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4 The Role of Consumption in Economic Fluctuations

Robert E. Hall

4.1 The Issues

Consumption is the dominant component of GNP. A 1% change in consumption is five times the size of a 1% change in investment. This paper investigates whether the behavior of consumers is an independent source of macroeconomic fluctuations or whether most disturbances come from other sectors.

Informal commentaries on the business cycle put considerable weight on the independent behavior of consumption. It is commonplace to hear of a business revival sparked by consumers. On the other hand, all modern theories of fluctuations make the consumer a reactor to economic events, not a cause of them. Random shocks in technology are generally the driving force in fully articulated models.

This paper develops a framework where the distinction between a movement along a consumption schedule and a shift of the schedule is well defined. Application of the framework to twentieth-century American data shows that shifts of the consumption schedule have probably been an important cause of fluctuations but have probably not been the dominant source of them.

I consider three sources of disturbances to the economy: (1) shifts of the consumption schedule; (2) shifts of the schedule relating spending in categories other than consumption and military spending; and (3) shifts in military spending. The reason for the explicit examination of military spending is that such spending is the only plainly exogenous

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major influence on the economy. Movements in military spending reveal the slopes of the consumption schedule and other spending schedules.

My basic strategy is the following. Fluctuations in military spending reveal the slope of the consumption/GNP schedule. GNP rises with military spending—quite stably, GNP has risen by about sixty-two cents for every dollar increase in military spending. This conclusion is supported by data from years other than those of major wars, when resource allocation by command may have made the consumption schedule irrelevant. But when GNP rises under the stimulus of increased military spending, consumption actually falls a little—the same dollar of military spending has depressed consumption by about seven cents.

Under the reasonable assumption that higher military spending does not shift the consumption schedule but only moves consumers along the schedule, we can infer the slope of the schedule from the ratio of the consumption change to the GNP change. The slope is essentially zero.

Equipped with this knowledge, we can measure the shift of the consumption schedule as the departure of consumption from a schedule with the estimated slope. My main concern is the absolute and relative importance of these shifts.

The effect of a consumption shift on GNP depends on the slope of the consumption schedule and also upon the slope of the schedule relating other spending to GNP. For this reason it is necessary to carry out a similar exercise for other spending. Again, the way other spending changes when military spending absorbs added resources is the way the slope can be inferred. Historically, other spending has declined when military spending has risen; investment, net exports, and nonmilitary government purchases are crowded out by military spending. For each dollar of added military spending, other spending declines by about thirty cents. The inference is that the schedule relating other spending to GNP has an important negative slope.

Over the period studied here, the correlation of the change in consumption and the change in GNP has been strong; the correlation coefficient is .59. Similarly, the correlation of the change in other spending and the change in GNP is strongly positive at .61. The results of this paper explain *all* of the correlation of consumption and GNP in terms of the unexplained shifts in the two schedules and *none* as the result of movements along the consumption function. Even more strikingly, the results explain the strong *positive* correlation of other spending and GNP in spite of the *negative* slope of the schedule relating the two.

Stated in terms of the scale of the economy in 1982, the standard deviation of the annual first difference of GNP for the period was $90 billion. The standard deviation of the component associated with the shift of the consumption function was $28 billion; for other spending including military, $72 billion. The decomposition between the two schedule shifts is ambiguous because they are highly correlated, but by assumption both are uncorrelated with the shift in military spending.

Because the slightly negative slope found for the consumption function in this work contradicts the thinking of many macroeconomists on this subject, I have repeated the exercise for two assumed values for the slope of the consumption/GNP schedule. One, which I think of as Keynesian, assumes a value of 0.3. The standard deviation of the consumption shift effect on GNP is \$26 billion. The shifts in the consumption function are estimated to be smaller in this case, but their contribution to movements in GNP is larger because the multiplier is larger.

A second case derives from equilibrium models of the business cycle. It interprets the consumption/GNP schedule as the expansion path of the consumption/labor supply decision of the household. The slope of the schedule should be *negative,* since presumably both consumption and leisure are normal goods. Any events that make people feel it is a good idea to consume more should also cause them to take more leisure and therefore work less. A reasonable value for the slope of the consumption/GNP schedule under this interpretation is -1. When this is imposed on the problem, the consumption shifts appear much larger, since this is a long step away from the regression relation. The standard deviation of the effect of consumption on GNP is \$47 billion, comparable to the effect of shifts in other spending, \$46 billion.

4.2 Earlier Research

Modern thinking about the possible role of shifts in the consumption function in overall macro fluctuations began with Milton Friedman and Gary Becker's "A Statistical Illusion in Judging Keynesian Models" (1957). They pointed out that random shifts in the consumption function could induce a positive correlation between consumption and income, which in turn could make the consumption look more responsive to income than it really was and also make the consumption function more reliable than it really was. However, neither Friedman and Becker nor other workers on the consumption function pursued the idea that shifts in the consumption function might be an important element of the business cycle.

More recently, Peter Temin's *Did Monetary Forces Cause the Great Depression?* (1976) argued forcefully for a role for shifts of the consumption function in explaining the contraction from 1929 to 1933. Temin focuses particularly on the residual from a consumption function in the year 1930 and suggests that the shift in consumption in that year was an important factor in setting off the contraction. His results are strongly supported in this paper, which finds large shifts in the consumption/GNP relation in all the years of the contraction.

Temin's critics, Thomas Mayer (1980) and Barry Anderson and James Butkiewicz (1980), confirm that consumption functions of various types had important negative residuals in 1930. It is a curious feature of Temin's work and that of his critics that no attention has been paid to the issue of finding the true slope of the consumption/income schedule. If the history of the United States is full of episodes where consumption shifts affected GNP, then the observed correlation of consumption and income is no guide at all to the slope of the consumption function. Temin considerably understates the power of his case by looking for departures from the historical relation between consumption and income, which is not at all the same thing as the slope of the structural relation. The historical relation summarizes numerous other episodes where a spontaneous shift in consumption had important macro effects. Temin looks only at the excess in 1930 over the usual amount of a shift, when his argument logically involves the whole amount of the shift.

Because of my use of military spending as the exogenous instrument that identifies the structural consumption function, I spend some effort here in understanding how a burst of military purchases influences the economy. Robert Barro (1981) has examined the theory of the effect of government purchases in an equilibrium framework and has studied United States data on the effect on GNP. He found a robust positive effect of all types of government purchases, with an especially large coefficient for temporary military spending. My results here are in line with Barro's, though I do not attempt to distinguish permanent and temporary purchases. Barro notes that higher government purchases should *depress* consumption as a matter of theory (p. 1094) but does not examine the actual behavior of consumption. Barro and Robert King (1982) point out the difficulties of creating a theoretical equilibrium model in which the covariance of consumption and work effort is anything but sharply negative.

Joseph Altonji (1982) and N. Gregory Mankiw, Julio Rotemberg, and Lawrence Summers (1982) use the observed positive covariation of consumption and hours of work to cast doubt on the empirical validity of equilibrium models. However, neither paper considers the possibility that feedback from shifts in household behavior creates an econometric identification problem. The results of this paper give partial support to their conclusion. With a serious treatment of the identification problem, the structural relation between work and consumption appears to be flat or slightly negatively sloped, but not nearly enough negatively sloped to fit the predictions of the equilibrium model.

