AN EMPIRICAL STUDY ON THE KERAN'S MODEL*

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〈CONTENTS〉

Ⅰ. Introduction

Today's great debate between the camps of Keynesians and Monetarists has been over the most effective means of economic stabilization through aggregate demand management.

During most of the 1960's, when the Keynesians were riding high in Washington, fiscal policy has been given the dominant role in economic stabilization efforts. The theoretical rationale for such reliance on fiscal actions was the simple Keynesian multiplier analysis. The simple form of the multiplier process holds that an increase in Government expenditures or decrease in the rate of texation induces repeated rounds of spending by consumers and business firms, resulting in a multiple expansion of total spending.

Alfthough fiscal policy reigned supreme during most of '60s, two occurrences invoked doubts on the part of economists about the supposed superiority of fiscal over monetary policy as a tool for economic stabilization.

1) Time Lag in Fiscal Legistration. Fiscal actions take much longer to implement than monetary actions because the former require Congressional approval whereas the latter are decided at frequent periodic meetings of the Federal Reserve System's

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Board of Governors. For an intance, it took Congress 18 months in '67-68 to enact a tax increase for the purpose of curbing inflationary pressures.

2) Changed Economic Environment. In the '30s and '40s the main challenge was to keep the economy bouyed up, and attention tended to center on methods of economic stimulation. During '50s inflation came to the forefront, and in the '60s the United States underwent unprecedented difficulties with its balance or payments.

The Monetarists deny that fiscal policy is an effective stabilizing device and point out that fiscal combined with misused monetary policy has magnified rather than mitigated business cycle. Thus, they object the whole Keynesian concept of "fine-tuning" economy. The monetarists argue that changes in the money supply are the chief determinants not only of prices, but also of production, employment and spending.[1] They conducted the historical survey going as far back as the Civil War in order to analyze the behavior of money and prices.

Michael W. keran's Model dubbed as the St. Louis Equation along with the preceding model by L. Anderson and J. Jordan is the outcome of another historical survey of monetary and fiscal influences on economic activity in the United States during 1919 through 1969.

The Keran's Model lent itself to substantiate the Monetarist contention that the changes in the money supply have larger, more predictable, and quicker effects on GNP than fiscal-policy changes.[2]

This paper attempts to critically appraise the Model in the light of the new empirical evidences based on quarterly first difference during 1965 thru 1980, when the American economy was characterized by the deeper involvement in the Viet Nam War during '60s, the Menacing inflation coupled with on-and-off recessions throughout '70s. Further, this paper endeavors to enhance the statistcal reliability, modifying the Model in methodology and specification.

Ⅱ. Theoretical Issues

The Model is a reduced form of the single equation approach. The single equation approach features in the advantage that it avoids the problem of specifying and measuring specific links between monetary and fiscal influences and economic activity. If the monetary and fiscal variables are admittedly exogeneous and are correctly specified, the single equation enables to capture the direct and indirect impact of monetary and fiscal influences on economic activity irrespective of the transmission channels.

The key methodological and statistical problems with the single equation consist in the selection of appropriate indicator of monetary and fiscal influences.

The variables selected to represent monetary and fiscal influences should not be contemporaneously determined by the behavior of the public as measured by changes in economic activity. If exogenous assumption is not satisfied, the direction of causalty is not certain and a close statistcal association with economic activity does not provide any evidence of the magnitude of the impact from monetary and fiscal influences. Suppose a rise in GNP resulting from an expansive fiscal policy tends to increase the money stock, mainly because it induces banks to borrow more from the central bank and reduce excess reserves, but partly also because the induced rise in interest rates reduce demand for time deposits, and thus permits an increase in demand deposits and money stock.

A regression of GNP on the money stock, then, combines the effects of GNP on money with those money on GNP. The regression of GNP on the money stock, therefore, would not yield statistically unbiased estimaties of the effects of monetary policy on the economy. Although the nature of the argument is straightforward, there is no satisfactory solution to test for exogeneity in either single equation or in the large structurel models due to the fact that we can only deal with the observable, measured error term, whreras the exogeneity of a variable is determined by the unobservable, "true" error term in the equation.

