

MONEY SUBSTITUTES AND MONETARY POLICY IN

THE UNITED KINGDOM 1923 to 1974*

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This paper is circulated for discussion purposes only and its contents should be considered preliminary.

* We are indebted to Mr. R. L. Thomas of W. Grenwell & Co. for assistance with data.

Introduction

This paper considers whether the growth of non-bank financial intermediaries, whose reserves are not under the control of the central bank in the way that those of commercial banks are, has led to monetary policy in the U.K. becoming impotent. The view that it has done so is generally ascribed to the Radcliffe Report;⁽¹⁾ that report is widely believed to have set out the view that any squeeze of the money supply will be frustrated by an offsetting expansion of the liabilities of these institutions, so that there is no effect on economic activity.

As was pointed out by John Gurley⁽²⁾ in his review of the Radcliffe Report, it is hard to find a statement precisely to that effect but in Gurley's words, "the reader is left with the thought." Gurley then went on to show, by means of an arithmetical example, that before these intermediaries can in this way frustrate monetary policy, their liabilities and those of the controlled intermediaries (i.e. the commercial banks) must be perfect substitutes. This same proposition was, some three years later, proved more formally by Tobin and Brainard.⁽³⁾ The demonstration will not be repeated here; but the intuitive sense of it can be easily seen. Any contraction of the money stock will alter the ratio in portfolios of money to other assets. For this to be an equilibrium the yield on these other assets must rise. This will act as a deterrent to the acquisition of new assets, and hence be contractionary in its effect on economic activity. This process can only be prevented if the contraction in money can be offset by the expansion of another asset which can take the place of money in portfolios without requiring any change in relative yields - i.e. the expansion of an asset which is,

by definition, a perfect substitute for money. This paper tests whether such a situation has come about in the United Kingdom.

It is perhaps worth noting that Henry Simons⁽⁴⁾, many years before the Radcliffe Report, suggested that non-bank financial intermediaries might impede or frustrate monetary policy by a different route. He conjectured that the growth of these intermediaries might lead to what he called "financial instability"; from the context, this plainly meant instability of the demand for money expressed as a function of the usual variables. This is not an issue we pursue directly, although our results do have some bearing on it, and we will comment later on this aspect of the problem.

The Test

These are two basically different approaches to testing the hypothesis that non-bank financial intermediaries, by expanding their liabilities to offset a monetary contraction (or the converse for an expansion) frustrate monetary policy. One is to build a general equilibrium model of the entire financial system, and test the hypothesis directly. This was the approach of Clayton, Dodds, Ford and Ghosh⁽⁵⁾, who found that financial intermediaries did in this way frustrate monetary policy. The other approach is to estimate a demand for money function, and observe its interest elasticity; only if this elasticity is infinite is the "Radcliffe Hypothesis" born out. Any lesser elasticity gives monetary policy control over interest rates. The latter, simpler, approach is the method of this paper.

A similar method was used by Cagan and Schwartz⁽⁶⁾ in a study of the question in the U.S.A. They fitted a function to data from two different periods (pre and post the Second World War) and found that the interest elasticity of demand for M_1 was infinite in neither period, and was in fact lower in the second than in the first, thus decisively rejecting, for the U.S.A., the "Radcliffe Hypothesis".

Our results are later compared with those of Clayton et al, and those of Cagan and Schwartz.

The Data

In the U.K. there are currently two series published for the money supply, M_1 and M_3 . M_1 is defined as notes and coin in circulation with the public, plus sterling current accounts held within the private sector; and M_3 is defined as all deposits held with the U.K. banking sector by the U.K. residents, of both the public and the private sectors, plus notes and coin. (The definitions of the series have recently been somewhat changed, but we ended our data period before the new definitions started, as the re-defined series are still subject to frequent and substantial revision, and have not yet been linked to the old series.) M_1 and M_3 have moved broadly together, diverging significantly only when a change in interest rates led to adjustment from interest-bearing to non-interest bearing money, or conversely; once the fairly rapid stock adjustments were over, the series resumed their similar path. (This is described in detail in Pepper and Wood⁽⁷⁾.) The same appears to be true for the U.S.A.; as was stated in the Federal Reserve Bank of St. Louis' "Monetary Trends" for the month ending July

31st, 1975, "The Major Monetary Aggregates historically have moved at similar rates of change". It would therefore appear that which data series should be used is economically a matter of indifference, and could be decided purely by which was the more reliable series. Cagan and Schwartz do not state why they used M_1 so these were presumably the grounds.

But in fact which series one uses is not a matter of economic indifference in the U.K. The reason is that in the U.K. M_1 is demand determined (on the majority of occasions). The Bank of England supplies whatever currency the general public wants and, except when there is a very severe liquidity squeeze, many people are able to replenish their current accounts from their deposit accounts and other liquid assets. When there is an acute liquidity squeeze M_1 is squeezed, but most of the time M_1 is determined purely by the demand for it. M_3 is the series that generally shows the effect of monetary controls, and it is therefore M_3 that is of interest for our purpose. This distinction between M_1 and M_3 is of course not a fact of life, but rather is a consequence of Bank of England policy; nevertheless, unless that policy changes only M_3 is relevant to the present question.

