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Long-Run Debt-Income Model of Consumer Installment Credit

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LONG-RUN DEBT-INCOME MODEL OF CONSUMER

INSTALLMENT CREDIT

(TITLE)

BY

TSENG HO WONG

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

Master of Arts in Economics

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

1977

YEAR

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LONG RUN DEBT INCOME MODEL OF CONSUMER
INSTALLMENT CREDIT

BY

TSENG HO WONG

B.A. in Psychology
Eastern Illinois University, 1975

ABSTRACT OF A THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Arts in Economics at the Graduate School
of Eastern Illinois University

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1977

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In the late forties and early fifties concern emerged in some economic circles because installment debt was growing more rapidly than income. Overextensions of debt in the long run were believed to jeopardize future prosperity of the economy. To demonstrate that the rate of growth of debt would not threaten future prosperity, A. Enthoven designed a debt-income growth model. Michael K. Evans reaffirmed Enthoven's conclusions in a later study. However, in 1964 and 1967, the model and its assumptions were attacked by Oliver and Chiu and Brosky, respectively.

This study tests again Enthoven's model and its assumptions using up-to-date data. It was found that the model, its assumptions and its implications, are still applicable to the present economy. Thus with the model, it is shown that the actual (current) debt to income ratio is still below its equilibrium level. It is also shown that asymptotic convergence of growth rates of debt and of income support the hypothesis that continued growth of installment debt is not inconsistent with the future prosperity of the economy.

TABLE OF CONTENTS

	Page
LIST OF TABLES	iii
LIST OF FIGURES	iv
CHAPTER	
I. INTRODUCTION	1
The Significance of Consumer Credit	1
Definition of Terms	3
Two Theories	4
Long-Run Problems	5
Scope and Purpose of this Study	7
II. REVIEW OF LITERATURE	9
Other People's Views and Enthoven's Argument	9
Enthoven's Life-Cycle Model	11
Debt-Income Growth Model	12
Controversy Over Debt-Income Model	18
III. EMPIRICAL RESULTS	21
Re-examination of Life-Cycle Model	21
Re-examination of the Change of Debt to Income Relationship	22
Fitting Data into Debt-Income Model	23
Testing of Hypothesis I	28
Testing of Hypothesis II	24
Differences in Equilibrium Debt to Income Ratios	28
IV. CONCLUSION	31
Suggestions for Further Research	32
APPENDIX	37
BIBLIOGRAPHY	39

LIST OF TABLES

Table	Page
1. FITTING DATA INTO DEBT-INCOME MODEL.	33
2. PERCENTAGE CHANGE OF INCOME AND OF DEBT; MARRIAGE RATES 1945-75.	34
3. RATIO OF ANNUAL INSTALLMENT DEBT PAYMENT TO PREVIOUS YEAR'S DISPOSABLE INCOME	35
4. TOTAL INSTALLMENT VERSUS NON-INSTALLMENT CREDIT OUTSTANDING 1929-75; TOTAL INSTALLMENT CREDIT EXTENDED AND REPAYED ANNUALLY	36

LIST OF FIGURES

Figures	Page
1. ACTUAL PERCENTAGE CHANGE OF INSTALLMENT DEBT ANNUALLY.	25
2. PREDICTED PERCENTAGE CHANGE OF INSTALLMENT DEBT ANNUALLY	26
3. THREE-YEAR MOVING AVERAGE OF PERCENTAGE CHANGE OF INSTALLMENT DEBT AND OF PERSONAL INCOME ANNUALLY	27
4. ACTUAL AND PREDICTED DEBT TO INCOME RATIOS	29

CHAPTER I

INTRODUCTION

The Significance of Consumer Credit

It is not an overstatement to say that when the economic history of this country's last 100 years is being written, the "expansion of consumer credit" will deserve a full chapter of attention. During the recent decades this expansion can be observed in the rapid growth of the volume of consumer credit, whether measured in an absolute sense or relative to income.¹ This rapid growth in the volume of credit was also accompanied by an equally vigorous development in other characteristics of the credit industry. Examples of these developments would be the liberalizing of terms of borrowing, the easing of downnpayment requirements, and the broadening usage of installment credit other than automobile purchases. These changes not only affect the patterns but also the level of spending of the American consumer.

Three of the notable changes are as follows. First, over the past few decades, extension of installment credit has provided consumers with more spendable funds than they have repaid. The extra amount is the net

¹The amount of installment debt outstanding increased almost by a factor of 80 since 1945 while personal income increased only by a factor of 7. Installment debt as a percentage to income grew from 1.45 percent to around 13 to 14 percent in the mid-1970's.

growth in installment credit outstanding.² This has added to borrowers' potential purchasing power beyond the amounts they have received from their incomes and other sources. As such, the extension of credit has affected aggregate spending by all consumer-borrowers and through the multiplier effect, thus affected the aggregate spending of the total economy. Second, the use of installment credit also affected the patterns of expenditures as well as the composition of goods and services that consumers purchased. The availability of easy installment loans reduced the liquid assets consumers needed to make large unit purchases. It also increased consumers' flexibility and shifted their purchases from frequent small outlays to occasional large ones. By buying durables like automobiles and washing machines with installment credit, consumers have shifted their long-run spending away from such competitive services as laundries and public transportation. Finally, installment credit also stimulated the introduction of new goods and of changed versions of existing goods. This occurred because installment credit increased consumers' flexibility and thus made introduction of new products a more attractive venture to business.

The above changes all imply consumer installment credit deserves closer attention by economists. Attention should be given especially to its relationship with aggregate demand of durable goods in particular and

²The net growth of installment credit is the total of the annual differences between new extensions and repayments. The net growth of installment credit from 1945 to 1975 is \$159.55 (in billions of dollars). For a discussion of whether the net growth of debt actually increases aggregate demand or merely shifts to the timing of it, see Paul W. McCracken, James C. T. Mao, and Cedric Fricke, Consumer Installment Credit and Public Policy (Ann Arbor, Michigan: University of Michigan, 1965), p. 20.

its relationship with the growth of income. Both have been substantially affected by consumer credit.

Definition of Terms

The term "consumer credit" includes "...all short and intermediate term credit that is extended through regular business channels to finance the purchase of commodities and services for personal, as opposed to business or government, consumption or to refinance debts incurred for such purposes."³

Consumer credit, however, can be broadly divided into installment and non-installment credit. Non-installment credit "...measures the obligations of consumers scheduled to be repaid in a single payment,"⁴ while installment credit includes "...all consumer credit to be repaid in two or more separate payments."⁵ It is the intention of the writer of this paper to ignore the non-installment component of consumer credit and just focus this study upon the significance of installment credit in affecting the aggregate activity of the economy. In this paper, whenever the term "consumer credit" is used, it refers only to the installment part of the consumer credit and excludes the non-installment component.

There are two reasons why non-installment credit is being ignored in this study. First, in the prewar period, the importance of installment credit relative to non-installment credit in total consumer credit fluctuated. Ever since World War II, however, installment credit has been

³Defined by Federal Reserve System: See P. A. Klein, The Cyclical Timing of Consumer Credit 1920-67 (New York: National Bureau of Economic Research, Columbia University Press, 1971), pp. 4-5.

⁴Ibid.

⁵Ibid.

consistently larger and has grown considerably faster than non-installment credit. At the end of 1975, total installment credit outstanding was 162,010 million dollars, while total non-installment credit outstanding was only 35,100 million dollars.⁶ The former is almost five times larger than the latter. Second, installment credit is also much more highly correlated to cyclical fluctuations than its counterpart--non-installment credit.⁷

For these two reasons, among others, most economists who studied the matter of consumer credit in the past devoted the major part of their attention to installment credit and only made occasional references to non-installment credit. For the same reasons, I will concentrate my study on the installment component of consumer credit. Attention will be devoted mainly to the effects of installment credit on aggregate consumption and expenditures, especially in its relationship with aggregate income.

Two Theories (Burden vs. Replacement)

There are two loosely formulated but opposing theories⁸ that try to explain the relationship between consumer installment credit and the

⁶Economic Report of the President (Washington, D. C.: U.S. Government Printing Office, January, 1975), p. 240.

⁷For illustrations see P. A. Klein, The Cyclical Timing of Consumer Credit 1920-67.

⁸The reason that these theories might be described as loosely formulated is that discussions of such theories appear in a number of articles and books. Not one single economist, however, is found to be responsible in presenting either of them in an organized form, defending and proving that the theory is a valid one.

purchases of consumer durables. One of the theories is known as the "replacement theory." This theory states that the use of consumer credit increases purchases of consumer durables over the long run. This theory suggests that durables are purchased by installment loans at the expense of other consumer items or at the expense of savings, or both.