Here I examine the importance of fluctuations in consumption as an interesting question in its own right. My finding of important shifts in the consumption function is also important for recent research on consumption and related issues in finance. As Peter Garber and Robert King (1983) point out, shifts in preferences or other sources of unexplained fluctuations in consumption behavior invalidate the Euler equation approach I and others have used in studying the reaction of consumers to surprises in income and to changes in expected real interest rates. The hope that the Euler equation is identified econometrically without the use of exogenous variables depends critically on the absence of the type of shift found in this paper. My findings suggest that the Euler equation is identified only through the use of exogenous instruments, just as are most other macroeconomic structural relations.

4.3 A Simple Structural Relation between GNP and Consumption

Keynesian theory denies consumers choice about the level of work effort. The effective demand process dictates the amount of work and the corresponding level of earnings. Consumers choose consumption so as to maximize satisfaction given actual and expected earnings. In general, the resulting relationship between earnings and consumption can be complicated—consumers will use the information contained in current and lagged earnings to infer likely future earnings and thus the appropriate level of consumption. Traditional Keynesian thought has emphasized the strength of the contemporaneous relation between income and consumption. Liquidity constraints probably contribute to the strength. Recent tests by Hall and Mishkin (1982) and by Marjorie Flavin (1981) have rejected the optimal response of consumption in favor of excess sensitivity to current income (however, these tests are likely to be contaminated by shifts in consumer behavior of the type investigated in this paper).

Otto Eckstein and Allen Sinai's paper in this volume (chap. 1) provides a reasonable estimate for the slope of the GNP/consumption schedule in a Keynesian framework. In their table 1.7, they estimate the effects on GNP and consumption of an exogenous increase in government purchases. The ratio of the change in consumption to the change in GNP is an estimate of the slope of exactly the schedule considered in this paper. The ratio is

Quarters after Increase	*GNP*	*Consumption*	*Ratio*
4	1.26	0.41	0.32
8	0.94	0.28	0.30
12	0.81	0.18	0.22
16	0.64	0.10	0.16
24	0.56	0.10	0.18

I will use an estimate for the year-to-year marginal propensity to consume of 0.3 on the basis of this evidence about the overall behavior of a fully developed Keynesian model.

4.3.1 Equilibrium Thinking about the Consumption/GNP Schedule

In an equilibrium model consumers are free to choose the most satisfying combination of hours of work and consumption of goods, subject to the market trade-off between the two:

$$\max_{\{c_t y_t\}} \Sigma\, D^t u(c_t,y_t)$$

$$\text{subject to } \Sigma\, R_t\,(p_t c_t - w_t y_t) = W.$$

My notation is:

- D: time preference factor
- $u(\,)$: one-year utility function
- c_t: consumption in year t
- y_t: employment in year t
- R_t: discount factor
- p_t: price of consumption goods in year t
- w_t: wage in year t
- W: initial wealth

I will work with one aspect of the overall problem, the consumption/work choice in year t. The first-order condition for that choice is:

$$\text{Marginal rate of substitution} = \text{real wage}$$

or

$$-\frac{\partial u/\partial y_t}{\partial u/\partial c_t} = \frac{w_t}{p_t} = \omega_t$$

Define the expansion path, $f(y_t,\omega_t)$, by

$$-\frac{\partial u(f(y,\omega),y)/\partial y}{\partial u(f(y,\omega),y)/\partial c} = \omega.$$

Other aspects of the overall choice problem determine the point the consumer chooses on the expansion path. These include wealth and the timing of consumption and work. With the real wage held constant, higher wealth moves the consumer to a point of higher consumption and lower work. Again with the real wage held constant, a higher real interest rate moves the consumer to a point of lower consumption and more work. Altonji (1982) pointed out the usefulness of examining the joint behavior of work effort, consumption, and the real wage;

his paper presents many more details on the derivation of their relationship.

It should be apparent that the expansion path slopes downward as long as consumption and leisure are normal goods.

The expansion path shifts downward if the real wage declines. Consequently, a higher tax rate depresses consumption given the level of

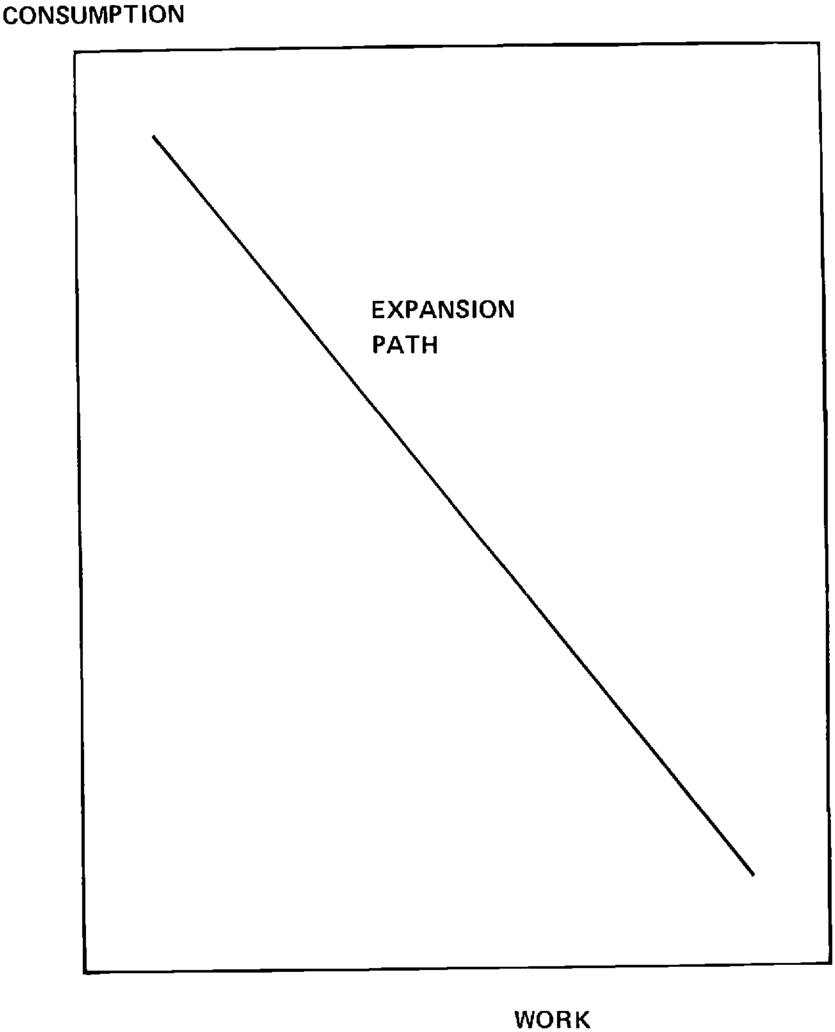

Fig. 4.1 The expansion path. For a given real wage, consumption and work occur in combinations given by the path. The real interest rate and the level of wealth determine the position on the expansion path chosen by the consumer.

work effort. On the other hand, the expansion path is unaffected by an increase in government purchases of goods and services or by lump-sum transfers or taxes. These latter influences will move the consumer along the expansion path but will not shift the path.

