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The Demand for Money Function in Ireland: Estimation and Stability

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I INTRODUCTION

In this paper we specify and estimate a demand for money function for Ireland. This function is then submitted to a stability test using a recently developed technique. The issue of the stability of the demand for money function is an important one for the monetary authorities irrespective of whether monetary policy is conducted within a relatively closed economy, such as in the US, or within a highly open economy with a fixed exchange rate dominated by external financial markets, as in the case of Ireland.

The revival of interest in the demand for money dates, perhaps, from Friedman's 1956 article. He stressed that, as an empirical hypothesis, the demand for money is a highly stable function of a few variables that determine it. A consequence of this is that changes in the nominal stock of money (which in a relatively closed economy is closely controllable by the monetary authorities) that tend to give rise to a disequilibrium in the money market will result in action by money holders to restore the equilibrium level of real money balances. If the nominal money stock tends to exceed the demand, monetarists argue that the equilibrating mechanism will be a general rise in prices as the public tries to unload its excess money balances.

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It is worth adverting to the process whereby such a disequilibrium can arise in an economy with zero or imperfect capital mobility. A central bank does not directly control the nominal money stock; it does so indirectly, principally by buying and selling government securities which affect the level of bank reserves and the level of short-term interest rates. The commercial banks' adjustment of their portfolio in the face of the new structure of interest rates has repercussions on the money stock. Although interest rate movements themselves represent an equilibrating mechanism, it is possible for individual transactors to find that their money holdings are out of line with their expectations and desires. Another source of disequilibrium arises from exogenous changes in the independent variables in the demand for money function.

The stability of the demand for money function has a different, but no less great, significance in an economy with approximately perfect capital mobility. With perfect capital mobility there is no scope for altering the domestic interest rate; any attempt to do so will be frustrated by capital flows. A stable demand for money function in this case implies that, if the authorities attempt to change the domestic component of the money stock, i.e., domestic credit, there will be an exactly offsetting change in the foreign component, i.e., external reserves.

In either type of economy, it is important to know whether or not the demand for money function is stable. In a closed economy, a stable function enables the authorities to know the effects of their open-market operations on the level of interest rates and, secondly, a stable function is a necessary condition for assessing the effects of monetary actions on income. In an open economy with virtually perfect capital mobility, a stable demand for money function enables the authorities to adapt domestic credit policy to attain an external reserves target.

II SPECIFICATION AND ESTIMATION OF DEMAND FOR MONEY FUNCTIONS

In this section, we specify and estimate demand for money functions at both aggregated and disaggregated levels.

II.1 The Definition of Money

The concept of credit that a central bank ought to control in a small open economy operating a fixed exchange rate dictates the definition of money to be used in an analysis of the demand for money (see Brau, 1971).

It is clear that an external reserve loss will continue if the drain on the money stock that results from the reserve loss is being offset by credit created by the banking system. Without such a credit expansion, the incipient reduction in money holdings would result in a self-correcting mechanism eliminating the balance-of-payments deficit. Brau argues, therefore, that a central bank should concern itself with controlling the credit of *all* domestic financial institutions with a credit-creating potential so that, given a stable money demand function, an excessive increase in credit does not take place with a consequential external reserve loss. Where non-bank financial intermediaries do not have a significant role in creating credit, it suffices for the central bank to concern itself with the credit-creating potential of the banking system. It follows from this that the proper concept of money (or bankers' liabilities) to be used in a demand for money investigation is broad money (M3), i.e., currency *plus* current accounts *plus* deposit accounts at all banks.

It is customary to exclude government accounts at commercial banks from the definition of money for two reasons. First, at a macro level, it is necessary to analyse economic behaviour within a consistent balance sheet framework (see, for example, Brainard and Tobin, 1968). This requires a recognition of the interdependencies between financial markets and between different sectors. The four sectors customarily isolated are government, commercial banks, central bank and the non-bank private sector. This requires asset demand functions to be estimated for each sector, one of which is the private sector's demand for money. Secondly, the determinants of the government's money holdings may be quite different from those of the private sector. A discretionary increase in taxes will increase government balances, but it would seem incorrect to view this as an increase in the demand for money balances by government.

Data on the money stock and other variables together with sources and methods are set out in Appendix 1.

II.2 SPECIFICATION

In the following two sections of the paper, we will consider money demand equations at aggregated and disaggregated levels. Goldfeld (1973, p. 592) has questioned the correctness of estimating a single demand for broad money over the alternative of estimating separate equations for the components of M3 on the grounds that a uniform specification may not be appropriate for the components of M3; in addition, aggregation leads to smudging of the interest rate effect since interest rates on deposits can be expected to be positively related to deposit accounts and negatively related to currency and current accounts. In the event, we concentrate on the two components of M3, M1 (the sum of currency and current accounts) and deposit accounts.

Before considering details of an empirical nature, it is necessary to clarify whether or not the money demand function should be specified in real or nominal terms. Although the specification in real terms is the one suggested by economic theory, some writers have couched their investigation in nominal terms. We follow the recommendation of Johnson (1971, p. 124) that estimation should be in terms of nominal money with the price level entered as an independent variable to determine whether, in fact, money demand is homogeneous of degree one in prices.

II.3 An Aggregate Demand For Money Function (M3)

As a first step, we specify and estimate an aggregate demand for money function. The functional forms used in the specifications are those encountered most frequently in the literature, the linear and log-linear formulations. In the event, the logarithmic specifications were found to have a very low explanatory power, so that we have concentrated on the linear specification.

Those studies that have regarded money as but one asset in a portfolio have logically tended to use wealth rather than income as the appropriate scale variable in a demand for money function. Since no series on wealth is available, it is necessary to operate with income as the scale variable, which of necessity lays emphasis on the transactions motive for holding money. Using income rather than wealth may make little difference to the efficiency of the equation estimates, to judge by the evidence of Goldfeld's (1973) comprehensive study.

On the question of what interest rates to include in the demand for money function, economists of a more Keynesian persuasion tend to regard money as a close substitute for other financial assets but a rather distant substitute for goods. Accordingly, the interest rate(s) to be included in a Keynesian demand for money function would be the own rate (i.e., the deposit rate) and rates on close substitutes such as building society deposits and Treasury Bills. Writers of a more monetarist kind, who regard money as a substitute for physical goods as well as alternative financial assets, would include the expected rate of inflation as an additional argument to represent the nominal return on physical goods (Friedman, 1956).