Keran challenges so-called the "reverse causation" argument, which asserts that the observed correlation between changes in money and changes in income causes changes in income is not because changes in money cause in income but because changes in income cause changes in money.[3)]

In order for economic activity to affect the money stock, it must operate through some transmission mechanism. Since money stock (M) is defined as product of the money multiplier (m) and monetary base (B), namely;

$$M = mB$$

the influence of economic activity on the money stock could operate either through the money base or the money multiplier. The approach employed by Keran et. al. to test for the influence of economic activity on the money base and/or money stock is regressional analysis of these variables;

$$\Delta B_t = b_0 + b_1 \Delta Y_t \qquad (1.1)$$

$$\Delta M_t = d_0 + d_1 \Delta Y_t + d_2 \Delta B_t \qquad (1.2)$$

These formats were tried using the quarterly first difference of the observations during the period of 1965 thru 1980, and results registered as follow;

$$\Delta B_t = .62 + .031 \Delta Y_t$$

$$(1.5) \quad (2.6) \qquad R^2 = .17 \quad D\text{-}W = 2$$

$$\Delta M_t = 1.1 + .08 \Delta Y_t + .11 \Delta B_t$$

$$(2.7) \quad (5.9) \quad 46) \qquad R^2 = .71 \quad D\text{-}W = 1.7$$

The figures inside the brackets represent t statistics.

The first equation shows the weak association of the money base with changes in income and the second equation menifests the relative influences of economic activity and the monetary base on the money stock that are negligible at most.

It follows that the meager relations of ΔB_t with ΔY_t, and ΔM_t with ΔY_t and ΔB_t signify an acceptable degree of the independence of the money stock from economic activity

Ⅲ. Specification of the empirical model

1. The generalized statement of the single equation in Keran's article is in the form:[4)]

$$\Delta Y_t = \alpha + \beta \Delta M_t + \gamma \Delta F_t \qquad (2.1)$$

where ΔY=changes in economic activity,

ΔM=changes in monetary influences,

ΔF=changes in fiscal influences.

The parameters β and γ indicate the magnitude of the impact of monetary and fiscal influences respectively, on economic activity and α is a proxy for the ret trend of all other influences on economic activity.

Let k denote the degree of polynomial, and m be the number of lags, then, the general form of the model in the Almon lag will be:

$$\beta_i = a_0 + a_{1i} + \cdots\cdots + a_K i^K$$

$$\gamma_i = b_0 + b_1 i + \cdots\cdots + b_K i^K$$

$$\Delta Y_t = \alpha + \sum_{i=0}^{m} (a_0 + a_1 i + \cdots\cdots + a_K i^K) \Delta M_{t-i}$$

$$+ \sum_{i=0}^{m} (b_0 + b_1 i + \cdots\cdots + b_K i^K) \Delta F_{t-i} + u_t$$

$$= \alpha + a_0 \sum_{i=0}^{m} \Delta M_{t-i} + a_1 \sum_{i=0}^{m} i \Delta M_{t-i} + \cdots\cdots\cdots + a_K \sum_{i=0}^{m} i^k \Delta M_{t-i}$$

$$+ b_0 \sum_{i=0}^{m} \Delta F_{t-i} + b_1 \sum_{i=0}^{m} i \Delta F_{t-i} + \cdots\cdots\cdots + b_K \sum_{i=0}^{m} i^K \Delta F_{t-i} + u_t$$

Defining $Z_{ot} = \sum_{i=0}^{m} \Delta M_{t-i}$ and $Z'_{ot} = \sum_{i=0}^{m} \Delta F_{t-i}$

$$Z_{1t} = \sum_{i=0}^{m} i \Delta M_{t-i} \qquad Z'_{1t} = \sum_{i=0}^{m} i \Delta F_{t-i}$$

$$\vdots \qquad\qquad \vdots$$

$$Z_{Kt} = \sum_{i=0}^{m} i^k \Delta M_{t-i} \qquad Z'_{kt} = \sum_{i=0}^{m} i^k \Delta F_{t-i}$$

$$\Delta Y_t = \alpha + (a_0 Z_{ot} + a_1 Z_{1t} + \cdots\cdots\cdots + a_k Z_{kt})$$
$$+ (b_0 Z'_{ot} + b_1 Z'_{1t} + \cdots\cdots\cdots + b_k Z'_{kt}) + u_t$$

Assuming $E(u_i) = 0$, $E(u_i, u_j) = \sigma^2$ if $i = j$
0 if $i \neq j$

Now, Y is regressed on Z and Z' variables. ΔY_t can be estimated by the usual ordinary least square procedure.

2. Keran's estimates of the equation generally resulted in low R^2 values ranging from 30 to 70 % and D–W statistics somewhere between 1.15 and 1.86.

