Monetary Neutrality

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Abstract:

We test the long-run neutrality of money proposition for the United States using the King and Watson (1997) methodology paying attention to the integration and cointegration properties of the variables. We use quarterly data (over the period from 1967:1 to 2014:1) and the new Center for Financial Stability Divisia monetary aggregates, documented in detail in Barnett *et al*. (2013). We make a comparison among the narrower monetary aggregates, M1 M2M, MZM, M2, and ALL, and the broad monetary aggregates, M4+, M4-, and M3, and show that there is no statistically significant evidence against long-run monetary neutrality, consistent with both monetarist and Keynesian macroeconomic theory.

JEL classification: E40, E50, C32.

Keywords: Monetary policy; Money shocks; Divisia monetary aggregates.

1 Introduction

The aim of this paper is to investigate whether monetary policy has real effects on the economy over long horizons. As Robert E. Lucas Jr. (1996, p. 661) put it in his Nobel Lecture, "[t]he work for which I have received the Nobel Prize was part of an effort to understand how changes in the conduct of monetary policy can influence inflation, employment, and production. So much thought has been devoted to this question and so much evidence is available that one might reasonably assume that it had been solved long ago. But this is not the case. It had not been solved in the 1970s when I began my work on it, and even now this question has not been given anything like a fully satisfactory answer." It is our objective in this paper to provide a 'satisfactory answer' to this question using state-of-the-art advances in macroeconometrics and monetary and financial measurement.

Over the years, the quantity-theoretic proposition known as long-run neutrality has been investigated in a large number of studies, more recently by Fisher and Seater (1993), King and Watson (1997), and Serletis and Koustas (1998). These studies use simple-sum money measures and advances in the theory of nonstationary regressors. However, regarding the use of simple-sum money measures, Lucas (2000), in his study of the welfare cost of inflation in the United States, argues that a direction for potentially productive research is to replace the simple-sum monetary aggregates with the Divisia monetary aggregates originated by Barnett (1980). Serletis and Koustas (2001) take up Lucas on his suggestion and test the long-run neutrality and superneutrality of money propositions using the King and Watson (1997) methodology, paying explicit attention to the univariate time series properties of the variables and the gains that can be achieved by rigorous use of microeconomic- and aggregation-theoretic foundations in the construction of monetary aggregates.

Serletis and Koustas (2001) use quarterly data (over the period from 1960:1 to 1996:2) and make comparisons among simple sum, Divisia, and currency equivalent (CE) monetary aggregates (at the M1, M2, M3, and L levels of aggregation) obtained from the St. Louis Fed Monetary Services Indices (MSI) database. As Serletis and Koustas (2001, pp. 137) conclude, "one puzzling result is that the CE monetary aggregates are integrated of order one, whereas the corresponding simple sum and Divisia aggregates are integrated of order two. This difference, which probably stems from small sample problems, reflects the essentially complicated monetary aggregation issues and makes results hard to interpret. In particular, the stochastic properties of the regressors influence the type of tests that we perform. However, based on these properties, the hypothesis of long-run neutrality finds support in the CE money data, whereas the hypothesis of long-run superneutrality finds little support in the simple sum and Divisia data."

Recently, the Center for Financial Stability (CFS) has initiated a new Divisia monetary aggregates database, maintained within its program Advances in Monetary and Financial Measurement (AMFM). The Director of the program is William A. Barnett, the inventor of the Divisia monetary aggregates — see Barnett (1980). The new CFS Divisia monetary aggregates are available at www.centerforfinancialstability.org/amfm.php and are documented in detail in Barnett *et al.* (2013). They are rigorously founded in economic aggregation and index-number theory and represent an improvement over the St. Louis Fed's Monetary Services Indices. It is our objective in this paper to use the new CFS Divisia monetary aggregates to reconsider the long-run neutrality and superneutrality of money propositions and provide an update regarding monetary neutrality in the United States. In doing so, we use the King and Watson (1997) methodology, quarterly data (over the period from 1967:1 to 2014:1), and provide a comparison among a number of CFS Divisia monetary aggregates — the narrower monetary aggregates, M1 M2M, MZM, M2, and ALL, and the broad monetary aggregates, M4+, M4-, and M3.