We have concentrated on a flow demand specification for a number of reasons: it is assumed that the economy inherits a stock of money from the past and, furthermore, that this stock of money is in equilibrium at the beginning of the estimation period; in each subsequent period changes in the arguments evoke changes in the flow demand for money which re-establishes stock equilibrium at the end of each period. (The assumption of equilibrium is plausible, given the very high degree of financial integration with the UK.) In other words, our specification is an equilibrium flow demand specification. This desired flow demand for money balances is specified to be a function of the expected values of the arguments. The respective expected values of the arguments are postulated to be weighted averages of their past values. We eschew the use of the Koyck approach in estimating the weights on past values, because it implies the imposition of identical geometrically declining lag structures on all the independent variables. The Almon approach, which is employed here, is much more flexible in that it does not impose any of the restrictions associated with the Koyck approach.

Our specification is, therefore, as follows:

$$\Delta M3 = a + b\,\Delta Y^e + c\,\Delta P^e + d\,\Delta R^e + e\,\Delta \dot{P}^e + u \tag{1}$$

where M3 = broad money, Y = real income, P = a general price index, R = interest rate term, $\dot{P}$ = the rate of inflation and u is a disturbance term.

The 'e' superscript indicates expected or permanent values of a variable, and these are measured as weighted averages of actual past values of the variables. This results in the following type of equation for estimation:

$$\Delta M3 = a_0 + \sum_{i=0}^{b} b_i\,\Delta Y_{t-i} + \sum_{i=0}^{m} c_i\,\Delta P_{t-i} + \sum_{i=0}^{n} d_i\,\Delta R + \sum_{i=0}^{p} e_i\,\Delta \dot{P} + u \tag{1^1}$$

To test for correct specification of Almon lags, we have applied a routine suggested by Harper (1977). First, however, it is noted that too high a degree of polynomial can be tested for by the conventional t-test on the coefficient of the highest degree term of the polynomial. If the parameters within the Almon method are specified incorrectly otherwise (e.g., an incorrect lag length or too low a degree of polynomial), Harper shows that the stochastic term in the incorrectly specified equation has a non-zero expectation. Ramsey (1969) has developed a number of tests for non-zero means of errors. Ramsey's test with OLS residuals consists of regressing these residuals against the series comprising the estimated dependent variable and its powers: if the standard F-test indicates that the vector of residuals is uncorrelated with the right-hand side variables, we can infer that the original specification is correct. (A more powerful test would use BLUS residuals; we have not used these since they are rather complicated to compute.) For different Almon specifications in this paper, Ramsey's test always led to the acceptance of the null hypothesis of no mis-specification against the alternative hypothesis that the expectation of the residuals can be approximated by a polynomial in the regressors. For the present exercise, therefore, Ramsey's test is not a useful one for choosing a particular specification.

In preliminary estimations, it emerged that the appropriate polynomial lag structures on the income and interest rates variables were linear and quadratic, respectively. (A quadratic polynomial on the income term results in a U-shaped pattern which is highly implausible.) A monotically declining structure on income is a common approach taken in deriving a permanent income series. The weights on the distributed lags on interest rates might be expected to exhibit a humped pattern, since the own rate of interest included in the demand function is the less than £25,000 rate and thus includes the deposits of small transactors who may be subject to a learning delay: a parallel argument holds for the opportunity cost rates, i.e. the Treasury Bill rate and the expected inflation rate. (The Treasury Bill rate is included as a general indicator of short-term financial-market yields.) The humped quadratic profile for interest rates has been suggested by Modigliani, Rasche and Cooper (1970).

Preliminary investigations of the flow demand for broad money (ΔM3) indicated that this demand was homogeneous with respect to changes in the price level. Thus, in the specification reported below, we impose the restriction of no money illusion. The result is as follows (the figures in parentheses are estimated standard errors):

$$\Delta\,(M3/P)_t = \underset{(3.81)}{0.71} + \sum_{i=0}^{5} a_i\,\Delta Y_{t-i} + \sum_{i=0}^{5} b_i\,\Delta TBR_{t-i} + \sum_{i=0}^{4} c_i\,\Delta ODR_{t-i} + \sum_{i=0}^{5} d_i\,\Delta \dot{P}_{t-i} - 36.23\,DUM \qquad (2)$$

Where

a_0 = .62 (.20)	b_0 = 5.04 (4.3)	c_0 = 0.52 (6.39)	d_0 = -4.46 (1.5)
a_1 = .51 (.17)	b_1 = -2.87 (3.27)	c_1 = 12.88 (3.90)	d_1 = -5.95 (1.80)
a_2 = .39 (.15)	b_2 = -7.38 (3.21)	c_2 = 17.85 (4.57)	d_2 = -6.59 (2.15)
a_3 = .28 (.16)	b_3 = -8.51 (3.70)	c_3 = 15.43 (4.07)	d_3 = -6.38 (2.12)
a_4 = .17 (.19)	b_4 = -6.25 (3.8)	c_4 = 5.62 (7.56)	d_4 = -5.32 (1.77)
a_5 = .05 (.24)	b_5 = -0.60 (3.6)		d_5 = -3.41 (1.72)

$\bar{R}^2 = .58, \quad DW = 2.13$

The variables entering this equation are as follows: M3/P = broad money in real terms, Y = real GNP, TBR = UK Treasury Bill rate, ODR = the ordinary deposit rate (<£25,000) at Associated Banks, $\dot{P}$ = the rate of change of the Consumer Price Index and DUM is a dummy variable to account for the downward effect of the disclosure of Associated Banks' profits on their deposits.

By conventional statistical criteria, this is quite a satisfactory equation with only the contemporaneous value of the Treasury Bill rate having an incorrect expected sign; the $\bar{R}^2$ indicates reasonably good explanatory power for a first-differences formulation and the Durbin-Watson statistic indicates that the null hypothesis of no first-order autocorrelation cannot be rejected. The elasticities furnished by the above specifications are quite plausible, although the income elasticity is somewhat lower than might have been expected: the permanent income elasticity is 0.81, while the elasticities with respect to the expected deposit rate, the expected Treasury Bill rate and the expected inflation rate are 0.32, –0.18 and –0.07, respectively, calculated for the fourth quarter of 1975. The peak impact of ΔODR and $\Delta\dot{P}$ occurs after two-quarters while the peak impact for ΔTBR occurs after three quarters, which is closely in line with other findings (see Goldfeld (1973) and Shapiro (1973)). A striking feature of the above estimated demand function is the very significant showing of the expected inflation rate. Although the direct effect of inflationary expectations is quite small, we must remember that the reported elasticity is probably a lower bound for this effect since inflationary expectations also feed into nominal interest rates via the Fisher effect. The coefficient on the dummy variable has the correct sign, and is very close to the actual estimated downward effect of the disclosure of banks' profits on the nominal money stock in March 1972 (£40 million).