The slope of the expansion path can be estimated as the negative of the ratio of the income effect in the demand for consumption goods to the income effect in the labor supply function. Estimated income effects for labor supply run on the order of fifty cents less in earnings for each dollar in increased nonlabor income. That is, an increase in nonlabor income of one dollar raises total income by only fifty cents. If all of the increase in total income sooner or later is applied to goods consumption, then the income effect for goods consumption is also fifty cents per dollar of nonlabor income. The resulting slope of the expansion path is -1.

The structural relation in the equilibrium model refers to consumption and work effort. For the purposes of this paper, I think the best measure of the change in work effort from one year to the next is the change in real GNP. In the short run, the amount of capital available for use in production hardly changes, though of course the intensity of its use changes. Almost all changes in output correspond to changes in hours of labor input and in the amount of effort per hour spent on the job (see Hall 1980 for an elaboration and empirical study of this point). Real GNP is the best available measure of all the dimensions of changes in work effort in the short run.

The structural relation suggested by the equilibrium model has the form

$$c_t = \beta y_t + \gamma \omega_t.$$

In addition to the level of work effort, measured by y_t, the after-tax real wage, ω_t, shifts consumption up relative to work effort. In the empirical work carried out here, it is not possible to estimate the coefficients of two different endogenous variables. The best that can be done is to estimate the coefficient of y_t *net* of the part of a real wage movement that is systematically related to y. For example, if the real wage is countercyclical, so that

$$\omega_t = -\delta y_t,$$

then it is possible to estimate the net relation,

$$c_t = (\beta - \gamma\delta) y_t.$$

Because β is negative, the countercyclical wage movements makes the consumption/GNP relation even more negatively sloped. It seems unlikely that procyclical movements of after-tax real wages are anywhere near large enough to explain my finding here of a zero net slope of the consumption/GNP relation. That finding is probably evidence against a pure equilibrium model.

4.3.2 Synthesis

Equilibrium and Keynesian models agree on a structural relation between consumption and income or work of the form

$$c_t = \beta y_t + \epsilon_t.$$

Here,

β: slope of the structural relation, negative for the equilibrium model (say -1), positive for the Keynesian model (say 0.3);

ϵ_t: random shift in the c-y relation.

4.4 Other Components of GNP

I will assume that military purchases of goods and services, g_t, is an exogenous variable.

I will define x_t as the remainder of GNP, that is, investment plus net exports plus nonmilitary government purchases of goods and services (the latter is largely state and local). x_t has a structural relation to GNP; fluctuations in this relation are a source of fluctuations in almost all theories of the business cycle.

It is not possible to estimate a detailed structural model for x_t for the reason just mentioned—a single exogenous variable limits estimation to a single endogenous variable. Basically, what can be estimated is the net effect of an increase in GNP on investment, net exports, and nonmilitary government purchases. On the one hand, considerations of the accelerator (particularly important for inventory investment) suggest a positive relation between GNP and x. On the other hand, increases in interest rates that accompany an increase in GNP bring decreases in x. For investment, especially in housing, the negative response to interest rates is well documented. For net exports, an increase in GNP raises imports directly. In addition, under floating exchange rates, the higher interest rates brought by higher GNP cause the dollar to appreciate, making imports cheaper to the United States and exports more expensive to the rest of the world. It is perfectly reasonable that the overall net effect of higher GNP on investment, net exports, and nonmilitary purchases should be negative.

The following simple relation summarizes these considerations:

$$x_t = \mu y_t + \nu_t.$$

The coefficient μ may well be negative, if crowding out through interest rates is an important phenomenon.

4.5 The Complete Model

The model comprises three equations:

$$c_t = \beta y_t + \epsilon_t$$

$$x_t = \mu y_t + \nu_t$$

$$y_t = c_t + x_t + g_t.$$

The solution for GNP is

$$y_t = \frac{1}{1 - \beta - \mu}(g_t + \epsilon_t + \nu_t).$$

This equation gives a precise accounting for the sources of fluctuations in output. The three driving forces for the economy are military purchases of goods and services, g_t, the random shift in the consumption schedule, ϵ_t, and the random shift in other spending, ν_t.

4.6 Identification and Estimation

The goals of estimation in this work are threefold:

1. Estimate the multiplier,

$$\frac{1}{1 - \beta - \mu},$$

which applies to each of the three components in the decomposition in the last section.

2. Estimate the "propensity to consume," β, in order to compute the residuals, ϵ_t, in the consumption function.

3. Estimate the "propensity to spend," μ, in order to compute the residuals, ν_t, in the function for other spending.

The solution to the first problem is perfectly straightforward. In the equation for the movement in GNP, military spending appears as a right-hand variable along with two disturbances assumed to be uncorrelated with military spending. Hence the regression of GNP on military spending should estimate the multiplier directly. Again, the interpretation of the estimated multiplier is net of feedback effects through interest rates.

To estimate the slope of the consumption/GNP schedule, β, note that c and g have the regression relation,

$$c_t = \frac{\beta}{1 - \beta - \mu}(g_t + \nu_t) + \frac{1-\mu}{1 - \beta - \mu}\epsilon_t.$$

An estimate of β can be computed as the ratio of this coefficient to the multiplier. Alternatively, exactly the same estimate can be computed with two-stage least squares applied to the c-y relation with g as the instrument.

The slope of the x-y relation can be computed analogously either by the ratio of the regression coefficient of x on g to the multiplier, or by applying two-stage least squares to the x-y equation with g as instrument.

The relationships estimated in this paper are approximations to more complicated equations. For example, the complete model does not do justice to the modern Keynesian notion that gradual wage and price adjustment gives the model a tendency toward full employment in the long run. The results are likely to look somewhat different with an estimation technique that gives heavy weight to lower frequencies from those based more on higher frequencies. Because cyclical fluctuations are the focus here, I want to exclude the lower frequencies from the estimation. I have accomplished the exclusion in two ways. First, I have detrended all the data in a consistent fashion. Second, I have used first differences in all of the basic estimation. With annual data, using first differences puts strong weight on the cyclical frequencies and no weight at all on the lowest frequencies.

4.7 Data

The data on real GNP in 1972 dollars for 1919–82 and real personal consumption expenditures for 1929–82 are from the United States national income and product accounts (NIPA). For 1919–28, data on real consumption are taken from John Kendrick (1961).

I used data on real military purchases of goods and services from the NIPA for 1972 through 1982 and from Kendrick for 1919–53. For 1954 through 1971, nominal military spending is taken from the NIPA and deflated by the implicit deflator for national security spending from the Office of Management and Budget (1983), converted to a calendar year basis.

For some additional results described at the end of the paper, I used the number of full-time equivalent employees in all industries, including military, from the NIPA.

To eliminate the noncyclical frequencies from the data, I started by fitting a trend to real GNP:

$$\log y_t = 5.14 + .0206\, t + .00014\, t^2.$$
(t is one in 1909)

Then I detrended real GNP, real consumption, and real military purchases with this real GNP trend. I preserved the 1982 values of each of the three variables, so the effect of detrending was to raise the earlier levels. For employment, I detrended with a log-linear trend of 1.96% per year and rebased the series so that it equals real GNP in 1982.