An alternative to the replacement theory is known as the "burden theory." This states that debt contracted at any given time represents a burden that must later be repaid. According to this theory, the availability of consumer credit does not change the total purchases of durables but merely shifts the timing of them. This theory suggests consumer installment credit actually has adverse consequences on our economy. These adverse consequences can be identified as the cyclical problem and the long-run problem.

The cyclical problem is essentially that the availability and the stock of consumer credit may intensify cyclical fluctuations which have their origins elsewhere. The long-run problem is that when the rate of growth of installment debt is consistently greater than the rate of growth in income over a long period of time, consumers eventually burden themselves to the limit with debt and repayments. Once this happens, further credit expansions must slow down and come to a halt. This may lead to a slump in the consumer durable goods industries and then in the economy as a whole.

Long-Run Problems

The long-run problem has been a real concern to some economists in the past. Their concern can further be described in terms of the install-

ment credit to income ratio. It was believed that there was some "prudent" limit for this ratio. Beyond this limit the great volume of repayment must cut into aggregate demand. In other words, in the long run when the growth of debt was so rapid that at some time the burden of debt and repayment would become intolerable to the consumers. Consequently, new borrowings would drop and in turn the growth of credit would stop.

This concern, although not legitimate as later pointed out by Enthoven, has been kept alive partially by the fact that year after year consumer credit has become an increasing percentage of personal income. Each year when a big jump in installment credit occurs, warning signs are seen and downturns in the economy are often forecast.

The reason that this concern existed may be seen by directly extrapolating the postwar rates of growth of debt and of income. If these rates of growth (especially the rates between 1945 and 1950) were to continue, installment credit would have been 20 percent of income in the early 1960's. If the same extrapolation were to be carried on, installment debt might even equal income not so far in the future. Obviously, long before this point would be reached, the burden effect would take place and cause the economy to experience a downturn.

The concern about the increasing debt-income ratio reached its peak in the late 1940's and early 1950's. Yet in December 1957, A. Enthoven, using his "Life-Cycle Model" and "Debt-Income Growth Model,"⁹ pointed out that such a concern was nothing more than a false alarm. He

⁹A. Enthoven, "The Growth of Installment Credit and Future Prosperity," American Economic Review, Vol. 47, No. 4 (Dec. 1957), pp. 913-929.

indicated in his article¹⁰ that far from exceeding some normal level of debt to income ratio, the economy in 1955 was actually below this equilibrium level.¹¹ Later, Michael K. Evans, using the same models of Enthoven reached the same conclusion by extending the model to 1964.¹²

Scope and Purpose of This Study

Since the concern that overextension of credit may become a drag to our economy still seems to linger on and since Enthoven's explanation seems to have escaped many economists and others, it would be valuable, I think, to extend his model to the present. I intend to reproduce Enthoven's models in some detail, then re-examine the method he used, re-evaluate its assumptions and update the study by extending the data from 1945 through 1975.

There are basically three reasons for redoing the study. First, in Enthoven's model, the main underlying method in finding the equilibrium debt-income ratio is by pushing the time component in the equation to

¹⁰Ibid.

¹¹According to A. Enthoven, despite the fast growing rate of installment debt annually, and the ever-increasing debt to income ratio, there would be a point where this rate would taper off and the ratio would stabilize at its equilibrium level. See footnote 13, infra, p. 8.

¹²Michael K. Evans, Macroeconomic Activity--Theory, Forecasting and Control. An Econometric Approach (University of Pennsylvania: Wharton School of Finance and Commerce, 1964), pp. 153-64.

infinity.¹³ Thus, the validity of his study actually depends rather much on the time span used. The longer the time span used, the more "accurate" the rate would be ("accurate" in the sense that the ratio calculated would be closer to the one that he was intending to obtain). Thus, the first justification of redoing this study is to increase the accuracy of the estimate by reproducing the study with current data.

Second, during the period when Enthoven and Evans did their studies, the actual debt-income ratios were still below the "equilibrium" ratio.¹⁴ In redoing the study using the same method and models, we cannot only check to see whether the equilibrium ratios are still the same as the ones found by Enthoven and Evans, but also we can see how close the current ratio of debt to income is to the equilibrium ratio.

Third, major changes in the economic world within the last 11 years (from 1964 to 1975) should be accounted for in redoing this study, in order to see if the assumptions of the original study still apply today. This will enable us to decide whether the models are still applicable and the results comparable.

$$\begin{aligned}
 &^{13}\text{Equilibrium Ratio } D_t/Y_t \\
 &= \frac{[a(1+r)/r] Y_0 [(1+r)^t - 1] + D_0}{Y_0(1+r)^t}
 \end{aligned}$$

as $t \rightarrow \infty$ (by pushing time component to infinity)

$$\frac{D_t}{Y_t} = \frac{a(1+r)}{r}$$

For more details, see infra, pp. 15-17.

¹⁴ The equilibrium debt-income ratio was 18.8 percent calculated by Enthoven while in 1956 the actual ratio was only 9.7 percent. The equilibrium ratio calculated by Evans was 17.8 percent (not too far off from that of Enthoven's) and the actual ratio was 12 percent in 1964. It can easily be seen that the actual ratio has been increasing and approaching the equilibrium ratio over the years.

CHAPTER II

REVIEW OF LITERATURE

Other People's View and Enthoven's Argument

Enthoven's study as well as the first large scale study done on consumer credit by the federal government¹⁵ were both triggered by the overwhelming concern that installment debt outstanding was increasing at a much faster rate than that of income.

It was generally believed, in the late 1940's and early 1950's, that the ratio of consumer installment credit to personal income was exceeding a "prudent" limit. Beyond this, the large annual volume of repayments would act as a burden to the economy and thus hinder further borrowing. Since aggregate demand for consumer durables is largely financed by installment credit, when borrowing does not increase or its rate of increase slows down, sales of consumer durables will decline. This fall in aggregate demand intensified through multiplier and accelerator effects, would allegedly end the prosperity that was financed by installment credit.

¹⁵At the request of the Council of Economic Advisers, the Board of Governors of the Federal Reserve System undertook a study and in March 1957 produced five volumes on various aspects of consumer installment credit. The five volumes are separated into Part I and Part II entitled, Consumer Installment Credit (National Bureau of Economic Research, U.S. Board of Governors of the Federal Reserve System, U.S. Government Printing Office, Washington, D. C., 1957).

Among the economists who shared this concern were S. E. Harris and H. M. Groves. Their positions, expressed in the following statements respectively, were rather representative of the time.

It could not be expected that this rate of increase [of installment credit] would continue. And is it not a prosperity built on this kind of progression at least in part of a sham prosperity? We are borrowing prosperity to some extent from the future.¹⁶

The economic gain of 1955 included "borrowed prosperity" supported by an accelerator of consumers' credit (and therefore money supply) that in consumers' credit so out of proportion to the rise of national product must eventually overburden the consumers' budgets with required payments...¹⁷

Gilbert Burck and Sanford Parker also took the same position in an article entitled, "The Coming Turn in Consumer Credit."¹⁸ There were still others who shared this belief; yet none of them spent enough time to put together evidence to prove that their point was a valid one.

Enthoven, however, was convinced that their concern was nothing more than a false alarm based upon a mistaken view of the burden of installment debt and an incorrect extrapolation of its growth. He pointed out that:

The basic model implicit in the conclusion of Harris and Groves, and in the popular view of installment debt, may be described as an 'expected value' model based upon the position and behavior of the average consumer...¹⁹

¹⁶S. E. Harris, "The Economics of Eisenhower: A Symposium," Review of Economic Statistics (Nov. 1956), Vol. 38, p. 358.

¹⁷H. M. Groves, "The Economics of Eisenhower: A Symposium," op. cit., p. 378.

¹⁸Gilbert Burck and Sanford Parker, "The Coming Turn in Consumer Credit," Fortune (March 1956), Vol. 53, pp. 99-102 and pp. 240-47.

¹⁹A. Enthoven, "The Growth of Installment Credit and Future Prosperity," op. cit., p. 915.

This, he observed as misleading reasoning and thus incorrect conclusions followed. In its place, Enthoven suggested the use of the "Life-Cycle" model in the consideration of the distribution of debt. Only by using such a debt distribution and by assuming income grows steadily over the years, he argued, could the growth of installment debt be extrapolated "properly". Thus Enthoven claimed he was able to show,

that the continued growth of installment debt, when correctly extrapolated, is not inconsistent with the assumed pattern of income growth.²⁰

Enthoven's Life-Cycle Model

According to the "expected value" model implied in Harris' and Groves' argument, an individual's indebtedness is calculated by taking the total debt outstanding in the economy and dividing it by the total number of people in the population to get average indebtedness. Since it was assumed that they are all in debt by approximately the same amount in relation to their income, when the critical ratio of debt to income is reached, consumers will all curtail their durable good purchases at approximately the same time. Such an aggregate effect was believed to be strong enough to set off a slump in consumer durable goods industries.