A plot of fitted on actual values from equation (2) is given in Figure A. Other than for the period 1965, quarter one, to 1967, quarter four, all the turning points and the amplitudes of peaks and troughs in the flow demand are picked up quite well.

The only other opportunity cost rate of interest tried in equation (1) was the rate of interest on share accounts in Building Societies. However, this rate performed very poorly with most of the coefficients having the incorrect expected sign. This might have been expected because of the limited variability of this rate. It is clear from the very high coherence between the two rates (see Browne and O'Connell, 1978) that the Irish Exchequer Bill rate could be substituted for the UK Treasury Bill rate in equation (1) with virtually the same effect.

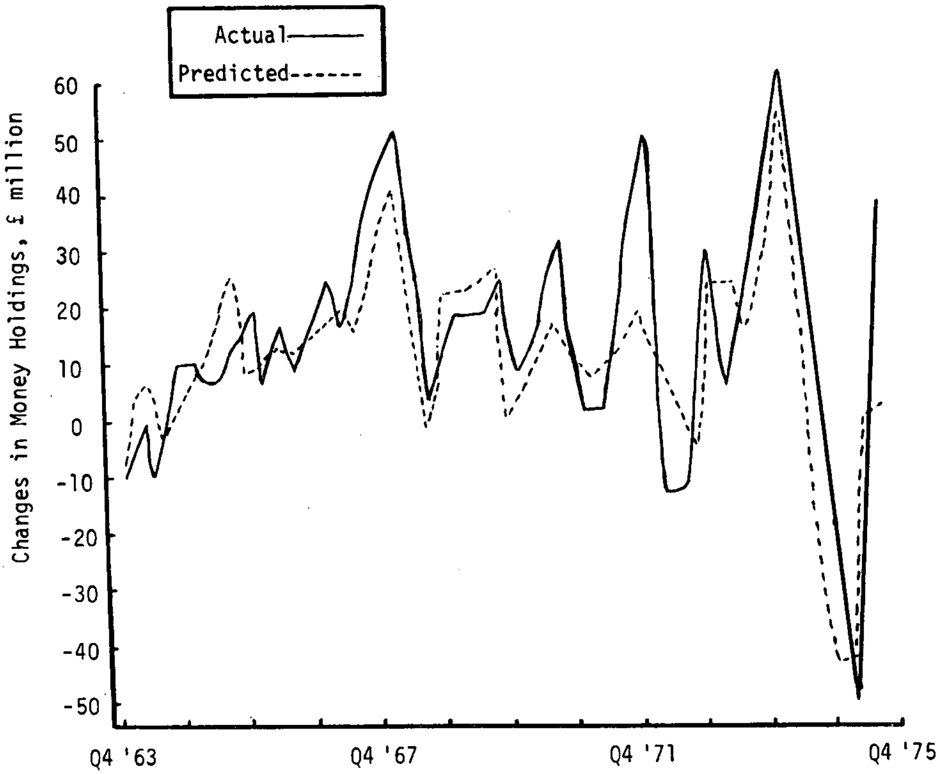

Figure A: Actual and Predicted Changes in Broad Money (M3), £ million

II.4 Disaggregated Demand For Money Functions

In estimating a flow demand for M3, which contains at least two different types of assets, one can inadvertently smooth over some of the factors peculiar to the demand for the component assets. In the following, we report results for just two components, namely narrow money M1 (i.e., the sum of currency and current accounts) and deposit accounts. Before proceeding to estimation, it was anticipated that the lag on income would be short in the M1 equation, because expected transactions in the current period might reasonably be measured by actual transactions in the immediate past. The demand for M1 in nominal terms is written as a function of nominal income and the opportunity cost of holding transactions balances, which is here assumed to be the rate of interest on deposit accounts. We obtain the following estimate (estimated standard errors appear in parentheses under the coefficients):

$$\Delta M1 = \underset{(1.3)}{3.29} + \sum_{i=0}^{4} a_i \Delta Y_{t-i} + \sum_{i=0}^{3} b_i \Delta ODR_{t-i} \tag{3}$$

$$\begin{array}{ll} a_0 = 0.101 & b_0 = -2.01 \\ \quad (0.04) & \quad (1.6) \\ a_1 = 0.107 & b_1 = -3.66 \\ \quad (0.02) & \quad (1.2) \\ a_2 = 0.113 & b_2 = -3.16 \\ \quad (0.02) & \quad (1.2) \\ a_3 = 0.118 & b_3 = -0.82 \\ \quad (0.03) & \quad (1.6) \\ a_4 = 0.124 & \\ \quad (0.05) & \end{array}$$

$$\bar{R}^2 = 0.645 \quad DW = 2.05$$

A feature of equation (3) is the virtually equal weights on past values of income. This plateau effect is somewhat surprising since we expect declining weights on past values of income. The income elasticity is quite plausible at 0.76, indicating economies of scale in the holdings of M1, while the interest rate elasticity is –0.098. Carrying out further disaggregation to the level of currency and current accounts and fitting separate demand functions (not reported here) indicates that the source of the trouble with M1 is current accounts which when fitted by the Almon method also had increasing weights on past values of income. No reasonable explanation for this phenomenon is easily available. The estimated narrow money equation (3) tracked the turning points moderately well, but the magnitude of the change is almost invariably underestimated. The expected inflation rate variable was dropped from equation (3) because of its insignificance.