In an attempt to improve the ststistical reliability the iterative procedure by Orcutt–Cuchrane method was employed to combine with the Almond distributed–lag technique in order that the existence of possible serial correlation due to the structure of the Almond–lag coefficients may be eliminated.[5)]

First, the regression of ΔY_t is run on Z and Z' variables. The residuals from the equation are then, used to perform the following regression.

$$\hat{u}_t = \rho \hat{u}_{t-1} + \varepsilon_t$$

The estimated value of ρ is used to proceed the generalized differencing transformation process, and a new regression is run :

$$\Delta Y_t^* = \alpha(1 - \hat{\rho}) + (a_0 Z_{ot}^* + a_1 Z_{1t}^* + \cdots\cdots + a_k Z_{kt}^*)$$
$$+ (b_0 Z'^*_{ot} + b_1 Z'^*_{1t} + \cdots\cdots + b_k Z'^*_{kt}) + \varepsilon_t$$

where,

$Y_t^* = Y_t - \hat{\rho} Y_{t-t}$

$Z_{0t}^* = Z_{0t} - \hat{\rho} Z_{0t-1}$

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The estimated, transformed equation yields revised parameter estimates to be substituted into the original equation, and new regression residuals are sbtained by running the regression:

$$\hat{u}_t = \rho \hat{\hat{u}}_{t-1} + \mathcal{E}_t$$

These second round residuals can be used to obtain a new estimate of,ρ and so on, until to stop the iteration when the new estimat e of ρ differs from the old ones by less than .01 or .005.

3. One of the controversial topics brought about between these two major economic schools is the impacts of changes in interest rate on economic activity.

The Keynesians theorize that interest rates influence substantially on total spending and business activity, whereas Monetarists rule out their effects on economic activity, believing that spending and interest rates are results of changes in the money supply.

In order to investigate the impacts of interest rates and to test the validity of the specification of the Keran's Model with this regard at the same time, interest is introduced into the model as an additional independent variable to account for the influence of interest variation on economic activity.

The equation will be, then:

$$\Delta Y = \alpha \Delta M + \beta \Delta M + \gamma \Delta + \delta \Delta R \quad (2.2)$$

where ΔR = changes in interest

In this project the quarterly net interest expenditure from the National Income Account was selectec as the indicator of interest,and the estimation was made as follow at 4 quarters' time lag:

$$Y = -5.68 + 7.77 \Delta M + 0.9 \Delta F + 1.01 \Delta R \quad (2.2')$$

$$(-1.3) \quad (5.87) \quad (.87) \quad (.95)$$

$$R^2 = .79 \quad F = 15.8 \quad D\text{-}M = 1.95$$

which is compared to the estimation of the equation (2.1) at the same time lag as follow:

$$Y = -7.68 + 7.7\Delta M + 1.6\Delta F \qquad (2.1')$$

$$(1.98) \qquad (5.9) \qquad (2.39)$$

$$R^2 = .77 \qquad F = 22.37 \qquad D\text{-}M = 2$$

In comparison to the equation (2. 1'), the equation (2,2') results in higher R^2 value and so much lower t statistics as statistically insignificant at 5% level, except the monetary variable.

The high value of R^2 associated with very low values of t of independent variables seems to indicate the evedent existence of multicollinearity.

Thus, the estimation of the equation (2.2) indicates that the impact of interest on economic activity is trifling, which is in line with the Monetarist contention.

Ⅳ. Estimation of the Equation

1. The data used in this study covering the period from 1965 to 1980 were derived from the U. S. Government publication, Economic Indicator, issued by the Department of Commerce in the form of quarterly observations.[7)]

   M - 1 was used as the indicator for monetary influence and the aggregate government expenditures to represent fiscal influence, while the quarterly measures of reserve money and currency in circulation were available for the base money.

   In estimating the equation three forms of measures were tried:

   1) quarterly first difference in billions of dollars,
   2) the same transformed into natural logarithm,
   3) quarterly first defference in percentage.

The measure 2) poses problem because the computer does not perform arithmetic operation setting the resuly zero when the quarterly first difference shows negative value. The data 3) yield unduly suppressed results due to the measures being below the decimal point, mostly the second digit preceded by zero.

Hince, only the results with quarterly first difference of the money stock and the Government expenditures are reported.

2. The test procedures conducted by Keran in his article were exactly followed in order to keep the results comparable. Quarter - to - quarter changes in the measure of economec activity were regressed against quarter - to - quarter changes in the indicators of monetary and fiscal influences, and the form of the equation were estimated with money alone, fiscal alone and a combination of the two.

Alternative time lags between t - 3 and t - 10 were tried using the Almond approach. During the period under the study t - 4 proved to generate the minimum standard error of estimate. The equation at four quarters time lag is estimated as follows:

$$Y_t = -7.68 + 7.7\Delta M_t + 1.6\Delta F_t \qquad (2.1')$$

$$(1.98) \qquad (5.9) \qquad (2.39)$$

$$R^2 = .77 \qquad F = 22.37 \qquad D-W = 2$$

The above estimation was already cited earlier at the Section 3, Chapter Ⅲ, to compare to that of the equation (2.2). Here, the translation of the estimation is in order.