Enthoven argued, however, that such reasoning was incorrect. He believed that installment debt should not be assumed to be averagely distributed; but instead, its distribution should be considered as correlated to one's life cycle. That is, household debt is highly correlated with family's status and varies systematically over its life cycle. For

²⁰Ibid.

example, young married couples use consumer credit much more than young single people; and those couples with children use debt more than those without children. Moreover, as the couple gets older, and their children grow up, they start paying off their debts and no longer need to borrow. The relative frequency of indebtedness thus declines steadily with increasing age.

According to Enthoven's model, therefore, consumer installment financing occurs primarily in the early phase of the life-cycle of every couple. There is thus a steady supply of new borrowers to replenish those who have borrowed. The fact that at any given time some sections of the population are heavily in debt does not necessarily imply that the sales of durable goods must decline. Each year new families are formed and children born so that new potential borrowers regularly step up to fill the places of borrowers who may have become debt saturated. In this manner, the debt rotates through the population and sales of durable goods are sustained.

The essential difference between the expected value model and life-cycle model is that in the former model, it is assumed that new borrowing must be done by people who are already in debt; hence the stock of debt may act as an absolute deterrent to further borrowing. In the latter model the outstanding stock of debt does not act as a deterrent to new borrowing and to the purchase of durable goods, because the class of eligible borrowers is constantly being replenished at an increasing rate.

Debt-Income Growth Model

The main objective of Enthoven's study, however, was to show that the faster rate of growth of debt than income in the postwar years was no

reason for alarm. The fact that the debt-income ratio continues to rise simply means that the consumers are adjusting their debt to some normal level which Enthoven calls "equilibrium debt-income ratio" ; and should therefore not be interpreted as consumers overextending themselves to a burden limit.

In order to show that the economy of 1955 was actually far below this equilibrium level, Enthoven constructed the debt-income growth model. In this model he made some simplifying although realistic assumptions about the economy which enabled him to formulate a direct mathematical path to the equilibrium debt-income ratio. These assumptions are as follows:

1. Initially, there is no consumer installment debt outstanding.²¹
2. Some changes occur in the institutional structure of borrowers.
3. All borrowers are couples in the first year of marriage.
4. All borrowers have the same average propensity to incur debt.
5. The number of borrowers remains a constant percentage of the population.
6. The long-run income elasticity of consumer durables is unitary.

The first assumption seems a little stringent at first glance, but actually it represented the situation at the beginning of the postwar period. At the end of 1945, consumer installment debt outstanding in the United States was less than \$2.5 billion--less than half the amount outstanding in 1941 and actually less than at the end of 1929.²² This abnormally low stock of debt was a consequence of war-time shortages and restrictions. Although not literally true in 1945, the assumption of a zero initial stock of debt in the model does serve as a useful abstraction.

²¹ Enthoven and Evans both used 1945 as their base year--the initial period to start the calculation of the model.

²² See Table 4 , infra, p. 36.

For the second assumption, there was clearly some changes in the structure of borrowing and in the borrowers right after the war. For one thing, credit controls were eased soon after the war ended, and durable goods again became available. Furthermore, the return home of the armed forces and transfer from military to civilian life also represented a great change in the circumstances and thus attitudes of borrowers. Assumption three, although not absolutely necessary, it helps to make the life-cycle model into its pure form.

In assumption four, the phrase "same average propensity to incur debt" means that for a given income level, consumers will incur the same amount of debt. Various cross-section studies²³ suggest that relatively homogeneous groups, such as couples in their first year of marriage, do have approximately the same average propensity to incur debt.

With respect to assumption five, Enthoven shows in his life-cycle model that the ratio of borrowers to the total population is actually equal to the ratio of newly-married couples to the total population. This ratio has remained almost constant over the years.²⁴

In the last assumption, a long-run income elasticity of unity implies that there will be no long-run substitution of durables for other goods. Evans was able to validate this assumption in his 1964 study.²⁵

²³See Janet A. Fisher, "Consumer Durable Goods Expenditures, With Major Emphasis on the Role of Assets, Credit, Intentions," Journal of the American Statistical Association (Sept. 1963), Vol. 58, No. 3, p. 654. See also, M. L. Lee, "An Analysis of Installment Borrowing by Durable Goods Buyers," Econometrica (Oct. 1962), Vol. 30, No. 4, p. 781. And L. R. Kleinard and J. B. Lansing, "Decisions to Purchase Consumer Durable Goods," Journal of Marketing (Oct. 1955), Vol. 20, No. 2, p. 130.

²⁴See Table 2, infra, p. 34.

²⁵Michael K. Evans, Macroeconomic Activity, op. cit.

Given these assumptions, Enthoven then proceeded to construct the model as follows.

Income Growth

$$Y_t = Y_0(1 + r)^t. \quad I$$

New Extension of Credit

$$N_t = \alpha Y_t. \quad II$$

Repayment of Credit

$$R_t = b_0 N_t + b_1 N_{t-1} + b_2 N_{t-2} + \dots + b_j N_{t-j}. \quad III$$

Change of Debt Outstanding

$$D_t = N_t - R_t. \quad IV$$

Equation I states that income in any period (Y_t) can be calculated as a function of income in the base year (Y_0) and some constant relative rate of growth (r). Equation II states that the new borrowing in any year is proportional to income in that year. Equation III states that repayments in any year are a linear combination of new borrowings in previous years. Finally, in Equation IV, the change of debt outstanding in any year is calculated as the net difference between new borrowings and repayments of that year. With these four basic equations Enthoven proceeded to find an equilibrium debt-income ratio.

By substituting Equation II into III (i.e., $N_t = \alpha Y_t$ into R_t) gives,

$$R_t = b_0 \alpha Y_t + b_1 \alpha Y_{t-1} + \dots + b_j \alpha Y_{t-j}.$$

Letting constants $b_0 \alpha$ be C_0 and $b_1 \alpha$ be C_1 ... etc., the following equation emerges,

$$R_t = C_0 Y_t + C_1 Y_{t-1} + \dots + C_j Y_{t-j}.$$

²⁶ Assuming that in the long run, income grows at a constant relative rate r , letting t denote the number of years that have elapsed since the base year and letting Y denote personal income.

Since $D_t = N_t - R_t$,

$$D_t = \alpha Y_t - (C_0 Y_t + C_1 Y_{t-1} + \dots + C_j Y_{t-j}).$$

Or

$$D_t = (\alpha - C_0) Y_t - C_1 Y_{t-1} - C_2 Y_{t-2} - \dots - C_j Y_{t-j}.$$

Since

$$Y_t = Y_0 (1 + r)^t,$$

And in general

$$Y_{t-j} = Y_0 (1 + r)^{t-j}.$$

By substituting Y_t, Y_{t-1}, \dots etc., into Y_0 , Enthoven obtained

$$\begin{aligned} \Delta D_t &= (\alpha - C_0) Y_0 (1 + r)^t - C_1 Y_0 (1 + r)^{t-1} - C_2 Y_0 (1 + r)^{t-2} - \\ &\dots - C_j Y_0 (1 + r)^{t-j} \end{aligned}$$

Therefore

$$\Delta D_t = (1 + r)^t \cdot Y_0 \cdot [(\alpha - C_0) - \frac{C_1}{1 + r} - \frac{C_2}{(1 + r)^2} - \dots - \frac{C_j}{(1 + r)^j}]$$

Since the expression in the bracket is a constant, and since $Y_t = Y_0 (1 + r)^t$;

Enthoven concluded that,

$$\Delta D_t = a Y_t$$

This means that the change of debt outstanding is proportional to income.