The Bank of England has published money supply data only since 1963, a period which falls far short of capturing the growth of non-bank financial intermediaries, and indeed starts after the Radcliffe Report was published. As we were concerned to see what had happened to the interest elasticity of the demand for money over a long period (our econometric technique, described below, lets us see how the elasticity varied from year to year) we wished to use a longer run of data. For the

period from 1923 to 1957, we used the net interest bearing deposits of the London Clearing Banks; (the series starts in 1922). This series has been shown (see Pepper and Thomas⁽⁸⁾ and the references therein) to be a satisfactory M_3 proxy, and from 1958 to 1963 we used data previously used by Laidler and Parkin.⁽⁹⁾

In estimating the interest elasticity of the demand for M_3 , one is immediately faced with a choice of interest rates. Over the period from 1923, only two rates are plausible candidates. These are the consol yield and the treasury bill rate; these are plausible both in the sense that they are rates in important markets throughout the entire period and in that the data are consistent and accurate. We estimated functions using both, and the results were broadly similar, so there is in a sense no need to make a choice. But if we had to do so, we would choose the consol rate. The reason is that it is that rate which is less under the control of the authorities, and better reflects money market conditions. This emerges from, for example, work by M. J. Hamburger^(10 and 11), and the point was also made by Michael Artis⁽¹²⁾, who noted further that the Treasury Bill rate was susceptible to the quasi-monopolistic influence of the discount house syndicate. Further, in the earlier part of our period the Treasury Bill rate was so low that it covered transaction costs for only the very largest investors, such as insurance companies, and was thus a relevant interest rate for only a very small group of investors. These reasons for preference can of course all be rejected without affecting our conclusions, as both functions behave, in general, in a very similar fashion; but, as will emerge, they do explain one noticeable difference in the behaviour of the interest elasticities.

The Econometric Test

(a) Theory

We assume that, in any time period t , a functional relationship exists between the money stock, M_t , income Y_t , the interest rate r_t and the money stock in the previous period M_{t-1} such that

$$(1) \quad M_t = f(Y_t, r_t, M_{t-1}) + u_t \quad t = 1, 2, \dots, T$$

where u_t is a disturbance term which may be brought in additively.

Furthermore for simplicity and ease of theoretical interpretation this relationship may be specified as linear in its parameters and additive in its independent variables. Thus it may be written

$$(2) \quad g(M_t) = \alpha_0 + \alpha_1 h_1(Y_t) + \alpha_2 h_2(r_t) + \alpha_3 h_3(M_{t-1}) + u_t$$

where α_i are coefficients and $g(X)$ and $h_i(X)$ are functions of their respective arguments, $i = 1, 2, 3$.

To make equation (2) explicit we make use of the power transformation introduced by Box and Cox⁽¹³⁾ i.e. for each variable, $X > 0$ say, in equation (2)

$$(3) \quad g(X) = h_i(X) = X^{(\lambda)} = \begin{cases} \frac{X^\lambda - 1}{\lambda} & \text{for } \lambda \neq 0 \\ \ln X & \lambda = 0. \end{cases}$$

Equation (2) may therefore be rewritten

$$(4) \quad M_t^{(\lambda)} = \alpha_0 + \alpha_1 Y_t^{(\lambda)} + \alpha_2 r_t^{(\lambda)} + \alpha_3 M_{t-1}^{(\lambda)} + u_t$$

Equation (4) may be interpreted as the reduced form arising from a desired money stock equation subject to a partial adjustment mechanism i.e. If M_t^* is desired money stock in period t

$$(5) \quad M_t^{*(\lambda)} = \beta_0 + \beta_1 Y_t^{(\lambda)} + \beta_2 r_t^{(\lambda)} + \varepsilon_t$$

$$(6) \quad M_t^{(\lambda)} = \gamma(M_t^{*(\lambda)} - M_{t-1}^{(\lambda)}) \quad 0 \leq \gamma \leq 1.$$

Use of the familiar Koyck transformation yields the reduced form⁽¹⁴⁾

$$(7) \quad M_t^{(\lambda)} = \gamma\beta_0 + \gamma\beta_1 Y_t^{(\lambda)} + \gamma\beta_2 r_t^{(\lambda)} + (1 - \gamma) M_{t-1}^{(\lambda)} + \gamma\varepsilon_t.$$

This is equivalent to equation (4) on making the substitutions

$$(8) \quad \begin{cases} \alpha_i = \gamma\beta_i & i = 0, 1, 2 \\ \alpha_3 = (1 - \gamma) \\ u_t = \gamma\varepsilon_t \end{cases}$$

Equation (4) has the following properties. Firstly, for $\lambda = 1$, the arithmetic function,

$$(9) \quad M_t = \alpha_0' + \alpha_1 Y_t + \alpha_2 r_t + \alpha_3 M_{t-1} + u_t$$

where $\alpha_0' = 1 + \alpha_0 - \alpha_1 - \alpha_2 - \alpha_3$, is obtained.

