

**Long Run Neutrality and Superneutrality of Money:
Aggregate and Sectoral Tests for Nicaragua**

Frederick H. Wallace
Departamento de Ciencias Económico-Administrativas
Universidad de Quintana Roo
Chetumal, Quintana Roo
México
fwalla@correo.uqroo.mx

and

Gary L. Shelley*
Department of Economics, Finance, and Urban Studies
East Tennessee State University
Johnson City, Tennessee
U.S.A.
Shelley@mail.etsu.edu

January 2004

*Corresponding author: Dept. of Economics, Finance, and Urban Studies, East Tennessee State University, Johnson City, TN 37614, Phone: (423) 439-5139 or 439-4202.

Abstract
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The Fisher-Seater (1993) methodology is applied to Nicaraguan data to test for long run neutrality and superneutrality of money. Real GDP and real output in six broadly defined sectors are I(1), while the money supply is I(2). These orders of integration imply that money is neutral with respect to both aggregate and sectoral output. However, superneutrality is rejected for real GDP as well as for all six sectors. Results of the superneutrality tests suggest that inflation driven by money growth imposed real costs on the private sector while the government sector benefited.

JEL Classification: E31, E52

Key words: Monetary neutrality, superneutrality, Nicaragua

1. Introduction

Neutrality of money means that a permanent and unexpected change in the stock of money has no permanent, real effect. Most economists accept this proposition as valid in the long run, but its short-run legitimacy is contentious. Indeed, many macro models are characterized by non-neutrality in the short run and neutrality in the long run. Lucas (1972) is a famous example.

A related proposition is superneutrality of money. We follow McCallum (1990) in defining money as superneutral when permanent changes in the money growth rate have no real effects other than on real money balances. Although money is superneutral in the well-known Sidrauski (1967) growth model, various extensions of the model provide cases in which superneutrality does not hold. Examples include Brock (1974), Carmichael (1982), and Danthine and Smith (1987). Indeed, long run deviations from superneutrality are fairly common in macro models. See Espinosa-Vega and Russell (1998) for a more current example.

Economists have long sought to test the neutrality and superneutrality propositions. Fisher and Seater (1993, henceforth FS) and King and Watson (1992) have provided general frameworks for testing the long-run neutrality (LRN) and long-run superneutrality (LRSN) propositions. In both frameworks, conclusions regarding LRN and LRSN critically depend on the orders of integration of the money and real variables to be tested. This paper rigorously tests for the orders of integration of money, real GDP, and real output in six broad sectors of the Nicaraguan economy for the 1960-1999 period, then applies the FS tests of long run monetary neutrality/superneutrality to these series.

There are three reasons for this study. First, the orders of integration of money and real output permit application of the FS superneutrality test.¹ Applications of the FS methodology generally deal with LRN because money in most countries is not integrated of at least order two, a necessary condition for testing LRSN. Our conjecture is that money is more likely to be $I(2)$ in countries such as Nicaragua that have experienced extremely high rates of inflation.

Second, little attention has been given in the literature to the economic situation in Nicaragua. From an orthodox macroeconomic perspective just about every possible form of government economic mismanagement occurred in the country during the sample period. Money-financed deficits, rapid growth in government spending, and price controls are a few of the most egregious examples. Hyperinflation and reductions in real output followed. We would like to know whether LRN and LRSN hold under the extreme conditions found in the Nicaraguan economy.

Third, it is important to determine if conclusions regarding LRN and LRSN with respect to aggregate real output hold at the disaggregated or sectoral level. This is particularly important given the low power of the FS tests, an issue stressed by Coe and Nason (2002, 2004). If one fails to reject LRN or LRSN at the aggregate level, a similar finding using sectoral data would provide support for the aggregate neutrality or superneutrality conclusion. It also is conceivable that one could fail to reject LRN or LRSN at the aggregate level, yet miss significant sectoral effects. Garrett (2003) shows that regression results using aggregate data can be very different from those using the disaggregated components. Alternatively, if LRN or LRSN is rejected at the aggregate level, then it is important to examine disaggregated data to identify possible sources of

¹ Real GDP and real sectoral output are $I(1)$ series and money is $I(2)$ for the sample period in Nicaragua.

non-neutrality and the transmission mechanism(s) of monetary policy. Indeed, we find that the effects of monetary policy are different for the public and private sectors in Nicaragua.

We derive three conclusions from this work. First, during the sample period of 1960 to 1999, money was LRN in Nicaragua; permanent changes in money had no effect on real GDP or on real output in any of the six sectors we examine. Second, money was not LRSN with respect to real output; permanent changes in money growth did have significant effects on real output. Third, the long-run effects of changes in the money growth rate differ for public and private sectors. Specifically, with respect to real GDP and all *private* sectors, increases in the growth rate of money had significant negative effects. This result suggests that high inflation associated with high rates of money growth imposed real costs on the private sector of the Nicaraguan economy. In contrast, increases in the growth rate of money appear to have had significant, positive effects on the public sector, suggesting that seigniorage revenues from money creation were an important revenue source for the Nicaraguan government.