All of the estimates used the first differences of the detrended series.

4.8 Results

All of the regressions reported here include intercepts, but the values of the intercepts are not reported because detrending makes them almost meaningless.

Estimation of the multiplier by regressing the change in GNP on the change in military spending for the years 1920–42 and 1947–82 gives the following results:

$$\Delta y_t = \underset{(.16)}{.62}\, \Delta g_t.$$

SE: \$81 billion; DW: 1.48

Because the multiplier is less than one, it is clear that a certain amount of crowding out took place, on the average. Each dollar of military purchases raises GNP by sixty-two cents, so nonmilitary uses of output decline by thirty-eight cents.

The regression of consumption on military spending is:

$$\Delta c_t = \underset{(.08)}{-0.07}\, \Delta g_t$$

SE: \$38 billion; DW: 1.50

Because the coefficient is close to zero, with a small standard error, it is clear that the implied slope of the c - y relation will be close to zero as well. Even though periods of wartime controls on consumption have been omitted from this regression, there is strong evidence against the proposition that those increases in GNP that can be associated with exogenous increases in military spending stimulated any important increases in consumption. Similarly, the strong *negative* response of consumption to military spending predicted by the equilibrium model has also been shown to be absent.

The ratio of the two regression coefficients is $-.12$; this is the estimate of the slope of the consumption/GNP schedule. The same estimate can be obtained by two-stage least squares, together with the standard error of β and the standard error of the residuals:

$$\Delta c_t = \underset{(.15)}{-0.12}\, \Delta y_t.$$

SE: \$46 billion; DW: 1.39

The confidence interval on the slope of the c - y relation includes a range of values but excludes the Keynesian value of 0.3 and the equilibrium value of -1 as well. Neither theory is able to explain the lack of a structural association of consumption and GNP.

In the next section I will make use of consumption equations with two different assumed values of the slope:

Keynesian,

$$\beta = 0.3$$
$$\Delta c_t = 0.3\Delta y_t$$
SE: $31 billion

Equilibrium,

$$\beta = -1$$
$$\Delta c_t = -\Delta y_t$$
SE: $117 billion.

The basic results of the paper can be guessed from these results. The residuals in the Keynesian consumption relation are smaller than those for the estimated relation (standard errors of $31 billion against $46 billion) and are very much smaller than are those for the equilibrium case ($117 billion). Even the smaller Keynesian residuals turn out to be important in the overall determination of GNP. GNP and consumption are positively correlated both because the consumption relation slopes upward and because shifts in the relation are an important determinant of both variables.

On the other hand, the equilibrium model sees very large shifts in the c - y relation. When the relation shifts upward, both c and y rise. Because most of the variation in both variables comes from the shifts in the relation, the two are highly positively correlated, even though the relation has a negative slope. That a positive slope gives a better fit in the consumption equation is not evidence against the equilibrium view at all.

4.8.1 Results for Other Spending, x

The regression of Δx on Δg gives:

$$\Delta x_t = \underset{(.12)}{-0.30}\ \Delta g_t.$$

SE: $58 billion; DW: 2.03

Investment, net exports, and nonmilitary government spending are quite strongly *negatively* influenced by military spending, again during years when wartime controls on private spending were not in effect. The estimate of the slope of the x - y schedule inferred by dividing by the multiplier is -0.48. The same estimate is available from two-stage least squares:

$$\Delta x_t = \underset{(.30)}{-0.48}\ \Delta y_t.$$

SE: \$95 billion; DW: 1.79

Plainly, the negative effects operating through interest rates dominate the positive effects of the accelerator. Higher GNP depresses nonconsumption, nonmilitary spending along this structural schedule.

4.9 Estimates of the Importance of the Consumption Shift

Because neither of the major schools of business cycle theory is consistent with my estimates of the slope of the c - y relation, I will proceed by making estimates for three different cases:

1. *Estimated*. The slope of the c - y relation is $-.12$, the value inferred from the fact that, historically, higher military purchases have raised GNP but not consumption. Consumption is virtually an exogenous variable. It influences GNP but is not influenced by GNP.
2. *Keynesian*. The slope of the c - y relation is 0.3. When more work is available, people consume more as well.
3. *Equilibrium*. The slope of the c - y relation is -1. Events that move consumers along their expansion paths leave the sum of GNP and consumption unchanged. Departures of the sum of GNP and consumption are a signal of a shift in the expansion path, possibly associated with a change in the after-tax real wage, but usually a random, unexplained shift.

Though the movements of GNP can be decomposed into three components for the three driving forces listed in the model in section 4.4 (military purchases, the random shift in the consumption schedule, and the random shift in the investment/exports schedule), I will concentrate on the consumption shift on the one hand and the sum of the two other components on the other hand. The consumption component is

$$\frac{1}{1 - \beta - \mu}\,\epsilon_t,$$

where ϵ_t is the residual from the consumption equation. Note that the magnitude of the consumption component depends on the magnitude of the residual and on the magnitude of the multiplier. The other component is just Δy_t less the consumption component.

Figure 4.2 shows the total change in real GNP and the consumption components for the three cases. As a general matter, the consumption component is most important for the equilibrium case and least im-

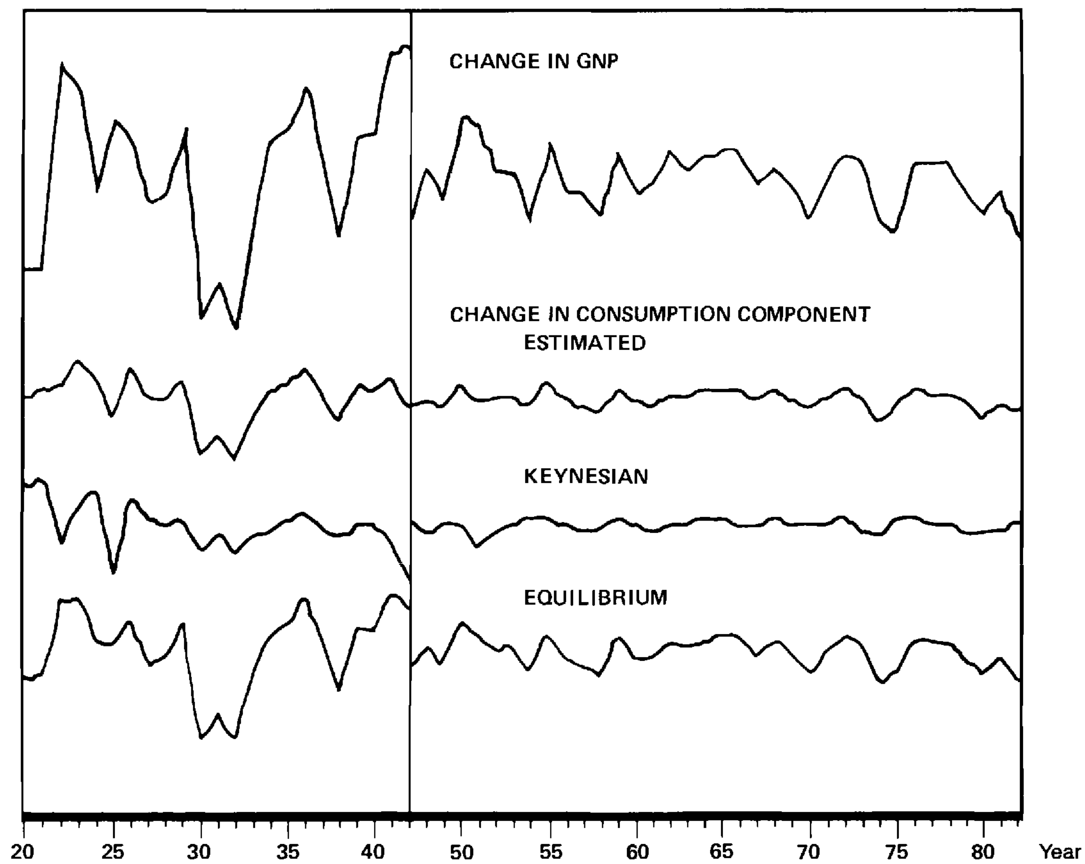

Fig. 4.2 Change in real GNP and the consumption component for the three cases.

