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ABSTRACT: This paper investigates whether fiscal and monetary policy actions are co-integrated with inequality in the size distribution of income. The effects of monetary policy on the size distribution of income have generally been ignored in the literature. We find that aggregate monetary and fiscal policy measures are co-integrated with various measures of income inequality. Indeed, the evidence from the error-correction specification implied by the co-integrating regression suggests that impacts of monetary policy actions on the size distribution of income are statistically significant.

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I. Introduction

Ever since Pareto's (1897) initial study on the subject, economists have been interested in the role that policy actions play in redistributing income. Although the effects of a tax and transfer scheme on inequality in the personal size distribution of income appear straightforward enough, the final effects are most likely distorted by policy-induced changes in labor supply incentives, in consumption spending patterns, and in factor prices, and so forth. As Atkinson and Stiglitz (1980) point out,

> "The tax or expenditure is likely to lead to changes in endowments and may well affect the general equilibrium of the economy. Thus a tax on capital income may have second-round effects on the accumulation of both physical and human capital."1/

If both quantities and prices are affected, these second-round effects need not be trivial. Consequently, the direction of change in the shape of the size distribution of income is ambiguous, thus implying that the overall effect on the level of income inequality is indeterminate.

Tullock (1983) underscored the empirical importance of the relationship between policy action and inequality in the size distribution of total income, stating that "redistribution is probably the most important single function of most modern governments."2/ It would be useful to better understand how government policies are related to the level of income inequality in a systematic way, so that policy actions can be designed which exploit this relationship. Indeed, it is crucial that some equilibrium relationship exist in order to validate government activism in this regard.

It is presumed that changes in fiscal policy have important effects on economic agent's decisions, which, in turn, is transmitted as a change in the shape of the income distribution. The role that monetary policy plays in the redistribution process is not understood as well. It is further presumed that the relationship between changes in policy actions and changes in the income distribution satisfy an equilibrium condition. If changes in fiscal policy, or monetary policy, are important for redistributional purposes, then the nature of the equilibrium relationship between these policies and the income distribution should be detectable through empirical analysis. Davidson, Hendry, Srba and Yeo (1978) developed a methodology to test for a certain class of equilibria which are commonly used in the macroeconomics literature--the error-correction representation. In an error-correction model, "a proportion of the disequilibrium from one period is corrected in the next period."3/ Granger has shown that an error correction representation exists if a vector of time series data are "co-integrated."

Co-integration is a statistical property which means that economic variables "hang together." In other words, both variables individually have long-run components, but a linear combination of these variables act together to cancel out these long-run components. Therefore, testing for whether the time series are co-integrated amounts to finding evidence consistent with the presence of an error-correction model to represent the long-run equilibrium relationship.

The specific purpose of this paper is to apply the Engle-Granger co-integration methodology to test whether both fiscal and monetary policy variables are co-integrated with income inequality (as measured by a summary statistic) and hence, whether there is an error-correction mechanism that characterizes the relationship between policy actions and changes in the size distribution of total income. We are not aware of any other studies which attempt such an analysis. If such a relationship does exist, then relevant information is provided to the policymaker attempting to formulate redistributive strategies, as we discuss below. It also means that a serious evaluation may be necessary on previous empirical work on this topic. In our study, changes in the size distribution of income are captured as changes in the degree of inequality as measured by various measures of income inequality. Here, public policy includes a broad measure of monetary policy as well as various measures of fiscal policy. Monetary policy's role in this process has not been examined very much (we discuss the exceptions below) and one of the principle aims of this study is to analyze money's impact on income inequality more rigorously. Thus, the marginal contribution of both fiscal and monetary policy actions, as they pertain to changes in the size distribution of income, are considered.

This paper is organized as follows. In section two, we discuss the relationship between policy actions and inequality. The error-correction model is reviewed in section three along with the presentation of the empirical results. Section four concludes the study.

II. The Relationship between Macropolicy and Inequality

The theoretical basis for the government's redistribution role is well-established. Empirical analysis of the effects of macroeconomic policy effects on the distribution of income, however, is limited. Musgrave, Case and Leonard (1974) examined the effects of taxes and public spending on income classes. They found broad evidence that taxes and expenditures do affect the distribution of income between income classes. Pechman and Okner (1974) used data at the individual level, and, similarly, found evidence which supports the hypothesis that tax policy affects the income distribution.

Metcalf (1969, 1972), Beach (1977) and Blinder and Esaki (1978) each investigated how changes in the business cycle affect the size distribution of income. Recently, Blank (1985) and Blank and Blinder (1986) have examined the impact of inflation and unemployment on inequality. The consensus in this work is that changes in the rate of inflation do not have an important redistributional effect on the economy, while, in contrast, changes in the unemployment rate do play an important role in redistributing income.4/

The macroeconomic effects of policy variables on the size distribution may not be limited to fiscal policy. What is the long-run impact of monetary policy on the size distribution of income? The "distribution effects" of actions undertaken by the monetary authority are a generally accepted short-run phenomenon. Co-integration, however, characterizes a long-run relationship between economic variables. Therefore, we are interested in long-run effects that monetary policy may introduce as they pertain to the size distribution of income.

A once-and-for-all increase in the rate of growth of monetary aggregates is positively related to the rate of inflation. The inflation tax is a potential source of distortion in the economy. To the extent that the burden of the inflation tax is not borne uniformly by each household, it will affect the size distribution of income. The Federal Reserve also affects the profitability of depository institutions through reserve requirements. With higher reserve requirements, the Federal Reserve forces depository institutions to adjust their portfolios so that the proportion non-interest-bearing assets rises relative to total assets. Thus, the tax imposed by reserve requirements affects depository institutions' profits.