In view of t statistics of each term, which is at least nearly 2, indicate each parameter is statistically significant. The coefficient of determination, R^2, that measures the percent of variation in ΔY due to variations in ΔM and ΔF is much higher than that reported by Keran. D - W value of 2 points out that there is no positive or negative autocorrelation at work.

The estimated coefficient on the monetary variable would imply that for every $ 1 increase in the money stock there will be a $ 7.70 increase in economic activity after the subsequent four quarters. The same goes for the fiscal variable that every $ 1 increase in the Government expenditure a $ 1.60 increase in economec activity after the following four quarters.

The negative sign of the constant term which represents a proxy for the net trend of all influences other than monetary and fiscal may be explained by the counteracting factors against those monetary and fiscal impacts during this period. As the involvement in Vietnam War went deeper the real Government purchase registered and increase of 12.9% toward mid '65 through the end of '66 which crowded out the private investment because of the rise in interest rate.[8)]

The investment in residential housing declined by 23% by the end of 1966 from its level reached in mid '65 and the monthly growth in mortgage debt in December 1966 dropped by 65%, The oil and food shocks in '73–74 coupled with the dooming inflation and persistent recession wiped out the stimulative efforts on the part of monetary and fiscal policies, pushing down the ratio of nominal to real GNP.

3. To measure the relative strength of monetary and fiscal influences one needs to know which has the largest impact on economic activity. The proposition Keran tested was whether monetary or fiscal influences were stronger, more predictable, and faster in their impacts. To make the estimated coefficients of the monetary and fiscal variables comparable for an assessment of their relative impact they were transformed into beta

coefficiemts. This is shown as follows:

Variable	: ΔM	ΔF
Beta Coefficient	: $\frac{\beta_i \sigma_s}{\sigma_Y} = \frac{1.3 \times 7.7}{12.4} = 0.8$	$\frac{\gamma_i \sigma_r}{\sigma_Y} = \frac{1.6 \times 0.67}{12.4} = 0.086$

It follows that the monetary influence is much stronger thar fiscal in that the beta coeffieient of the former is over 9 times larger than that of the latter.

For the comparison of the predictability t values of the coefficients were used, since the variable with more statistically significant coefficient is also more reliable in that its relationship to economec activety is more predicitable.During the period from 1965 thru 1980, the coefficient of the monetary variable indicated a t value of 5.9 which is compared to 2.4 of the fiscal coefficient. It turns out that the former is about two times and a half as large as the latter.

V. Review of the Empirical Evidences

The suvey conducted to cover the period under the study, '65—'80 reveals that the changes in the money supply and those in the Government expenditures do affect economic activity. The estimation of the Keran's Model using quarterly observations during this decade and a half, however, attests the monetary influence is stronger and more predicatable, although it leaves room for debate over the impact of the velocity of money and the definition of meney.

As the involvement in the Vietnam War went deeper the the Government expenditures boosted to $ 27.3 billion from mid '65 to the end of '66, whereas the real money supply remained constant during this five-quarter interval. This signifies the shift of IS curve rightward on the LMcurve, yielding a hefty increase in real income by $ 60.4 billion. This sharp rise in the Government spending with real money supply constant drove up interest rates and crowded out prive investments.

In 1967 and 1968 the money supply began to grow rapidly allowing the private spnding to grow in addition to the ongoing rapid increase in defence expenditures.

Since the economy was straining at the limit of its productive capacity, the phenominal spending growth caused a serious inflation. During '65—'71 the Fed was engaged in procyclical money supply permitting both nominal and real money to accelerate twice between mid late '68. The Fed's excessive monetary expansion is an additional factor responsible for the menacing inflation during '70s.

The decade of '70s is characterized by the unstable nominal to real GNP ratio, soaring inflation, but relatively stable M1 growth. The four-quarter M1 growth rate during this decade registers the standard deviation of 1.41 with mean of 6.5 as compared to 1.53 and 4.9 of the standard deviation and mean respectively during '65 thru '70.

The Fed, again, has been accused of playing politics for the '72's presidential election raising M1 growth in late '72 and boosting the nominal to real GNP ratio to its peak around the time of the election. Also the Fed was blamed for exacerbating the recession by allowing M1 growth to slow down steadily when the oil and food shocks affected the economy severely in 1974.