Further, for $\lambda = 0$ we obtain the logarithmic function

$$(10) \ln M_t = \alpha_0 + \alpha_1 \ln Y_t + \alpha_2 \ln r_t + \alpha_3 \ln M_{t-1} + u_t.$$

The long-run elasticities of the money stock with respect to income, η_{yt} , and the interest rate, η_{rt} , are defined as

$$(11) \eta_{yt} = \frac{\partial M_t}{\partial Y_t} \cdot \frac{Y_t}{M_t} = \beta_1 \left(\frac{Y_t}{M_t} \right)^\lambda$$

$$(12) \eta_{rt} = \frac{\partial M_t}{\partial r_t} \cdot \frac{r_t}{M_t} = \beta_2 \left(\frac{r_t}{M_t} \right)^\lambda$$

Thus, this generalisation of the functional form allows alternative forms of the relationship between the money stock and its determinants to be specified, as well as admitting the more popular arithmetic and logarithmic forms as special cases. Additionally, and more important to the aim of this paper, the elasticities are seen to depend on the levels of the variables and the parameter of transformation, and therefore are variable over time. Of course, for $\lambda = 0$, the elasticities are given by $\eta_y = \beta_1$ and $\eta_r = \beta_2$, the constant elasticity situation which is a well known property of the logarithmic functional form (viz Cobb-Douglas production functions).

(b) Estimation

As already shown, the value of the transformation parameter λ defines a particular functional form of the money stock relationship. We may obtain an estimate of this parameter by assuming that the disturbance

term u_t in equation (4) is normally distributed with zero mean and constant variance σ^2 for some 'true' value of λ . An estimate of λ is then obtained by considering the likelihood of equation (4) for given λ (15)

$$(13) L = \frac{1}{(2\pi)^{T/2} \sigma^2} \exp \left[-\sum_{t=1}^T \left(\frac{M_t^{(\lambda)} - \alpha_0 - \alpha_1 Y_t^{(\lambda)} - \alpha_2 r_t^{(\lambda)} - \alpha_3 M_{t-1}^{(\lambda)}}{2\sigma^2} \right)^2 \right] \cdot J$$

where J is the Jacobian of the inverse transformation from the dependent variable $M_t^{(\lambda)}$ to the actually observed M_t

$$(14) J = \prod_{t=1}^T \left| \frac{dM_t^{(\lambda)}}{dM_t} \right| = \prod_{t=1}^T M_{t-1}^{\lambda-1}$$

The maximised log likelihood for a specific value of λ is thus, except for a constant,

$$(15) S(\lambda) = - T/2 \log \hat{\sigma}^2 + \log J$$

where $\hat{\sigma}^2 = \frac{R(\lambda)}{T}$, $R(\lambda)$ being the residual sum of squares from the regression of $M_t^{(\lambda)}$ on $Y_t^{(\lambda)}$, $r_t^{(\lambda)}$ and $M_{t-1}^{(\lambda)}$. Equation (15) may be rewritten

$$(16) S(\lambda) = - T/2 \log [R(\lambda)] + (\lambda - 1) \sum_{t=1}^T \log M_t + T/2 \log T$$

This equation may then be calculated for each λ in a specified range.

The maximum likelihood estimate, $\hat{\lambda}$, is given by that value $\hat{\lambda}$ such that

$$(17) S(\hat{\lambda}) > S(\lambda)$$

for all specified λ . At this value $\hat{\lambda}$, maximum likelihood estimates of the α_i are given by the ordinary least squares estimates of the coefficients of the regression of $M_t^{(\hat{\lambda})}$ on $Y_t^{(\hat{\lambda})}$, $r_t^{(\hat{\lambda})}$ and $M_{t-1}^{(\hat{\lambda})}$.

Box and Cox (op.cit) show that inferences on λ may be made by noting that an approximate 100(1- α)% confidence region for λ may be obtained from

$$(18) S(\hat{\lambda}) - S(\lambda) < \frac{1}{2} \chi_1^2(\alpha)$$

Thus, for instance, an approximate 95% confidence interval is given by

$$(19) S(\hat{\lambda}) - S(\lambda) < 1.92$$

Given the estimate $\hat{\lambda}$ and the corresponding coefficient estimates $\hat{\alpha}_i$ the long run elasticities defined by equations (11) and (12) may be calculated from

$$(20) \hat{\eta}_{yt} = \frac{\hat{\alpha}_1}{(1 - \hat{\alpha}_3)} \cdot \left(\frac{Y_t}{M_t} \right)^{\hat{\lambda}}$$

$$(21) \hat{\eta}_{rt} = \frac{\hat{\alpha}_2}{(1 - \hat{\alpha}_3)} \cdot \left(\frac{r_t}{M_t} \right)^{\hat{\lambda}}$$

The Results

The log likelihood plots of equation (4) with the associated 95% confidence intervals for λ , using both the Consol Yield and the Treasury Bill rate are shown in Figures 1 and 2. It is of interest to note that neither confidence interval includes the logarithmic case of $\lambda = 0$, thus rejecting the hypothesis of constant elasticity over time and, incidentally, the use of a logarithmic functional form such as is common in empirical work on the demand for money.

The maximum likelihood estimates of the coefficients $\hat{\alpha}_i$ of equation (4), with the implied average elasticities and adjustment coefficient, along with related statistics are shown in Figure 3. It should be noted that all coefficients are of the correct sign and are highly significant, with the coefficients of determination both high. Although the h statistic rejects the hypothesis of zero autocorrelation at the 5% level, it must still be concluded that since we have been able to obtain a good fit of the function to such a long run of data, including the war period, the growth of non-bank financial intermediaries has not brought "financial instability" of the type Simons feared.

The yearly interest elasticities of the demand for money with respect to the Consol Yield and the Treasury Bill rate, calculated from equations (20) and (21) are plotted in Figures 4 and 5.