Russell, Slottje and Haslag (1987) investigated whether or not monetary policy affects the size distribution of income using a reduced-form specification. They found preliminary evidence that such a relationship exists between monetary policy actions and inequality. Balke and Slottje (1988) also found evidence that monetary policy actions affect the shape of the size distribution of income. In Balke and Slottje, the effects of monetary policy on income inequality are examined using a macroeconometric model which includes both the unemployment rate and the rate of inflation as explanatory variables. None of this previous work, however, has considered the possibility that the link between policy and inequality is a co-integrated one.

The presence of co-integration is consistent with two (or more) series exhibiting a long-run relationship. While money may have short-run distributional effects, putting a monetary aggregate into a co-integrating regression tests whether there is any permanence to the effects observed in the short-run relationship between monetary policy and the size distribution of income. In other words, it test whether monetary policy has long-run "real" effects on the level of inequality in the size distribution of income.

III. <u>The Empirical Evidence</u>

In this paper, the emphasis will be on the effects of macroeconomic policy on the size distribution of total income. We are interested in whether aggregate measures of fiscal and monetary policy affect the size distribution of income, and if the relationship is an equilibrium one.

Specifically, we ask whether the proposed equilibrium relationship can be represented by an error-correction mechanism.

3.1 Measures of Income Inequality

A summary statistic of the level of inequality inherent in the empirical size distribution of income is desirable. Since every well-known inequality measure describes a different aspect of the empirical distribution, several different measures are employed in this analysis.

One approach to measuring income inequality, without imposing a functional form of statistical distribution on the income graduation, is to use Lorenz-based inequality measures. The Lorenz curve is defined as the relationship between the cumulative proportion of income units and the cumulative proportion of income received when units are arranged in ascending order of their income, cf. Kakwani (1980). Lorenz proposed this curve in 1905 in order to compare and analyze inequalities of wealth in a country during different periods.

The Lorenz curve can be generated by defining the income earner units as (say) quintile share where q_i, i=1, ..., 5 represents the i th income earner share and letting

$$0 \le q_1 \le q_2 \dots \le q_5 \le 1.$$

From this simple ordering many well-known inequality measures can be formulated. For instance, the Gini (1913) measure is defined as,

$$(1) \quad G = 1 - 1/n - 2/n \, [\, \Sigma \, (n-k)q_k \,].$$

The Gini measure is the average difference of all pairwise comparisons of income. It is most frequently criticized for putting more weight on a transfer between middle income earners than at the tails (see Cowell, 1977). This measure is defined over the unit interval taking a value of 1 when income is "perfectly concentrated" in one household. Conversely, if the Gini index equals zero, income is uniformly distributed across households in the population. The relative mean deviation measure is defined as:

$$(2) \quad R = n/(2n-2) \, [\, \Sigma \, | q_k - 1/n | \,].$$

As Kakwani notes,

> "if population is divided into two groups, (a) those who receive less than or equal to mean income and (b) those who receive more than mean income, the relative mean deviation represents the percentage of total income that should be transferred from the second group to the first so that both groups have exactly the same mean income."5/

It also is a zero-one measure. Theil (1967) normalized entropy measure is defined as:

$$(3) \quad T = 1 + 1/\ln(n) \, [\, \Sigma \, q_k \ln q_k \,].$$

Theil formulated his measure based on whether a given physical system was more or less orderly. He reinterpreted this 'order' as income levels. The measure is defined over all non-negative values.

Kakwani measure takes the form:

$$(4) \quad K = 1 - 2 \,/\, 2 - 2 \text{ with } 1 = \Sigma \, 1_k$$

$$\text{and } 1_k = q_k^2 + 1/n^2.$$

Kakwani's measure looks at inequality between the classes and the weighted sum of inequality within each class. This measure takes on values from $-\infty$ to $+\infty$ and is more sensitive to redistribution occurring between the middle quintiles.

Finally, Atkinson's (1970) inequality index is explicit about the social welfare basis for the index itself. The index which Atkinson derived is based upon an underlying social welfare function. Following Cowell, we define the index as:

$$(5)\quad SW = 1 - [1/n\ \Sigma\ (n\ q_i)^{1-\varepsilon}\ ]^{1/1-\varepsilon} \qquad i = 1,2,\ldots, 5$$

where ε denotes the "inequality aversion parameter." Cowell interprets this parameter in the following way. Consider a rich man R with five times the income that is received by a poor man, denoted P. The degree to which we are inequality averse can be expressed as the amount of income we willing to let R give up to give a dollar to P. For example, if $\varepsilon = 0$, we will only take $1 from R to give a dollar to P. If $\varepsilon = 1/2$, we will take $2.24 from R to give a dollar to P. The higher the value of ε, the more averse to inequality we are and the higher is the premium we are willing to pay to effect a transfer of a given quantity to those in the lower income groups. In this study we calculated five Atkinson inequality measures by taking values of ε of 0.5, 0.75, 0.95, 1.5 and 2, which correspond to A1, A2, A3, A4 and A5, respectively.

The quintile data used to calculate these inequality measures are obtained from the Current Population Survey. The measure of monetary policy is the growth rate of the Federal Reserve Bank of St. Louis adjusted monetary base (ΔSTLBAS). The St. Louis base adjusts the source base for changes in reserve requirement ratios, and hence, reflects all actions undertaken by the monetary authority.6/ Four different measure of fiscal policy are used: Federal government purchases of goods and services (GPGS), personal tax payments net of transfer payments to individuals (PITT), transfer payments to individuals (TRANS), and the high-employment government budget surplus (HEGBS).

Annual averages are calculated for STLBAS, GPGS, PITT, TRANS and HEGBS. The sample period is 1947-86. The small sample size for the analysis that follows is problematic. The power of the test statistics in a small sample have yet to be resolved. Consequently, we must be cautious in interpreting our results. Unfortunately, historical data on inequality has only recently been collected.