In the following section the Fisher-Seater test is briefly described along with the related literature. The macroeconomic experience of Nicaragua during this period is summarized in section three, and the time series properties of the data are discussed in the fourth part of the paper. Test results are presented in section five and conclusions in the final section.

2. The Fisher and Seater Methodology

FS begin with a bivariate log-linear ARIMA model. The model, given by equations (1) and (2), is assumed stationary and invertible. The FS test can be applied to

a wide range of variables but in this paper m_t is the logarithm of money and y_t is the logarithm of real output. The error terms, u_t and w_t , are independent and identically distributed.

$$a(L)\Delta^{\langle m \rangle}m_t = b(L)\Delta^{\langle y \rangle}y_t + u_t \quad (1)$$

$$d(L)\Delta^{\langle y \rangle}y_t = c(L)\Delta^{\langle m \rangle}m_t + w_t \quad (2)$$

The notation $\langle q \rangle$ refers to the order of integration of variable $q = \{m, y\}$.² L is the lag operator, $\Delta = (1-L)$, and $a_0 = d_0 = 1$.

Equation (3) defines the long run derivative ($LRD_{z,x}$) of a real variable, z , with respect to a permanent change in the monetary variable, x .

$$LRD_{z,x} = \lim_{k \rightarrow \infty} \frac{\partial z_{t+k} / \partial u_t}{\partial x_{t+k} / \partial u_t} \quad (3)$$

where $\lim_{k \rightarrow \infty} \frac{\partial x_{t+k}}{\partial u_t} \neq 0$. Note that $x_t = m_t$ if $\langle m \rangle = 1$ and $x_t = \Delta m_t$ if $\langle m \rangle = 2$. Likewise $z_t =$

y_t if $\langle y \rangle = 1$ and $z_t = \Delta y_t$ if $\langle y \rangle = 2$. If the limit of the denominator is zero, then no

permanent changes in the monetary variable have occurred and the neutrality and

superneutrality propositions cannot be tested. For $\langle m \rangle \geq 1$, FS show that equation (3) can

be written as

$$LRD_{z,x} = \frac{(1-L)^{\langle x \rangle - \langle z \rangle} \gamma(L)|_{L=1}}{\alpha(L)} \quad (3')$$

where $\alpha(L)$ and $\gamma(L)$ are functions of the coefficients from the original bivariate ARIMA

model, equations (1) and (2).³ Equation (3') demonstrates that the value of $LRD_{z,x}$ is

² We follow the FS notation.

³ Specifically, $\alpha(L) = d(L)/[a(L)c(L) - b(L)c(L)]$ and $\gamma(L) = c(L)/[a(L)c(L) - b(L)c(L)]$.

dependent on $\langle x \rangle - \langle z \rangle$, the difference in orders of integration of the monetary and real variables.

Unit root tests applied to the Nicaraguan data (reported below) indicate that money is I(2) while real GDP and output in the individual sectors are I(1).⁴ FS show that in this case the long-run derivative of output with respect to money is equal to zero because $\langle m \rangle > \langle y \rangle = 1$; therefore, money is long run neutral. When testing for superneutrality, $z = y$, and $x = \Delta m$.⁵ Assuming that money is exogenous in the long run, FS show that an OLS estimate of b_k , the coefficient for the $(\Delta m_t - \Delta m_{t-k-1})$ term in equation (4), is a consistent estimator of $LRD_{y,\Delta m}$.

$$y_t - y_{t-k-1} = a_k + b_k (\Delta m_t - \Delta m_{t-k-1}) + e_{kt} \quad (4)$$

Significant values of b_k indicate an absence of superneutrality.⁶

Many of the studies that apply the FS methodology use data from industrial countries characterized by relatively low inflation rates.⁷ In such cases the monetary and real variables tend to be I(1); Boschen and Otrok (1994), Haug and Lucas (1997), Olekalns (1996), and Coe and Nason (2002) are examples.⁸ The conclusions of these studies regarding the long run neutrality proposition vary and depend on such factors as the sample period and the particular money measured used; however, the weight of the evidence is supportive of long run neutrality. With respect to developing economies,

⁴ This corresponds to case iii in section C on long-run superneutrality in Fisher and Seater.

⁵ Note that $\langle m \rangle = 2$ and $\langle y \rangle = 1$, as is the case for Nicaragua, implies $\langle \Delta m \rangle = 1$ $\langle y \rangle = 1$.

⁶ Serial correlation is addressed using the Newey-West correction. Degrees of freedom are T/k where T is the number of observations.

⁷ Bullard (1999) provides a more complete summary of these studies.