portant for the Keynesian case. However, it is a significant contributor to GNP fluctuations in all three cases.

Under the estimated results where consumption is effectively exogenous, shifts in the consumption schedule are important, but so are shifts in the other determinants of GNP, especially in the interwar period. Responsibility for the Great Contraction is shared between shifts in the *c-y* relation and the other sources. However, in the postwar period, shifts in other spending account for the bulk of the movement of GNP. The two large drops of GNP in 1973–74 and 1974–75 are partly the result of drops in consumption. Some of the long contraction since 1978 is the result of a consumption shift as well.

In the Keynesian view, shifts in the consumption function are bound to be less important than in the other two cases. When consumption and GNP drop together, all or part of the decline in consumption can be attributed to the drop in GNP. Still, shifts in consumption are a part of the story of total fluctuations.

For the equilibrium case, the story about the Great Contraction in 1929–32 told by these results will help clarify what the theory is saying. Rescaled real GNP fell by $227 billion in 1929–30, $171 billion in 1930–31, and $243 billion in 1931–32. Of this, $140 billion came from a random shift in household behavior toward less work and less consumption in 1929–30, $97 billion in 1930–31, and $148 billion in 1931–32. The remaining $87 billion in the first year, $74 billion in the second year, and $95 billion in the third year came from changes in military spending and shifts in the investment/exports schedule. Of the two, the first was almost negligible. But the most important part of the story of the contraction was a sudden lack of interest in working and consuming, according to the equilibrium model.

Table 4.1 summarizes the findings for the three cases in terms of simple statistical measures. It is interesting that the standard deviation

Table 4.1 Statistical Summary

Standard Deviation of Change	Keynesian	Case Estimated	Equilibrium
Real GNP	90	93	93
Consumption component	26	28	47
Other component	97	72	46
Correlation of two components	−.40	.53	.86

Note: Standard deviations are in billions of 1972 dollars, with quantities rescaled to 1982 magnitudes.

of the consumption component for the Keynesian case is about the same as for the estimated case. Although the residuals in the Keynesian consumption function are smaller than the residuals in the other case, the multiplier is quite a bit higher (0.85 as against 0.62). The big difference between the two cases is in the size of the other component. Again, because the multiplier is lower for the estimated case and higher for the Keynesian case, the other component is larger for the Keynesian case. The Keynesian case reconciles a larger other component with a consumption component of about the same size by invoking a lower correlation of the two components. The negative correlation permits the sum to have the same standard deviation (the known standard deviation of the change in real GNP) even though one of the components is more variable.

4.10 Other Estimates

Estimates for other time periods and other specifications have convinced me that the basic findings of this paper are robust. First, estimates for the entire period, the interwar period, and the postwar period are

Entire period, 1920–82

$$\Delta c_t = \underset{(.09)}{-.16}\,\Delta y_t$$

SE: \$47 billion; *DW:* 1.37

$$\Delta x_t = \underset{(.18)}{-.54}\,\Delta y_t.$$

SE: \$96 billion; *DW:* 1.78

For both equations, the considerable extra variance from the extraordinary level of military spending during World War II helps to reduce the sampling variation without changing the coefficients much.

Interwar period, 1920–42

$$\Delta c_t = \underset{(.24)}{-0.13}\Delta y_t$$

SE: \$70 billion; *DW:* 1.31

$$\Delta x_t = \underset{(.50)}{-.50}\,\Delta y_t$$

SE: \$144 billion; *DW:* 1.75

Postwar period, 1947–82

$$\Delta c_t = \underset{(.20)}{-.11}\ \Delta y_t$$

SE: \$23 billion; *DW:* 1.78

$$\Delta x_t = \underset{(.41)}{-.36}\ \Delta y_t.$$

SE: \$46 billion; *DW:* 1.94

4.10.1 Results for a Direct Measure of Work Effort

In his comment on the version of this paper presented at the conference, Angus Deaton suggested that the negative findings for the equilibrium model might be the result of the use of GNP as a measure of work effort. Because GNP might measure the result of other productive factors, including pure good luck, and these other factors reasonably might be positively correlated with consumption, the consumption/GNP relation might be more positively sloped than is the consumption/work effort relation.

To check this possibility, I repeated the analysis with full-time equivalent employment in place of real GNP. I detrended the series by its own exponential trend and rescaled it to equal real GNP in 1982. Application of two-stage least squares to the relation of the first difference of consumption to the first difference of employment, with the change in military spending as the instrument, for the periods 1930–42 and 1947–82, is

$$\Delta c_t = \underset{(.18)}{-0.10}\ \Delta y_t.$$

SE: \$41 billion; *DW:* 0.91

Again, the structural slope is slightly negative, but not nearly negative enough to fit the equilibrium hypothesis. The hypothetical value of -1 is strongly rejected.

4.11 Conclusions

A simple structural relation between GNP and consumption is a feature of two major theories of economic fluctuations, though the theories differ dramatically in most other respects.

In the Keynesian analysis, the consumption function slopes upward, so in principle the positive correlation of GNP and consumption could be explained purely by forces other than shifts in consumption behavior. Nonetheless, my results show that shifts in the consumption function are a source of overall fluctuations in a Keynesian analysis. In the first place, even the Keynesian consumption function has residuals, though they are smaller than the residuals from the equilibrium or estimated $c - y$ relationships. In the second place, exactly because of the Keynesian multiplier process operating through a positively sloped consumption function, the consumption disturbances are much more strongly amplified than they are in the equilibrium or estimated models.

In the equilibrium theory, the relation is the expansion path of the work/consumption choice. The public is free to pick a point along the path in response to economic conditions. Shifts in government tax and spending policies and shifts in investment and net exports will move the economy along its negatively sloped $c - y$ schedule. If ever GNP and consumption move together, it is the result of a shift in the consumption schedule. Because consumption and GNP frequently move together, random shifts of the consumption/work schedule must be a *dominant* part of the equilibrium explanation of cyclical fluctuations.