To get an expression for debt at any period "t", it is necessary to calculate $D_t = \sum_{i=0}^t (\Delta D)_{t-i}$. Since $\Delta D_t = a Y_t$, or $\Delta D_1 = a Y_1 \dots$ etc., it follows

that in period 1 (i.e., $t = 1$),

$$\begin{aligned} D_1 &= \Delta D_1 + D_0 \\ &= a Y_1 + D_0, \end{aligned}$$

assuming a small initial stock of debt D_0 , again by substituting

$Y_t = Y_0 (1 + r)^t$ in Y_1 , Enthoven obtained,

$$D_1 = a(1 + r)Y_0 + D_0$$

and $D_2 = a(1+r)^2 Y_0 + a(1+r)Y_0 + D_0$

In general then,

$$D_t = a(1+r)^t Y_0 + a(1+r)^{t-1} Y_0 + \dots + a(1+r)Y_0 + D_0$$

Or,

$$D_t = aY_0 \cdot \sum_{j=1}^t (1+r)^j + D_0$$

Thus,

$$D_t = \frac{a(1+r)}{r} \cdot Y_0 \cdot [(1+r)^t - 1] + D_0^{27}$$

The above equation was used to find the equilibrium debt-income ratio and also the equilibrium rate at which debt will grow. Thus,

$$\frac{D_t}{Y_t} = \frac{[a(1+r)/r] \cdot Y_0 \cdot [(1+r)^t - 1] + D_0}{Y_0(1+r)^t} \quad \text{VI}$$

And as t approaches infinity

$$\frac{D_t}{Y_t} = \frac{a(1+r)}{r} \quad \text{VII}$$

By similar algebraic manipulations it was shown that,

$$\frac{\Delta D_t}{D_{t-1}} = \frac{(1+r)^t \cdot r}{(1+r)^t - (1+r) + (rD_0/aY_0)}.$$

As t approaches infinity,

$$\frac{\Delta D_t}{D_{t-1}} = r \quad \text{VIII}$$

The derivation of these two equations (VII and VIII) revealed that the growth rate of debt in terms of itself will exceed that of income in an economy with a low initial debt level and that the two rates will approach each other asystematically. Thus, in the limit, the ratio of debt to income will be constant and stable as shown.

²⁷This can be shown by using some elementary results from partial sums. If S_x is a partial sum, then,

$$\begin{aligned} S_x &= x + x^2 + \dots + x^t \\ xS_x &= x^2 + \dots + x^t + x^{t+1} \end{aligned}$$

Controversy Over Debt-Income Model

Enthoven conducted his study in December 1957. Evans updated the study in 1964. In the same year F. R. Oliver wrote an article criticizing this study.²⁸ Oliver launched his attack basically on the three assumptions of the debt-income model. These assumptions²⁹ are that: (I) income grows by a constant proportion each year; (II) borrowings (or new extension of debt) in each year is a constant proportion of income; and (III) repayment conditions are constant. Oliver argues,

Therefore, Enthoven's conclusion that debt income ratio tends to a limit is correct only in a trivial sense; in fact, it always equals the "limit".³⁰

Furthermore, Oliver points out that the constancy of debt-income ratio implied by Enthoven's model is not empirically accurate, especially before the mid-1950's. Oliver thus contended that Enthoven's model is technically misleading if not positively erroneous.³¹

$$^{27}(\text{cont.}) \quad S_x(1-X) = X(1-X^t)$$

and

$$S_x = \frac{X(X^t-1)}{X-1}$$

In this case

$$X = 1 + r, \text{ so that } S_r = \frac{(1+r)[(1+r)^t - 1]}{r}$$

as shown.

²⁸F. R. Oliver, "On a Debt-Income Model of Consumer Installment Credit Growth: Comment," American Economic Review (June 1964), Vol. 54, pp. 415-17.

²⁹See supra, p. 15.

³⁰F. R. Oliver, "On a Debt-Income Model of Consumer Installment Growth: Comment," op. cit., p. 415.

³¹Ibid.

Enthoven replied to Oliver,³² admitting that his criticism was correct but of little consequence. He argued that Equation V, derived from Assumptions I, II and III,³³ is actually independent of its own. That is, V can be valid even under conditions in which II and III are not satisfied. Since the whole model rests entirely on Equations I and V, Enthoven claimed that he could afford to abandon either or both of the hypotheses represented by II and III without destroying the validity of his model. In addition, he demonstrated numerically that his model had performed well.³⁴

Unfortunately, this did not quite settle the controversy. In December 1967, S. Y. Chiu and John J. Brosky again examined Enthoven's model.³⁵ Using aggregate time series data of installment credit extended yearly from 1946 to 1965, they found that $N_t = -19.36 + 0.173Y_t$. This empirical finding clearly does not support Enthoven's Assumption II ($N_t = \alpha Y_t$).

Replacing $N_t = \alpha Y_t$ with $N_t = k + \alpha Y_t$, Chiu and Brosky proceeded to derive the equilibrium debt-income ratio.³⁶ They found that Enthoven's debt-income ratio remained intact even with empirically determined non-

³²A. Enthoven, "On a Debt-Income Model of Consumer Installment Credit Growth: Reply," American Economic Review (June 1964), Vol. 54, pp. 417-23.

³³See supra, p. 15.

³⁴A. Enthoven, "On a Debt-Income Model: Reply," op. cit., pp. 419-21.

³⁵S. Y. Chiu and John J. Brosky, "On a Debt-Income Model of Consumer Installment Credit: Comment," American Economic Review (Dec. 1967), Vol. 57, pp. 1244-49.

³⁶See Appendix I, infra, p. 37.

zero intercept. That is, D_t/Y_t still equals $(1 + r)/r$ when "t" is pushed to infinity.

There is, however, another controversy that Chiu and Brosky brought up. In Equation V, Enthoven states that annual change of debt is directly proportional to the income of the same year with no constant term in the equation. This equation, together with Equation I, are the two cornerstone assumptions upon which Enthoven developed his whole model. As we recall, he abandoned assumptions 4 and 5 while trying to defend his model against Oliver's criticism; thus the validity of Equations I and V are now crucial to his model. Yet Chiu and Brosky empirically found that the correlation between the annual change of debt and annual personal income is rather poor. Furthermore, there is a negative intercept in the equation.³⁷ Therefore, if their empirical findings are correct, Enthoven might even have to abandon assumption 5 which jeopardizes his entire model.

³⁷Chiu and Brosky found $D_t = 0.4957 + 0.01132Y_t$
 $r = 0.5602.$

CHAPTER III

EMPIRICAL RESULTS

Re-examination of Life-Cycle Model

In order to see whether the life-cycle model upon which Enthoven developed the basic assumptions for his debt-income model is still applicable to today's economy there are at least two things that need to be examined. One is the marriage rate and the other is the distribution of debt according to age and family status.

In Assumption 5,³⁸ Enthoven assumes the number of borrowers remains a constant percentage of the population. Enthoven made this assumption because he believed that the ratio of borrowers to the total population is actually equal to the ratio of newly married couples to the total population. An examination of the marriage rate from 1945-72 (figures shown in Table 2)³⁹ shows that it has remained relatively stable over the years. Thus Enthoven's Assumption 5 was justified and remains applicable today.

In order to illustrate that the distribution of debt in the population was as described in the life-cycle model, Enthoven presented data collected by Survey Research Center in his first article.⁴⁰ For the same

³⁸See supra, p. 13.

³⁹See infra, p. 34.

⁴⁰A. Enthoven, "The Growth of Installment Credit and Future Prosperity," op. cit., p. 20.

illustrative purpose, the data of the 1970 Survey of Consumer Finances⁴¹ is presented here in Table 3.⁴² A close examination of these figures reveals that the frequency and the amount of debt are still highly correlated with the individual's age and family status. People who are young, married and have children appear to be in debt more than people who are older and people who are single. These empirical results support Enthoven's assumption about installment debt distribution.

Re-examination of the Change of Debt to Income Relationship

As we recall, in the last chapter Enthoven's derived Equation V states that annual change of debt is directly proportional to income ($\Delta D_t = aY_t$). Chiu and Brosky, however, found that the two variables are not directly proportional but linearly correlated, with a negative intercept. Furthermore, the correlation was rather poor, with $r = 0.5602$.

Using the annual data of debt change and personal income from 1945 to 1975, I ran another regression on these two variables. My empirical results show that change of debt and personal income, although not directly proportional, yet are certainly linearly correlated, with a coefficient of correlation high enough to justify such a relationship.⁴³

⁴¹George Katona, Lewis Mandell, and Jay Schmiedskamp, Survey of Consumer Finances--1970 (Survey Research Center, University of Michigan, Ann Arbor, Michigan).

⁴²See infra, p. 35.

⁴³ $D_t = 0.1394 + 0.1027Y_t$ with $r = 0.6972$ (or $r^2 = 0.4861$), and significance $r = 0.00001$.

I concluded that Enthoven's debt-income model developed from the life-cycle model and Equations I and V still stand on solid ground despite the criticisms of Oliver, Chiu and Brosky.⁴⁴

Fitting Data Into Debt-Income Model

The two hypotheses that require retesting are first, the debt to income ratio should approach asymptotically to an equilibrium limit; and second, the rate of growth of debt in terms of itself should converge asymptotically to the rate of growth of income over the long run. In order to test these two hypotheses, we need to know first the values of a and r .

By fitting $Y_t = Y_0(1 + r)^t$, Equation I, to personal income in 1945 and 1975, the rate of growth and income, r , was determined to be 6.88 percent. The value of a , the ratio of annual change of debt to income, is obtained by fitting the derived equation for D_t ⁴⁵ to data for the same years, 1945 to 1975.⁴⁶ The value of a was found to be 0.00951.