⁸ When $\langle m \rangle = \langle y \rangle = 1$, $z = y$ and $x = m$. Fisher and Seater show that neutrality may be tested by OLS estimation of $y_t - y_{t-k-1} = a_k + b_k(m_t - m_{t-k-1}) + e_{kt}$. In this instance, significant values of b_k indicate a rejection of neutrality.

Shelley and Wallace (2003) apply the FS neutrality test to Mexico and reject LRN for the 1932-2001 period.

There are two studies corresponding to the situation examined in this paper in which money is I(2) and the real variable is I(1). Using monthly data from the interwar German hyperinflation, Fisher and Seater find that money is I(2) and real money balances are I(1).⁹ Their results indicate that money is neutral but not superneutral with respect to real balances during this period. Bae and Ratti (2000) find that money is I(2) and real output is I(1) in Brazil and Argentina, thus LRN cannot be rejected. However, Bae and Ratti reject LRSN and conclude that increases in the rate of money growth diminished real output in both countries.

3. Data and Economic Performance 1960-1999

Annual data series from the Central Bank of Nicaragua (2003) for the period 1960 through 1999 are used in this study. The monetary variable is M2a, which includes M2 plus the deposits of the nonfinancial public sector.¹⁰ Aggregate real output is measured using real GDP in 1980 córdobas. Tests of long run money neutrality and superneutrality also are applied to six major sectoral components of real GDP: Agriculture, commerce, construction, government, manufacturing, and services (excluding housing services, which are measured separately). These six sectors accounted for 74% of Nicaraguan GDP in 1999. The three largest sectors in 1999 were manufacturing (19.8% of GDP),

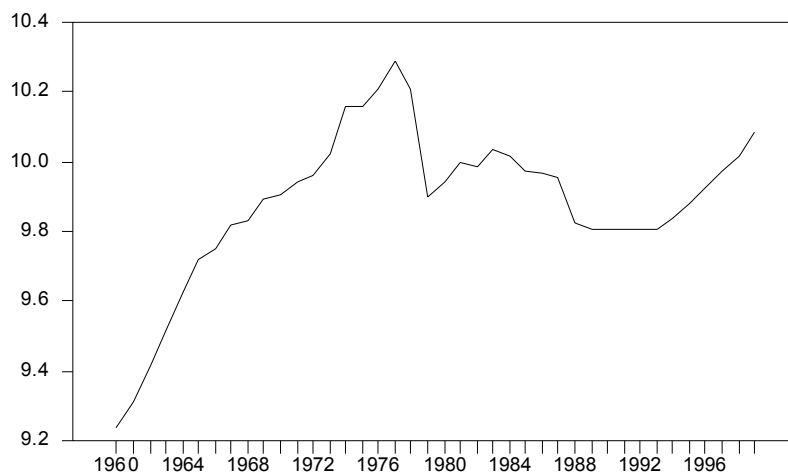
⁹ Unlike McCallum, FS implicitly include an absence of effects on real money balances in their definition of superneutrality.

¹⁰ M2a is the dependent variable for all FS results reported in the paper; however, the results are virtually identical when the monetary base is used instead. Results using the monetary base are available from the authors.

agriculture (18.6% of GDP), and commerce (17.6% of GDP). All variables are converted to logarithms. Appendix A provides additional details concerning the data.

As can be seen in Figure 1, real GDP for Nicaragua grew from 1960 until 1977, as did output in most sectors.¹¹ In the latter part of this period, oil price shocks and the intensification of the civil war with the Sandinistas worsened the economic situation. In 1978 real GDP declined 8% then decreased an additional 26% the following year when the Sandinistas took control of the country. Output in each of the five private sectors showed similar sharp declines in 1978-1979.

Figure 1
Nicaraguan Real GDP: 1960-1999



Except for a slight decrease in 1982, the economy grew from 1980 to 1983 although sectoral performance was erratic. However, in 1984 real GDP decreased 1.6%; the first of eight consecutive years of declining real output. A particularly large decrease occurred in 1988. Ocampo (1992) cites the internal war with the Contras and the opposition of the United States to the Sandinista regime as the main destabilizing forces

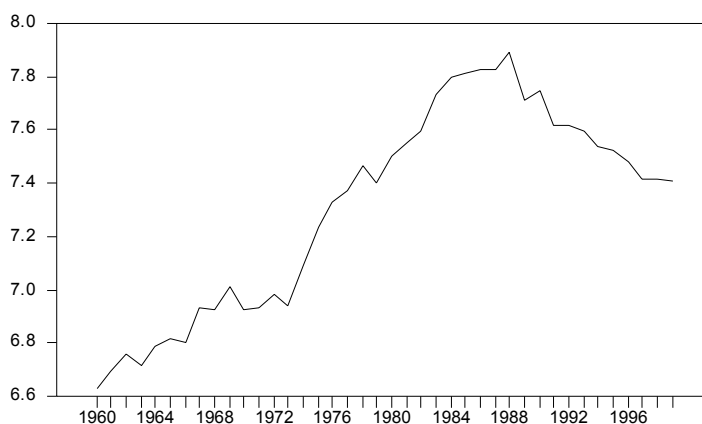
¹¹ Plots of real output in the private sectors are omitted due to their similarity to aggregate GDP; they are available from the authors.

during this period. Dijkstra (1996) points to Sandinista “adjustment” policies, resulting in higher production costs and credit restrictions, as a cause of the 1988 decline.