Government efforts to redistribute income are often associated with specific fiscal programs.7/ The impact of specific programs means that the composition of government spending and taxes are assumed to affect the size distribution of income. At the aggregate level, separating out compositional changes is essentially impossible. Identifying the direct effects of specific programs on the size distribution of income are, therefore, overlooked at the aggregate level.

The systematic effects of aggregate federal spending on the size distribution of income will arise primarily due to two factors. First, the goods and services in the government basket are a proper subset of the goods and services in the economy. An additional $1 dollar of government spending increases the demand for these subset of goods and results in relative price changes. The effects of higher government spending on the size distribution of income, for instance, reflect households' responses to the relative price changes. Provided the incomes are not altered equiproportionately, the level of inequality in the size distribution will be affected.

A second way in which the increase in government spending might affect the size distribution of income is based on the notion that government purchases substitute for private purchases. Aschauer (1985) found that $1 of federal government consumption substitutes on average for roughly 33 cents of private consumption. What the government buys with a once-and-for-all increase in spending is important. On net, government purchases supplant the demand for goods by the private sector, which, in turn, lowers the demand for goods by the private sector and results in changes in relative prices. The "shock" to the demands for a subset of goods will affect relative prices, which, in turn, induces changes in income flows received by households.

The impact of monetary policy on the size distribution of income is postulated to occur through three channels. First, the long-run relationship between the rate of money growth and the rate of inflation means that Federal Reserve policies may give rise to a distortionary tax whicn, in turn affects income inequality. Like any other distortionary tax, the incidence of a higher rate of inflation is likely to be borne non-uniformly across households.

Second, the Federal Reserve also sets reserve requirements which affect depository institutions. Consequently, an increase in reserve requirements distorts the after-tax profits of depository institutions. Moreover, the Monetary Control Act of 1980 extended the scope of the reserve requirement tax to all depository institutions that offer transaction accounts. Thus, the short-run "distributional effects" associated with actions undertaken by the monetary authority may persist.8/

Third, the interaction between monetary and fiscal policy actions may bear on the size distribution of income. Consider the case where the public knows that the present value of all publicly-held government debt is exactly equal to the present value of (completely internalized) future tax obligations. Furthermore, let the Federal Reserve give its profits to the Treasury so that principal and interest paid to the monetary authority are transferred back to the fiscal authority. In effect, the Federal Reserve's purchases of government debt displaces part of the public's current and future tax obligations. Hence, for a given path of government deficits and surpluses, a once-and-for-all increase in the rate of money growth achieved through open market purchases means that the present value of the public's current and future tax liabilities are decreased. In this way, the Federal Reserve's interaction with the Treasury affects agent's intertemporal budget constraints, which, in turn, may give rise to changes in the size distribution of income.

In this paper, we examine whether the data indicate that the distribution of monetary policy actions and/or aggregate fiscal policy actions exhibit a long-run equilibrium relationship with the level of inequality in the size distribution of income. Generally, the results exhibit commonality across the alternative income inequality measures.

3.2 Results from the Univariate Analysis

Before we test for co-integration, it is necessary to determine the order of integration of the time-series being considered. If the order of integration is equal to zero, then the series is stationary. If, on the other hand, the series is integrated of order d (denoted I(d)), where d is some positive number, then the series is non-stationary. Univariate analysis is conducted to determine the order of integration. Specifically, unit-root tests are conducted.

Several methods to test for the presence of unit roots are available.9/ In this paper, we adopt the augmented Dickey-Fuller specification. That is,

$$(6)\quad \Delta x_t = \beta_0 + \beta x_{t-1} + \sum_{j=1}^{2} \Delta x_{t-j}.$$

The presence or absence of a unit root depends on the value of the coefficient β. The null hypothesis is that the variable, x_t, has a unit-root. In other words, rejecting the null hypothesis means that the series is stationary. If the test statistic indicates that the coefficient is significantly (in a statistical sense) less than zero, the null hypothesis is rejected and the series is I(0). Conversely, if the coefficient is not significantly less than zero, the series, x_t, does have a unit root. Hence, the variable is non-stationary.

The test statistic is of the form of the usual student's t for β, but the distribution of the test statistic is non-normal even asymptotically. The appropriate cumulative distribution is provided in Fuller (1976). From this cumulative distribution, the probability that the t-statistic is less than -3.00 (i.e., the probability of a Type-I error) is five percent.

We first examine each variable individually for the presence of a unit root. Table 1 reports the results using the augmented Dickey-Fuller specification to test this hypothesis. The four fiscal policy measures and the measures of income inequality are in levels, while the rate of growth of the adjusted monetary base is being tested for a unit root. In each case the value of the t-statistic is clearly greater than -3.00. The Dickey-

Fuller tests, therefore, are consistent with the presence of a unit-root in each series. Thus, the evidence suggests that the series are all I(d), d > 0.10/

Table 2 repeats the Dickey-Fuller tests to determine if a second unit root is indicated. The income inequality measures and the rate of growth of the adjusted monetary base are first-differenced, but the appropriate transformation applied to GPGS, PITT, TRANS and HEGBS is to calculate the rate of growth. With HEGBS, the t-statistic is greater than -3.00. The autocorrelation function, however, damps quickly which suggests that the rats of growth of the high-employment government budget surplus is stationary. Therefore, we will proceed with the analysis treating each individual series as being I(1).11/

3.3 Results from the Co-integration Tests

While each of the series appears to be I(1), it is possible that linear combinations of these variables are I(0). If so, the existence of such a combination would indicate that the vector of series are co-integrated. Here, co-integration equations will be utilized to address questions concerning the relationship between various policy measures and the level of inequality in the size distribution of income. Specifically, these questions fall into three categories. First, are various measures of fiscal policy co-integrated with the measures of income inequality? Secondly, is the measure of monetary policy co-integrated with inequality in the size distribution of income? Lastly, are a vector of fiscal and monetary policy variables co-integrated with the these inequality measures?