The interest elasticity of the demand for money, with respect to both interest rates used, but particularly the consol yield, show an upward trend. The elasticity never approaches infinity, however, so the

"Radcliffe Hypothesis" is clearly rejected. The result is thus inconsistent with both that of Clayton et al, which supported the "Radcliffe Hypothesis", and that of Cagan and Schwartz, which found that the elasticity had declined.

In fact there is no serious inconsistency with Cagan and Schwartz, even had the studies been for the same country, reconciliation would be straightforward. They examined M_1 and we have examined M_3 . As M_1 is non interest bearing, it may be used more to satisfy transactions demands than to satisfy a wealth demand, while the opposite may be true for M_3 . The liabilities of non-bank financial intermediaries may well be, as Alvin Marty⁽¹⁶⁾ suggested in his review of Gurley and Shaw's "Money in a Theory of Finance", closer substitutes for the latter than the former. Our result, therefore both supports that conjecture of Alvin Marty's and is reconciled to Cagan and Schwartz's result by that conjecture.

The Clayton et al result is completely inconsistent with ours; no reconciliation is possible. But in fact their conclusion does not bear detailed examination. It requires that money and the liabilities of non-bank financial intermediaries be perfect substitutes. (See Gurley, and Tobin and Brainard, both op.cit). If that is so, then the interest elasticity of the demand for money must be infinite. But in their model the interest elasticity of the demand for money does not appear to be infinite; a rise in bank rate, for example, reduces the demand for money by the personal sector, and, so far as can be ascertained without running their model, does the same for other sectors. Their model is therefore internally inconsistent.

While comparing our results with earlier work, it is worth

noting in passing a discussion of the effect of trade credit in dampening the efficacy of monetary policy. The outcome of work by Brechling and Lipsey (17, 18) and by White (19) was that trade credit is, at most, a very weak frustrator of monetary policy. Our work is fully consistent with that result.

Contrasts between Treasury Bill and Consol Elasticities

There are two contrasts. First is the much steeper rise in the interest elasticity with respect to Consol Yields. Second is the sharp rise, followed later by a sharp fall, in the interest elasticity with respect to the Treasury Bill rate, in the immediate post World War II years. These are considered in that order. If, as argued above, consol yields are the better indicator of money market conditions, then the rise may simply represent the increasing importance of non-bank financial intermediaries. The effect is less marked for the Treasury Bill rate simply because that rate does not so well represent money market conditions.

The explanation for the fluctuation in the interest-elasticity with respect to the rate in Treasury Bills is related to the same factor - to the closeness of the authorities' control over Treasury Bill rate. In the relevant period, the government was committed to a policy of "cheap money". The money markets were aware that the government could successfully thus influence the Treasury Bill rate, although remaining sceptical about the scope for influencing the consol rate, and thus became sharply more willing to substitute other assets for Treasury Bills in response to rate changes on the latter, while not being significantly affected in their behaviour towards consols.

Policy Implications

The major implication for policy is of course that monetary policy has not been rendered impotent by the growth of non-bank financial intermediaries. It is, of course, also true that to produce the same interest rate effect an operation by the monetary authorities would have had to be larger in 1974 than in 1923 - by about 100%. Does that pose any problems? It is worth noting that it brings one benefit, as was pointed out by Brainard⁽²⁰⁾ it reduces the response of the economy to shocks. Further, it should be noted that, while the size of the operation needed has grown by 100%, money GNP has grown by 1500%, and wealth by approximately the same magnitude. These observations are relevant when one considers why, if the operation needed is of a less than infinite size, there should be any concern at all about the size of the operation. Concern may arise from two sources. The first is that the chances of policy error, or of large policy error, increase with the size of operation; reasons why they should be far from obvious. The size of the operation is important, however, because of the money market's "appetite" for stock - very large operations may give rise to uncertainty and to withdrawing from the market; and they may have disruptive side effects on financial institutions. These fears, however, are, if justified, relevant only to operations which have grown disproportionately relative to related magnitudes; and it is clear that this has not happened in the U.K.

Nonetheless, the steady growth in the interest elasticity does suggest that it would be worthwhile for the authorities to monitor the effect of financial innovation on the interest elasticity of their control variable

Summary and Conclusions

By fitting a demand for money function to data from 1923 to 1974, it was found that the interest elasticity of the demand for money had risen over the period, but certainly not sufficiently to render monetary policy impotent to influence the yield on existing capital. This bears out earlier work on the significance of trade credit in the U.K., and is consistent with work on the same question in the U.S.A. The "Radcliffe View", that unregulated financial intermediaries have vitiated the effect of monetary policy, was decisively rejected. Monetary policy in the U.K. does affect the terms on which the community will hold capital goods valued at the prices of current production; and altering these terms is, in the words of Tobin and Brainard (op.cit) "what monetary policy is all about."