In the Keynesian model, an increase in military purchases should raise GNP and raise consumption. In the equilibrium model, an increase in military purchases should raise GNP and lower consumption. The data for the past six decades examined in this paper seem to split the difference—consumption is unaffected by military purchases, whereas GNP rises. Hence the estimate of the slope of the $c - y$ relation inferred through the use of military purchases as an instrument is about zero. In the compromise economy (which does not have a theory to go with it), random shifts in consumption are an important source of overall fluctuations.

Comment Angus Deaton

In these comments I discuss a number of both theoretical and empirical issues. First I take up the question of the theoretical equilibrium relationship between consumption and income. While Hall interprets observed fluctuations with respect to two models of consumption, and while the first, Keynesian, formulation with its coefficient of 0.3 is clearly arbitrary, I shall not quarrel with it but shall concentrate rather on the equilibrium story. I argue that it is the relation between consumption and wage income, not between consumption and GNP, that ought to have a negative slope, and that even this result depends on asset shocks dominating wage shocks in affecting consumer behavior. I also dispute Hall's reading of the empirical evidence; if his model is taken seriously, then his equilibrium consumption function should have

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a slope not of -1, but of somewhere between -5 and -9. These large negative slopes suggest an even more exaggerated role for consumption in the genesis of economic fluctuations, one that I for one do not find in the least plausible. In fact Hall finds that, using either GNP or full-time equivalent employment as a measure of work effort, the *actual* slope of the consumption function is essentially zero, a result that, if credible, would challenge a good deal more than Hall's version of the equilibrium story. Fortunately, I do not yet believe that it is necessary to discard the findings of the past four decades of research; the second section explains why.

Theoretical Considerations

I use the intertemporal linear expenditure system as a simple framework to illustrate the issues. The maximand is

$$\sum_t D^t\{\beta \log(c_t - \gamma_1) + (1 - \beta)\log(l_t - \gamma_2)\} \tag{1}$$

for discount factors D^t, consumption c_t and leisure l_t. Maximization *under certainty* yields

$$c_t = \gamma_1 + \beta\, D_t r_t \tag{2}$$

$$w_t h_t = (T - \gamma_2) - (1 - \beta)\, D_t r_t \tag{3}$$

for work effort (hours) h_t, *real* wage w_t, and parameters γ_1, $(T - \gamma_2)$ and β. The quantity r_t is written

$$r_t = \delta\{A_0 - \sum_0^L \tilde{p}_t \gamma_1 + \sum_0^L \tilde{w}_t\,(T - \gamma_2)\}/\tilde{p}_t \tag{4}$$

for discounted present values at 0 of prices, $\tilde{p}_t$ and wage rate $\tilde{w}_t$, initial assets A_0 and $\delta = \Sigma D_t$. r_t is the real price of utility in t, or reciprocal of the marginal utility of money. Under *uncertainty*, the *expected value* of (1) is maximized. Following through the standard stochastic control problem yields (2) and (3) unchanged, with r_t governed by

$$E_t\,\{(1 + i_{t+1})/r_{t+1}\} = 1/r_t \tag{5}$$

for real interest rate i.

To simplify further discussion, I assume that real interest rates are known and constant and equal to the rate of time preference. There are therefore two sources of uncertainty, real wage shocks and asset shocks. I can then write $\theta_t = D_t r_t$ and the system is

$$c_t = \gamma_1 + \beta\theta_t \tag{6}$$

$$w_t h_t = (T - \gamma_2) w_t - (1 - \beta)\theta_t \tag{7}$$

$$E_t(\theta_t/\theta_{t+1}) = 1. \tag{8}$$

Write u_t for $\Delta\theta_t$, and assume that (8) allows us to assume $E_t(u_{t+1}) = 0$ in the usual way. Detrending of (6), (7) removes wage growth, so after first-differencing we get

$$\Delta c_t = \beta u_t \tag{9}$$

$$\Delta(w_t h_t) = (T - \gamma_2)\, u_t^w - (1 - \beta)u_t. \tag{10}$$

With no wage shocks, u_t^w can be deleted, so that

$$E(\Delta c_t, \Delta(w_t h_t)) = -\beta(1 - \beta)\sigma^2 \tag{11}$$

$$E[\{\Delta(w_t h_t)\}^2] = (1 - \beta)^2\sigma^2. \tag{12}$$

Hence the slope of the consumption function, b, is given by

$$b = -\beta/(1 - \beta), \tag{13}$$

which is Hall's result. With $\beta = 1/2$, $b = -1$, but my reading of the empirical evidence suggests a much larger value for β. By far the most up to date and authoritative survey of empirical studies of male labor supply is that by Pencavel for the forthcoming *Handbook of Labor Economics*. Pencavel discusses twenty-three studies using American data, nine based on experimental data and fourteen on nonexperimental data. Without making any attempt to exclude estimates that are of doubtful experimental status, the mean value of $1-\beta$ from the experimental studies is 0.12, while that of the nonexperimental studies is 0.20. Of the latter, two studies produce estimates that Pencavel dismisses as very unlikely; if these are excluded, the mean is again 0.12. This is certainly a more likely figure than that of 0.5 as assumed by Hall, in which case the equilibrium slope would be -7.3, not -1. But the former only *seems* more absurd than the latter; given the truth of the theory, it is the more plausible number of the two.

But there are other, theoretical difficulties: (*a*) consumers experience real wage shocks, not only asset shocks; (*b*) GNP does not consist only of wage income, but also includes income from capital. Allowing for (*a*) and (*b*) produces a quite different picture. Take point (*a*) first and note that u_t^w and u_t will typically be correlated, since new information about real wages will also change the marginal utility of money. In view of (4), a likely formula is

$$u_t = \delta u_t^A + \delta L(T - \gamma_2)u_t^w, \tag{14}$$

where u_t^A is the asset shock and L is the time horizon. Substituting in (9) and (10), assuming that u_t^A and u_t^w are uncorrelated, and evaluating the variance and covariance gives a consumption function with slope

$$b = \frac{\beta\delta L - \beta(1 - \beta)\rho}{\{1 - (1 - \beta)\delta L\} + (1 - \beta)^2\rho}, \tag{15}$$

with

$$\rho = \sigma_A^2 \delta^2 \{\sigma_w^2 \, \{\sigma_w^2 (T - \delta_2)^2 \, (1 - (1 - \beta)\delta L)\}^{-1}. \tag{16}$$

This is much more likely to be positive than is the previous expression (13), to which it reduces if $\sigma_w^2 = 0$. Indeed, if δ^2 is small or σ_A^2 is small, $b = 1$ if $\delta L = 1$, and values of b between 0 and 1 are easily generated for smaller values of δL.

Even this is not the correct expression for the slope between consumption and GNP. The latter includes asset income that can be allowed for in a number of ways. The simplest is to write y_t for GNP and to assume

$$\Delta y_t = (w_t h_t) + \delta \, \Delta A_t \tag{17}$$

(remember that $\delta \simeq$ rate of time preference and is taken to be equal to the real rate of interest). Recalculating b gives (finally)

$$b = \frac{\beta \delta L + \beta^2 \rho}{\{1 - (1 - \beta)\delta L\} + \beta^2 \rho}. \tag{18}$$

All traces of Hall's negative coefficient have now gone, and we have once again that $\delta L = 1$ implies $b = 1$ with $b < 1$ for lower values. The equilibrium story is clearly consistent with a fairly wide range of *positive* coefficients; it is certainly consistent with Hall's evidence.

