The Demand for Money in Pakistan: Some Alternative Estimates

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In a recent article in this Review, Akhtar [2] presented 30 estimates of demand for money functions in Pakistan. One of the purposes of Akhtar's study was to test two alternative theories, "the modern quantity theory of money and what may be called the 'accumulating capital' framework" [2, p. 40]. We have examined Akhtar's estimates and have serious reservations concerning the validity of his results. In the present paper, therefore, we raise several criticisms against Akhtar's study and then offer alternative estimates of demand for money in Pakistan.

To test "the modern quantity theory," Akhtar takes a conventional demand for money function of the form:

$$\left(\frac{M}{P}\right) = f\left(\frac{Y}{P}, r, i^*\right) \tag{1}$$

where $\frac{M}{P}$ is the money stock measured at constant prices, $\frac{Y}{P}$ is national income also measured at constant prices, r is the rate of interest and i^* is the expected rate of inflation. For the purposes of estimation, Akhtar specifies the following form of equation (1):

$$\ln\left(\frac{M}{P}\right) = a_0 + a_1 \ln\left(\frac{Y}{P}\right) + a_2 \ln(D) + a_3 \ln(r) + a_4 \ln(i) \tag{2}$$

where D is the index of industrial production and i is the current rate of inflation.

There are five points which we wish to make regarding equation (2). The first is simply that since the rate of inflation was negative in six years between 1950 and 1970, the period for which Akhtar obtains his estimates, we wonder how he took logarithms. Second, there is now much evidence indicating that the expected rate of inflation, i^*, differs substantially from the current rate of inflation. Expectations, it appears, are formed on the basis of past as well as present rates of inflation. There are a variety of ways to specify the expected rate of inflation. We have estimated it using the polynomial technique suggested by Almon [3]. Third, it is generally accepted that the correct specification of a demand for money function uses *per capita* real monetary holdings and real income rather than aggregate values (*e.g.* [5]). Not only does this specification have stronger theoretical foundations but it also reduces problems of heteroscedasticity and spurious association due to time trend movements in the money and income variables. Although Goldfeld [4] has recently concluded that deflation by population is unnecessary in the case of the U.S.A., this cannot be taken as applicable to Pakistan: population growth has been rapid here. Fourth, evidence from many other countries indicates that a lagged adjustment process takes place in the demand for money.

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Finally, the inclusion of the industrial production index, D, is justified by Akhtar on the following grounds:

> Most of the investment in such economies [LDCs] is a result of planning in the public sector and expansionary monetary policies. The excess of *ex ante* investment over *ex ante* saving realized through economic planning and expansionary monetary policies explains the growth of industry unexplained by current savings. [2, p. 41].

We fail to understand how a gap between planned investment and savings explains industrial growth. The relevance of the index of industrial production to demand for money on these grounds is also unclear. Deficit financing increases the nominal stock of money but has no direct effect on the real stock of money; this is determined by the public. By causing inflation, *i.e.* a cost to money holders, deficit financing can result in a lower real stock of money. Nonetheless, we might be prepared to let the industrial production index stand as a proxy for a collection of variables indicating the degree of monetisation.

For these reasons, we offer the following demand for money function as an alternative. The long run demand for money is expressed:

$$\left(\frac{M^*}{PN}\right) = \alpha\left(\frac{Y}{PN}\right)^{\beta} e^{\gamma r + \rho i^*} \qquad (3)$$

where N represents population. Taking natural logarithms, equation (3) becomes:

$$\ln\left(\frac{M^*}{PN}\right) = \ln(\alpha) + \beta \ln\left(\frac{Y}{PN}\right) + \gamma r + \rho i^* \qquad (4)$$

Actual or short run demand for money can be derived from a standard adjustment process:

$$\ln\left(\frac{M}{PN}\right) = \ln\left(\frac{M}{PN}\right)_{-1} + \theta\left(\ln\left(\frac{M^*}{PN}\right) - \ln\left(\frac{M}{PN}\right)_{-1}\right) \qquad (5)$$

which assumes that the gap between long run demand or desired real money balances and initial money holdings, *i.e.* $\ln\left(\frac{M}{PN}\right)_{-1}$, is closed by some constant fraction θ each time period. Equation can be rewritten:

$$\ln\left(\frac{M}{PN}\right) = \theta \ln\left(\frac{M^*}{PN}\right) + (1-\theta)\ln\left(\frac{M}{PN}\right)_{-1} \qquad (6)$$

Substituting (4) into (6):

$$\ln\left(\frac{M}{PN}\right) = \theta[\ln(\alpha) + \beta\ln\left(\frac{Y}{PN}\right) + \gamma r + \rho i^*] + (1-\theta)\ln\left(\frac{M}{PN}\right)_{-1} \qquad (7)$$

Before presenting our estimates of equation (7), we turn to Akhtar's specification of the "accumulating capital" theory.