In the February 1990 elections, the Sandinistas were defeated by the National Opposition Union. Dijkstra provides a discussion of the Chamorro government’s reforms, begun in 1991, which included a restructuring and privatization of state banks, privatization of state enterprises, strict credit policies, a temporary wage freeze, and a devaluation. There was virtually no economic growth in 1992 and 1993, which might be viewed as an improvement on the performance of the preceding eight years; but real rates of growth resumed after 1993, ranging from 3.3% to 7.4% annually. Again, output in the five private sectors generally followed this same pattern.

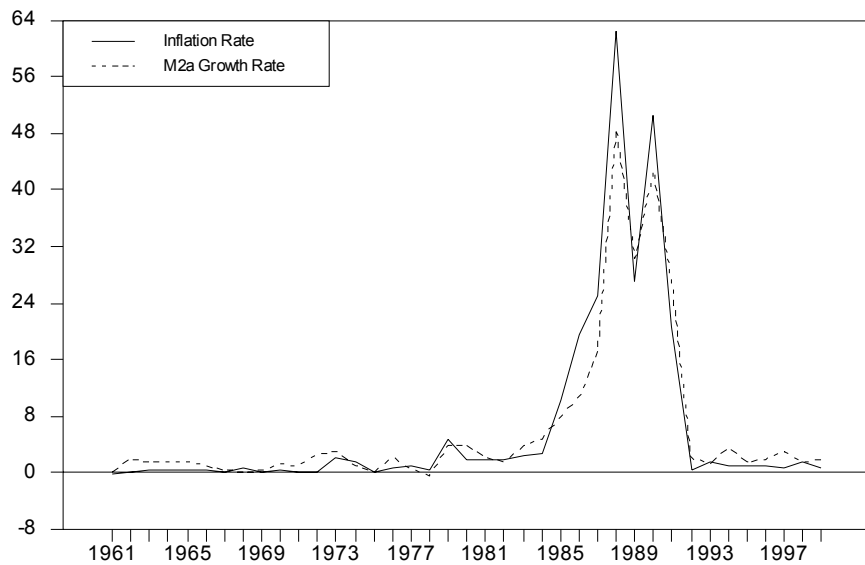
Real government output, presented in Figure 2, behaved somewhat differently than real GDP or output in the private sectors. Government output began to grow rapidly after 1972. According to Ocampo, orthodox management of the economy ended after the earthquake in 1972, and government deficits began to increase. The government sector continued to grow until 1988 but then declined almost every year through 1999.

Figure 2
Nicaraguan Real Government Output



During the first part of the sample period, 1960-1978, the highest annual rate of inflation was 27%, occurring in 1973. The only other years with rates higher than 10% were 1974 (18.3%) and 1977 (10.2%). The situation deteriorated considerably in 1979 when inflation reached 79% under the new Sandinista government. The inflation rate remained somewhat higher than 23% annually until 1985 when it jumped sharply to 219%. Inflation further worsened during the next six years, ranging from 747% to 33,548% annually during 1986-1991. Figure 3 shows each year's average monthly inflation rate and monthly M2a growth rate for 1961-1999.¹² In 1988 and 1990 the average monthly inflation rate exceeded 50%, the common norm defining a hyperinflation.

Figure 3
Monthly Inflation and Money Growth Rates
Nicaragua: 1961-1999



¹² A graph with annual rates would be difficult to read as a result of the distortions of the scale introduced to accommodate the hyperinflationary rates. The use of monthly average rates diminishes the problem.

In 1992 the inflation rate fell to 3.5% for the year and stayed below the 20% annual level through 1999. Consistent with the observations of Sargent (1993), declines in the government budget deficit and reductions in the rate of money growth in 1991 were accompanied by the elimination of the hyperinflation without any reduction in real GDP in 1992 and 1993. Subsequently real GDP began to grow and continued to do so through the end of the sample period.

4. Time Series Properties of the Data

To apply the appropriate Fisher-Seater test, it is necessary to determine the orders of integration of the variables. We begin with the familiar augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests for the presence of unit roots in the data. Visual examination of the plots of real GDP and sectoral output indicates that a smooth, linear trend in these series seems unlikely; however, there is possible upward movement in some of the series. To help determine the correct specification of the unit root tests, we initially regress the log of each variable on a constant and a trend, applying the Newey-West correction for serial correlation. A trend is then added to the unit root specification if the trend coefficient from the OLS regression has a marginal significance of 15% or less. By this criterion, a trend is included in the unit root tests for M2a, GDP, construction, government, and manufacturing, but excluded from the unit root specifications for agriculture, commerce, and services. All unit root tests include a constant.

