric estimation of aggregate economic relationships can be very misleading. Unless we have a prior economic theory to guide our empirical work it is almost impossible to interpret the economic meaning of our estimated relationships. When studying China the difficulty is even greater because the data are derived from a framework that is not particularly suitable for the theoretical models that we work with. Unless this problem can be remedied, the possibilities of doing serious empirical work is severely limited. We have tried to overcome some of these limitations by using econometric techniques, but increasing econometric sophistication is not a substitute for collecting better data.

FOOTNOTES

1. Chow (1985) uses a definition of consumption that includes both personal and public consumption.

2. Notice again that the deflator used here to deflate national income is different from that used by Chow (1985), who had no access at the time of his study to these price indices.

REFERENCES

1. H. Akaike, "A New Look at the Statistical Model Identification", *IEEE Transaction on Automatic Control*, AC-19, 1974, pp. 716-723.

2. H. Akaike, "Statistical Predictor Identification", *Annals of the Institute of Statistical Mathematics*, Vol. 21, 1969, pp. 203-217.

3. J. E. Alt and K. A. Chrystal, *Political Economics*, Berkeley and Los Angeles, CA: University of California Press, 1983.

4. G. C. Chow, "A Model of Chinese National Income Determination", *Journal of Political Economy*, Vol. 93, No. 4, August 1985, pp. 782-792.

5. A. Deaton, "Life-cycle Models of Consumption: Is the Evidence Consistent with the Theory?" Working Paper No. 1910, National Bureau of Economic Research, 1986.

6. M. Friedman, *A Theory of the Consumption Function*, Princeton, NJ: Princeton University Press, 1957.

7. R. E. Hall, "Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence", *Journal of Political Economy*, Vol. 86, No. 6, December 1978, pp. 971-987.

8. T. Haavelmo, "Measuring the Marginal Propensity to Consume", *Studies in Econometric Method*, ed. by W. C. Hood and T. C. Koopmans, New York: Wiley, 1953.

9. J. M. Keynes, *The General Theory of Employment, Interest and Money*, New York and London: Harcourt, Brace & Co., 1936.

10. S. Kuznets, *Uses of National Income in Peace and War*, New York: National Bureau of Economic Research, 1942.

11. F. Modigliani and R. Brumberg, "Utility Analysis and the Consumption Function: An Interpretation of the Cross-Section Data", *Post-Keynesian Economics*, ed. by K. K. Kurihara, New Brunswick, NJ: Rutgers University Press, 1954.

12. G. Schwartz, "Estimating the Dimension of a Model, *Annals of Statistics*, Vol. 6, 1978, pp. 461-464.

13. *Statistical Yearbook of China*. Beijing: State Statistical Bureau, 1981, 1983, 1984, 1985, 1986.

Table 1

National Level Personal and Total Consumption Functions
(Equation 1) 1952-85

	PC_t	PC_t	PC_t	TC_t	TC_t	TC_t
Intercept	142.1 (6.72)	316.4 (17.26)	302.6 (16.19)	99.7 (3.90)	312.3 (14.90)	295.0 (14.17)
NI_t	0.4662 (48.02) [0.8571]	-	-	0.5704 (48.39) [0.9120]	-	-
GO_t	-	0.1711 (47.23) [0.6838]	-	-	0.2095 (50.60) [0.7281]	-
TP_t	-	-	0.1468 (46.95) [0.6973]	-	- [0.7432]	0.1799 (51.58)
R^2	0.986	0.986	0.986	0.987	0.988	0.988
DW	0.736	0.535	0.560	0.659	0.507	0.560
r	0.589	0.719	0.711	0.606	0.723	0.702
s	61.1414	62.1460	62.5187	74.2400	71.0406	69.7002

Note:
1. Absolute t-values in parentheses.
2. r is first-order autocorrelation coefficient.
3. s is the root mean-squared error.
4. DW is the Durbin-Watson statistics.