In Table I,⁴⁷ the odd-numbered columns contain the actual values for personal income, installment debt outstanding, changes of debt from

⁴⁴The non-zero intercept of change of debt to income relationship, $D_t = k' + aY_t$, has already incorporated in the modification of Chiu and Brosky. See Appendix I, infra, p. 37.

⁴⁵ $D_t = \frac{a(1+r)}{r} \cdot Y_0 \cdot [(1+r)^t - 1] + D_0$. For details of derivation, see supra, p. 17.

⁴⁶1945 is the zero period, and 1975 is the t^{th} period.

⁴⁷See infra, p. 33.

year to year (expressed as a percentage of debt of the earlier year), and the ratio of debt to income. The even-numbered columns contain the comparable figures predicted by the model. These predicted figures are calculated by fitting a and r values calculated, personal income and debt outstanding of the base year (1945) into the equations derived in Chapter II.⁴⁸

Testing of Hypothesis II--Asymptotic Convergence of the Two Growth Rates

The values in column 5 are the actual annual percentage change in installment debt outstanding and are plotted in Figure 1. The values in column 6 are the predicted percentage change in debt outstanding and are plotted in Figure 2. A comparison of these two curves, with exceptions of trough periods (as circled) reveal that there is a general resemblance between the trend of the actual percentage change of debt with the predicted trend. A three-year moving-average of the actual percentage change in debt plotted in Figure 3,⁴⁹ reveals a smoother curve, which compares even more favorably to the predicted line. The average actual percentage change in income, when superimposed on the average actual percentage change in debt. It shows that there is a general convergence. (See Figure 3) This supports Enthoven's second hypothesis which is expressed

⁴⁸For column 2, we use $Y_t = Y_0(1+r)^t$; for column 4, we use $D_t = \frac{a(1+r)}{r} \cdot Y_0 \cdot [(1+r)^t - 1] + D_0$; for column 6, we use $\frac{D_t}{D_{t-1}}$ = $\frac{(1+r)^t - r}{(1+r)^t - (1+r) + (rD_0/aY_0)}$; and for column 8, we use $\frac{D_t}{Y_t}$ = $\frac{[a(1+r)/r] \cdot Y_0 \cdot [(1+r)^t - 1] + D_0}{Y_0(1+r)^t}$

⁴⁹See infra, p. 27.