The first two questions establish separate roles for fiscal and monetary policy with regard to the level of inequality in the size distribution of income. By controlling for changes in the "other" policy variable in the co-integrating regression, the third question examines whether the <u>interaction</u> between fiscal and monetary policies is important in explaining movements in the shape of the size distribution of income.

Table 3 presents results from the co-integrating regressions where each fiscal policy measure and the monetary policy measure appear separately. For this bivariate analysis, both the Durbin-Watson (D.W.) and augmented Dickey-Fuller (A.D.F.) statistics are used for testing co-integration. With each test, the null hypothesis is that each series is not co-integrated with the measure of income inequality.

There are three main results coming from an analysis of individual policy measures and measures of income inequality. First, there is substantial differences between the inferences drawn regarding the presence of co-integration depending on whether one uses the D.W. or the A.D.F. test statistics. In only one case, with PITT as the fiscal policy measure, the D.W. test is marginally significant which suggests that co-integration is present. If one were to use the A.D.F. test, however, there are 16 separate occasions where the value of test statistic is (at least marginally) consistent with the presence of co-integration. Since the first differences of the individual time series are not white noise, Engle and Granger (1987) recommend that the augmented Dickey-Fuller test be adopted.

Second, the inference drawn from the bi-variate models concerns the choice of the fiscal policy measure in the co-integrating equation. Whereas the growth rate of the adjusted monetary base is not co-integrated with the measure of income inequality, the results vary with the four alternative measures of fiscal policy used here. By far, HEGBS performs the best. Except for the two Atkinson measures with the highest inequality aversion parameters, there is at least marginal evidence consistent with the high-employment federal budget surplus being co-integrated with inequality in the size distribution of income. There is at least marginal support that PITT is co-integrated with each of the four non-Atkinson measures. Because the other measures are components of the federal deficit, the robust finding with respect to HEGBS suggests that budget items other than expenditures on goods and services and transfer payments play an important role in affecting the size distribution of income. The finding with respect to personal income tax payments net of transfers also suggests that this is an fiscal policy variable is important in the government's redistributive efforts.

Third, it appears that the measure of income inequality also matters in efforts to uncover co-integration. As seen in Table 3, each of the fiscal policy measures is co-integrated with inequality in the size distribution of income when the Relative mean and the Gini coefficient are used as measures of income inequality. With the Kakwani and Theil measures, the evidence is consistent with PITT and HEGBS being co-integrated with the measure of income inequality. Finally, there is marginal evidence which suggests that HEGBS is co-integrated with the three Atkinson measures--A1, A2, and A3--which correspond to the lowest values of the inequality aversion parameter.

In short, the bi-variate models suggest that a broad measure of fiscal policy does appear to be co-integrated with inequality in the size distribution of income. The results suggest that other measures of fiscal policy fare less well and the presence of a long-run equilibrium characterized by an error-correction mechanism depends on the measure of income inequality used. Furthermore, individually, monetary policy does not appear to be co-integrated with income inequality.

In Table 4, each of the four fiscal policy measures are combined with the growth rate of the adjusted monetary base. This approach emphasizes the consolidated effects of fiscal and monetary policy as they pertain to inequality in the size distribution of income. Here, the null hypothesis is that some combination of fiscal and monetary policy variables are co-integrated with the measures of income inequality.

With HEGBS as the fiscal policy measure, by including a monetary policy term, the results improve modestly in the sense that the A.D.F. test statistic is significant at the five-percent level in six of the nine cases as compared with only three cases when HEGBS is used alone in the co-integrating equation. Moreover, with the other three measures of income inequality, there is marginal evidence that HEGBS, ΔSTLBAS and the measure of income inequality are co-integrated. With TRANS and ΔSTLBAS, the evidence is consistent with both fiscal and monetary policy variables being co-integrated with income inequality in six cases. Only when the Relative mean is the measure of income inequality, however, is the test significant at the five percent level. There is also marginal evidence that PITT and ΔSTLBAS are co-integrated with income inequality when Kakwani and A3 are the measures. Similarly, there is marginal support that GPGS and ΔSTLBAS are co-integrated with three measures of income inequality--the Relative mean, the Gini coefficient and Theil.

Thus, although the results tend to vary across the measures of inequality in the size distribution used and the fiscal policy measure, there is evidence that is consistent with the combination of fiscal and monetary policy variables exhibiting a long-run equilibrium relationship with income inequality. The inclusion of a monetary policy variable seems to augment the long-run equilibrium relationship between fiscal policy variables and inequality in the size distribution of income. It is undeniable that including a fiscal policy terms improves the chances of finding evidence that suggests monetary policy is co-integrated with income inequality.

The sequential processing of co-integrating regressions suggests that in the first pass, an important variable is omitted. Suppose that the "true" co-integrating regression includes both a fiscal policy and monetary policy variable represented in general form as

$$(7) \quad I_t = a_1 F_t + a_2 M_t + v_t,$$

where I denotes the measure of income inequality. Now suppose that equation (7) is estimated with F_t omitted. The residuals coming from this regression, v_t^*, will equal v_t plus $a_1 F_t$. That is, the sum of an I(0) term and an I(1) term, which will be I(1). Likewise, omitting M_t from the regression will yield nonstationary errors. Only by including both fiscal and monetary policy terms will the I(0) nature of v_t be revealed.