Table 2

Provincial Level Personal Consumption Functions
(Equation 1) 1983-84

Intercept	13.0817 (1.95)	32.9860 (3.37)	22.7221 (2.66)
NI_t	0.5317 (18.25) [0.8878]	-	-
GO_t	-	0.2458 (10.34) [0.7172]	-
TP_t	-	-	0.2159 (13.12) [0.8052]
R^2	0.8556	0.6539	0.7535
s	26.8197	41.5254	35.0474
N	57	57	57
	Significant Residuals		
Positive	Sichuan	Guangdong	Sichuan Shandong Sichuan
Negative	Beijing Shanghai Tianjin	Beijing Shanghai Tianjin	Beijing Shanghai Tianjin

Note:
1. Values in square brackets are elasticities.
2. Significant residuals denote those whose absolute value are greater than the estimated root mean square error.
3. Absolute t-values in parentheses.
4. s is the root mean-squared error.

Table 3
Provincial Level Per Capita Personal Consumption Functions
of Peasant Households (Equation 1) 1981-85

Intercept	12.7650 (1.73)
Y_t	0.7563 (33.08) [0.9840]
R^2	0.8872
s	27.0099
N	140

Significant Residuals

	Positive	Negative
Beijing		84,85
Tianjin	81	
Hubei	84	
Shanxi	84	
Liaoning	85	83,84
Jilin	85	83,84
Heilongjiang		83,84
Shanghai	81,82,83,85	
Jiangsu	83	
Zhejiang	81,83,85	
Fujian	85	
Shandong		84
Hunan	85	
Xinjiang		84

Note:
1. Significant residuals are those whose absolute value is greater than the estimated root mean square error.
2. 81-85 denotes the years 1981-85.
3. Absolute t-values in parentheses.
4. s is the root mean-squared error.

Table 4

National Level Personal and Total Consumption Functions
(Equation 9) 1952-85

	PC_t	PC_t	PC_t	TC_t	TC_t	TC_t
Intercept	-26.13 (0.81)	21.99 0.46)	23.10 (0.52)	-49.20 (1.69)	9.49 (0.18)	16.13 (0.34)
NI_t	0.0900 - (1.39)	-	0.0927 (1.22)	-	-	
GO_t	-	0.0399 (1.91)	-	-	0.0474 (1.77)	-
TP_t	-	-	0.0361 (2.11)	-	-	0.0460 (2.08)
PC_{t-1}	0.9161 (5.86)	0.8715 (6.33)	0.8575 (6.53)	-	-	-
TC_{t-1}	-	-	-	0.9559 (6.30)	0.8839 (6.10)	0.8508 (6.08)
R^2	0.993	0.994	0.994	0.994	0.994	0.995
DW	0.679	0.673	0.683	0.674	0.652	0.651
r	0.544	0.569	0.568	0.543	0.573	0.578
s	42.4267	41.3404	40.8541	49.5064	48.2457	7.4254

Note: 1. Absolute t-values in parentheses.
2. r is the first-order autocorrelation coefficient.
3. s is the root mean-squared error.
4. DW is the Durbin-Watson statistics.

Table 5

Provincial Level Personal Consumption Functions (Equation 9) 1983-84

Intercept	-0.5772 (-0.28)	-0.7299 (-0.35)	-0.6459 (-0.31)
NI_t	0.0139	-	- (0.67)
GO_t	-	0.0076 (1.08)	-
TP_t	-	-	0.0058 (0.84)
PC_{t-1}	1.1033 (26.58)	1.1061 (41.66)	1.1059 (34.67)
R^2	0.9945	0.9946	0.9945
s	5.5124	5.4368	5.4853
N	28	28	28

Significant Residuals

Positive	Anhui Hubei Sichuan Zhejiang	Anhui Hubei Sichuan Zhejiang	Anhui Hubei Sichuan Zhejiang
Negative	Heilongjiang Shandong	Heilongjiang Shandong	Heilongjiang Shandong

Note:
1. Values in square brackets are elasticities.
2. Significant residuals denote those whose absolute value are greater than the estimated root mean square error term.
3. Absolute t-values in parentheses.
4. s is the root mean-squared error.