Results of unit root tests can be sensitive to the lag selection technique employed; therefore, we check the robustness of our results by applying four different methods of

selecting the augmenting lag length for the ADF tests. The first method chooses the number of lags (from zero to 4) that is needed to eliminate autocorrelation based on a series of Lagrange multiplier tests of the test-equation residuals. Akaike's information criterion and Schwartz's Bayesian information criterion are used to determine lag length in the second and third ADF specifications. Finally, a general-to-simple procedure (GS) is followed in the final version. In the GS case, four lags are originally included in the test equation. If the final lag is not significant it is dropped and the equation is re-estimated with one fewer lag. The process continues until the final lag is significant. A 5% marginal significance level is the criterion for all tests involved in lag selection.

We unambiguously fail to reject a unit root in the M2a and all real output series at a 5% marginal significance level, with the exception of agriculture. All versions of the ADF test fail to reject a unit root in agriculture using a 5% critical value; however, results from the PP test are less conclusive. A unit root is rejected in the PP test using the 5% critical value, but cannot be rejected using the 1% critical value. We conclude that the weight of evidence supports the presence of a unit root in agricultural output.

Perron (1989) and Rappoport and Reichlin (1989) have suggested that macroeconomic data series may be trend-stationary with a structural break in the trend function rather than integrated series. Further, Perron demonstrates that standard unit root tests can incorrectly fail to reject the unit root null hypothesis if the true data generating process is trend-stationary with a structural break. Visual inspection of the plots of aggregate and sectoral real output indicates that it is possible that some of these series are trend-stationary with a structural break. For example, the plot of Nicaraguan real GDP (Figure 1) shows the possibility of either a sudden break occurring after 1978

or a gradual break beginning around 1973. Therefore, using procedures developed by Perron (1997) and Vogelsang and Perron (1998), the unit root null hypothesis versus a trend-break stationary alternative is tested for each real output series.

Both the Additive Outlier (AO) and Innovative Outlier (IO) approaches are applied in testing for a unit root versus trend-break stationary series. The former allows for a sudden change in the coefficients of a trend function while the latter permits a gradual change in coefficients. In both cases the potential break dates are chosen endogenously as those dates that minimize the t-statistic in the ADF regression. The lag-length for these tests is chosen by the commonly used general-to-simple (GS) method described above. Potential breaks are allowed for in both the trend and the intercept as recommended by Sen (2003). In no case can a unit root be rejected in favor of the trend-break alternative. Thus the earlier conclusions from ADF and PP tests are robust to the trend-break alternative.

We next test for presence of a unit root in the log-differenced series (growth rates) following similar procedures. Results of the OLS regression with constant, trend, and Newey-West corrected standard errors indicate possible trends in the growth rates of M2a, GDP, commerce, government, and manufacturing. Trends are included in the ADF and PP test equations for these series. All tests fail to reject a second unit root in M2a even at the 10% critical value. A second unit root in GDP, commerce, manufacturing, agriculture, and construction is rejected by all tests at the 1% critical value.

For the government and service sectors, all tests reject a second unit root at the 1% level with exception of the AIC version of the ADF test. However, one can reject a second unit root in services, even with the AIC version of the ADF test, if a 10% critical

value is used. Similarly, for the government sector, the test statistic using the AIC method is very close to the 10% critical value. We conclude that neither government real output nor real output in the service sector contains a second unit root.

Franses and Haldrup (1994) demonstrate that the presence of additive outliers (AO's) in a series can lead to incorrect rejections of the unit root null in ADF testing. An AO is an unusually large, temporary movement in a series. The presence of AO's may cause an integrated series to appear mean reverting, thus causing standard ADF tests to incorrectly reject a unit root in the series. Most plots of the growth rates of the Nicaraguan real output series, as well as most plots of the residuals from the earlier ADF test equations, display such AO's. These often occur between 1978 and 1980 and again in some series at 1988. The AO's are so severe that normality of the residuals from the ADF tests is easily rejected by a Jarque-Bera test at a 1% marginal significance level. Franses and Haldrup show that the effects of the additive outliers on ADF unit root tests can be removed, without affecting the distribution of the test statistics, by including dummy variables for each AO in the ADF test equations. To test the robustness of our earlier results, we conduct an additional set of ADF tests of the real growth rate series with dummy variables included for dates with residuals from the original ADF tests falling beyond two standard deviations. In all cases, our original conclusion is maintained that a second unit root in the real output series can be rejected at a 1% marginal significance level. Jarque-Bera tests fail to reject normality of the residuals from these tests.