APPENDIX

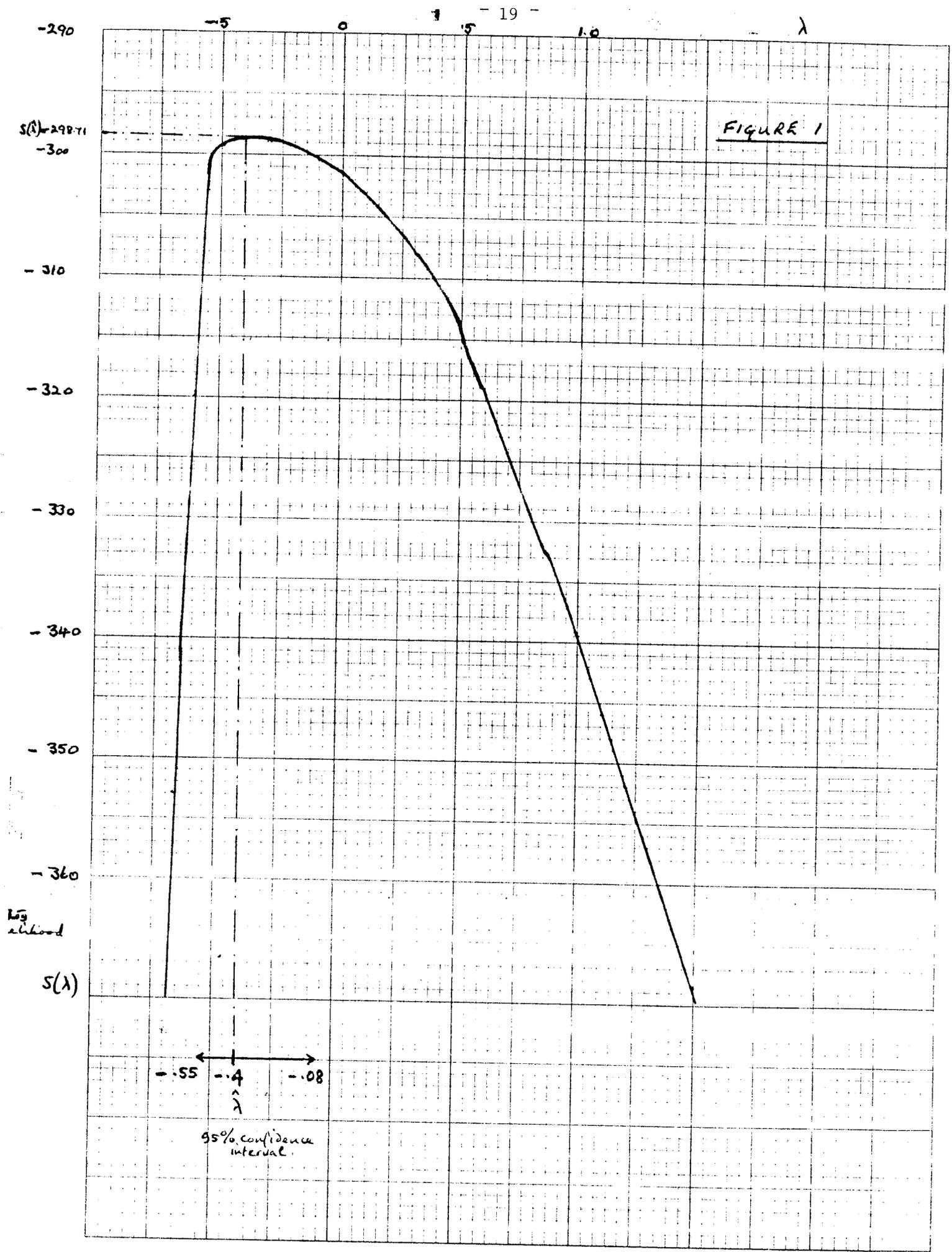
The inclusion of the war years 1939 to 1945 in the observation set represents a departure from usual practices. However, as a confirmation of the results presented in this paper, the post and pre war periods were estimated separately i.e. from 1923-1939 and 1946-1974. Briefly the results were as follows. The maximum likelihood estimate $\hat{\lambda}$, was .5 for both the pre and post war periods using the Consol Yield. Similarly use of the Treasury Bill Rate gave estimates of $\hat{\lambda} = -.5$ pre war and $\hat{\lambda} = .2$ post war. However, confidence intervals were much wider compared to those obtained over the whole period. This is to be expected since the number of observations and hence degrees of freedom is much reduced. Likewise, although coefficient estimates were of the correct sign, their significance dropped somewhat for the same reason.

Most importantly however, the yearly elasticities calculated separately for the two periods give confirmation of the conclusions already reached. Figure 6 shows that the interest elasticity for both the Consol Yield and the Treasury Bill rate is higher for the post war period than the pre war period, but certainly not high enough to render monetary policy impotent.