The evidence reported here is consistent with the notion that changes in both federal deficit and monetary policy variables do contribute to changes in the level of inequality in the size distribution of income. Moreover, monetary policy exhibits this long-run relationship with the inequality measure only when one accounts for the effects of changes in fiscal policy, particularly when the fiscal policy variable adopted gauges federal deficit policies. This finding is interpreted as further evidence that the interaction between the Federal Reserve and Treasury is important when formulating redistributive policies. Alternatively, when the government is interested in achieving income redistribution, it must take account of the coordinated efforts of the fiscal and monetary authorities.

Thus, the co-integration test suggest that when looking at fiscal policy measures alone, a long-run relationship with the size distribution of income depends on the inequality measure used. Moreover, there is marginal evidence that uncovering a co-integrating relationship is more likely when a broad measure, like the federal deficit, is used. With monetary policy, the tests indicate that monetary policy is not co-integrated with income inequality when viewed alone. Combining broad measures of both fiscal and monetary policy together in the co-integrating regression, however, suggests that a long-run relationship does exist. Thus, the interaction between fiscal and monetary policy appear to be important in formulating strategies for redistributing income. Given the sample size caveat, the evidence suggests that previous econometric modelling of the relationship between policies and inequality may be misspecified.

3.4 The Error-Correction Model

Based on the results from the co-integration tests, an error-correction representation of the system including both fiscal and monetary policy variables and inequality in the size distribution of income is suggested. The error-correction representation is estimated using vector-autoregression after appropriate transformation of the data so that each series is stationary. Also included in the estimation is the "equilibrium" error specification derived from the co-integrating regression. Through variance decomposition derived from the vector-autoregression estimation, it is possible to further deduce the relative contribution of both fiscal and monetary policy measures in explaining movements in income inequality. The variance decompositions tell us how much of the forecast variance in each future forecast period would be due to an innovation in the variable in question.

Tables 5 - 11 report the results obtained by estimating the error-correction model. The models estimated correspond to those cases where co-integration was detected at the five-percent significance level. Three main results are suggested by the error-correction models. First, lagged values of ΔSTLBAS are significantly related to measures of income inequality. This result suggests that monetary policy does Granger-cause changes in income inequality. In six of the seven models estimated, the results further suggest that increases in the rate of growth of the adjusted base are associated with decreases in the income inequality.

Second, the error-correction term, Z_{t-1}, is a significant explanatory variable in the equations when either the income inequality measure or the fiscal policy measure is the dependent variable. This finding is consistent with income inequality and fiscal policy adjusting to "shocks" which occur in this equilibrium system. Alternatively, in disequilibrium, adjustments in income inequality and fiscal policy are observed. Movements in the monetary policy measure, however, are independent of disequilibrium in this model. Thus, the results are consistent with monetary policy not adjusting to disequilibrium shocks in this system.

Third, in five of the seven models, there is evidence consistent with changes in the income inequality measure Granger-causing changes in the fiscal policy measure. This finding suggests that fiscal policy responds to changes in inequality in the size distribution of income. The fiscal authority's response to changes in inequality in the size distribution of income is probably reflects a convex combination of activist policies designed to affect income inequality, and actions such as transfer programs and income tax receipts which respond passively to movements in the size distribution of income.

Table 12 reports the proportion of forecast variance of the inequality explained using selected combinations of fiscal and monetary policy variables.12/ The sole criteria used in the selection process was that the tests for co-integration were significant at least at the five-percent level. The models estimated include two lagged values of the inequality measure, the fiscal policy measure and the monetary policy measure combined with the first lagged value of the error correction term from the co-integrating regression, denoted Z_{t-1}.

The results show that the rate of growth of the adjusted monetary base generally accounts for between 20 and 30 percent of the forecast variance in the measure of income inequality. Innovations in the fiscal policy measure vary more, with the federal deficit measure accounting for up to 6 percent of the forecast error variance. Using with transfer payments or federal expenditures on goods and services accounting for roughoy 11 and 20 percent, respectively.

The results of the variance decomposition are consistent with the notion that changes in monetary policy have indirect effects on inequality in the size distribution of income. Indeed, when coordinated with fiscal policy, the results suggest that changes in monetary policy explain between

1/5 and 1/4 of the variation in the inequality measure's future predicted values.

In short, the results of the co-integration test (recalling our sample size) conducted in this paper suggest that policymakers should not view a single (say) fiscal policy action as a redistribution mechanism and believe that this action will have a long-run redistributive impact. Instead, the policymaker must also take account of the monetary policy actions being simultaneously undertaken. The results are consistent with the coordinated use of both fiscal and monetary policy actions as exhibiting a long-run equilibrium relationship with inequality in the size distribution of income.

IV. Summary

This paper examines the role that changes in fiscal and monetary policy variables play with regard to the level of inequality in the size distribution of total income. We first examined whether fiscal and monetary policy measures are co-integrated with various measures of inequality in the size distribution of income. There is marginal evidence presented in this paper which suggests that a long-run equilibrium relationship between individual fiscal policy measures and the size distribution of total income exists. Individually, monetary policy is not co-integrated with income inequality.

Combining fiscal and monetary policy measures together in the co-integrating equation suggests that a long-run relationship does exist. Therefore, the coordination of fiscal and monetary policy appear to be related to changes in the size distribution of income. This result has important implications for the policymaker whose aim is redistribution. It is the joint efforts of fiscal and monetary policy which exhibit long-run equilibrium relationship with income inequality. Hence, singular policy attempts at redistribution, which do not consider the impacts of other policies concurrently undertaken, will not likely achieve the desired long-term effects.

The error-correction representation is also estimated in this paper. Monetary policy has not received much attention in the literature which investigates the various determinants affecting the size distribution of total income where it has been done it may not have correctly specified since co-integration appears to be present. From the error-correction representation, variance decomposition is utilized to examine whether changes in monetary policy contribute relative to changes in fiscal policy measures in explaining the forecast variance of the various measures of income inequality. Regardless of the fiscal policy measure used, changes in the growth rate of the adjusted monetary base generally explained over 20 percent of the forecast variance in inequality measures. This finding is consistent with monetary policy being an important policy tool when policymakers wish to gerrymander the size distribution of income.