The organization of the paper is as follows. The next section briefly discusses the CFS Divisia monetary data and Section 3 investigates the integration and cointegration properties of the data. In Section 4 we test the long-run neutrality of money proposition and discuss the empirical evidence. The final section concludes.

2 The Data

We use quarterly United States data, over the period from 1967:1 to 2014:1, on two variables: money, M, and real GDP, Y. The real GDP series is from the Federal Reserve Economic Database (FRED), maintained by the Federal Reserve Bank of St. Louis. In regards to money, we use the new CFS data and make comparisons among eight Divisia monetary aggregates: the narrower monetary aggregates, M1 M2M, MZM, M2, and ALL, and the broad monetary aggregates, M4+, M4-, and M3. We ignore the simple-sum monetary aggregates as it has been argued over and over again, and by a large number of studies, that they are inconsistent with the relevant aggregation and index number theory. In fact, as Barnett and Chauvet (2009, pp. 1) put it, "since monetary assets began yielding interest, the simple sum monetary aggregates have had no foundations in economic theory and have sequentially produced one source of misunderstanding after another. The bad data produced by simple sum aggregation have contaminated research in monetary economics, have resulted in needless "paradoxes," and have produced decades of misunderstandings in international monetary economics research and policy."

Similarly, we are not providing a comparison between the CFS Divisia monetary aggregates and the St. Louis Fed MSI aggregates. We think that the CFS Divisia monetary aggregates represent the current state-of-the-art in Divisia monetary aggregation. In particular, in constructing the narrower Divisia monetary aggregates, M1 M2M, MZM, M2, and ALL, the CFS uses an alternative benchmark interest rate in the Divisia formula, thus making its narrower aggregates slightly different from the MSI aggregates. Moreover, the broad monetary aggregates, M4+, M4-, and M3, are only provided by the CFS and are more informative than the narrower ones. In this regard, the CFS Divisia M3 monetary aggregate includes the components of the discontinued simple-sum aggregate, produced by the Federal Reserve before 2006, and the components of the St. Louis Fed's current MSI aggregates, M2-ALL. In addition, the CFS Divisia M3 aggregate includes large time deposits and overnight and term purchase agreements. Among all of the CFS Divisia monetary aggregates, the Divisia M4+ monetary aggregate is the broadest aggregate and is based on the components of the Federal Reserve's former broadest simple-sum monetary aggregate, L. The Divisia M4- aggregate excludes Treasury bills from the Divisia M4+ aggregate. See Table 1 and Figure 1 in Barnett *et al.* (2013) for more details regarding the component clusterings within each aggregation level and the CFS approach to Divisia monetary aggregation.

3 Unit Root and Cointegration Tests

We use the King and Watson (1997) bivariate autoregressive model and pay attention to the integration and cointegration properties of the variables, because meaningful neutrality and superneutrality tests critically depend on such properties. In particular, as shown by King and Watson (1997) and Fisher and Seater (1993), neutrality tests are possible if both nominal and real variables are at least integrated of order one and superneutrality tests are possible if the order of integration of the nominal variables is equal to one plus the order of integration of the real variables.