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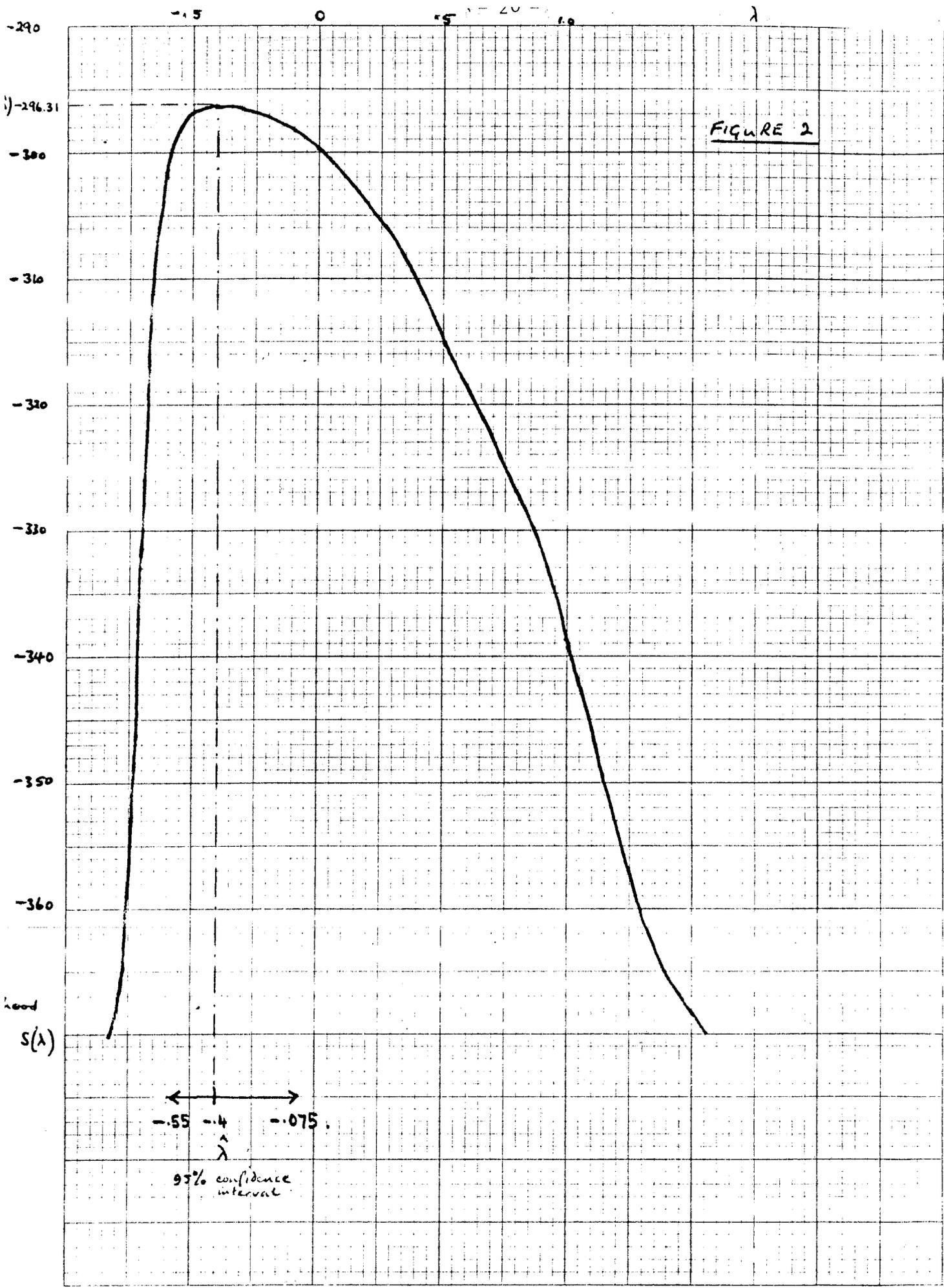


Figure 3

Maximum likelihood estimates of equation (4)

Consol Yield as r_t

$\hat{\lambda}$	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$\bar{\eta}_y$	$\bar{\eta}_r$	γ	R^2	h
-0.4	-.378	.323	-.00089	.827	1.181	-.551	.173	.995	2.35
	(3.72)	(3.25)	(2.74)	(13.14)					