The Empirical Results

Turning now to Hall's empirical results, I should like first to protest the extraordinarily sparse reporting style. While I too am a great believer in economic theory, that is no reason to suppress or omit reasonable diagnostic statistics. The key equations are presented with standard errors and Durbin-Watson statistics only. The latter are low enough to suggest *substantial* positive autocorrelation, even after detrending and differencing, so that if conventional formulas were used to calculate them, the standard errors as presented are not consistent estimates of the true standard errors. This is hardly the way to win friends and influence people! Hall's procedure here is based on the assumption that military expenditure is exogenous to the process of income determination, so that it is a valid instrument, indeed the *only* valid instrument, for estimating the relation between consumption and income, both of which are endogenous. Old-fashioned empirical macroeconomics used to be careful to exclude wars. Modern analysis has discovered the mistake, and we know now that nothing can be known *without* the wars! But why should military expenditure be singled out for such special attention? There are many theories, of no greater implausiblity than the equilibrium theory considered here, in which wars and military buildups are endogenous, and standard expressions such as "arms race" implicitly suppose so. It seem to me that either we accept more conventional instrumentation procedures for the consumption function together with their more conventional estimates of the consumption/income slope, or we admit that everything depends on everything else, throw up our hands, and go home. If instrumentation by quadratically detrended first-differenced military expenditure is the only way of identifying macroeconomic relationships, then macroeconomic relationships are not identified.

Even so, it seems churlish to refuse to admit the exogeneity of military expenditure, at least as a starting point, so that, even if the standard errors are ignored (as they ought to be, except possibly as lower bounds), Hall's parameter estimates still require explanation. Three dollars of differenced detrended military expenditures generate two dollars of differenced detrended GNP, none of which is differenced detrended consumption. The results are qualitatively similar if full-time equivalent employment is substituted for GNP. In my original comments, I indicated such results did not seem at all surprising, given that we are told nothing about the measurement and timing of recorded military expenditure in relation to actual military procurement or about the *type* of income generated. For example, as Robert Gordon has pointed out to me, if military expenditure is recorded as such at the moment when the tanks and planes are physically transferred from private manufacturers' stocks to government installations, then there is no reason to predict any relationship with consumption no matter what is believed about the consumption function. The relationship with income is likely to be more complex, and it seems to me that the current aggregate model, without clear distinctions between profits and wages, is not a good vehicle for uncovering what is really going on. While the result that changes in income are typically *not* accompanied by changes in consumption requires explanation, there are many possible candidates, and until they are examined, it still seems to me that Hall is most likely exaggerating the role that consumption disturbances play in economic fluctuations.

Comment Robert G. King

In this provocative paper, Robert Hall argues that shifts in consumption behavior play a major role in business fluctuations. A corollary is that a major revision is necessary in thinking about fluctuations from either

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the Keynesian or the equilibrium perspective, since each of these strands of thought generally views the main business cycle impulses as originating outside the consumption sector.

Hall's analysis is based on two simple theoretical elements: (*a*) a static Keynesian consumption function; and (*b*) a static efficiency condition relating consumption and effort, which is a necessary condition for optimal intertemporal consumption and labor supply decisions of an agent with time-separable preferences and thus forms a component of most equilibrium theories of fluctuations. These conditions are manipulated so each becomes a parameter restriction on "a simple structural relation between GNP and consumption," with the residuals from this relation taken to be shifts in consumption behavior.

Generally, my bias is in favor of simple and revealing empirical work; I rank two of Hall's previous consumption studies (1978, 1981) highly according to that metric. But the simplicity of the present analysis strikes me as providing misleading directions to research. That is, the role of behavioral shifts is probably *overstated* by the simple framework Hall employs.

The Consumption/GNP Relation

The centerpiece of Hall's analysis is the following "simple structural relation between GNP and consumption."

$$c_t = \beta y_t + \epsilon_t, \tag{1}$$

where c_t is consumption, y_t is gross national product, and ϵ_t is a random shift in the c-y relation. Interpretation of the error term is the main focus of this discussion because Hall views it as representing purely behavioral shifts.

For the purpose of discussing the consumption/GNP relationship in Keynesian and equilibrium models, it is useful to systematically discuss the sort of intertemporal problem under certainty posed by Hall. (For the sake of clarity, however, I use n_t to denote hours worked in year t and reserve y_t for income/product in year t.) That is, the household is viewed as choosing sequences of consumption and effort so as to maximize the lifetime utility function (2),

$$U_t = \sum_{j=0}^{\infty} D^j\, u(c_{t+j}, n_{t+j}), \tag{2}$$

subject to the lifetime budget constraint,

$$\sum_{j=0}^{\infty} R_{t,j}\,(p_{t+j}c_{t+j} - w_{t+j}n_{t+j}) = A_t, \tag{3}$$

where $R_{t,j}$ is the date t discount factor applicable to cash flows at $t + j$ and A_t is initial wealth.

The Keynesian Relation

Since quantities are demand determined in a pure Keynesian regime, the household faces a sequence of maximum labor quantities that can be supplied, $n_t \leq \tilde{n}_t$.[1] This constraint is taken to be binding on the household's choice in each period, so that the sole nontrivial decision is the intertemporal allocation of consumption. If $u(c,n)$ is additively separable in its two arguments, then date t consumption is a function of "lifetime wealth" and real discount factors, without any direct effect of the constrained level of hours worked $(\tilde{n}_t)$. For example, if $u(c_t,n_t) = \{c_t^{1-\sigma}\}/(1 - \sigma) + v(n)$, then the consumption function takes the form

$$(4) \qquad c_t^k = g(\{\rho_{t,j}\}_{j=0}^{\infty}) \left[\frac{A_t}{p_t} + \sum_{j=0}^{\infty} \rho_{t,j}\omega_{t+j}\tilde{n}_{t+j}\right],$$

where $\rho_{t,j} = p_{t+j}R_{t,j}/p_o$; ω_t/P_t; and

$$g(\{\rho_{t,j}\}_{j=0}^{\infty}) = \left[\sum_{j=0}^{\infty} \rho_{t,j}{}^{1-\frac{1}{\sigma}} \beta^{j\frac{1}{\sigma}}\right]^{-1}.$$

If some portion (λ_t) of the population is fully liquidity constrained[2] in period t, then its consumption will just be initial wealth plus current labor income, $c_t^l = [W_t^l/p_t + \omega_t^l \, \tilde{n}_t^l]$.

Thus the aggregate structural consumption relation will be given by

$$(5) \qquad c_t = \lambda_t c_t^l + (1 - \lambda_t)c_t^k.$$

Suppose that (5) is the true structural consumption relationship, which is exact in the sense that there are no preference shifts in the household's objective (2). Nevertheless, the error term in (1) would not be zero, but would reflect omitted variables such as wealth, (expected) future income, and discount factors.

The Equilibrium Relation

Under the equilibrium regime, consumption and effort are both nontrivial intertemporal choices. Time-separable preferences, however, deliver strong restrictions on the cyclical comovements of consumption and effort (see Barro and King 1982 for a detailed discussion). If the date t wage is held fixed, then consumption and leisure move in the

1. I abstract here from temporary constraints on factor supply. Barro and Grossman 1976, chap. 2, discuss such hybrid situations.