The demand for real deposit accounts (DA/P) equation is identical to the broad money specification reported in equation (2). It was expected that the lags on the past values of the arguments would be marginally longer than for M3 since, for the latter, the length of the lags might be shortened by the inclusion of M1; however, this proved not to be the case. The resulting equation is set out below. The income elasticity furnished by equation (4), 0.79, is not very different from the corresponding elasticity for broad money. However, the own interest rate elasticity, 0.39, is larger than the corresponding elasticity for M3, a result to be expected since the presence of currency and current accounts in M3 serves to attenuate the interest rate effects. Although all of the lagged values of the Treasury Bill rate have the correct expected sign (the contemporaneous coefficient has the incorrect expected sign) several of the coefficients are statistically insignificant for conventional Type 1 error sizes and the value of associated elasticity is small at –0.11. The inflation rate elasticity is exactly the same as for the M3 equation. (In fact, it has been pointed out to us that, since a large proportion of current accounts is held by the business sector, that current accounts could be quite sensitive to movements in the Treasury Bill rate.)

$$\Delta\,(DA/P)_t = \underset{(3.2)}{2.27} + \sum_{i=0}^{5} a_i\,\Delta Y_{t-i} + \sum_{i=0}^{5} b_i\,\Delta TBR_{t-i} + \sum_{i=0}^{4} c_i\,\Delta ODR_{t-i} + \sum_{i=0}^{5} d_i\,\Delta \dot{P}_{t-i} - \underset{(16.8)}{35.5}\,\Delta DUM \qquad (4)$$

a_0 = 0.45	b_0 = 4.39	c_0 = 2.65	d_0 = -2.55
(0.17)	(3.62)	(5.4)	(1.26)
a_1 = 0.36	b_1 = -0.13	c_1 = 8.95	d_1 = -3.76
(0.14)	(2.76)	(3.30)	(1.52)
a_2 = 0.28	b_2 = -2.99	c_2 = 11.82	d_2 = -4.41
(0.13)	(3.13)	(3.86)	(1.82)
a_3 = 0.19	b_3 = -4.21	c_3 = 11.27	d_3 = -4.49
(0.13)	(3.08)	(3.42)	(1.79)
a_4 = 0.10	b_4 = -3.78	c_4 = 7.30	d_4 = -4.01
(0.16)	(3.04)	(6.30)	(1.49)
a_5 = 0.01	b_5 = -1.71		d_5 = -2.97
(0.20)	(4.00)		(1.46)

$$\bar{R}^2 = 0.62 \qquad DW = 1.92$$

A plot of the fitted and actual values from equation (4) (not presented here) indicates that the equation performs well over the period of estimation.

Before concluding this section, it should be noted that the lengths of the lags on the various arguments in the equations were determined empirically after some experimentation. For the M3 and deposit account specifications, lag lengths of four to six periods for real income were tried and, in general, the lag lengths presented were determined by eliminating lag periods with non-significant coefficients and re-estimating. For interest rates and the inflation rate, we tried lag lengths of 3 to 5 periods and concentrated on the reported lengths on the basis of the same criterion as for real income. In summary, the above equations of money demand, with the Almon lags on the arguments as shown, provide a satisfactory explanation of money holdings over the period 1962 to 1975.

III THE STABILITY OF THE DEMAND FOR MONEY FUNCTION

III.1 TECHNIQUES FOR TESTING STABILITY

Testing the stability of a function normally refers to testing for the stability of the regression equation over time. The principal deficiency in the traditional Chow stability test is that it requires prior knowledge of the time-period at which the regression relationship changes. Alternative tests of stability have been suggested by Brown, Durbin and Evans (1975) which do not require prior specification of the time-period when the regression relationship changes. These techniques use so-called recursive residuals, i.e., standardised residuals for the R–th, (R+1)–th, etc. periods calculated from regressions based on the first (R–1), R, etc. observations, respectively. If the disturbances in the regression equation whose stability is being tested are spherical, then, under the null hypothesis of constant regression coefficients over time, it can be shown that the recursive residuals themselves have spherical properties with a constant variance equal to that of the regression stochastic term.

The TIMVAR program applied here (see Evans, 1973) uses cumulative sums or 'cusums' of the recursive residuals (U_j's) against time.

$$\text{i.e.,} \quad W_R = \frac{1}{\hat{\sigma}} \sum_{j=k+1}^{R} U_j, \qquad R = k+1, T$$

where $\hat{\sigma}$ is the estimated standard deviation for the regression over the whole-time period of the analysis. (The summation over U_j goes from (k+1) since there are k regressors.) The mean and variance of the W_R's are zero and (R–k), respectively. Under the null hypothesis H_0, since the mean of W_R is zero, the graph of W_R against time will fluctuate randomly about the line $W_R = 0$. A test for stability, therefore, can be made by defining a critical region for a specified Type 1 error size defined by two lines symmetrically above and below the $W_R = 0$ line. (The actual critical region is defined by a pair of curves symmetrically on either side of this line. Durbin *et al* approximate this region by taking a pair of lines tangent to these curves at the time period halfway between t = k and t = T, where there are k regressors and T observations.) If the W_R sample path moves outside these lines, H_0 may be rejected. This is a method borrowed from quality control, where, if the industrial process moves outside an accepted tolerance, the process is terminated. The program prints out the maximum standardised cusum residual which can be compared with a benchmark computed by Durbin *et al* for specified significance levels. In addition, the cusum residuals can be graphed and assessed over the full-time period by reference to the lines defining the critical region.

An alternative stability test in the TIMVAR package uses the cusum of squared residuals which complements the cusum test especially when the departure from constancy of regression is random rather than systematic.

The test statistic for this case is:

$$S_R = \left(\sum_{j=k+1}^{R} U_j^2\right) / \left(\sum_{j=k+1}^{T} U_j^2\right)$$

The mean of S_R is $(R-k)/(T-k)$. As with the cusum test, the maximum deviation of S_R from its mean value is printed out and can be compared with the critical values on the lines bounding the critical region. The S_R statistics can also be plotted to see their departure, if any, from the mean line.

It should be pointed out that the application of the two cusum tests requires that the residuals be non-autocorrelated and homoscedastic. The presence of the former can be tested for using the conventional DW test, while the latter can be assessed from the estimated variance which is calculated from moving regressions of fixed time segments.

III.2 Stability of the Demand for Money Functions

The stability tests outlined above were applied to the estimated demand for money equations set out in Section II. Before doing so, however, it is necessary to check that the residuals are non-autocorrelated and homoscedastic; the DW statistics in the equations of Section II are of a size to suggest the absence of first-order autocorrelation, while the estimated variance calculated from the residuals from moving regressions of fixed length supports the hypothesis of homoscedasticity in the case of the M3 and deposit accounts equations. In the case of the M1 equation, however, the estimated variance is monotonically increasing up to the last few moving regressions this suggests that the stability tests for this equation should be treated with caution.