After the oil shock in 1973 a stimulative fiscal policy was enforced, jacking up the Government spending in the 2nd quarter of 1974 thru '75 and the second quarter in '77 thru 3nd quarter of '78 entailing acceleration of M1 growth in 1978. The economy recovered albeit veryshort, during the last quarter of '78 bring the nominal to real GNP ratio close to unity.

The tightening up of M1 growth during 4th quarter of '79 thru '80 particularly the sharp decline in mid '80 is blamed for aggravating the already severe 1980 recession.

The growth rate of GNP certaintly reflected major acceleration and deceleration in M1 growth. The growth of GNP, however, in spite of apparent association with the money supply is by no mans a mirror image of money. The irregular diserepancy between the nominal GNP and M1 growth indicates the influence excercised by the growth of velocity of M1. The velocity is activated either by the stimulative fiscal policy, a decline in the demand of monay due to the rising interest, or by the drop in consumer saving which effects the increase in autonomous consumption, shifting IS to the right.[9]

The velocity of M1 demonstrated pronouncedly fluctuating during '70s as shown below:[10]

4-qtr growth rate of velocity of M1 during 1970s

Four quarters ending in:

1971:Q1	1.4
1972:Q1	2.0
1973:Q1	3.5
1974:Q1	2.8

1975 : Q1	2.3
1976 : Q1	7.7
1977 : Q1	4.1
1978 : Q1	2.6
1979 : Q1	6.1
1980 : Q1	1.8

VI. Summary

Michael W. Keran brought out his model dubbed as the St. Louis Equation in the Federal Reserve Bank of St. Louis Review, Nov. 1969.

The Model is the outcome of his expansive survey covering the period, 1919 thru 1969. The Model is the reduced form of single equation, featuring in three-variable regression with the proxy for economic activity as dependent variable and the indicators of fiscal and monetary influences as explanatory variables.

This paper intends to critically appraise the Model in the light of new evidences from the period of 1965 thru 1980 with regard to its theoretical validity.

The reverse causation argument which tests the exogeneity of the dependent variable, is revisited. Then, the specification of the Model is closely examined.

Introduction of interest rate is tried to evaluate its influence on economic activity. It follows that if the role of interest rate is correctly captured, then, it guides to determine whether or not the Model should be modified from that point of view. Keran's estimation of the Model remains much short of the statistical reliability in terms of statistics such as t. D−W, R^2 in particular.

An effort was made to achieve a better result, employing the reiterative technique by Cuchrane and Orcutt to combine with the Almond-lag method.

The results are reviewed with reference to the episodical context during the period under this study, 1965 thru 1980.

It may be pointed out that the Keran's Model lends itself to substantiate the monetarist contention on the ground of these later observations.

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Keran의 모델에 관한 실증적 고찰

김　　태　　식

(國 文 抄 錄)

1959年 11月 St. Louis 연방은행 Review誌에 발표된 통칭 St. Louis 방정식으로 불리는 Miehael W. Keran의 모형은 학계에 지대한 반향을 이르켰다.

동모형은 1919년에서 1969의 50년간의 자료를 토대로 재정정책및 화폐정책을 대표하는 두 설명변수와 경제활동의 전반적지표로서 국민소득을 종속변수로하여 전자의 후자에 미치는 영향을 계량적으로 파악코저하는 회귀분석인데 단일 방정식이라는 접근방식이 구조적 특징이다.

본 연구는 1965년에서 1980년까지의 새로운 자료에 입각하여 동모형의 이론적 타당성을 비판적으로 검토하고, 또한 통계학적 신빙성을 提高할 수 있는 改善方案을 모색코저 試圖한 것이다. 우선 單一方程式 接近의 問題點인 종속변수의 EXOGENEITY를 시험하기 爲한 소위 Reverse−Causation Argument를 再點檢하였고, 이이서 동모형의 Specification을 면밀히 살펴봤다. 특히 이자율의 변동을 설명변수로 도입해서 동변수가 경제활동전반에 끼치는 영향을 추정함으로서 설명변수의 추가적 設定의 타당성여부를 검토하였다. Keran의 결과가 t, D−W 및 R^2 등의 주요 통계치가 매우 미흡한 수준이였으므로 이들 통계치의 提高를 위해 Almond-lag 방식을 Cuchrane/Oreutt 技法과 결합해서 적용하여 Almond의 지연구조에 緣由하는 自動相關 效果를 排除코저 하였다. 끝으로 본연구대상기간인 '65년에서 '80년간의 역사적 발전을 배경으로 동모형의 적용 결과를 再照明함으로서 동모형의 타당성을 살펴봤다.