In an important new book, McKinnon [6] presents a theory of finance in the process of economic development. A key relationship in his model is "the basic complementarity between money and physical capital" [6, p. 59]. It is reflected in the following demand for money function:

$$\left(\frac{M}{PN}\right) = L\left(\frac{Y}{PN}, \frac{I}{Y}, d-i^*\right) \qquad (8)$$

where I is investment and d the nominal rate of return to the holders of money, *i.e.* the weighted average interest rates on all components of the money stock [6, p. 59]. The complementary relationship is exhibited in the sign of the partial derivative with respect to the ratio of investment to income:

$$\frac{\delta L}{\delta (I/Y)} > 0$$

In testing McKinnon's theory, Akhtar uses the following equation:

$$\ln\left(\frac{M}{P}\right) = b_0 + b_1 \ln\left(\frac{Y}{P}\right) + b_2 \ln\left(\frac{I}{Y}\right) + b_3 \ln(d'-i) \qquad (9)$$

Here, d′ is the average deposit rate on six to twelve month time deposits. We again have several criticisms. First, Akhtar continues to face the insuperable problem of taking logarithms of negative numbers since d′-i is negative in several years during the period 1950—1970. Second, the use of i rather than i* is an unnecessary as well as unjustifiable modification to McKinnon's model. Third, Akhtar uses net investment and net income while a complete reading of McKinnon suggests that he is referring to gross investment and income. McKinnon defines d as the weighted average nominal return on all components of the money stock. This means that a change in the composition of money holdings can change the value of d without any change in deposit rates having taken place. The change in d can therefore be an endogenous response to a change in the composition of real balances rather than an exogenous variable affecting demand for money. For this reason, we *concur with Akhtar in substituting d′, the average time deposit rate, for McKinnon's* d. However, because of the above modification we decompose $d'-i^*$ into its components, d′ and i*. Since d′ is now the nominal rate of return only on time deposits, the reaction to a change in this variable can be quite different from the reaction to a change in the expected rate of inflation in the demand for money function.

A fourth problem lies in the reversibility of McKinnon's complementary relationship: "This complementarity works both ways; the conditions of money supply have a first-order impact on decisions to save and invest" [6, p. 60]. McKinnon argues that factors such as the real deposit rate and the spread of bank branches which increase demand for money can raise the level of investment: money balances first have to be accumulated before investment can be financed.

McKinnon's model can be represented graphically as in Figure 1. F represents the financial constraint. Although composed of a number of elements, here it is simply taken to consist of an administratively determined institutional interest rate. I is the investment function and S the savings function. Since the interest rate is constrained by F and cannot rise to its equilibrium level at which planned saving would equal planned investment, actual investment is limited to I_0, the volume of savings forthcoming at the fixed interest rate r_0. Any change in the rate of interest will change the amount of savings and hence the actual level of investment. It is evidently the savings function which is being traced by changing rates of interest, as seen in Figure 2.

For this reason, we substitute domestic savings for investment in equation (8) and formulate the following savings function which is to be determined simultanously with demand for money:

$$\left(\frac{Sd}{Y}\right) = f\left(\frac{Y}{PN}, \Delta\ln\left(\frac{Y}{PN}\right), \frac{M}{PN}, \frac{X}{Y}, \frac{F}{Y}\right) \qquad (10)$$

where X represents exports and F foreign savings. The demand for money function now becomes:

$$\left(\frac{M}{PN}\right) = L\left(\frac{Y}{PN}, \frac{Sd}{Y}, d', i^*\right) \qquad (11)$$

It is these two equations which we feel provide a truer representation of McKinnon's complementarity hypothesis than does equation (9). Because $\frac{M}{PN}$ and $\frac{Sd}{Y}$ are endogenous variables in McKinnon's model, estimation has to be performed through two stage least squares to avoid simultaneous equation bias. In this model, money is always broadly defined since it represents the conduit between savings and investment. Akhtar's estimates using a narrow definition of money have no place here.