2. Again I abstract from the potential that the liquidity constraint will be binding in future periods but is not at present. Again, Barro and Grossman 1976, chap. 2, analyze this case.

same direction in response to changes in all relevant variables (initial wealth, real interest rates, future wages, etc.), so long as consumption and leisure are normal goods. This is readily seen from the data t intratemporal efficiency condition

$$(6) \qquad \frac{\partial U_t/\partial n_t}{\partial U_t/\partial c_t} = \frac{u_1(c_t,n_t)}{u_2(c_t,n_t)} = \omega_t\,(1 - z_t),$$

where $u_i\,(c_t,u_t)$ is the partial derivative of momentary utility with respect to its ith argument. Nonseparabilities in preferences typically imply that the marginal rate of substitution depends on actions at dates other than t, so avoiding the implication about the correlation of consumption and effort discussed above.

From my perspective, the key implication of (6) is that consumption and effort cannot be positively correlated—as they are in business cycles—unless the real wage is procyclical or taste shifts toward consumption and away from leisure take place. In this analysis, the real wage refers to the shadow value of an individual's time and is not necessarily well represented by aggregate series.

To discuss the relation between consumption and GNP, let us adopt one of MaCurdy's (1981) specifications of the momentary utility function

$$(7) \qquad u(c_t,n_t,\theta_t) = \frac{\theta_t}{1 - \sigma}\, c_t^{\,1-\sigma} - \frac{1}{1 + \gamma}\, n_t^{\,1+\gamma}\,,$$

where the parameters σ and γ are positive. The positive stochastic process θ_t represents behavioral shifts that induce more consumption in period t. Taking logarithms of the associated first-order condition, the following log-linear specification is derived.

$$(8) \qquad \log c_t = \frac{1}{\sigma} \log \omega_t \frac{\gamma}{\sigma} \log n_t + \frac{1}{\sigma} \log \theta_t.$$

Suppose that one knows (or consistently estimates) γ and σ, then the Hall procedure would compute the error term as the term { } in (9):

$$(9) \quad \log c_t = -\frac{\gamma}{\sigma} \log y_t + \left\{\frac{1}{\sigma} \log \omega_t + \frac{\gamma}{\sigma} \log \left(\frac{y_t}{n_t}\right) + \frac{1}{\sigma} \log \theta_t\right\}.^{3}$$

That is, in this equilibrium version of the model, the regression error

3. This relationship may readily be linearized to conform more closely to the specification (1). If one defines $\bar{c}_t,\bar{y}_t$ as the trend values of consumption and GNP, then

$$\frac{c_t - \bar{c}_t}{\bar{c}_t} \cong -\frac{\gamma}{\sigma}\frac{y_t - \bar{y}_t}{\bar{y}_t} + \epsilon_t.$$

term would be an agglomeration of movements in real wages, productivity, and true behavioral shifts.

Thus the error term in specification (1) does not capture simply behavioral shifts in either the Keynesian or the equilibrium versions of the model.

Implications

Based on the theoretical analysis above, it is impossible for me to rationalize treating the error terms in Hall's consumption functions as a purely behavioral disturbance. Thus the historical decompositions for the three models—equilibrium, estimated, and Keynesian—do not aid me in interpreting either specific episodes (such as the Great Depression) or the sectoral origins of economic fluctuations in general.

A specific example may be helpful in this regard. Following Temin (1976), Hall notes that there are major negative consumption function residuals in the early years of the Great Depression. The Temin/Hall interpretation is old-fashioned Keynesian, viewing these, as autonomous shifts, as independent causes of the depression. But suppose the true Keynesian consumption function is of the permanent income variety—for example, (4) above—so that Hall's error term includes expected future income as an omitted variable. Further, in the early years of the depression, let consumers adjust their expected future income downward. Then a negative residual will occur in the static consumption function (1), but it need not be autonomous or causal.

That is not to say that elements that Hall would view as "taste shocks" are not an important component of business fluctuations. It is true that most fully articulated business cycle models (e.g., Long and Plosser 1983) view random shocks to technology as the central driving variables in economic fluctuations, with individuals having stable preferences over consumption of final market produced goods. The assumption of stable preferences highlights the two factors that lead to rich dynamics in real business cycle theories: agents' desire to spread wealth increments across time and goods; and rich intra- and intertemporal substitution possibilities in production that permit them to accomplish that goal. But if one adopts a Beckerian view of household activities, then there is no special reason to view household production technology as less subject to technical shocks than market production technology. With variations in home production technology, derived preferences over market inputs would fluctuate, even if preferences over ultimate consumption goods were stable. But my own research preference is to push equilibrium analysis as far as possible without relying too heavily on such fluctuations in basic tastes or home production technology.

Discussion Summary

Several of the participants felt the Keynesian view had been given short shrift in this paper. Eisner pointed out that a Keynesian model should contain two regimes: one when the economy was away from full employment and another when it was at full employment. Ignoring this change of behavior and estimating a single regime would lead to Hall's downward biased estimate of the marginal propensity to consume. Gordon echoed this view and pointed to the 1941–42 military buildup and the Korean conflict, when output rose but consumption fell, as the main forces driving the estimated coefficient downward. In regard to the equilibrium model, Robert Barro claimed that the "puzzling" comovement of consumption and work effort found by Hall could be arrived at easily in a model where shocks to the economy came through technology that affected labor productivity.

The exogeneity of the government defense spending instrument used by Hall was called into question by several participants. In addition DeLong noted that this instrument had power only at low frequencies, since it came in discrete chunks from the Korean and Vietnam wars, and hence it was not clear why it should bear on the high frequency consumption/income relation. Singleton argued that even if this instrument were taken to be exogenous, Hall's multiequation model was unlikely to be identified as estimated. To achieve such identification would entail imposing a priori restrictions on the error structure of the model. However, economists have priors about coefficients rather than about covariances, and as the examples of Angus Deaton and Robert King made clear, it is not possible to arrive at unique restrictions on covariances from restrictions on coefficients. It seemed then that there was little justification for Hall's claim that the errors from the estimated consumption equation represented random shifts in consumption behavior.

Hall responded to several of the points made in the discussion. He dismissed Eisner's remark about the two regimes by pointing out that in almost all recent empirical work the aggregate supply curve is found to be a straight line. He agreed with Gordon's observation about the role of the 1941–42 and Korean observations in leading to his result, and added that the Vietnam period has the same effect. The failure of consumption to rise in such periods was precisely the point of the paper. He agreed with Barro's comment as a matter of theory but had been unable to find any evidence in the data for the twentieth-century American economy suggesting that shocks in technology were an important driving force in economic fluctuations. As for DeLong's comment about the low frequency power of the defense spending variable, Hall replied that the bulk of the power of the military spending variable is in middle frequencies, corresponding to the three major buildups during the period. Finally, Hall claimed that Singleton was mistaken in his belief that the model in the paper was not identified. It could not have been estimated by two-stage least squares. Furthermore, Hall stressed that he had not made any restrictions on error covariances, nor were any needed for identification.

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