The results of the test are graphed in Figures 1 to 6. (Time is measured on the horizontal axes. The time span ranges from the beginning of 1966 to the end of 1975.) Corresponding to a significance level of 5 per cent, each of the estimated demand for money equations passes both the cusum and cusum squared tests except for the case of M1 when submitted to the cusum squared tests.

Taking first the M3 graphs, it can be seen from Figures 1 and 2 that the cusum and cusum squared graphs lie comfortably within the non-critical region as represented by the area bounded by the broken line (in the cusum case, only one of the symmetrical lines is drawn in order to conserve space). In fact, for the cusum squared test, the M3 equation passes the stability tests at the 10 and 20 per cent significance level.

Broad Money (M3)

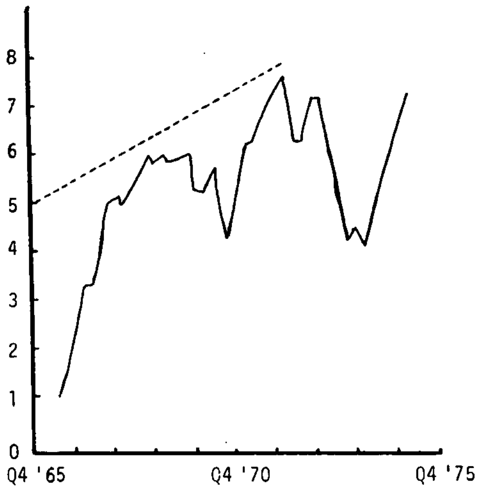

Fig. 1: Cusum of Recursive Residuals

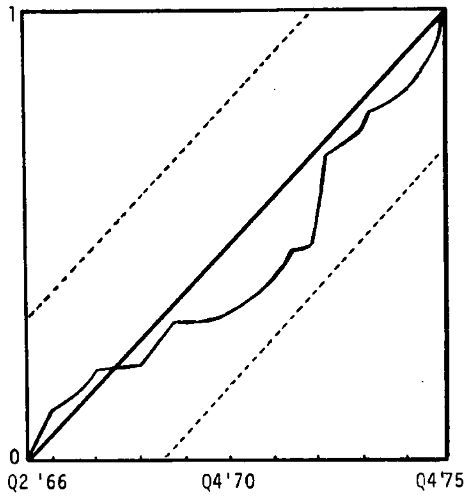

Fig. 2: Cusum of Squared Recursive Residuals

Currency and Current Accounts (M1)

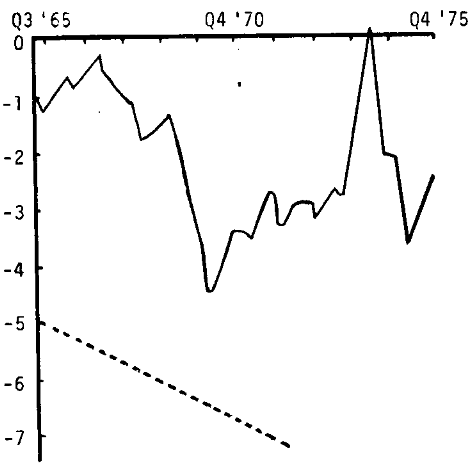

Fig. 3: Cusum of Recursive Residuals

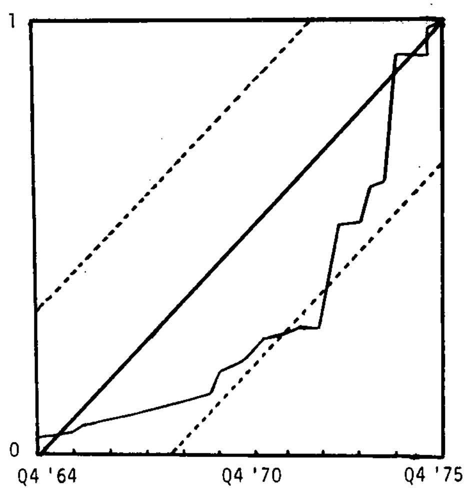

Fig. 4: Cusum of Squared Recursive Residuals

Deposit Accounts

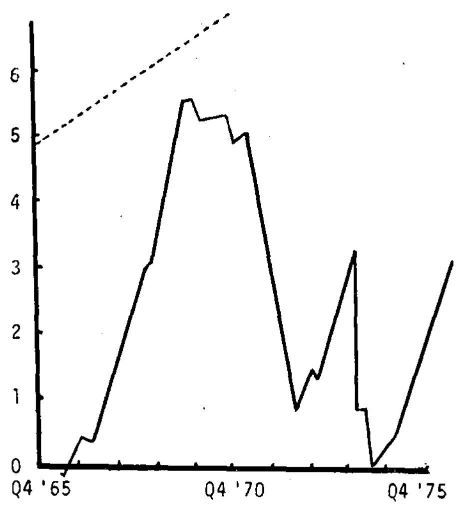

Fig. 5: Cusum of Recursive Residuals

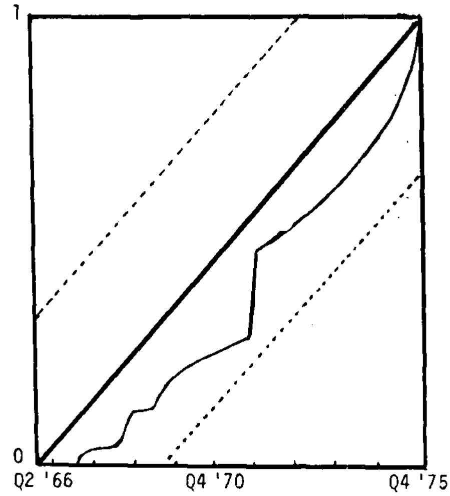

Fig. 6: Cusum of Squared Recursive Residuals

The M1 equation easily passes the cusum test, but fails the cusum squared test where the cusum squared graph crosses into the region of rejection of the null hypothesis. (If the significance level was 1 per cent, the M1 equation would pass both tests.) This result for M1 may be influenced by the breakdown of the assumption of constant variance (homoscedasticity) of the disturbance term.

The deposits account equation, like M3, passes both stability tests, although it comes close to the boundary line on one occasion on the cusum squared graph.