Table 6

Provincial Level Per Capita Personal Consumption Functions
of Peasant Households (Equation 9) 1981-85

Intercept	3.2830 (0.069)
Y_t	0.1397 (3.76)
PC_{t-1}	0.8912 (17.80)
R_2	0.9667
s	14.7678
N	112

Significant Residuals

	Positive	Negative
Beijing		83,85
Tianjin	83	85
Hubei	83	
Liaoning		82,84
Jilin		82,83,85
Heilongjiang		84
Shanghai	81,82,83,85	
Jiangsu	83	
Zhejiang	85	
Anhui	82	84
Fujian	85	
Shandong	82	
Hebei	82	
Hunan	82	
Guangdong		85
Guangxi	82	
Quizhou		83
Yunnan	82	83,85
Shaanxi	83	
Qinghai	83	82

Note:
1. Significant residuals are those whose absolute value is greater than the estimated root mean square error.
2. 81-85 denotes the years 1981-85.
3. Absolute t-values in parentheses.
4. s is the root mean-squared error.

Table 7

Basic Macro Model of the Chinese Economy
(Equation 15-18) 1952-85

	TC_t	I_t	TC_t	I_t	NI_t
Intercept	-180.2155 (-2.89)	15.4884 (0.49)	-100.2067 (-4.31)	-157.6542 (-3.26)	-257.8609 (-4.36)
NI_t	-0.3102 (-1.75)	-	-	-	-
TC_{t-1}	1.7674 (4.92)	-	1.2352 (21.77)	0.4805 (4.08)	1.7157 (11.90)
NI_t	-	0.6714 (4.07)	-	-	-
I_{t-1}	-	0.9276 (15.72)	-0.1244 (-1.75)	0.5254 (3.56)	0.4010 (2.22)
R^2	0.9910	0.9609	0.9943	0.9609	0.9884
DW	0.961	1.467	0.961	1.467	1.283
r	0.414	0.227	0.414	0.227	0.277
s	48.3085	100.4043	48.3085	100.4026	122.7348

Note:
1. Absolute t-values in parentheses.
2. r is first-order autocorrelation coefficient.
3. s is the root mean-squared error.
4. DW is the Durbin-Watson statistics.

Table 8

Extended Macro Model of the Chinese Economy
(Equations 19-21) 1952-85

	PC_t	I_t	GC_t	PC_t	I_t	GC_t	NI_t
Intercept	-5.559 (-0.12)	16.503 (0.52)	-11.935 (-1.33)	14.801 (0.57)	-160.074 (-1.91)	-15.748 (-1.19)	-161.022 (-1.60)
NI_t	0.1246 (1.33)	-	0.0065 (0.35)	-	-	-	-
PC_{t-1}	0.8264 (3.57)	-	-	0.9437 (13.56)	0.5136 (2.28)	0.0200 (0.56)	1.4773 (5.45)
GC_{t-1}	-	-	1.1067 (5.99)	1.3559 (5.05)	0.2032 (0.23)	1.1218 (8.18)	2.6809 (2.56)
NI_t	-	0.6228 (3.95)	-	-	-	-	-
I_{t-1}	-	0.9320 (15.75)	-	-0.1585 (-3.44)	0.5261 (3.52)	-0.0083 (-0.35)	0.3594 (2.00)
R^2	0.9934	0.9579	0.9865	0.9965	0.9580	0.9862	0.9887
DW	1.333	1.489	2.074	1.333	1.489	2.074	1.349
r	0.494	0.241	-0.047	0.311	0.216	-0.053	0.279
s	42.551	100.821	15.663	31.080	100.765	15.870	121.009

Note:
1. Absolute t-values in parentheses.
2. r is first-order autocorrelation coefficient.
3. s is the root mean-squared error.
4. DW is the Durbin-Watson statistics.