In reestimating Akhtar's demand for money functions we found two errors in data manipulation and use. Akhtar uses end of year money stock data. The least that might have been expected is that centred mid-year estimates be calculated by averaging beginning and end of year figures. Since monthly data exist for Pakistan, much better series can be calculated using annual averages of centred monthly figures; this we do.

Finally, deflating income and money stock figures by consumer and wholesale price indices has no justification. Since there exist data on net national product at constant prices these should clearly be used. For consistency, the money stock must be deflated by the same index as net national product. Here, we use income

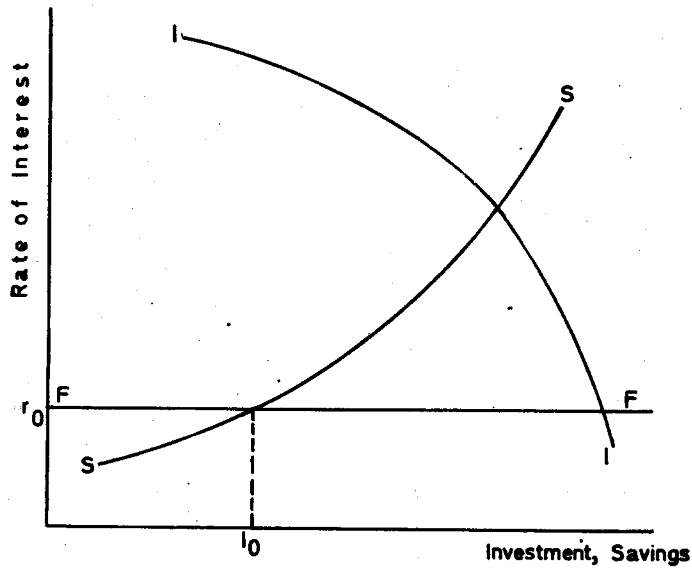

Figure. 1

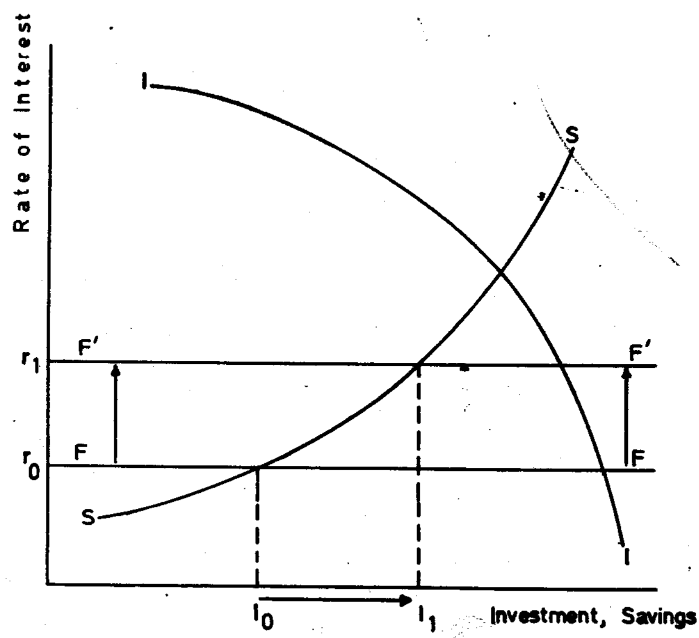

Figure 2

and money stock estimates deflated by the implicit national income deflator. This, of course, in no way precludes use of consumer and wholesale price indices for the actual and expected rate of inflation.[1]