The conclusions to be drawn from this section are that, generally, the money demand equations estimated have displayed a fairly high degree of stability over the period examined. If stability of a functional relation is to be a criterion for choosing a definition of money (see Laidler 1969) then the evidence presented here would point to a broad definition of money as being the appropriate one. (There is also a theoretical reason noted above for focusing on this concept.)

IV SUMMARY AND CONCLUSIONS

In this paper we have estimated demand for money functions for Ireland and tested their stability. The equation specifications have been couched in the first difference form and have focused on the flow demand for money, changes in which enable money holders to attain stock equilibrium within the unit of time used in the study, i.e., one quarter.

The problem of simultaneous equations bias does not arise, and so a single equation demand for money can be validly estimated, because of the well-nigh complete financial integration with the UK and the consequential horizontal money supply function for Ireland.

Changes in money holdings were postulated to depend on changes in permanent or expected values of the independent variables, which were measured as weighted averages of past values of these variables using the Almon method. The resulting equations gave a reasonably good explanation of the evolution of money holdings over the sample period. The demand for money equations was then submitted to two stability tests recently devised. The broad money (M3) and deposit account equations passed both stability tests, while the M1 failed one of these tests.

The parameter estimates of the demand for money function are quite plausible. For M3, the permanent income elasticity is 0.81, while the elasticities with respect to the expected deposit rate, the expected Treasury Bill rate and the expected inflation rate are respectively 0.32, –0.18 and –0.07. For deposit accounts, the permanent income and expected inflation rate elasticities are virtually the same as for the corresponding elasticity for M3, while the own rate of interest is larger as expected.

The conclusion is that the demand for broad money (M3) function is a stable function of the variables determining money holdings. This adds weight to the belief that the monetary approach to the balance of payments might usefully be applicable in Ireland; as Johnson (1977, p. 263) has put it in a recent article: 'proper test of the monetary approach must be essentially a test of the stability of the demand for money'. While in its extreme form, by suggesting that a disequilibrium in the money market will be removed by capital movements in the balance of payments, the monetary approach tends to play down the implications of such a disequilibrium for the markets for goods and other financial assets, in the Irish context with very high capital mobility, the monetary approach does provide a useful framework for balance of payments analysis. This implies that, given a stable demand for money function and high capital mobility, the monetary authorities can affect external reserves, one counterpart to the money stock, by operating on the other, domestic credit, counterpart.

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APPENDIX I

A. Sources and Method

1. *Currency* is defined as Irish notes and coin outstanding adjusted to exclude holdings by the Associated Banks. Non-Associated Banks' holdings of notes and coin are negligible. The average of Friday figures in each week was taken. The source for 1962 Q1 – 1967 Q3 is the Central Bank's folder of Irish Economic Statistics (1977). From 1967 Q3 to 1975 Q4 the figures were taken from the Central Bank's Quarterly Bulletins (various issues).
2. *Current Accounts* are defined as current accounts at Associated and non-Associated Banks. Current accounts at Associated Banks are adjusted for cheques in the course of collection. Since April 1971, estimated offsets

have been deducted from Associated Bank current accounts, as published in Quarterly Bulletins of the Central Bank. In order to obtain a consistent series for current accounts at Associated Banks, therefore, offsets must be added on after April 1971. Current accounts of non-Associated Banks were assumed to be zero up to and including 1964.

Figures for non-Associated Banks are not published until 1966. End-year figures are available for 1965 and 1966: the quarterly figures for 1965 and 1966 were obtained by assuming exponential growth between the end-year figures. For 1967 and 1968 end-quarterly figures are available; from 1969 onwards end-monthly figures are available as for the Associated Banks. Government current accounts held with the Associated Banks are excluded from current accounts, since we wish to focus on the non-bank private sector's holdings of money balances.

3. *Deposit Accounts* are defined as the sum of Associated and non-Associated Banks' deposit accounts *less* government deposit accounts with the Associated Banks *less* all interbank balances (all of which are assumed to be deposit accounts). There is a discontinuity in the deposit accounts series for the Associated Banks. From March 1972 the data have been compiled on the basis of full disclosure of profits and reserves: this disclosure had a downward effect on deposits of £40m. Non-Associated Banks' deposit accounts include "other accounts". The source for the Associated Banks' figures is the Central Bank's Annual Reports and Quarterly Bulletins. The non-Associated Banks' figures for 1966 to 1975 were obtained from the same source; for 1963 to 1965 end-year figures are available from the unpublished balance sheets of the non-Associated Banks — the corresponding quarterly figures are obtained by either linear or exponential interpolation. Interbank balances are obtained from the Money Supply Table in the Statistical Appendix of the Central Bank Quarterly Bulletins and from internal Central Bank files. These are obtained by subtracting item (9) from the sum of items (1) to (4). Before 1971, the Money Supply Table is not presented in this format and thus the interbank balances before this period were obtained from the returns to the Central Bank of both the Associated and non-Associated Banks.

   Discontinuities in the monetary series arising from the bank closures of 1966 and 1970 were dealt with by interpolating for the missing observations.

4. *Aggregate Debits* are obtained from the "Associated Banks: Turnover of Current Accounts" Table of the Statistical Appendix in Central Bank bulletins. This series was used in the M1 equation without much success.

5. *Interest Rates, Yields.* All interest rates are measured as either daily weighted averages or averages of end-weekly figures. The source for the

ordinary deposit rate, the rate on share accounts in Building Societies, the issue rate on Exchequer Bills and the Central Bank rediscount rate is the Banking Department of the Central Bank. The data on interest rates which are published in the Central Bank bulletins relate only to the rate prevailing at the end of each month: taking an average of end-monthly data could give quite an inaccurate picture of the average rate prevailing during the quarter. The UK local authority rate is the rate for a minimum term of three months and thereafter, at seven days' notice. The Treasury Bill rate is also three months to maturity: the rate is expressed as a yield (per cent per annum of 365 days). The UK government security rate is the gross redemption yield on short-dated (5 years to maturity) government stock; it is the rate of interest which, if used to discount future dividends and the sum due at redemption, makes their present value equal to the present price of the stock. Following Hamburger (1977), the dividend-price ratio is used as a measure of current dividends which is presumed to be a better proxy of expected future earnings than a weighted average of current and past earnings. The last four mentioned rates are taken from the Statistical Appendix of the Bank of England Bulletins. For the empirical work, the rates used were the ordinary deposit rate applicable to deposits of less than £25,000, the UK Treasury Bill rate and the Building Society share account rate.