Table 9

AIC, SBC and FPE Statistics of ARIMA Models of
Log Personal Consumption per capita 1952-85
(Maximum Likelihood Estimates)

	First Differences			Levels		
	AIC	SBC	FPEx10^3	AIC	SBC	FPEx10^3
MA(1)	-110.84	-107.85	2.023	---	---	---
ARMA(1,1)	---	---	---	-97.61	-93.03	2.840
AR(0)	-105.05	-103.55	2.427	---	---	---
AR(1)	-114.37	-111.37	1.808	-87.42	-84.37	3.927
AR(2)	-112.46	-107.97	1.916	-101.02	-96.44	2.565
AR(3)	-112.62	-106.63	1.896	-104.35	-98.24	2.263
AR(4)	-111.67	-104.18	1.946	-103.08	-95.45	2.362
AR(5)	-112.27	-103.29	1.886	-101.98	-92.82	2.434
AR(6)	-110.41	-99.93	2.000	-92.41	-81.73	3.258
AR(7)	-109.25	-97.27	2.057	-91.00	-78.79	3.392

Note:
1. Only the AR(1) and MA(1) coefficients are statistically significant in all the models.
2. AIC denotes the Akaike Information Criterion.
3. SBC denotes the Schwartz Bayesian Criterion.
4. FPE denotes the Final Prediction Error.

Table 10

Maximum Likelihood Estimates for ARIMA Models
of Log Personal Consumption per capita in First-Differences 1952-85

Intercept	.0348	.0348	.0365	.0366	.0171	.0158	.0156	.0139
	(4.12)	(3.29)	(3.36)	(3.76)	(2.46)	(2.63)	(2.34)	(2.43)
AR(1)	---	---	---	---	.5709	.6108	.6070	.6632
					(3.61)	(3.81)	(2.12)	(2.35)
MA(1)	---	---	-.4439	-.4910	---	---	.0505	.0782
			(2.67)	(2.81)			(.15)	(.23)
GLF	---	-.0987	---	-.0796	---	-0.719	---	.0728
		(3.29)		(3.15)		(3.31)		(3.16)
FPEx10^3	2.427	1.912	2.023	1.580	1.808	1.406	1.919	1.490
AIC	-105.05	-112.93	-110.84	-118.94	-114.37	-122.62	-112.41	-120.71
SBC	-103.55	-109.94	-107.85	-114.46	-111.37	-118.13	-107.92	-114.73
s	.0485	.0425	.0438	.0381	.0413	.0359	.0419	.0365

Note:
1. Absolute t-values in parentheses.
2. FPE denotes the Final Prediction Error.
3. AIC denotes the Akaike Information Criterion.
4. SBC denotes the Schwartz Bayesian Criterion.
5. s denotes the root mean square error.
6. GLF is a differenced dummy variable for the years 1959-62 which attempts to capture the "Great Leap Forward" effect of false reporting.

Table 11

Maximum Likelihood Estimates for ARIMA Models
of Log Personal Consumption per capita in First-Differences 1952-85

Intercept	-.1417	-.1019	.0067	.0370	.0368	.0359	.0159	.0152
	(1.22)	(.71)	(.08)	(.18)	(4.10)	(3.16)	(2.26)	(2.16)
AR(1)	---	---	.5574	.6043	---	---	.5823	.6036
		(3.33)	(1.99)				(3.23)	(1.98)
MA(1)	---	-.4059	---	.0491	---	-4.391	---	.0309
		(2.36)		(.14)		(2.41)		(.09)
Y_{t-1}	.0336	.0263	.0046	.0006	---	---	---	---
	(1.53)	(.96)	(.13)	(.02)				
P_{t-1}	--	---	---	---	-.2282	-.1303	-.1161	-.1198
					(1.20)	(.62)	(.61)	(.62)
FPEx10^3	2.399	2.092	1.923	2.041	2.494	2.080	1.847	1.967
AIC	-105.43	-109.79	-112.38	-110.41	-101.00	-106.61	-110.20	-108.22
SBC	-102.44	-105.30	-107.89	-104.43	-98.06	-102.21	-105.81	-102.36
s	.0476	.0438	.0420	.0427	.0485	.0436	.0411	.0418

Note:
1. Absolute t-values in parentheses.
2. FPE denotes the Final Prediction Error.
3. AIC denotes the Akaike Information Criterion.
4. SBC denotes the Schwartz Bayesian Criterion.
5. s denotes the root mean square error.