Finally, second-differenced log M2a is tested for the presence of a third unit root. All tests reject this hypothesis at the 1% critical value. Overall, we conclude that M2a is

I(2), and that all real output series are I(1). Note, too, that the evidence favors the presence of a trend in the growth rates of real GDP, commerce, government, and manufacturing. There is no evidence of a trend in the growth rates of agriculture, construction, or services.¹³

Money is assumed exogenous in the FS test. We address this issue for real GDP and money using Granger-causality tests. Given the results of our unit root tests, we regress the change in the M2a growth rate on various lags of real GDP growth. None of the coefficients on lagged real GDP growth are individually or jointly significant at a 15% marginal significance level. Both the Akaike information criteria (AIC) and the Bayesian information criteria (BIC) are maximized with no included lags of real GDP growth. These results are consistent with the assumption that changes in money growth are exogenous with respect to real GDP growth in Nicaragua during the sample period.¹⁴

The assumption that money is exogenous with respect to real output in the various private sectors probably is innocuous. The possibility that private sectoral output and money are driven by some common, aggregate shock seems unlikely given the failure of real GDP to Granger-cause money. However, it is possible that changes in money growth could be Granger-caused by growth in the government sector, especially if the Nicaraguan government used money growth to obtain seigniorage. We test this possibility by regressing changes in M2a growth on various lags of real growth in the government sector. As with real GDP growth, no lags were individually or jointly significant, and both AIC and BIC are maximized with zero included lags. Changes in

¹³ The full results, including equation specifications and test statistics, are available from the authors.

¹⁴ Failure to reject the null in the Granger causality test is not a sufficient condition for exogeneity but rejection of the null would be strong evidence against the exogeneity assumption.

the money growth rate appear exogenous with respect to changes in real government output.

5. Fisher-Seater Test Results

As discussed in section 2, $LRD_{y,m} = 0$ for Nicaragua because money is I(2) and real output (GDP or sectoral) is I(1). Thus, the null hypothesis of monetary neutrality cannot be rejected. Failure to reject neutrality depends strictly on the orders of integration of money and real output. Further testing of the neutrality proposition is not required. These orders of integration, however, permit testing for long-run superneutrality of money. In this case $LRD_{y,\Delta m}$ is the long-run elasticity of real output with respect to money growth.

For those (logged) series without a trend in their growth rates (agriculture, construction, and services), long-run superneutrality of money can be rejected if the estimated b_k coefficients in equation (4), reproduced below, significantly differ from zero.

$$y_t - y_{t-k-1} = a_k + b_k(\Delta m_t - \Delta m_{t-k-1}) + e_{kt}. \quad (4)$$

The growth rates of (logged) real GDP, commerce, government, and manufacturing have trends. For these series we modify the FS superneutrality regression in equation (4) with the addition of a linear trend and estimate the version given by (4A).¹⁵

$$y_t - y_{t-k-1} = a_k + \lambda t + b_k(\Delta m_t - \Delta m_{t-k-1}) + e_{kt} \quad (4A)$$

¹⁵ Justification for this form of the superneutrality test is provided in an appendix available from the authors.

Plots of the b_k coefficients obtained by estimating the appropriate version of the superneutrality test for logged values of real GDP and output in each of the private sectors are provided in Figures 4a-4f. Each plot also includes the 95% confidence interval for the b_k . As is the norm in the FS literature, the 95% confidence intervals are constructed using the Newey-West corrected standard errors. Due to the limited number of observations on the output and money series, k is restricted to values from 1 through 16. Even with restricted number of observations, the high variability of the data makes us confident that the FS tests capture long-run relationships. Fisher and Seater make the same argument when applying the LRSN test to fewer than five years of monthly data from the German hyperinflationary period after WWI.

As can be seen in the figures, for real GDP and all private sectors (except construction) the upper confidence limit is below zero for more than half the b_k coefficients, indicating that these coefficients are significantly negative. Even in the case of the construction sector, about a third of the b_k coefficients are significantly negative. These results indicate that the hypothesis of LRSN can be rejected for the economy as a whole (real GDP) and for the five private components of GDP. Interestingly, the coefficient plots are quite similar for real GDP and each of the private sectors, with relatively small, negative coefficients for low values of k becoming more negative through $k = 12$ or 13 and then increasing slightly.

Figure 4a
Superneutrality Test Results: Real GDP
Trend Included in FS Regressions