The evidence presented above should be viewed as preliminary. The analysis was generally atheoretical. Many questions still remain concerning the transmission mechanism through which monetary and fiscal policy actions lead to changes in the size distribution of income. Moreover, it is interesting that the coordination of fiscal and monetary policy is important when analyzing movements in the size distribution of income.. Certainly, understanding the nature of the coordination scheme that is important for redistributive purposes deserves further examination.

FOOTNOTES

1. See Atkinson and Stiglitz (1980) , pg. 411.

2. See Tullock (1983, pg. 1.

3. See Engle and Granger (1987), pg. 254.

4. A caveat is applied to the finding that changes in the unemployment rate affect the size distribution of income, namely, that these results depend on the sample period under consideration.

5. Champernowne (1974) provides an excellent discussion concerning desirable criteria for a summary measure of inequality for the size distribution of income. Although the Gini coefficient satisfies his criteria, it still has well-known problems (cf. Cowell (1977). Moreover, as summary measure, one can not deduce from the Gini coefficient which specific income classes are net gainers or net losers. Braun (1988) compared different inequality measures and found that the Gini coefficient was never most highly correlated with any of the fifteen SES variables.

6. See Haslag and Hein (1989) for a complete description of the adjustment process used to calculate the adjusted monetary base.

7. Among those programs which transfer income are Aid for Families with Dependent Children. Other programs designed to redistributed income make payments-in-kind such as the food stamp program.

8. See Grandmont (1988) for a complete discussion of how the distribution of money balances will affect short-run aggregate behavior in a general equilibrium model. Note that movements in the size distribution of income are not inconsistent with output being unaffected. In other words, the relative price changes resulting from monetary policy may be small, and hence not be detected by in say a regression of real GNP on monetary aggregates. With a constant level of real income, however, the distribution of nominal income may be affected.

9. For instance, see Phillips (1987) for a discussion of some of the issues involved in testing for unit roots.

10. We also included a time trend in our unit root tests. For each series, the joint null hypotheses was that the coefficient on the time trend was equal to zero and the coefficient on the lagged level of the dependent variable was tested, which is one of the tests forwarded in Dickey and Fuller (1981). Accepting the null hypotheses suggests that a unit-root does exist. Conversely, rejecting the null hypotheses is consistent with the absence of a unit root. With the time trend included, the results of the tests are the same with regard to the presence of a unit root to those reported in Tables 1 and 2. In other

words, a unit root is suggested for the variables in levels (or growth rates for STLBAS), but after the appropriate transformation, the series appear to be stationary. The critical values for this test are presented in Dickey and Fuller, p.1063.

11. For example, the autocorrelation function takes on values of 1.0, 0.82, 0.65, 0.50, 0.34 and 0.22 for lags 0 through 5 with the HEGBS.

12. There are two things to note at this point. First, because there are so few degrees of freedom, we do not calculate the "optimal" lag length. The specification used in the VAR is that lags 1 through 4 are important. It is true, however, that including an additional lag for all terms in the VAR gives coefficients which statistically significant.

Second, the ordering of the variance decomposition does not seem to matter. We separately examined the variance decomposition with both the ΔSTLBAS ordered first and observe no major differences compared with the reported findings.

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Table 1

Unit Root Tests (on levels)
Dickey-Fuller Test-Statistics

Variable	β	Value of t-statistic[2]	Box-Leung Q lag=6
GPGS	0.087	2.61	3.18
TRANS	0.033	1.73	6.20
PITT	-0.165	-1.20	2.17
GC	-0.091	-0.80	2.60
K	-0.087	-0.69	1.48
R	-0.054	-0.53	2.11
T	-0.091	-0.80	2.51
A1	-0.107	-0.93	3.07
A2	-0.112	-1.00	3.37
A3	-0.117	-1.05	3.49
A4	-0.127	-1.18	3.60
A5	-0.133	-1.27	3.52
ΔSTLBAS[1]	-0.103	-1.36	3.18
HEGBS	0.092	1.01	8.01

[1] The adjusted monetary base variable is in growth rates.

[2] The critical value of the (Augmented) Dickey-Fuller test-statistic at the 5-percent level is -3.00 (see Fuller (1976) p. 373).

Table 2

Unit Root Tests (on first differences)
Dickey-Fuller Test-Statistics

Variable	β	Value of t-statistic	Box-Leung Q lag=6
GPGS[1]	-1.012	-10.50	0.33
TRANS[1]	-0.875	-4.22	1.72
PITT[2]	-1.066	-3.17	0.03
GC	-1.052	-3.91	0.81
K	-1.241	-3.67	1.25
R	-0.978	-3.69	0.57
T	-1.049	-3.80	1.06
A1	-1.124	-4.09	1.15
A2	-1.113	-4.16	1.20
A3	-1.118	-4.20	1.22
A4	-1.145	-4.31	1.21
A5	-1.163	-4.33	1.19
ΔSTLBAS	-1.468	-4.39	3.37
HEFGBS[2]	-0.680	-2.50	6.61

[1] Denotes first-difference of log-levels for these variables.

[2] Denotes percent-change calculated using $\frac{x_t - x_{t-1}}{(x_t + x_{t-1})/2}$.