Table 12

Maximum Likelihood Estimates for ARIMA Models of
Log National Income per capita 1952-85

Intercept	.0731	.1172	1.1985	1.8174	.1246	.2862	1.8615	.2528
	(4.53)	(7.20)	(42.79)	(62.08)	(6.01)	(7.39)	(47.33)	(60.81)
t	---	---	.0410	.0394	---	---	.0405	.0385
			(7.81)	(10.59)		(8.47)	(8.16)	
AR(1)	.9863	1.3829	.7380	1.0731	.9767	.4140	.5933	1.5561
	(22.81)	(8.61)	(5.80)	(6.69)	(17.15)	(1.27)	(3.16)	(8.81)
AR(2)	---	-.4049	---	-.4692	---	.5328	---	-.6111
		(2.35)		(2.83)		(1.56)		(3.25)
MA(1)	---	---	---	---	-.3983	-1.1643	-.4314	.5756
				(2.38)	(4.01)	(2.09)	(.81)	
MA(2)	---	---	---	---	---	-5.861	---	-.4244
				(3.42)	(.01)			
FPEx10^3	1.324	1.178	1.006	0.829	1.167	1.181	0.886	0.911
AIC	-43.94	-50.71	-59.12	-65.22	-50.96	-49.97	-63.15	-61.03
SBC	-43.89	-46.13	-54.55	-59.12	-46.38	-42.34	-57.04	-51.88
s	.1118	.1040	.0961	.0861	.1035	.1015	.0890	.0880
Γ	.7849	.984	.1603	---	.6821	.3889	.1095	---

Note: 1. Absolute t-values in parentheses.
2. Γ is the annuity value of an innovation to income evaluated at a 2 percent interest rate.
3. FPE denotes the Final Prediction Error.
4. AIC denotes the Akaike Information Criterion.
5. SBC denotes the Schwartz Bayesian Criterion.
6. s denotes the root mean square error.

Table 13

Maximum Likelihood Estimates for ARIMA Models of
Log National Income per capita in First-Differences 1952-85

Intercept	.0456 (2.62)	.0340 (2.03)	.0238 (.63)	.0196 (.55)	.0466 (2.11)	.0808 (1.83)	.0266 (.56)	-.0073 (12.13)
t	---	---	.0012 (.66)	.0011 (.47)	---	--- (.48)	.0011 (.17)	.0004
AR(1)	---	.2765 (1.60)	---	.2660 (1.51)	---	-.6646 (1.87)	--- (1.71)	.8053
MA(1)	---	---	---	---	-.3389 (2.00)	-1.1813 (3.56)	-.3339 (1.93)	.5931 (.01)
MA(2)	---	---	---	---	---	-.5183 (2.92)	--- (.02)	.4053
FPEx10^3	1.032	.980	1.082	1.066	.975	1.024	1.029	1.012
AIC	-57.28	-57.93	-55.74	-56.17	-59.02	-57.05	-57.27	-56.45
SBC	-55.79	-54.93	-52.74	-51.68	-56.03	-51.07	-52.78	-48.97
s	.1001	.0976	.1010	.0988	.0959	.0956	.0971	.0937
Γ	1	1.3575	1	1.3393	1	.6124	1	4.2910

Note: 1. Absolute t-values in parentheses.
2. Γ is the annuity value of an innovation to income evaluated at a 2 percent interest rate.
3. FPE denotes the Final Prediction Error.
4. AIC denotes the Akaike Information Criterion.
5. SBC denotes the Schwartz Bayesian Criterion.
6. s denotes the root mean square error.