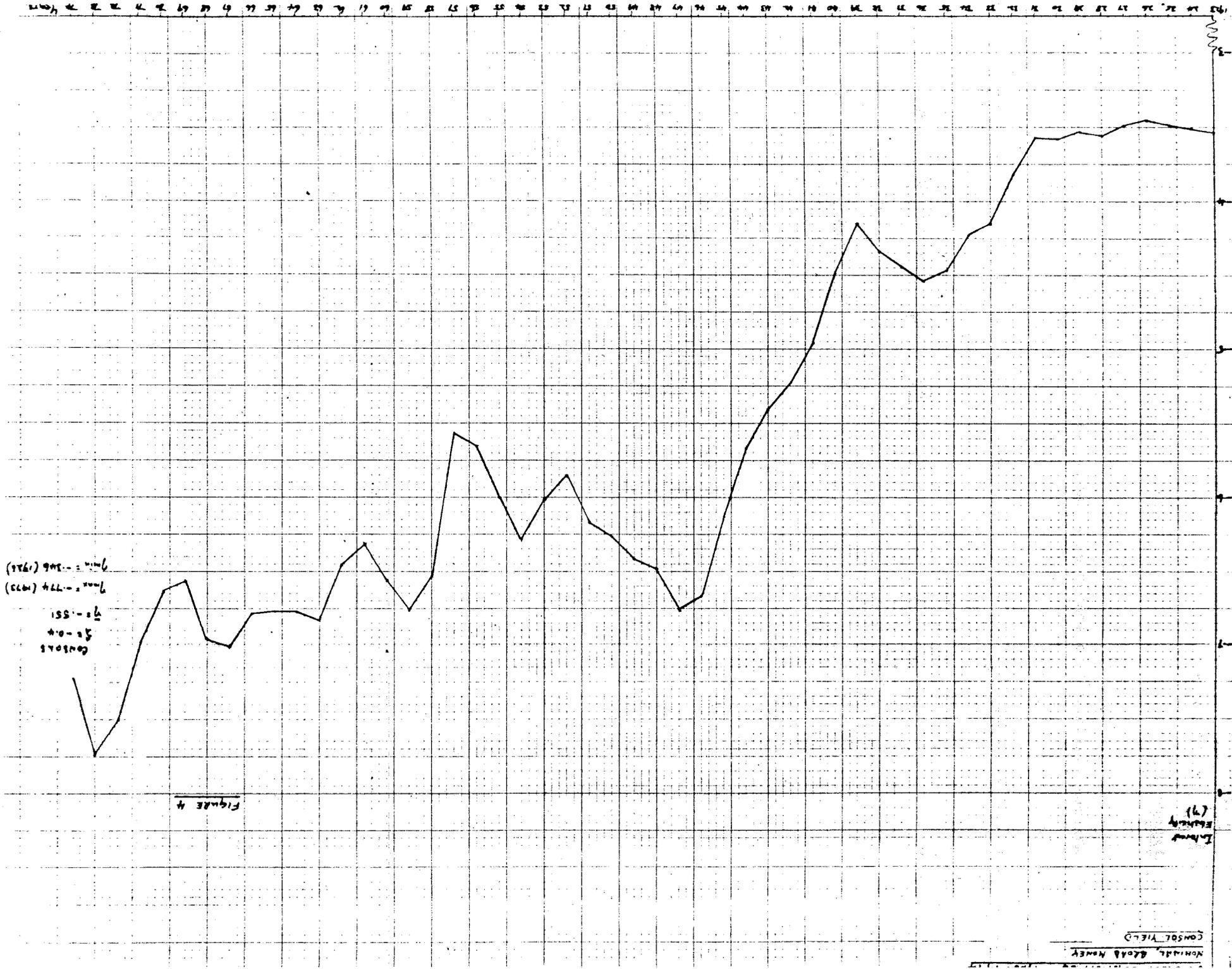
Treasury Bill Rate as r_t

$\hat{\lambda}$	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$\bar{\eta}_y$	$\bar{\eta}_r$	γ	R^2	h
-0.4	-.463	.444	-.00026	.742	1.089	-.147	.258	.996	2.59
	(4.42)	(4.15)	(3.58)	(11.04)					

$\bar{\eta}_y$, $\bar{\eta}_r$ are average elasticities with respect to income and the interest rate respectively.

t statistics are given in parentheses $t_{0.995}(48) = 2.68$.

h statistic rejects the null hypothesis of zero autocorrelation at the 5% level if $h > 1.645$.



CONSOL YIELD
 Normal, Good Money
 50-55
 70-75 (1970)
 90-100 (1975)

FIGURE 4

CONSOL YIELD
 Normal, Good Money
 (7)