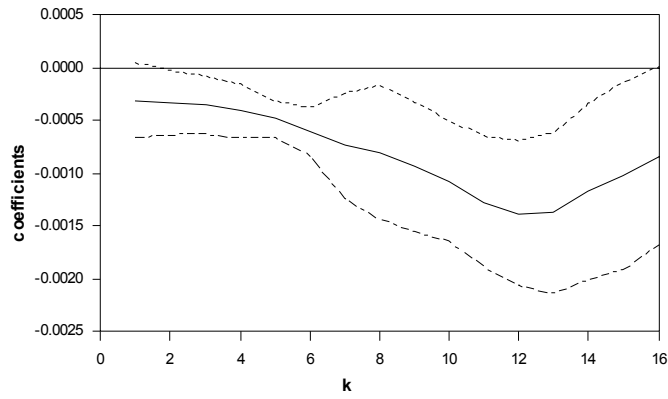


Figure 4b
Superneutrality Test Results: Agriculture

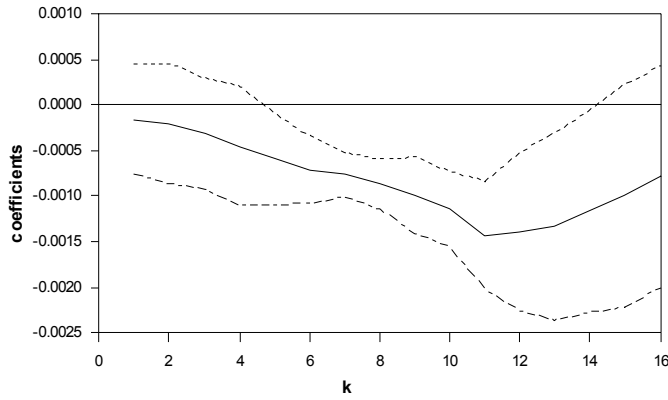


Figure 4c
Superneutrality Test Results: Commerce
Trend Included in FS Regressions

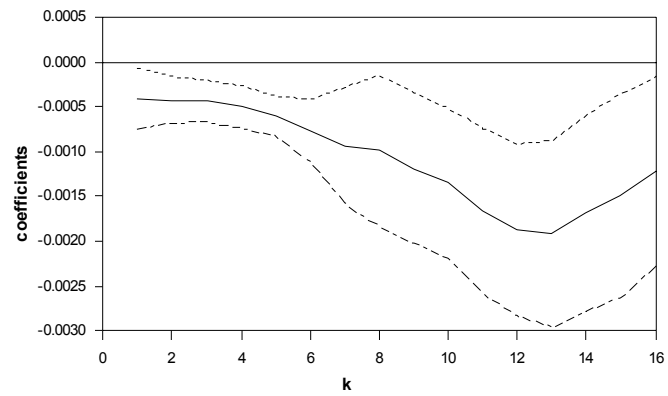


Figure 4d
Superneutrality Test Results: Construction

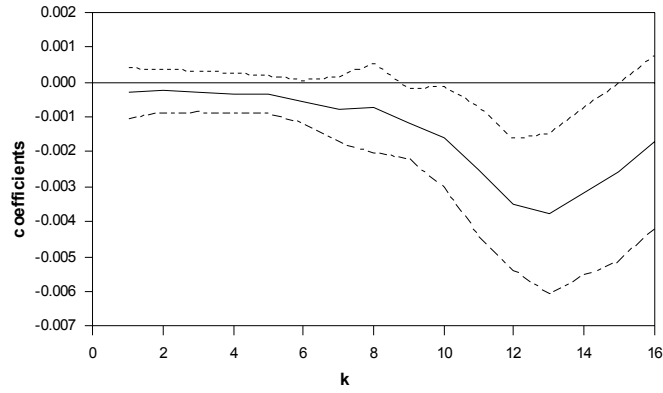


Figure 4e
Superneutrality Test Results: Manufacturing
Trend Included in FS Regressions

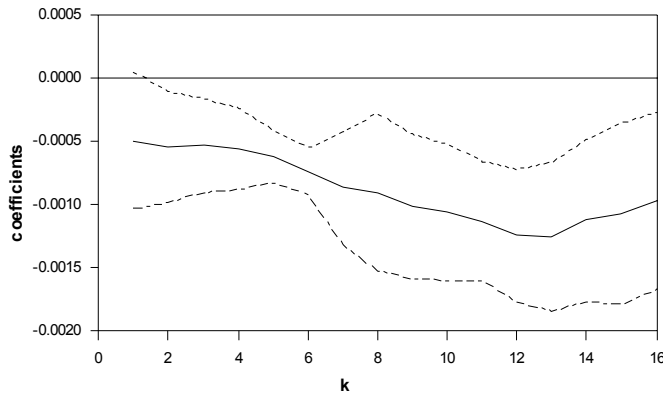
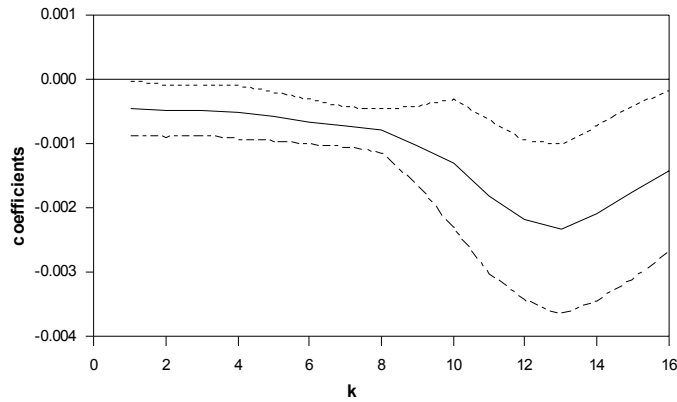