FIGURE 1

ACTUAL PERCENTAGE CHANGE OF INSTALLMENT DEBT ANNUALLY

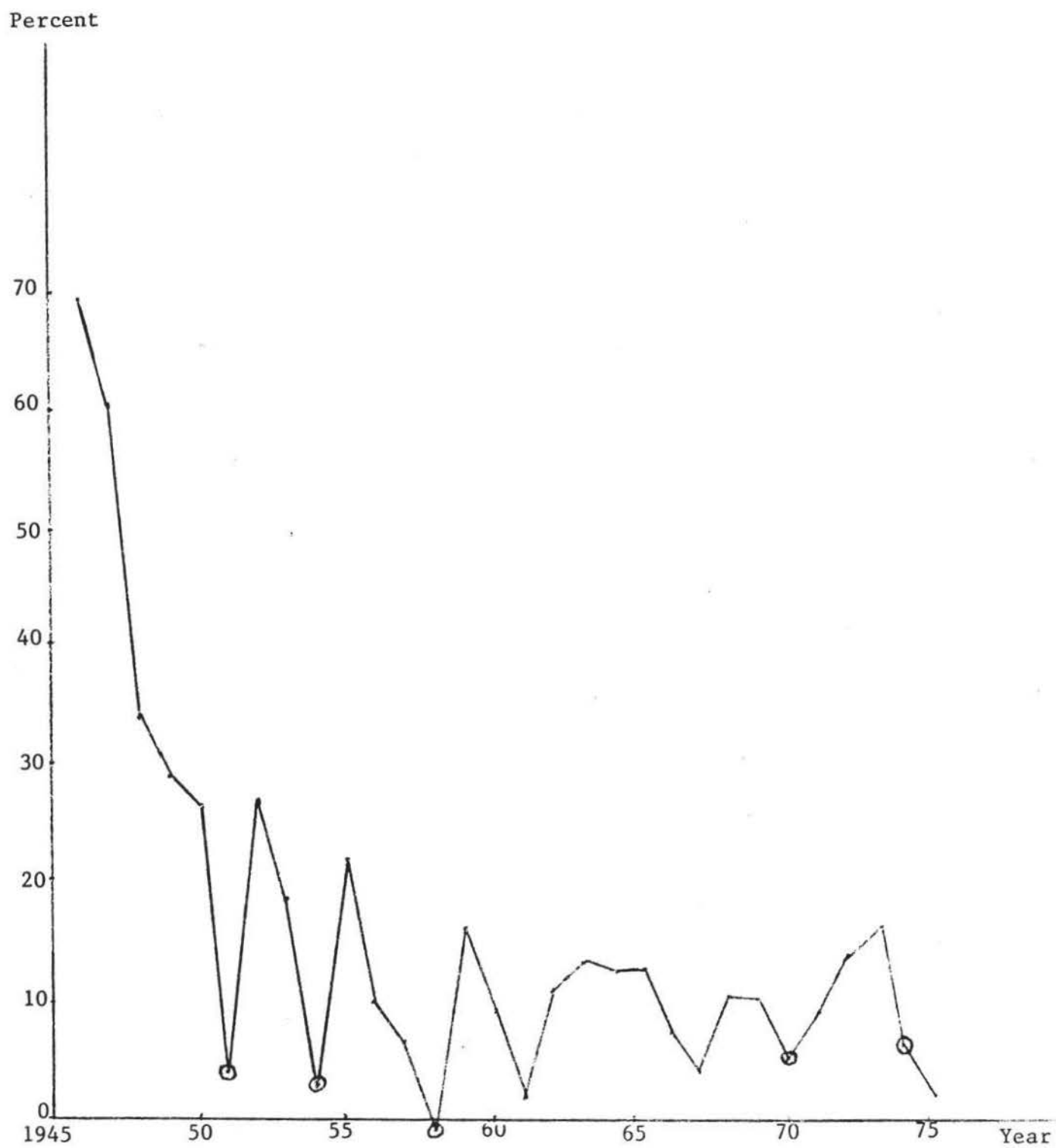


FIGURE 2

PREDICTED PERCENTAGE CHANGE OF INSTALLMENT DEBT ANNUALLY

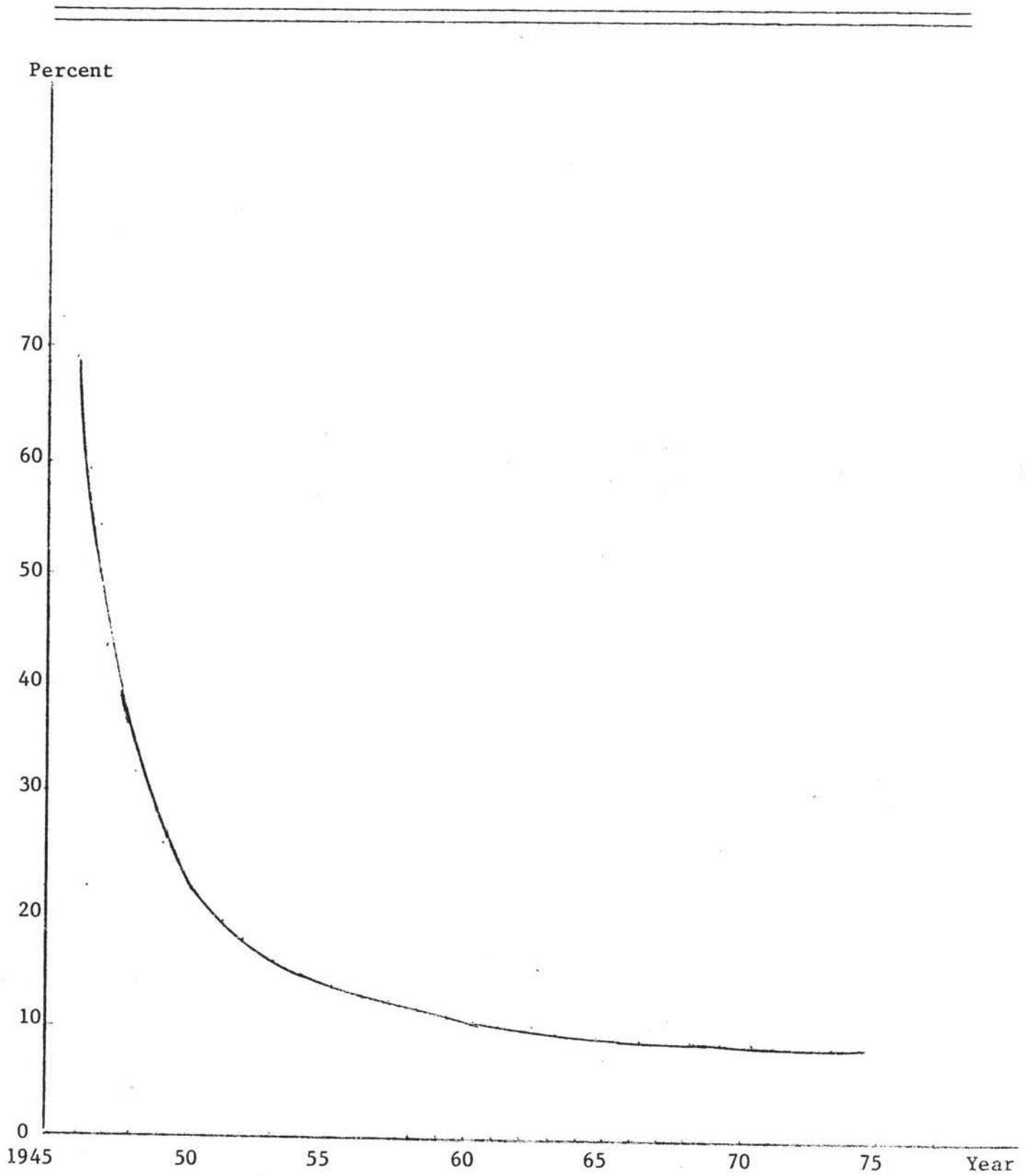
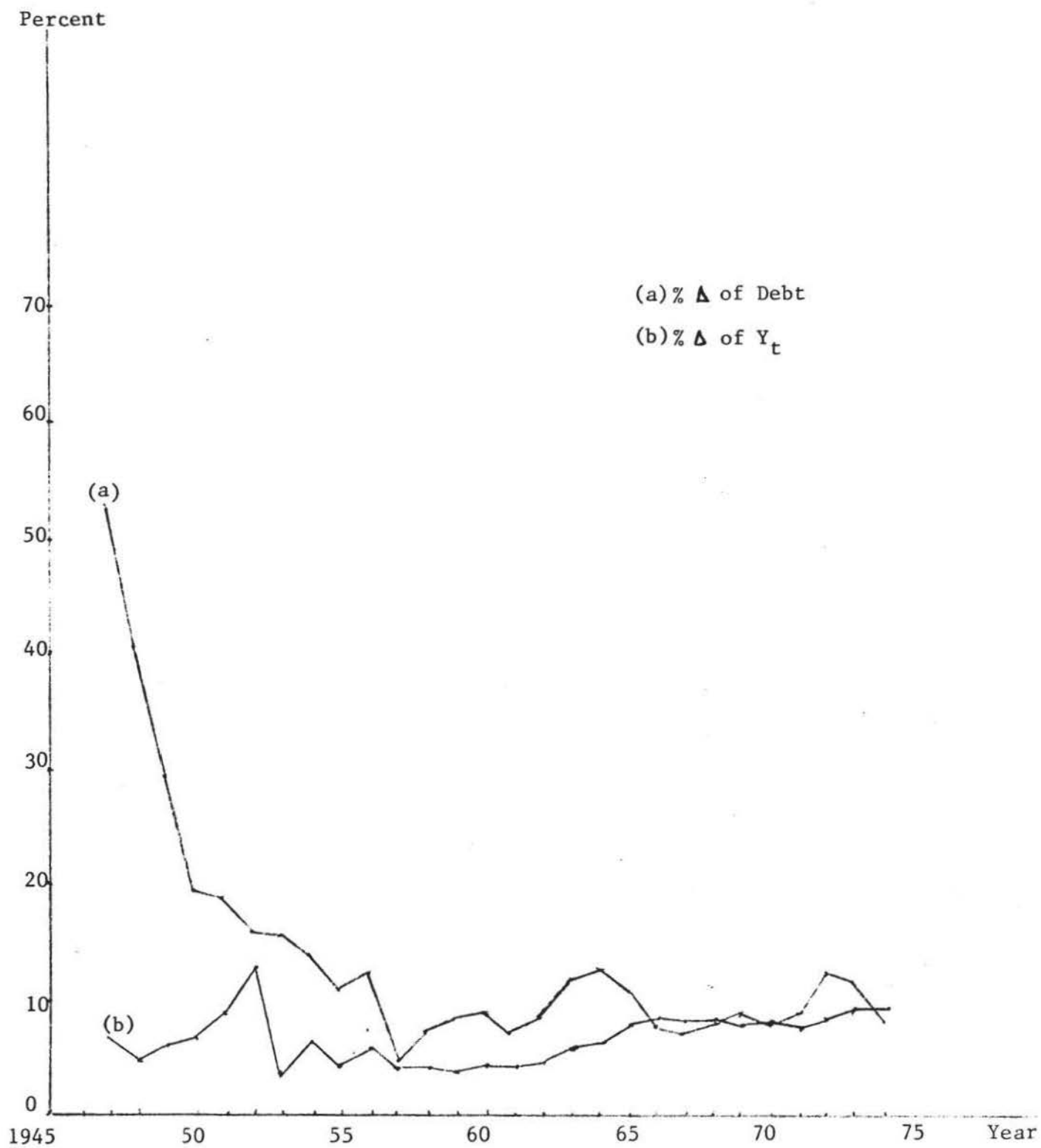


FIGURE 3

THREE-YEAR MOVING AVERAGE OF PERCENTAGE CHANGE OF
INSTALLMENT DEBT AND OR PERSONAL INCOME ANNUALLY



as $\lim (D_t - D_{t-1})/D_{t-1} = r$. In other words, the rate of growth of debt in terms of itself would exceed that of income in an economy with low initial debt level; and in the limit, as t approaches infinity, the two rates will approach each other asymptotically.

Testing of Hypothesis I--Asymptotic Approach of Equilibrium Debt-Income Ratio

The values in column 7 and column 8 plotted in Figure 4*, show a rather good fit between the predicted and the actual debt to income ratios (with recession years circled).

According to Enthoven's first hypothesis the debt to income ratio should become constant and stable in the limit, that is, $\lim_t D_t/Y_t = a(1+r)/r$. Taking the values of a and r as calculated above, these figures imply an equilibrium ratio of debt to income to be 14.8.⁵⁰ The actual debt to income ratio between 1965 and 1975⁵¹ has not changed drastically. There is some indication that there is a tendency for such a debt to income ratio to stabilize in the near future. Yet, with no prior reason, we cannot be certain that it will stabilize. Therefore, I think, Enthoven's first hypothesis cannot be confirmed until more data (at least another five to ten years) are available.

Differences in Equilibrium Debt to Income Ratios

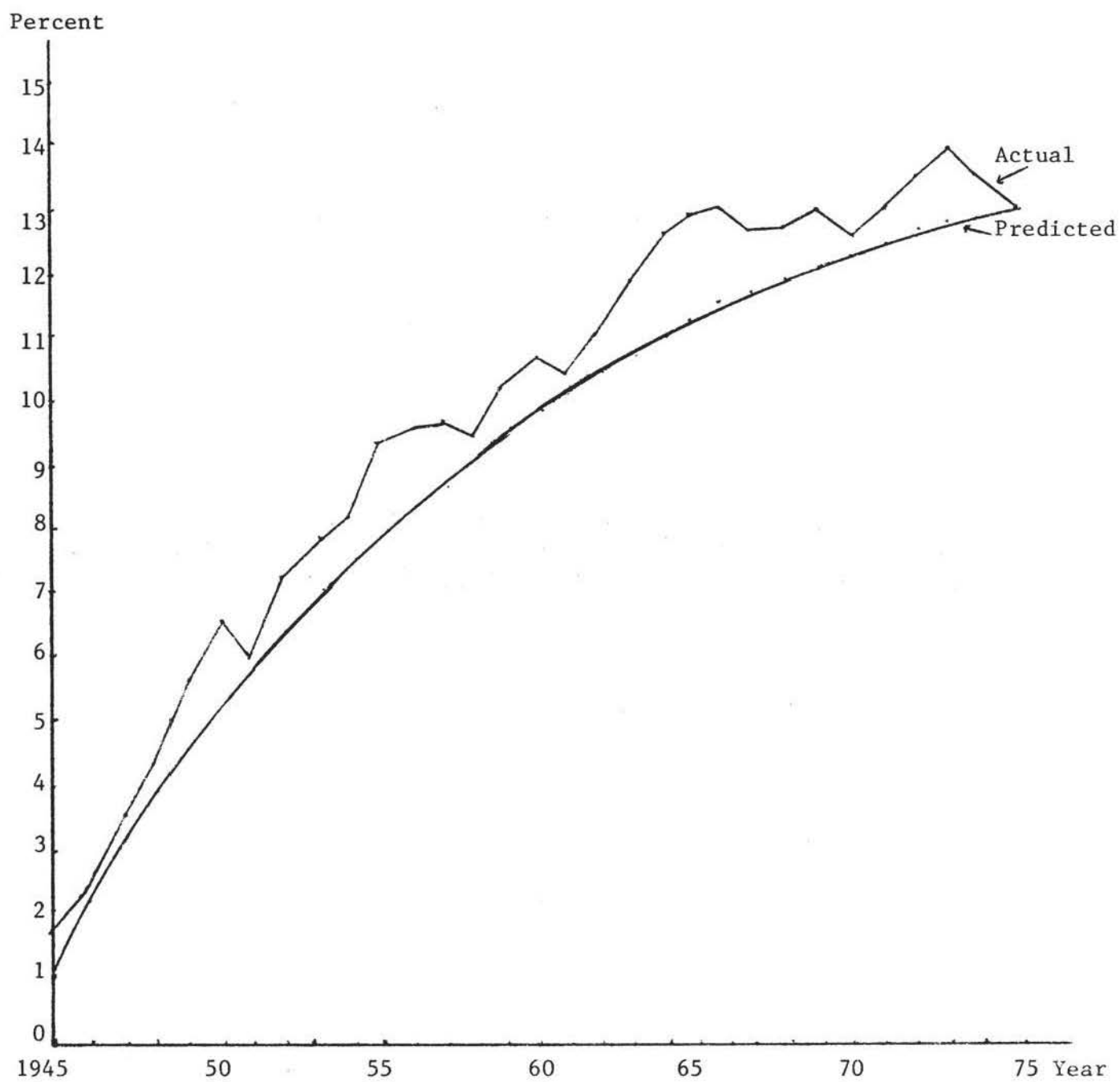
The equilibrium debt-income ratio was 18.8 percent calculated by Enthoven in 1956, and 17.8 percent calculated by Evans in 1964. However,