To investigate the order of integration of the variables, we conduct a number of unit root and stationarity tests — the ADF test [see Dickey and Fuller (1981)], the PP test [see Phillips and Perron (1988)], and the KPSS test [see Kwiatkowski *et al.* (1992)] — in the logged series ($\ln Y$ and $\ln M$). As can be seen in Table 1, in all cases the ADF and PP test statistics are smaller — in absolute terms — than their 1, 5, and 10 percent critical values and thus unable to reject the unit root null at conventional significance levels. By contrast, the KPSS statistic $\hat{\eta}^{\mu}$ that tests the null hypothesis of level stationarity is large relative to the 1 percent critical value of 0.739, suggesting that level stationarity can be rejected. Combining the results of the tests of the stationarity hypothesis with the results of the tests of the unit root hypothesis, we conclude that all the series are integrated of order one [or I(1) in the terminology of Engle and Granger (1987)], meaning that only the long-run monetary neutrality proposition can be tested; the superneutrality proposition cannot be tested, because the nominal variables are of the same order of integration as the real variables.

King and Watson (1997) also argue that long-run neutrality tests are inefficient in the presence of cointegration, in the sense that if the output and money series are nonstationary and cointegrate, then a finite vector autoregressive process in first differences does not exist and this is typically sufficient for rejecting long-run neutrality. To present some evidence on this issue, in Table 2 we report Engle and Granger (1987) cointegration tests between logged real GDP, $\ln Y$, and logged money, $\ln M$. The tests are first done with $\ln Y$ as the dependent variable in the cointegrating regression and then repeated with $\ln M$ as the dependent variable. These tests use a constant and a trend variable and the number of augmenting lags is set to four. The results suggest that the null hypothesis of no cointegration between output and money cannot be rejected (at the 10% level of significance). Hence, the conditions necessary for meaningful neutrality tests hold and in what follows we use the King and Watson (1997) methodology to test the long-run neutrality of money proposition.

4 The Neutrality of Money

Following King and Watson (1997), we consider the following bivariate structural vector-autoregressive model of order p

$$m_t = \lambda_{my} y_t + \sum_{j=1}^{p} \alpha_{my}^{j} y_{t-j} + \sum_{j=1}^{p} \alpha_{mm}^{j} m_{t-j} + \varepsilon_t^m \tag{1}$$

$$y_t = \lambda_{ym} m_t + \sum_{j=1}^{p} \alpha_{yy}^{j} y_{t-j} + \sum_{j=1}^{p} \alpha_{ym}^{j} m_{t-j} + \varepsilon_t^y \tag{2}$$

where m_t is the growth rate of the money supply ($m_t = \Delta \ln M_t$) and y_t the growth rate of real output ($y_t = \Delta \ln Y_t$). ε_t^m and ε_t^y represent exogenous unexpected changes in money and output, respectively, and λ_{my} and λ_{ym} represent the contemporaneous effect of output on the money supply and the contemporaneous response of output to changes in the money supply, respectively. We are interested in the dynamic effects of the money shock, ε_t^m, on y_t.

The matrix representation of the model is

$$\boldsymbol{\alpha}(L) \boldsymbol{z}_t = \boldsymbol{\varepsilon}_t \tag{3}$$

where

$$\boldsymbol{\alpha}(L) = \sum_{j=0}^{p} \boldsymbol{\alpha}_j L^j,$$

L is the lag operator (i.e., $L^j \boldsymbol{z}_t = \boldsymbol{z}_{t-j}$), and

$$\boldsymbol{z}_t = \begin{bmatrix} m_t \\ y_t \end{bmatrix}; \ \boldsymbol{\varepsilon}_t = \begin{bmatrix} \varepsilon_t^m \\ \varepsilon_t^y \end{bmatrix}; \ \boldsymbol{\alpha}_0 = \begin{bmatrix} 1 & -\lambda_{my} \\ -\lambda_{ym} & 1 \end{bmatrix}; \ \boldsymbol{\alpha}_j = -\begin{bmatrix} \alpha_{mm}^j & \alpha_{my}^j \\ \alpha_{ym}^j & \alpha_{yy}^j \end{bmatrix}, \quad j = 1, \dots, p.$$

Thus, in this notation the long-run multipliers are $\gamma_{ym} = \alpha_{ym}(1) / \alpha_{yy}(1)$ and $\gamma_{my} = \alpha_{my}(1) / \alpha_{mm}(1)$, where $\alpha_{\phi\psi}(1) = \sum_{j=1}^{\infty} \alpha_{\phi\psi}^{j}$. Hence, γ_{ym} measures the long-run response of output to a permanent unit increase in m, and γ_{my} measures the long-run response to m to a permanent unit increase in output.