Figure 4f
Superneutrality Test Results: Services



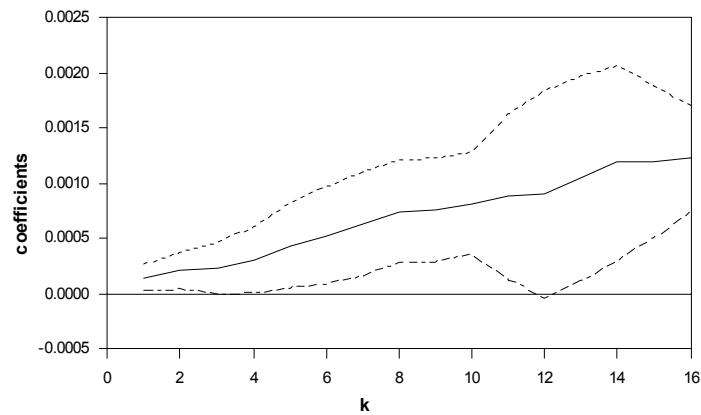
The significant, negative coefficients in Figures 4a-4f indicate that increases in the growth rate of money imposed real costs on the private sectors of the Nicaraguan economy that resulted in reduced aggregate output. These costs were probably associated with the higher rates of inflation that accompanied more rapid money growth in Nicaragua (see Figure 3). Rejection of superneutrality and the negative relation between money growth and real output are consistent with the conclusions of Bae and Ratti for Argentina and Brazil.

Our finding that accelerated money growth and accompanying inflation led to declines in real output, is consistent with recent findings in the literature on the relation between inflation and growth. Gylfason (1998) shows that inflation can negatively affect both real output and its growth rate by driving a wedge between the marginal returns to real and financial capital. In a model with long-term customer relationships, Ball and Romer (2003) demonstrate that inflation can negatively affect real output by reducing the information content of current prices. Michener (1998), in a modified version of the Lucas island model, demonstrates that expected inflation can have negative effects on real output. Using filtered data, Valdovinos (2003) finds a negative correlation between real growth and the rate of inflation for eight Latin American countries. Bruno and Easterly (1998) find that inflation rates in excess of 40% annually tend to reduce economic growth.

An interesting contrast with the results for aggregate output and the private sectors is offered by estimates obtained for the government sector, presented in Figure 5, using the version of the FS test given in equation (4A). Superneutrality again is rejected; however, all the estimated b_k coefficients are positive and most are significant. In other

words, permanent increases in the growth rate of money are associated with increases in real government output. The significant, positive coefficients suggest that the Nicaraguan government financed growth of the public sector by augmenting the growth rate of money and collecting substantial seigniorage revenues.

Figure 5
Superneutrality Test Results: Government
Trend Included in FS Regressions



6. Conclusions

The 1960-1999 period in Nicaragua offers an interesting application of long-horizon neutrality and superneutrality tests for two reasons. First, monetary policy was highly variable during this time with annual inflation rates ranging from the negative single digits in 1961 and 1962 to more than 30,000% in 1988. Second, a number of real shocks, most notably a civil war and U.S. economic sanctions, affected the economy. Results of our tests indicate that long-run monetary neutrality holds but superneutrality does not hold at the aggregate level under such extreme conditions. This conclusion is supported by our finding that money is long-run neutral but not superneutral at the

sectoral level as well. Rejection of superneutrality is particularly strong evidence against this proposition given the lack of power of the FS test (emphasized by Coe and Nason).

Sectoral estimates indicate that higher money growth was associated with declines in output in the private sectors but that higher money growth was accompanied by an expansion of real government output. This suggests that the Nicaraguan government successfully used seigniorage and an inflation tax to finance expansion of the government sector during the sample period. However, the results suggest that gains to the government sector were at the expense of the private sectors of the economy.

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Appendix A

Real GDP, the monetary base, M2a, and the inflation rate are from the Central Bank of Nicaragua (CBN). During the 1960-1999 period the Nicaraguan government twice changed the monetary unit. In response to high rates of inflation the new córdoba was introduced in 1988 at an exchange rate of 1000 córdobas for each new córdoba. Three years of hyperinflation followed and in 1991 the gold córdoba replaced the new córdoba at the exchange rate of five million new córdobas per gold córdoba.¹⁶

The CBN reports monetary data in terms of the money of the day. Thus, from 1960 to 1987 the monetary data are córdobas; from 1988-1990 they are new córdobas; and after 1990 the data are gold córdobas. To obtain a consistent series the exchange rates reported by Ocampo are used. Monetary data in terms of córdobas are divided by one thousand and those in terms of gold córdobas are multiplied by five million to convert both the monetary base and M2a to new córdoba equivalent units.

Data on real GDP, real sectoral output, and the inflation rate are obtained directly from CBN. No adjustments were made to these series.

¹⁶ Rates are taken from Ocampo.