Table 3

Results from the Bi-Variate
Co-integration Tests

Policy Measures

Inequality Measure	GPGS		PITT		TRANS		HEGBS		ΔSTLBAS	
	D.W.	A.D.F.	D.W.	A.D.F.	D.W.	A.D.F.	D.W.	A.D.F.	D.W.	A.D.
Kakwani	0.52	-2.74	0.72	-3.29**	0.54	-2.58	0.56	-3.23*	0.35	-0.9
Relative Mean	0.42	-3.65**	0.86*	-3.23*	0.45	-3.36**	0.58	-4.16**	0.27	-1.
Theil	0.36	-2.96*	0.69	-2.91*	0.37	-2.73	0.43	-3.55**	0.26	-0.
Gini	0.38	-3.21*	0.75	-3.13*	0.39	-2.97*	0.48	-3.79**	0.27	-1.
Atkinson A1, ε=0.5	0.36	-2.71	0.64	-2.7	0.36	-2.53	0.42	-3.2*	0.27	-0.
A2, ε=0.75	0.34	-2.6	0.61	-2.6	0.35	-2.44	0.40	-3.06*	0.27	-0.
A3, ε=0.95	0.34	-2.51	0.58	-2.52	0.34	-2.36	0.39	-2.94*	0.26	-0.
A4, ε=1.5	0.33	-2.26	0.52	-2.30	0.33	-2.15	0.36	-2.61	0.27	-0.
A5, ε=2.0	0.32	-2.09	0.46	-2.14	0.32	-2.01	0.34	-2.39	0.27	-0.

* indicates significance at the 10% level
** indicates significance at the 5% level

Table 4

Results from Co-Integration Test
with Combinations of the Fiscal Policy Measures
and the St. Louis Adjusted Monetary Base

Fiscal Policy Measures (with ΔSTLBAS)

Inequality Measure	GPGS	PITT	TRANS	HEGBS
Kakwani	-3.05	-3.67*	-3.33	-3.69*
Relative Mean	-3.95**	-3.23	-4.06**	-4.20**
Theil	-3.57*	-3.27	-3.61*	-4.18**
Gini	-3.66*	-3.31	-3.71*	-4.13**
Atkinson A1, ε=0.5	-3.34	-3.12	-3.36*	-3.76**
A2, ε=0.75	-3.35	-3.17	-3.43*	-3.82**
A3, ε=0.95	-3.30	-3.44*	-3.18	-3.81**
A4, ε=1.5	-3.21	-3.17	-3.37*	-3.67*
A5, ε=2.0	-3.09	-3.15	-3.28	-3.52*

* indicates significance at the 10% level
** indicates significance at the 5% level

Table 5

Results from the Error-Correction Model
with the Gini Coefficient as the Income Inequality Measure

Independent Variables	Dependent Variables Gini	HEGBS	ΔSTLBAS
Intercept	-0.38 E-4 (-0.04)	0.25 (0.30)	0.87 E-3 ( )
$Gini_{t-1}$	0.24 (1.26)	53.21 (0.35)	0.271 (0.73)
$Gini_{t-2}$	0.421** (2.63)	257.74* (2.01)	-0.18 (-0.59)
$HEGBS_{t-1}$	0.56 E-4 (0.26)	0.175 (1.01)	0.30 E-3 (0.72)
$HEGBS_{t-2}$	-0.83 E-4 (-.037)	-0.16 (-0.88)	0.95 E-3** (2.19)
$\Delta STLBAS_{t-1}$	-0.153* (-1.75)	18.67 (0.27)	-0.289* (-1.71)
$\Delta STLBAS_{t-2}$	0.161* (1.88)	146.66** (2.12)	-0.314* (-1.89)
$\tilde{Z}$	-0.443** (-2.75)	-258.55* (-2.00)	-0.157 (-0.50)

** indicates significance at the ten-percent level
* indicates significance at the five-percent level

Table 6

Results from the Error-Correction Model
with the Relative Mean as the Income Inequality Measure

Independent Variables	RM	Dependent Variables GPGS	ΔSTLBAS
Intercept	-0.14 E-2	0.05**	0.18 E-2
	(-1.52)	(3.60)	(0.68)
RM_{t-1}	0.259	0.112	0.962*
	(1.58)	(0.05)	(1.77)
RM_{t-2}	0.591**	-3.33	-0.145
	(4.03)	(-1.53)	(-0.33)
$GPGS_{t-1}$	0.56 E-2	0.705**	0.04
	(0.52)	(4.43)	(1.24)
$GPGS_{t-2}$	0.78 E-2	-0.408**	-0.039*
	(1.11)	(-3.90)	(-1.87)
$\Delta STLBAS_{t-1}$	-0.058*	0.463	-0.154
	(-0.94)	(0.51)	(-0.84)
$\Delta STLBAS_{t-2}$	0.115*	-0.161	-0.259*
	(1.85)	(-0.18)	(-1.41)
$\tilde{Z}$	-0.571	3.975*	-0.239
	(-3.92)	(-1.84)	(-0.01)

** indicates significance at the ten-percent level
* indicates significance at the five-percent level

Table 7

Results from the Error-Correction Model
with the Relative Mean as the Income Inequality Measure

Independent Variables	Dependent Variables RM	TRANS	ΔSTLBAS
Intercept	-0.93 E-3 (-0.56)	0.69E-1** (3.28)	0.35 E-2 (0.62)
RM_{t-1}	0.319** (2.10)	-4.73** (-2.44)	0.577 (1.13)
RM_{t-2}	0.559** (3.30)	3.54 (1.64)	0.029 (0.05)
$TRANS_{t-1}$	0.95 E-2 (0.67)	0.594** (3.31)	-0.109 (-0.23)
$TRANS_{t-2}$	-0.79 E-2 (-0.71)	-0.248* (-1.76)	-0.47E-2 (-0.13)
$\Delta STLBAS_{t-1}$	-0.72E-2 (-0.12)	-1.55** (-2.06)	-0.211 (-1.06)
$\Delta STLBAS_{t-2}$	0.195** (3.03)	1.88** (2.29)	-0.375* (-1.73)
$\tilde{Z}$	-0.735** (-4.30)	-2.95 (-1.35)	0.012 (0.02)