With the above modifications, we reestimated Akhtar's equations for the period 1951-52—1969-70, a sample of which are presented below:

$$\ln\left(\frac{M1}{PN}\right) = -0.886 + 0.858\ \ln\left(\frac{NNP}{PN}\right) + 0.520\ r_g \qquad (12)$$

$$t \qquad (-0.278) \quad (1.463) \qquad\qquad (0.082)$$

$$R^2 = 0.455 \qquad DW = 0.562 \qquad F = 6.68$$

(comparable to Akhtar's equation (6))

$$\ln\left(\frac{M2}{PN}\right) = -2.246 + 1.062\ \ln\left(\frac{NNP}{PN}\right) + 12.654\ r_g \qquad (13)$$

$$t \qquad (-0.660) \quad (1.693) \qquad\qquad (1.864)$$

$$R^2 = 0.809 \qquad DW = 0.569 \qquad F = 33.83$$

(comparable to Akhtar's equation (7))

$$\ln\left(\frac{M1}{PN}\right) = -1.812 + 1.024\ \ln\left(\frac{NNP}{PN}\right) - 0.609\ r_m + 0.241\ i \qquad (14)$$

$$t \qquad (-0.720) \quad (2.307) \qquad\qquad (-0.314) \qquad (1.404)$$

$$R^2 = 0.518 \qquad DW = 0.676 \qquad F - 5.38$$

(comparable to Akhtar's equation (8))

$$\ln\left(\frac{M2}{PN}\right) = -4.442 + 1.505\ \ln\left(\frac{NNP}{PN}\right) + 3.243\ r_m + 0.168\ i \qquad (15)$$

$$t \qquad (-1.594) \quad (3.063) \qquad\qquad (1.510) \qquad (0.888)$$

$$R^2 = 0.819 \qquad DW = 0.778 \qquad F = 22.62$$

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[1]In fact, we used only the wholesale price index justified by McKinnon as follows:

> The basic reason is that tangible physical capital, that is, inventories of commodities of all kinds, is the principal alternative asset open to savers —which may be either substitutable or complementary with real money balances, as explained in Chapter 6. In other words, pure services cannot be "held" in asset portfolios and be subject to intertemporal reallocations of the kind described in the Fisherian model presented in Chapter 2. Even households that save with the ultimate intention of consuming services in the distant future must hold those savings in the form of either goods or financial assets. Hence, it is primarily the rate of change of *commodity* prices that wealth holders compare with nominal rates of interest on financial assets in deciding on their stocks of money and near-monies relative to their incomes and relative to their holdings of goods.
>
> [6, p. 97]

[illegible]ates of wholesale prices were taken from Pakistan Institute of Development Economics, [illegible] *of Inflation in Pakistan*, 1951—60 (Karachi: Pakistan Institute of Development Eco- [illegible] Monograph No. 4, 1961), Table 1, p. 5 and *Central Statistical Office Monthly Statistical* [illegible]—1971. To avoid losing degrees of freedom in estimating expected inflation rates [illegible] past years, we have taken the wholesale price index for the period 1944—1951 for [illegible] L. Narain, *Price Movements in India, 1929—1963 (Meerut: Shri Prakashan, 1963).* [illegible] our regression equations are based on the 19 observations for the period 1951-52 —

where NNP is net national product, r_g the yield on government bonds, and r_m the call money rate of interest.

These examples suffice to illustrate the fact that using *per capita* data reduces spuriously inflated coefficients of determination; the coefficients reported here are considerably lower than those obtained by Akhtar. Coefficients on the rates of interest and inflation are insignificant and anyway have the wrong signs in all but one case. Furthermore, these estimates highlight the existence of serial correlation in the disturbance term. Since serial correlation suggests misspecification, alternative demand for money functions can be considered. In particular, a lagged adjustment process in the demand for money might well explain the prevalence of serial correlation.

Taking the variables used in equations (12) – (15), we estimated demand for money for the same period with the lagged adjustment process discussed above:

$$\ln(\tfrac{M1}{PN}) = -4.091 + 0.887 \ln(\tfrac{NNP}{PN}) - 3.034\, r_m + 0.774 \ln(\tfrac{M1}{PN})_{-1} \quad (16)$$

$$t \quad (-3.034) \quad (3.977) \quad (-2.829) \quad (6.892)$$

$$R^2 = 0.869 \qquad DW = 1.574 \qquad F = 33.24$$

$$\ln(\tfrac{M2}{PN}) = -4.034 + 0.887 \ln(\tfrac{NNP}{PN}) - 1.352\, r_m + 0.765 \ln(\tfrac{M2}{PN})_{-1} \quad (17)$$