6. *National Accounts Data.* The quarterly National Income data used are calculated by estimating from their annual counterparts the individual GNP components. The principal method used was linking to related series using regression methods. Where this was not possible, the annual series were interpolated using the Boot-Feibes-Lisman program.

   All data were seasonally adjusted where necessary by using the Bureau of the Census X-11 method.

Data Appendix

		Currency	*Current accounts*	*Deposit accounts*	*Aggregate debits*	*Ordinary deposit rate*	*Building society rate*	*UK Local authority rate*	*Treasury bill rate*	*Exchequer bill rate*
1962	Q1	81.8	130.70	228.5	739.0	1.91	3.67	6.01	4.89	5.48
	Q2	82.3	134.19	232.8	815.6	1.31	3.67	4.62	3.92	4.17
	Q3	82.7	135.63	239.5	802.5	1.28	3.67	4.70	3.84	4.10
	Q4	84.2	143.61	245.2	909.7	1.26	3.67	4.44	3.69	3.94
1963	Q1	85.8	144.97	249.4	763.2	1.01	3.67	4.13	3.42	3.65
	Q2	87.9	148.41	251.5	970.8	0.99	3.67	4.36	3.66	3.79
	Q3	89.9	154.43	254.6	924.4	1.03	3.67	4.39	3.78	3.98
	Q4	91.1	158.33	255.0	994.2	1.01	3.67	4.29	3.62	3.90
1964	Q1	94.4	167.54	255.8	1024.5	1.11	3.67	4.48	3.96	3.89
	Q2	97.3	168.12	259.4	988.5	1.49	3.67	4.97	4.36	4.44
	Q3	99.8	173.97	264.6	1080.9	1.54	3.67	5.21	4.72	4.88
	Q4	103.3	177.51	270.1	1067.9	1.84	3.67	6.29	5.78	5.55
1965	Q1	103.9	179.28	276.6	1069.4	2.42	3.70	7.31	6.26	6.60
	Q2	103.7	182.32	282.5	1072.7	2.50	3.70	6.92	6.07	6.48
	Q3	104.4	183.65	292.2	1132.2	2.57	3.70	6.71	5.66	5.93
	Q4	105.4	185.02	297.6	1133.8	2.52	3.70	6.23	5.27	5.70
1966	Q1	106.6	192.58	309.4	1100.2	2.40	3.88	6.08	5.35	5.58
	Q2	109.0	199.73	320.2	1051.3	2.51	3.88	6.37	5.66	5.84
	Q3	110.5	199.45	331.5	1107.0	3.03	3.88	7.50	6.67	6.72
	Q4	111.1	202.03	345.6	974.3	3.55	3.88	7.30	6.45	6.88
1967	Q1	112.6	199.08	352.0	1254.1	3.36	3.88	6.31	5.76	6.23
	Q2	114.1	201.47	366.1	1343.9	2.89	4.38	5.70	5.34	5.76
	Q3	116.6	210.09	383.0	1334.6	2.55	4.38	5.66	5.36	5.59
	Q4	118.6	218.92	391.0	1352.4	3.33	4.38	7.01	6.43	6.38
1968	Q1	120.2	218.56	415.9	1397.3	4.10	4.38	7.85	7.13	7.39
	Q2	122.2	222.04	440.6	1433.7	4.26	4.38	8.34	7.24	7.57
	Q3	124.5	228.36	473.3	1565.4	4.30	4.38	7.85	6.95	7.41
	Q4	128.1	236.08	492.3	1660.6	3.57	4.38	7.45	6.53	7.00

Data Appendix (contd.)

		Currency	Current accounts	Deposit accounts	Aggregate debits	Ordinary deposit rate	Building society rate	UK Local authority rate	Treasury bill rate	Exchequer bill rate
1969	Q1	129.5	237.48	513.2	1665.9	3.59	4.38	8.08	7.04	7.37
	Q2	130.4	237.12	529.8	1865.1	4.48	4.38	9.22	8.14	8.50
	Q3	131.7	241.79	551.2	1798.0	4.53	5.38	9.52	7.92	8.41
	Q4	134.4	242.04	574.4	1860.0	4.60	5.38	9.30	7.75	8.25
1970	Q1	138.8	256.13	587.2	1950.9	4.41	5.50	8.74	7.42	7.83
	Q2	143.1	265.47	611.2	1972.5	4.45	5.50	8.27	7.20	7.65
	Q3	146.4	268.77	637.1	2085.8	4.56	5.50	7.45	6.85	7.29
	Q4	148.5	274.23	663.1	2020.1	4.58	5.50	7.34	6.78	7.17
1971	Q1	153.0	286.79	681.3	2113.4	4.41	5.50	7.22	6.67	6.98
	Q2	157.5	297.06	695.4	2120.8	3.94	5.50	6.65	5.98	6.31
	Q3	160.3	302.90	712.2	2480.6	3.85	5.50	6.27	5.36	5.70
	Q4	165.2	314.18	739.4	2615.6	3.02	5.50	4.90	4.44	4.68
1972	Q1	167.3	334.04	739.9	2648.8	2.93	5.50	4.60	4.32	4.51
	Q2	170.8	356.97	750.2	2830.7	2.97	5.50	5.46	4.90	5.00
	Q3	176.3	356.73	795.6	2908.3	3.32	5.50	7.52	5.95	6.12
	Q4	180.6	360.73	835.8	3310.9	3.98	5.50	7.98	7.06	7.24
1973	Q1	188.0	368.05	905.4	3569.6	4.67	5.67	9.61	8.19	8.56
	Q2	193.9	366.99	971.5	3687.9	6.03	6.33	9.77	7.86	7.95
	Q3	201.4	381.08	1041.6	3725.0	7.23	7.00	11.81	10.23	9.84
	Q4	207.4	386.88	1140.8	4075.5	9.40	8.00	14.03	11.50	11.53
1974	Q1	211.7	376.50	1216.9	4433.7	10.15	8.00	14.76	12.26	11.97
	Q2	218.1	372.74	1284.7	4102.5	10.37	8.00	14.38	12.36	12.28
	Q3	223.6	370.37	1347.8	5483.4	9.50	8.00	12.82	11.36	11.50
	Q4	230.5	373.52	1446.3	5013.5	8.86	8.00	12.07	10.78	10.63
1975	Q1	240.4	387.90	1516.3	5640.7	8.25	8.00	10.91	10.22	10.22
	Q2	249.8	408.24	1547.9	6899.2	7.56	8.00	10.72	10.15	10.18
	Q3	260.4	435.17	1605.0	7546.1	7.95	8.00	10.40	10.35	10.39
	Q4	272.6	455.70	1729.8	7799.8	7.36	8.00	11.00	10.85	10.81

Data Appendix (contd.)