The endogeneity of the money supply, however, makes equation (3) econometrically unidentified, as noted by King and Watson (1997). To see this, write the primitive system (3) in standard form as

$$\boldsymbol{z}_t = \sum_{j=1}^{p} \boldsymbol{\Phi}_j \boldsymbol{z}_{t-j} + \boldsymbol{e}_t$$

where $\boldsymbol{\Phi}_j = -\boldsymbol{\alpha}_0^{-1} \boldsymbol{\alpha}_j$ and $\boldsymbol{e}_t = \boldsymbol{\alpha}_0^{-1} \boldsymbol{\varepsilon}_t$. The following equations determine the matrices $\boldsymbol{\alpha}_j$ and $\sum_{\boldsymbol{\varepsilon}}$:

$$\boldsymbol{\alpha}_0^{-1} \boldsymbol{\alpha}_j = -\boldsymbol{\Phi}_j, \quad \text{where } j = 1, \dots, p \tag{4}$$

$$\boldsymbol{\alpha}_0^{-1} \sum\nolimits_{\boldsymbol{\varepsilon}} \left(\boldsymbol{\alpha}_0^{-1} \right)' = \sum\nolimits_{\boldsymbol{\varepsilon}}. \tag{5}$$

Equation (4) determines $\boldsymbol{\alpha}_j$ as a function of $\boldsymbol{\alpha}_0$ and $\boldsymbol{\Phi}_j$. Equation (5) cannot determine both $\boldsymbol{\alpha}_0$ and $\sum_{\boldsymbol{\varepsilon}}$, given that $\sum_{\boldsymbol{\varepsilon}}$, is a 2×2 symmetric matrix with only three unique elements.

Therefore, only three of the four unknown parameters — λ_{my}, λ_{ym}, $\text{var}(\varepsilon_t^y)$, $\text{var}(\varepsilon_t^m)$ — can be identified, even under the assumption of independence of ε_t^m and ε_t^y. Clearly, one additional restriction is required to identify the model and test the long-run neutrality restrictions.

We follow King and Watson's (1997) eclectic approach, and instead of focusing on a single identifying restriction, we report results for a wide range of identifying restrictions. In particular, we iterate each of λ_{my}, λ_{ym}, γ_{my}, and γ_{ym} within a reasonable range, each time obtaining estimates of the remaining three parameters and their standard errors. This testing strategy is clearly more informative in terms of the robustness of inference about long-run neutrality to specific assumptions about λ_{ym}, λ_{my}, or γ_{my}. The model is estimated by simultaneous equations methods, as described in King and Watson (1997).

We follow the approach of the same authors in reporting empirical results based on equation (3) for a wide range of plausible identifying parameter restrictions. We set $\boldsymbol{z}_t = (m_t, y_t)$ to investigate long-run neutrality using the CFS Divisia monetary aggregates. All of the models include six lags of the relevant variables and the results are summarized in Tables 3 and 4 (with standard errors in parentheses) and Figures 1-8. As King and Watson (1997) report, the results are not sensitive to the choice of the lag length in the VAR.

To deal with the identification problem mentioned earlier, we estimate equation (3) under appropriate identification restrictions. Columns 3-5 of Table 3 provide ranges of values on the short-run impact of output on money, λ_{my} (in column 3); the short-run impact of money on output, λ_{ym} (in column 4); and the long-run impact of output on money, γ_{my} (in column 5), consistent with long-run neutrality ($\gamma_{ym} = 0$) at the 95% confidence level. The same information is summarized in Figures 1-8, which present point estimates and 95% confidence intervals for the long-run multiplier, γ_{ym}, for a wide range of values of λ_{my} (in panel A), λ_{ym} (in panel B), and γ_{my} (in panel C).