⁵¹See column 7, Table I, infra, p. 33.

⁵⁰The current (actual) debt to income ratio is around 13.5 percent, which is still below its equilibrium level.

*See infra, p. 29.

FIGURE 4
ACTUAL AND PREDICTED DEBT TO INCOME RATIOS



the equilibrium ratio calculated in this study is only 14.8 percent. The differences in this equilibrium ratio, calculated at different times, can be partially explained by the relationship between the values of a and r . Unfortunately, a is not necessarily independent of r ; they are positively related. Therefore, a decline in r , with other variables remaining constant, would entail a decline in a . Moreover, depending upon the different base and end years chosen, it will give us a different set of values of a and r , which taken together will in turn give us different equilibrium ratios.

CHAPTER IV

CONCLUSION

The main purpose of this thesis is to test the validity of Enthoven's debt-income model in today's economy. In this study current data was used to determine if the debt to income ratio would stabilize in the long run, and also to determine if the current growth of debt is still consistent with the growth of income.

It was found that Enthoven's life-cycle model is still applicable to the present economy because debt distribution according to age and family status still remain relatively stable. Hence, it was justifiable to use the same methods and equations that Enthoven and Evans used in their 1957 and 1964 studies.

The criticisms made by Oliver, Brosky and Chiu against Enthoven's model are found to be of little significance. Although they did find that the assumption underlying two of Enthoven's equations was inaccurate--Enthoven assumed zero intercepts for new extension of debt, and also for the annual change of debt both as a function of income--whereas these relationships actually have non-zero intercepts. Further mathematical derivation, however, shows that Enthoven's original model still remains unharmed despite these inaccuracies.

My empirical results, moreover, show that the model has performed well. The values predicted by the model do give a realistic picture of

the growth of installment credit through the years. The results also prove that Enthoven's first hypothesis is correct--if the debt-income ratio is initially below its equilibrium level, then the relative rate of growth of debt will always exceed that of income, and it will converge on the latter asymptotically from above. The second hypothesis, on the other hand, cannot be confirmed conclusively without further data. The trend strongly indicates, however, that the debt-income ratio will approach a limit asymptotically from below.

Finally, the model also shows that the absolute rate of increase of stock of debt is proportional to income. Since it is this rate that is relevant for the growth of durable goods sales and national income, the growth of debt is therefore not incompatible with continued prosperity.

Suggestions for Further Research

The debt-income model can be improved by restating the relationship between the repayments and new extensions of credit in more specific terms. In the present equation the repayment of credit is a function of new extension of credit of the past years: $R_t = b_0N_t + b_1N_{t-1} + b_2N_{t-2} \dots b_jN_{t-j}$. Oliver argues that this equation is too general.

A more specific relationship between the repayments and new extensions of debt can be obtained by regression. For example, different functions should be obtained for each of the major types of installment credit --personal loans, repair and modification loans, automobile paper and other consumer goods paper. Based on these equations found by regression, an improved overall relationship between repayment and new borrowings may be developed.

TABLE 1
FITTING DATA INTO DEBT-INCOME MODEL
(billions of dollars)

Years	Actual Y_t (1)	Predicted Y_t (2)	Actual D_t (3)	Predicted D_t (4)	Actual % Δ in D_t (x100)(5)	Predicted % Δ in D_t (x100)(6)	Actual D_t/Y_t (x100) (7)	Predicted D_t/Y_t (x100) (8)
1945	169.8	169.8	2.46	2.46			1.5	1.5
1946	177.3	181.5	4.17	4.19	69.5	70.2	2.4	2.3
47	189.8	194.0	6.69	6.03	60.4	44.1	3.5	3.1
48	208.5	207.3	8.99	8.00	34.4	32.7	4.3	3.9
49	205.6	221.6	11.59	10.11	28.9	26.3	5.6	4.6
1950	226.1	236.8	14.70	12.36	26.8	22.3	6.5	5.2
51	253.7	253.1	15.29	14.77	4.0	19.5	6.0	5.8
52	270.4	270.5	19.40	17.34	26.9	17.4	7.2	6.4
53	286.1	289.1	23.00	20.09	18.6	15.9	8.0	7.0
54	288.2	309.0	23.50	23.03	2.4	14.6	8.2	7.5
55	308.8	330.3	28.90	26.17	22.7	13.6	9.4	7.9
56	330.9	353.0	31.72	29.53	9.8	12.8	9.6	8.4
57	349.3	377.3	33.86	33.12	6.7	12.2	9.7	8.8
58	359.3	403.3	33.64	36.95	-0.65	11.6	9.4	9.2
59	382.1	431.0	39.24	41.05	16.6	11.1	10.3	9.5
1960	399.7	460.7	42.96	45.43	9.5	10.7	10.8	9.9
61	415.0	492.4	43.89	50.11	2.2	10.3	10.6	10.2
62	440.7	526.2	48.72	55.12	11.0	10.0	11.1	10.5
63	463.1	562.4	55.48	60.47	13.9	9.7	12.0	10.8
64	495.7	601.1	62.69	66.18	13.0	9.5	12.7	11.0
65	537.0	642.5	70.89	72.29	13.1	9.2	13.2	11.3
66	584.9	686.7	76.24	78.82	7.6	9.0	13.0	11.5
67	626.6	733.9	79.42	85.80	4.2	8.9	12.7	11.7
68	685.2	784.4	87.74	93.26	10.5	8.7	12.8	11.9
69	745.8	838.4	97.10	101.24	10.7	8.5	13.0	12.1
1970	801.3	896.1	102.06	109.76	5.1	8.4	12.7	12.3
71	859.1	957.7	111.66	118.87	9.4	8.3	13.0	12.4
72	942.5	1023.6	127.44	128.60	14.1	8.2	13.5	12.6
73	1052.4	1094.1	148.27	139.01	16.3	8.1	14.1	12.7
74	1153.3	1169.3	158.10	150.13	6.6	8.0	13.7	12.8
75	1249.7	1249.8	162.01	162.01	2.5	7.9	13.0	13.0

Source: Economic Report of the President (Jan. 1975).