$$t \quad (-2.843) \quad (3.388) \quad (-1.006) \quad (6.453)$$

$$R^2 = 0.950 \qquad DW = 1.282 \qquad F = 94.11$$

$$\ln(\tfrac{M1}{PN}) = -4.039 + 0.866 \ln(\tfrac{NNP}{PN}) - 2.996\, r_m - 0.032\, i + 0.791 \ln(\tfrac{M1}{PN})_{-1} \quad (18)$$

$$t \quad (-2.883) \quad (3.607) \quad (-2.693) \quad (-0.317) \quad (6.159)$$

$$R^2 = 0.870 \qquad DW = 1.603 \qquad F = 23.46$$

$$\ln(\tfrac{M2}{PN}) = -3.441 + 0.721 \ln(\tfrac{NNP}{PN}) - 1.383\, r_m - 0.160\, i + 0.851 \ln(\tfrac{M2}{PN})_{-1} \quad (19)$$

$$t \quad (-2.416) \quad (2.610) \quad (-1.068) \quad (-1.476) \quad (6.637)$$

$$R^2 = 0.956 \qquad DW = 1.328 \qquad F = 76.67$$

Coefficients of determination are considerably higher, the Durbin-Watson statistics have been improved and the coefficients on r_m and i now have the correct sign. As found elsewhere, the interest rate is only significant in the determination of demand for money narrowly defined. The coefficient on the rate of inflation is not significantly different from zero. The value of the coefficient of the lagged money stock, indicating a value of $(1-\theta)$ of between 0.75 and 0.85, suggests that only 15 to 25 percent of the gap between actual and desired money balances is closed each time period.

The next set of estimates illustrates what happens when expected rather than actual rates of inflation are introduced:

$$\ln(\tfrac{M1}{PN}) = -2.075 + 0.621 \ln(\tfrac{NNP}{PN}) - 1.418\, r_m - 0.916\, i^* + 0.652 \ln(\tfrac{M1}{PN})_{-1} \quad (20)$$

$$t \quad (-1.648) \quad (3.141) \quad (-1.413) \quad (-3.087) \quad (6.659)$$

$$R^2 = 0.922 \qquad DW = 2.062 \qquad F = 41.49$$

$$\ln\left(\frac{M2}{PN}\right) = -2.552 + 0.656\ \ln\left(\frac{NNP}{PN}\right) - 1.045\ i^* + 0.731\ \ln\left(\frac{M2}{PN}\right)_{-1} \quad (21)$$

$$t \quad (-3.545)\ (4.107) \qquad (-4.573) \qquad (11.257)$$

$$R^2 = 0.978 \qquad DW = 1.631 \qquad F = 226.53$$

The significance of the coefficients on the expected rate of inflation here as opposed to the insignificance of those on the actual rate of inflation in the previous equations is striking.[2] The interest rate has been dropped from the demand function for money broadly defined (M2), since its coefficient was consistently insignificant.

Finally, we report the following results in which the index of industrial production is included as a proxy for the extent of monetisation in Pakistan:[3]

$$\ln\left(\frac{M1}{PN}\right) = -1.337 + 0.639\ \ln\left(\frac{NNP}{PN}\right) + 0.057\ \ln(D) - 2.602\ r_m$$

$$t \quad (-1.224)\ (4.066) \qquad (2.236) \qquad (-2.273)$$

$$- 1.255\ i^* + 0.393\ \ln\left(\frac{M1}{PN}\right)_{-1} \quad (22)$$

$$t \quad (-3.420) \qquad (3.559)$$

$$R^2 = 0.951 \qquad DW = 2.317 \qquad F = 50.56$$

$$\ln\left(\frac{M2}{PN}\right) = -2.110 + 0.816\ \ln\left(\frac{NNP}{PN}\right) + 0.084\ \ln(D) - 1.580 i^* + 0.328\ \ln\left(\frac{M2}{PN}\right)_{-1} \quad (23)$$

$$t \quad (-3.383)\ (6.531) \qquad (4.012) \qquad (-6.001) \qquad (3.831)$$

$$R^2 = 0.988 \qquad DW = 2.290 \qquad F = 288.81$$

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[2] With a five year lag, the first expected rate of inflation, i.e. for the year 1951-52, is calculated from actual rates in each year between 1946-47—1951-52. The expected rates of inflation were calculated from the following lag structures :