The results in column 3 of Table 3 and panel A of Figures 1-8 indicate that long-run neutrality cannot be rejected for a wide range of values of λ_{my}. However, the frequently imposed identifying restriction of contemporaneous money exogeneity ($\lambda_{my} = 0$) lies slightly outside the 95% confidence interval. Also, long-run neutrality cannot be rejected for a reasonable range of values of λ_{ym} (see column 4 of Table 3 and panel B of Figures 1-8). It should be noted that the results are consistent with models that imply $\lambda_{ym} < 0$ (that is, output declines on impact in response to a monetary expansion) such as the Lucas (1972) monetary misperceptions model (due to incomplete information concerning the state of the economy). Finally, the results in column 5 of Table 3 and panel C of the relevant figures indicate that the long-run neutrality hypothesis cannot be rejected for a reasonable range of values of γ_{my} including long-run money exogeneity ($\gamma_{my} = 0$).

A second set of evidence is presented in the last three columns of Table 4. It concerns the estimates of λ_{my}, λ_{ym}, and γ_{my}, and their associated standard errors, under long-run neutrality ($\gamma_{ym} = 0$) as an identifying restriction. This is also shown in panels A-C of Figures 1-8, which present 95% confidence intervals for λ_{my}, λ_{ym}, and γ_{my} (containing [by definition] the true values of λ_{my}, λ_{ym}, and γ_{my} 95% of the time), under the maintained hypothesis of long-run neutrality. The confidence intervals are reasonably wide in all cases. The confidence intervals for λ_{my} are consistent with accommodative monetary policy and Goodfriend's (1987) argument that the monetary authority responds to changes in output to achieve interest rate smoothing. The confidence intervals for the contemporaneous effect of money on output (λ_{ym}) are reasonable. The point estimates of λ_{ym} under the restriction of long-run money neutrality are statistically different from zero in all cases, though not by much, suggesting that long-run money neutrality may be inconsistent with short-run money neutrality. The confidence intervals for the long-run effect of output on money (γ_{my}) do not allow rejection of the long-run money exogeneity hypothesis ($\gamma_{my} = 0$) under the long-run money neutrality restriction, except in the case of the M3, M4+, and M4- monetary aggregates.

5 Conclusion

In the context of the bivariate autoregressive methodology proposed by King and Watson (1997), we test the long-run neutrality of money proposition in the United States, over the period from 1967:1 to 2014:1, using the new CFS Divisia data, documented in detail in Barnett *et al.* (2013). We present evidence that Divisia money is neutral in the long run, consistent with both monetarist and Keynesian macroeconomic theory.

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TABLE 1. Unit Root Test Results (in Log Levels)

Series	ADF ($t-$statistic)	PP ($t-$statistic)	KPSS ($\hat{\eta}_\mu$statistic)	Integration order
Real GDP	-0.981	-1.298	3.864***	I(1)
CFS Divisia M1	0.305	0.397	3.859***	I(1)
CFS Divisia M2M	1.128	1.546	3.812***	I(1)
CFS Divisia MZM	0.573	0.732	3.831***	I(1)
CFS Divisia M2	0.203	0.153	3.805***	I(1)
CFS Divisia ALL	-0.405	-0.531	3.819***	I(1)
CFS Divisia M4+	-1.706	-2.201	3.820***	I(1)
CFS Divisia M4-	-1.482	-2.060	3.818***	I(1)
CFS Divisia M3	-1.232	-1.583	3.809***	I(1)

Notes: ADF and PP critical values 1% (***) -3.467, 5% (**) -2.877, 10% (*) -2.575.
KPSS $\hat{\eta}_\mu$ critical values 1% (***) 0.739, 5% (**) 0.463, 10% (*) 0.347.
The null hypothesis in the ADF and PP tests is the presence of a unit root.
The null hypothesis in the KPSS is stationarity.