TABLE 2
PERCENTAGE CHANGE OF INCOME AND OF DEBT,
MARRIAGE RATES 1945-75

t	Years	% Δ of Y_t	3-Year Rotating Averages of % Δ of Y_t	% Δ of D_t	3-Year Rotating Averages of % Δ in D_t	Rate* of Marriages
0	1945					12.2
1	1946	4.4		69.5		16.4
2	47	7.1	7.1	60.4	54.8	13.9
3	48	9.9	5.2	34.4	41.2	12.4
4	49	-1.4	6.1	28.9	30.0	10.6
5	1950	10.0	6.9	26.8	19.9	11.1
6	51	12.2	9.6	4.0	19.2	10.4
7	52	6.6	8.2	26.9	16.5	9.9
8	53	5.8	4.4	18.6	16.0	9.8
9	54	0.73	6.5	2.4	14.6	9.2
10	55	7.1	5.0	22.7	11.6	9.3
11	56	7.2	6.6	9.8	13.1	9.5
12	57	5.6	5.2	6.7	5.3	8.9
13	58	2.9	4.9	-0.65	7.6	8.3
14	59	6.3	4.6	16.7	8.5	8.5
15	1960	4.6	4.8	9.5	9.4	8.5
16	61	3.8	4.9	2.2	7.6	8.5
17	62	6.2	5.0	11.0	9.0	8.5
18	63	5.1	6.1	13.9	12.6	8.8
19	64	7.0	6.8	13.0	13.3	9.0
20	65	8.3	8.1	13.1	11.2	9.3
21	66	8.9	8.1	7.6	8.3	9.5
22	67	7.1	8.5	4.2	7.4	9.7
23	68	9.4	8.4	10.5	8.4	10.4
24	69	8.8	8.5	10.7	8.8	10.6
25	1970	7.4	7.8	5.1	8.4	10.6
26	71	7.2	8.0	9.4	9.6	10.6
27	72	9.7	9.5	14.1	13.3	11.0
28	73	11.7	10.3	16.3	12.4	
29	74	9.6	9.9	6.6	8.5	
30	75	8.4		2.5		

Source: Figures from Table 1.

*Rates are marriages per 1,000 population residing in area.

Source: Vital Statistics of U.S. 1972, Vol. IV, Marriage and Divorce.

TABLE 3

RATIO OF ANNUAL INSTALLMENT DEBT PAYMENT TO PREVIOUS YEAR'S DISPOSABLE INCOME 1971-1972
(percentage distribution of families)

	No Debt	Less than 5%	5-9%	10-19%	20-39%	40% or more	Not ascer- tained	Total
Life cycle stage of family head								
Younger than age 45								
Unmarried, no children	59	2	8	15	12	2	1	100
Married, no children	38	8	20	21	9	2	2	100
Married, youngest child under age 6	28	19	21	21	9	1	1	100
Married, youngest child age 6 or older	29	19	26	18	5	1	2	100
Age 45 or older								
Married, has children	43	17	17	17	2	1	3	100
Married, no children, head in labor force	57	12	15	11	1	2	2	100
Married, no children, head retired	85	4	5	2	2	1	1	100
Unmarried, no children, head in labor force	71	9	9	8	3	*	*	100
Unmarried, no children, head retired	86	4	4	4	1	*	1	100
Any age								
Unmarried, has children	47	11	15	17	6	2	2	100

Source: Survey of Consumer Finances 1971-72.

TABLE 4

TOTAL INSTALLMENT VERSUS NON-INSTALLMENT CREDIT OUTSTANDING 1929-75;
 TOTAL INSTALLMENT CREDIT EXTENDED AND REPAID ANNUALLY
 (millions of dollars)

Years	Total Consumer Credit Outstanding	Total Installment Credit Outstanding	Total Non- Installment Credit Outstanding	Total Installment Credit	
				Extended	Repaid
1929	7,116	3,524	3,592		
1933	3,885	1,723	2,162		
1939	7,222	4,503	2,719		
1940	8,338	5,514	2,824		
41	9,172	6,085	3,087		
42	5,983	3,166	2,817		
43	4,901	2,136	2,765		
44	5,111	2,176	2,935		
45	5,665	2,462	3,203		
46	8,384	4,172	4,212	8,495	6,785
47	11,598	6,695	4,903	12,713	10,190
48	14,447	8,996	5,451	15,585	13,284
49	17,364	11,590	5,774	18,108	15,514
1950	21,471	14,703	6,768	21,558	18,445
51	22,712	15,294	7,418	23,576	22,985
52	27,520	19,403	8,117	29,514	25,405
53	31,393	23,005	8,388	31,558	27,956
54	32,464	23,568	8,896	31,051	30,488
55	38,830	28,906	9,924	38,972	33,634
56	43,334	31,720	10,614	39,866	37,056
57	44,971	33,868	11,103	42,019	39,870
58	45,129	33,642	11,487	40,110	40,339
59	51,544	39,247	12,297	48,048	42,603
1960	56,141	42,968	13,173	49,793	46,073
61	57,982	43,891	14,091	49,048	48,124
62	63,821	48,720	15,101	56,191	51,360
63	71,739	55,486	16,253	63,591	56,825
64	80,268	62,692	17,576	70,670	63,470
65	89,883	70,893	20,237	78,661	70,463
66	96,239	76,245	21,662	82,832	77,480
67	100,783	79,428	23,235	87,171	83,988
68	110,770	87,745	25,932	99,984	91,667
69	121,146	97,105	28,652	109,146	99,786
1970	127,163	102,064	25,099	112,158	107,199
71	139,107	111,662	27,445	124,686	115,087
72	157,939	127,448	30,491	142,865	127,073
73	180,803	148,273	32,530	164,526	143,703
74	191,451	158,101	33,356	166,176	156,341
75	197,110	162,010	35,100	166,510	162,662

Source: Economic Report of the President (Jan. 1975), p. 240.

APPENDIX I

CHIU AND BROSKY'S MODIFICATION OF ENTHOVEN'S DEBT-INCOME

Chiu and Brosky established empirically that there is a non-zero intercept in the relationship between new borrowings and income:

$$N_t = -19.36 + 0.1730Y_t \text{ with } r = 0.9921$$

(1.66) (0.0048)

Since Enthoven assumed that there was no constant in the relationship, that is

$$N_t = \alpha Y_t,$$

Chiu and Brosky adjusted Enthoven's model to include the constant. They showed that the equilibrium term remains the same despite the modification. Since now,

$$N_t = k + \alpha Y_t$$

$$R_t = b_0 N_t + b_1 N_{t-1} + b_2 N_{t-2} + \dots + b_j N_{t-j}$$

Thus,

$$R_t = L[N_t, N_{t-1}, N_{t-2}].$$

This means that repayment is a linear combination of the new extension of debt in previous periods. And since,

$$\Delta D_t = D_t - D_{t-1} = N_t - R_t.$$

Therefore,

$$\begin{aligned} D_t - D_{t-1} &= k + \alpha Y_t - L[k + \alpha Y_t, k + \alpha Y_{t-1}, k + \alpha Y_{t-2}] \\ &= k' + a_1 Y_t + a_2 Y_{t-1} + a_3 Y_{t-2} = k' + a Y_t^{38} \end{aligned}$$

where $k' = k - L[k] = L'[k] = lk$; i.e., k' is proportional to k .

²⁸This equation is different from Equation V derived by Enthoven,
 $\Delta D_t = a Y_t.$

And since,

$$\begin{aligned} D_1 &= \Delta D_1 + D_0 \\ &= k' + aY_1 + D_0 \end{aligned}$$

Then

$$\begin{aligned} D_t &= k' + aY_t + D_{t-1} \\ &= k' + aY_t + k' + aY_{t-1} + D_{t-2} \\ &= \dots \\ &= tk' + a \sum_{j=1}^t Y_j + D_0 \\ &= \frac{a(1+r)}{r} Y_0 [(1+r)^t - 1] + D_0 + tk'. \end{aligned}$$

The debt-income ratio, therefore, is,

$$\begin{aligned} \frac{D_t}{Y_t} &= \frac{a(1+r)/r \cdot Y_0 \cdot [(1+r)^t - 1] + D_0 + tk'}{Y_0(1+r)^t} \\ &= \frac{a(1+r)}{r} - \frac{a(1+r)}{r(1+r)^t} + \frac{D_0 + tk'}{Y_0(1+r)^t} \\ &= \frac{a(1+r)}{r} - \left[\frac{a(1+r)}{r} - \frac{D_0}{Y_0} \right] (1+r)^{-t} + \frac{tk'}{Y_0(1+r)^t} \end{aligned}$$

This equation is the same as the equation above²⁹ (or Enthoven's Equation 9 in his 1957 article)³⁰ Except that the last term here is new and comes about because of the non-zero intercept. According to l'hospital's rule, this term $tk'/Y_0(1+r)^t$ will vanish as t approaches infinity. This is the so called indefinite form of ∞/∞ . That is,

$$\frac{tk'}{Y_0(1+r)^t} = 0 \quad \text{as } t \text{ tends to infinity.}$$

Therefore, Enthoven's debt-income ratio remains intact even with the empirically determined non-zero intercept. That is, the ratio still equals $a(1+r)/r$ as the term $tk'/Y_0(1+r)^t$ vanishes.

²⁹See Equation VIII, supra, p. 17.

³⁰A. Enthoven, "The Growth of Installment Credit and Future Prosperity," op. cit., p. 9.

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