** indicates significance at the ten-percent level
* indicates significance at the five-percent level

Table 8

Results from the Error-Correction Model
with the Relative Mean as the Income Inequality Measure

Independent Variables	Dependent Variables RM	HEGBS	ΔSTLBAS
Intercept	-0.42 E-5 (-0.5E-3)	0.248 (0.28)	0.92 E-3 (0.44)
RM_{t-1}	0.20 (1.01)	55.45 (0.27)	0.369 (0.76)
RM_{t-2}	0.472** (2.81)	324.35* (1.86)	-0.175 (-0.42)
$HEGBS_{t-1}$	0.52 E-4 (0.31)	0.20 (1.12)	0.30 E-3 (0.72)
$HEGBS_{t-2}$	-0.39 E-4 (-0.22)	-0.159 (-0.87)	0.93 E-3** (2.14)
$\Delta STLBAS_{t-1}$	-0.116 (-1.69)	9.20 (0.13)	-0.30* (-1.75)
$\Delta STLBAS_{t-2}$	0.120* (1.78)	142.60** (2.05)	-0.318* (-1.93)
$\tilde{Z}$	-0.40** (-2.55)	-290.84* (-1.79)	-0.118 (0.31)

** indicates significance at the ten-percent level
* indicates significance at the five-percent level

Table 9

Results from the Error-Correction Model
with the Atkinson Measure (A1) as the Income Inequality Measure

Independent Variables	Dependent Variables A1	HEGBS	ΔSTLBAS
Intercept	-0.39 E-5 (-0.01)	0.221 (0.26)	0.81 E-3 (0.40)
$A1_{t-1}$	0.252 (1.31)	148.43 (0.48)	0.57 (0.77)
$A1_{t-2}$	0.359** (2.21)	530.97** (2.06)	-0.38 (-0.61)
$HEGBS_{t-1}$	0.36 E-6 (0.34)	0.146 (0.86)	0.32 E-3 (0.78)
$HEGBS_{t-2}$	-0.59 E-4 (-0.54)	-0.128 (-0.73)	0.90 E-3** (2.14)
$\Delta STLBAS_{t-1}$	-0.064 (-1.44)	23.84 (0.33)	-0.271 (-1.59)
$\Delta STLBAS_{t-2}$	0.082* (1.87)	157.08** (2.25)	-0.312* (-1.87)
$\tilde{Z}$	-0.397** (-2.42)	-547.95** (-2.10)	-0.45 (0.72)

** indicates significance at the ten-percent level
* indicates significance at the five-percent level

Table 10

Results from the Error-Correction Model
with the Atkinson Measure (A2) as the Income Inequality Measure

Independent Variables	Dependent Variables A2	HEGBS	ΔSTLBAS
Intercept	-0.36 E-4 (-0.05)	0.346 (0.41)	0.83 E-3 (0.42)
$A2_{t-1}$	0.259 (1.34)	55.52 (0.27)	0.43 (0.89)
$A2_{t-2}$	0.338** (2.06)	328.97* (1.87)	-0.32 (-0.78)
$HEGBS_{t-1}$	0.13 E-4 (0.08)	0.155 (0.89)	0.28 E-3 (0.70)
$HEGBS_{t-2}$	-0.71 E-4 (-0.43)	-0.144 (-0.81)	0.93 E-3** (2.23)
$\Delta STLBAS_{t-1}$	-0.905 (-1.35)	22.31 (0.31)	-0.268 (-1.59)
$\Delta STLBAS_{t-2}$	0.14** (2.13)	152.27** (2.16)	-0.318* (-1.92)
$\tilde{Z}$	-0.402** (-2.46)	-366.17** (-2.09)	-0.299 (-0.72)

** indicates significance at the ten-percent level
* indicates significance at the five-percent level

Table 11

Results from the Error-Correction Model
with the Atkinson Measure (A3) as the Income Inequality Measure

Independent Variables	A3	Dependent Variables HEGBS	ΔSTLBAS
Intercept	-0.51 E-3 (-0.52)	0.398 (0.48)	0.92 E-3 (0.48)
$A3_{t-1}$	0.286 (1.50)	31.74 (0.19)	0.277 (0.72)
$A3_{t-2}$	0.357** (2.21)	248.96 (1.79)	-0.308 (-0.94)
$HEGBS_{t-1}$	-0.42 E-4 (0.21)	0.155 (0.88)	0.29 E-3 (0.70)
$HEGBS_{t-2}$	-0.14 E-3 (-0.61)	-0.159 (-0.89)	0.98 E-3** (2.33)
$\Delta STLBAS_{t-1}$	-0.087 (-1.04)	27.43 (0.38)	-0.279 (-1.65)
$\Delta STLBAS_{t-2}$	0.197** (2.39)	154.28** (2.18)	-0.342** (-2.05)
$\tilde{Z}$	-0.416** (-2.60)	-289.96** (-2.11)	-0.208 (-0.64)

** indicates significance at the ten-percent level
* indicates significance at the five-percent level

Table 12

Results from Variance Decomposition
from Selected Error-Correction Models

Percentage of 10-step-ahead squared prediction error in:	Innovations in: GPGS - ΔSTLBAS	TRANS - ΔSTLBAS	HEGBS - ΔSTLBAS
Relative Mean	19.9 - 26.4	11.1 - 27.1	5.9 - 19.4
Gini			6.1 - 21.3
A1			6.2 - 20.4
A2			5.4 - 16.8
A3			5.9 - 20.9

LEGEND: The first number in the column represents the proportion of the forecast error variance contributed by the fiscal policy measure, whereas the second number represents the proportion which is explained by innovations in the monetary policy variable.

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