	Equation (20)		Equation (21)
i_t	0.1892	i_t	0.2595
i_{t-1}	0.1965	i_{t-1}	0.2057
i_{t-2}	0.1916	i_{t-2}	0.1644
i_{t-3}	0.1744	i_{t-3}	0.1356
i_{t-4}	0.1450	i_{t-4}	0.1193
i_{t-5}	0.1033	i_{t-5}	0.1155
	[Second degree polynomial]		[Second degree polynomial]

[3] Expected rates of inflation were calculated from the following lag structures:

	Equation (22)		Equation (23)
i_t	0.0927	i_t	0.1500
i_{t-1}	0.1834	i_{t-1}	0.1581
i_{t-2}	0.1867	i_{t-2}	0.1610
i_{t-3}	0.1648	i_{t-3}	0.1576
i_{t-4}	0.1481	i_{t-4}	0.1468
i_{t-5}	0.1344	i_{t-5}	0.1276
i_{t-6}	0.0899	i_{t-6}	0.0988
	[Fourth degree polynomial]		[Fourth degree polynomial]

To test McKinnon's complementarity hypothesis, we estimated the demand for money and savings functions using two stage least squares. Since McKinnon's theory concerns the demand for money broadly defined, we only report estimates for M2[4]:

$$\ln\left(\frac{M2}{PN}\right) = -2.782 + 0.809\left(\frac{\hat{Sd}}{Y}\right) + 0.799\ln\left(\frac{GNP}{PN}\right) + 0.125d' \qquad (24)$$

$$t \quad (-2.199) \quad (2.226) \quad (3.704) \quad (0.055)$$

$$-1.396\, i^{*} + 0.563\ln\left(\frac{M2}{PN}\right)_{-1}$$

$$t \quad (-3.841) \quad (7.475)$$

$$R^2 = 0.985 \qquad DW = 2.044 \qquad F = 167.81$$

$$\frac{Sd}{Y} = -0.107 + 0.129\ln\left(\frac{\hat{M2}}{PN}\right) - 0.060\ln\left(\frac{GNP}{PN}\right) \qquad (25)$$

$$t \quad (-0.151) \quad (2.103) \quad (-0.385)$$

$$+ 0.277\,\Delta\ln\left(\frac{GNP}{PN}\right) + 0.224\frac{X}{Y} - 0.558\frac{F}{Y}$$

$$t \quad (1.354) \quad (0.483) \quad (-1.746)$$

$$R^2 = 0.543 \qquad DW = 1.190 \qquad F = 3.08$$

These results contrast sharply with Akhtar's equations (11) and (12). Ours show strong support for McKinnon's complementarity hypothesis in both the demand for money and the savings functions; the coefficient of $\frac{\hat{Sd}}{Y}$ in the demand for money function and of $\ln\left(\frac{\hat{M2}}{PN}\right)$ in the savings function are both positive and significant.[5] Interestingly, in equation (25) the coefficient of $\frac{F}{Y}$ is negative and significant, which agrees with other empirical work indicating that there is substitutability between foreign and domestic savings.

In conclusion, our results do support Akhtar's finding that income is the primary determinant of the demand for money in Pakistan. We also find the rate of interest significant in estimates of the narrowly defined money demand function (M1). However, in contrast to Akhtar's findings our results suggest that the rate of inflation, when included as an expected rate, is highly significant.

Akhtar relies on the index of industrial production as his only support for McKinnon's complementarity hypothesis. We find no place for this variable in McKinnon's model. Using two stage least squares estimating procedures we do obtain strong support for this theory in the case of Pakistan. Elsewhere, we have presented tests of this theory showing mixed results for a number of other countries [1]. We hope this contributes to meeting the "definite need for more empirical analyses along these lines" [2, p. 53].

[4]The expected rates of inflation series used in equation (24) was the same as that used in equation (23). The instrumental variables used in both equations (24) and (25) were $\ln\left(\frac{GNP}{PN}\right)$, $\Delta\ln\left(\frac{GNP}{PN}\right)$, d', i^{*}, $\ln\left(\frac{M2}{PN}\right)_{-1}$, $\frac{X}{Y}$ and $\frac{F}{Y}$.

[5]Since these equations are two stage least squares estimates, the "t" values do not provide conclusive tests of significance.

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