		Short-term UK Govt. security rate	*Dividend/ price ratio*	*Central Bank rediscount rate*	*Personal consumers' expenditure in constant (1970) prices*	*Nominal consumers' expenditure*	*C.P.I.*	*Nominal GNP*	*Real GNP (1970 prices)*
1962	Q1	5.83	5.00	5.52	210.70	139.52	75.80	192.35	301.05
	Q2	5.40	5.10	4.30	207.05	138.64	77.80	188.95	294.21
	Q3	4.97	5.52	4.18	207.31	138.98	77.40	188.04	293.88
	Q4	4.60	4.94	4.02	213.90	142.86	77.20	196.25	305.31
1963	Q1	4.83	4.49	3.68	210.45	144.20	78.50	197.28	300.79
	Q2	4.92	4.31	3.89	219.22	147.69	78.30	203.26	313.49
	Q3	4.64	4.01	4.06	219.91	149.02	78.20	206.88	317.28
	Q4	4.56	3.60	3.96	223.07	155.97	80.60	212.71	316.30
1964	Q1	4.91	3.96	4.06	225.64	159.86	81.10	226.67	327.90
	Q2	4.99	3.97	4.52	228.02	165.80	84.30	232.60	325.50
	Q3	5.37	3.90	4.93	229.24	169.51	85.30	233.79	322.58
	Q4	5.83	4.64	5.65	228.44	170.49	86.20	239.57	327.01
1965	Q1	6.60	4.91	6.64	228.66	173.55	87.20	236.73	320.59
	Q2	6.79	5.43	6.63	230.16	175.44	88.70	247.94	333.28
	Q3	6.85	5.70	6.04	229.56	176.79	89.00	256.40	340.72
	Q4	6.59	4.81	5.84	227.93	176.22	89.00	255.00	336.90
1966	Q1	6.60	4.70	5.68	227.64	177.04	89.10	260.36	339.54
	Q2	6.81	4.46	5.97	227.33	178.52	90.70	255.99	330.73
	Q3	7.30	6.06	6.88	241.00	193.82	92.20	264.13	334.79
	Q4	6.87	6.35	6.90	238.64	192.90	92.40	271.73	344.57
1967	Q1	6.54	5.69	6.36	239.07	193.49	92.60	274.63	345.23
	Q2	6.35	4.71	5.81	237.66	193.81	94.20	284.13	353.31
	Q3	6.59	4.16	5.59	243.59	199.95	94.20	290.77	358.08
	Q4	7.15	3.40	6.74	248.43	206.30	94.80	298.77	362.97
1968	Q1	7.47	3.01	7.47	252.11	213.44	96.80	304.20	365.70
	Q2	7.56	2.28	7.55	260.62	222.86	98.30	321.93	384.30
	Q3	7.66	1.93	7.40	267.65	231.12	98.50	331.52	393.82
	Q4	7.70	1.87	6.90	269.59	237.39	100.00	340.72	393.11

Data Appendix (contd.)

		Short-term UK Govt. security rate	Dividend/ price ratio	Central Bank rediscount rate	Personal consumers' expenditure in constant (1970) prices	Nominal consumers' expenditure	C.P.I.	Nominal GNP	Real GNP (1970 prices)
1969	Q1	8.26	1.90	7.28	263.12	237.95	103.30	337.80	379.31
	Q2	8.94	2.41	8.74	284.18	259.89	105.10	376.12	414.57
	Q3	9.08	2.94	8.44	282.45	263.84	106.80	385.13	415.03
	Q4	8.93	2.76	8.28	281.51	265.86	107.60	390.13	412.94
1970	Q1	8.56	2.68	7.92	289.60	275.93	109.40	411.33	428.41
	Q2	7.99	3.63	7.66	279.32	276.22	113.90	405.22	410.29
	Q3	7.41	3.33	7.34	282.19	285.36	115.80	419.80	414.06
	Q4	7.76	3.31	7.27	291.42	303.20	118.40	438.09	423.88
1971	Q1	7.62	3.24	7.08	291.25	305.82	120.30	454.37	437.04
	Q2	7.09	2.31	6.61	291.94	314.30	123.60	467.39	431.79
	Q3	6.65	1.96	6.05	293.76	323.91	126.00	480.63	425.70
	Q4	6.10	1.90	5.25	298.32	337.74	128.60	506.27	445.13
1972	Q1	6.02	1.54	4.67	306.15	351.54	131.50	533.89	450.48
	Q2	6.82	1.53	5.08	308.27	359.05	133.50	549.00	446.77
	Q3	8.79	1.58	6.18	309.41	373.90	137.20	590.33	472.79
	Q4	8.97	1.59	7.26	315.99	391.86	139.20	604.00	462.04
1973	Q1	9.34	2.00	8.26	323.68	414.92	144.70	642.30	463.05
	Q2	9.20	1.98	8.89	328.53	433.19	149.10	681.93	480.43
	Q3	11.05	2.33	9.73	325.91	441.81	152.60	688.41	473.16
	Q4	12.14	2.85	11.06	326.15	455.43	156.80	724.37	485.07
1974	Q1	12.72	4.19	12.32	329.32	472.98	164.20	727.62	491.99
	Q2	12.26	5.79	12.80	329.50	495.31	173.30	719.64	475.95
	Q3	12.29	10.49	12.12	325.75	511.14	179.90	735.87	474.87
	Q4	12.68	15.92	11.81	317.44	525.56	188.20	803.87	491.02
1975	Q1	11.53	6.14	10.89	310.90	550.53	203.30	852.88	485.11
	Q2	10.95	4.58	10.44	303.99	571.29	215.70	891.32	471.38
	Q3	11.59	4.65	10.12	315.47	595.66	214.00	946.26	484.11
	Q4	12.02	3.63	9.83	327.51	643.26	219.90	982.22	485.38