CONSOL YIELD
 Normal, Good Money

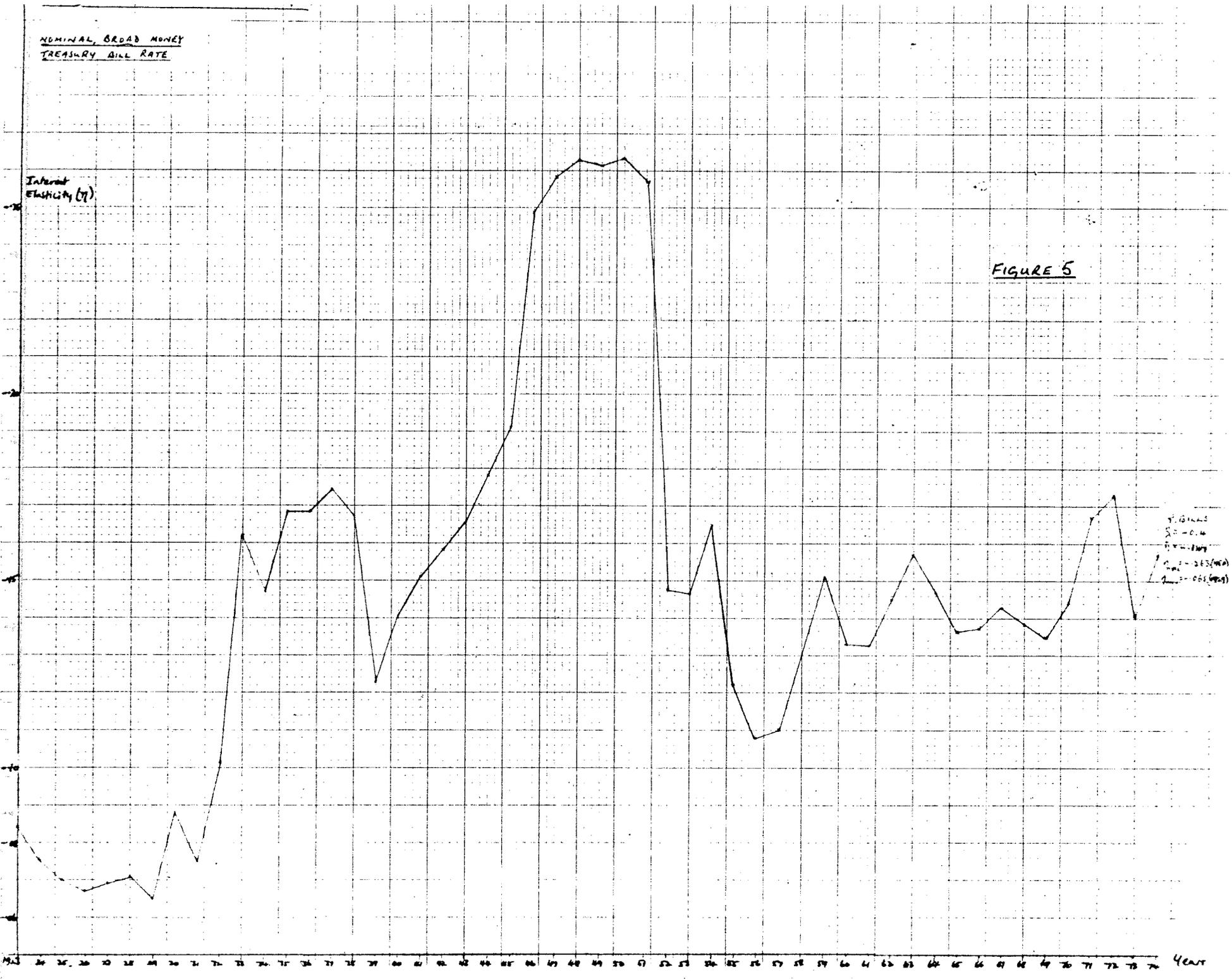
NOMINAL BROAD MONEY
TREASURY BILL RATE

Interest
Elasticity (η)

FIGURE 5

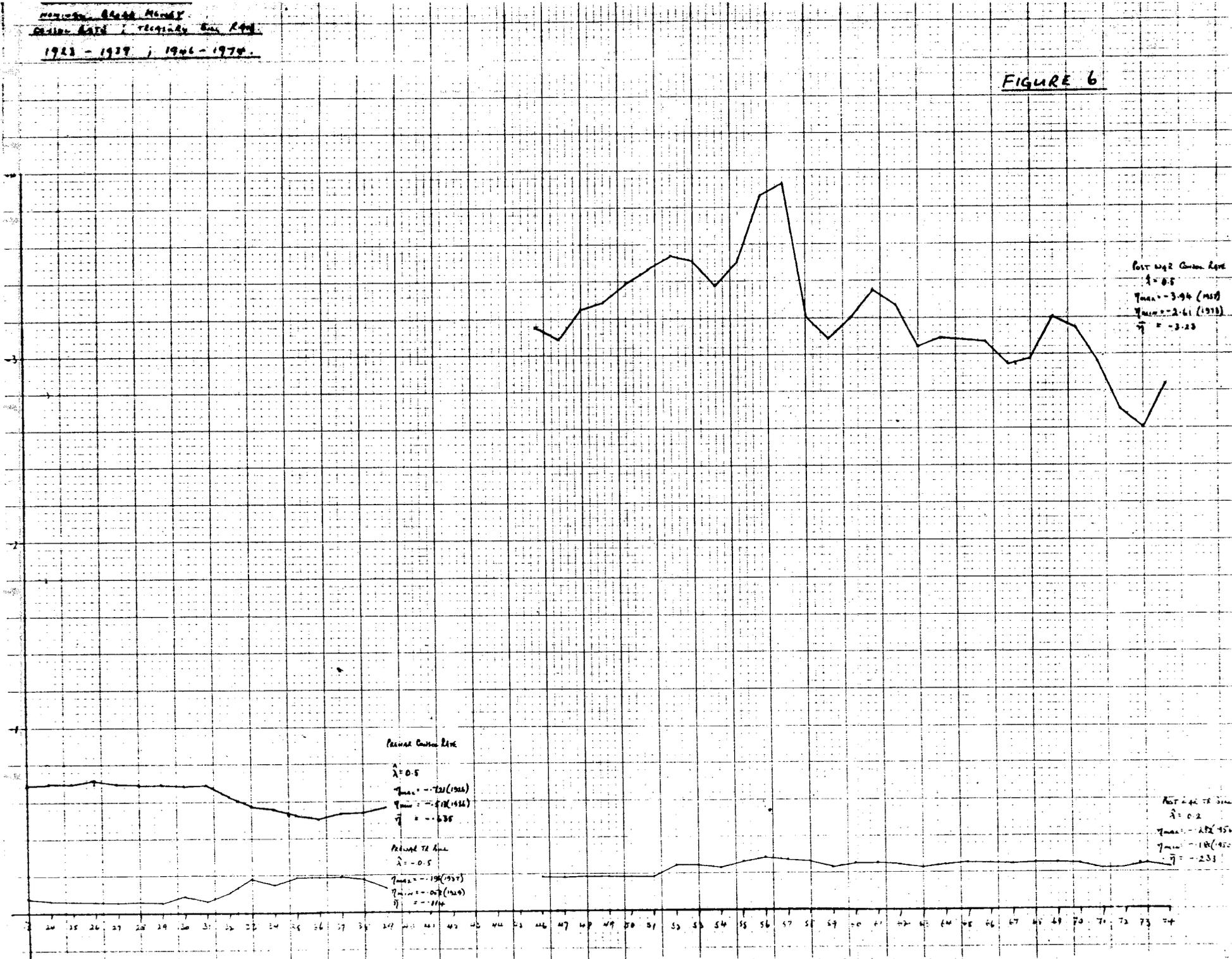
η BROAD
 $S = 0.14$
 $\beta = 1.07$
 $\alpha = 2.65(\text{M2})$
 $\gamma = 0.61(\text{M1})$

- 23 -



Maximum Black Money
 Dollar Rate & regularly on 24th
 1923 - 1937 ; 1946 - 1974.

FIGURE 6



- 24 -