TABLE 2. Cointegration Test Results

Aggregate	ADF t-statistics Dependent variable: $\ln Y_t$	$\ln M_t$
CFS Divisia M1	-1.94	-3.70*
CFS Divisia M2M	-2.98	-2.83
CFS Divisia MZM	-2.32	-2.64
CFS Divisia M2	-2.72	-2.71
CFS Divisia ALL	-2.12	-2.64
CFS Divisia M4+	-2.43	-2.12
CFS Divisia M4-	-2.39	-2.31
CFS Divisia M3	-2.06	-2.27

Notes: All tests use a constant and a trend variable in the cointegrating vector. The Engle-Granger cointegration testing procedure tests the residuals from the first-stage regression for a unit root. The ADF test on the residuals employs four lags. Critical values 1% (***) -4.41, 5%(**) -3.83, 10%(*) -3.54.

TABLE 3. THE NEUTRALITY OF MONEY

Aggregate	$\boldsymbol{z}_t$ in equation (3)	$\gamma_{ym} = 0$ in 95% confidence interval		
		λ_{my}	λ_{ym}	γ_{my}
CFS Divisia M1	$(m_t, y_t)'$	$\geqq 0.05, \leqq 2.1$	$\geqq -1.50, \leqq -0.10$	$\geqslant -0.20, \leqq 1.5$
CFS Divisia M2M	$(m_t, y_t)'$	$\geqq 0.10$	$\geqq -1.90, \leqq -0.10$	$\geqslant -0.10, \leqq 1.6$
CFS Divisia MZM	$(m_t, y_t)'$	$\geqq 0.15, \leqq 2.1$	$\geqq -1.20, \leqq -0.10$	$\geqslant -0.50, \leqq 1.5$
CFS Divisia M2	$(m_t, y_t)'$	$\geqq 0.10$	$\geqq -2.60, \leqq -0.10$	$\geqslant -0.40, \leqq 1.6$
CFS Divisia ALL	$(m_t, y_t)'$	$\geqq 0.00$	$\geqq -1.60, \leqq -0.20$	$\geqslant -0.15$
CFS Divisia M3	$(m_t, y_t)'$	$\geqq 0.01$	$\leqq -0.15$	$\geqslant -0.10$
CFS Divisia M4+	$(m_t, y_t)'$	$\geqq 0.01$	$\leqq -0.00$	$\geqslant -0.20$
CFS Divisia M4-	$(m_t, y_t)'$	$\geqq 0.02$	$\leqq -0.10$	$\geqslant -0.40$

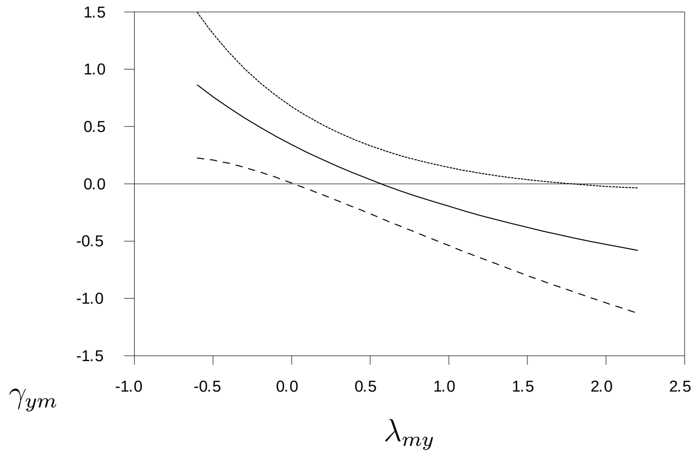
Note: All of the models include six lags of the relevant variables.

TABLE 4. THE NEUTRALITY OF MONEY

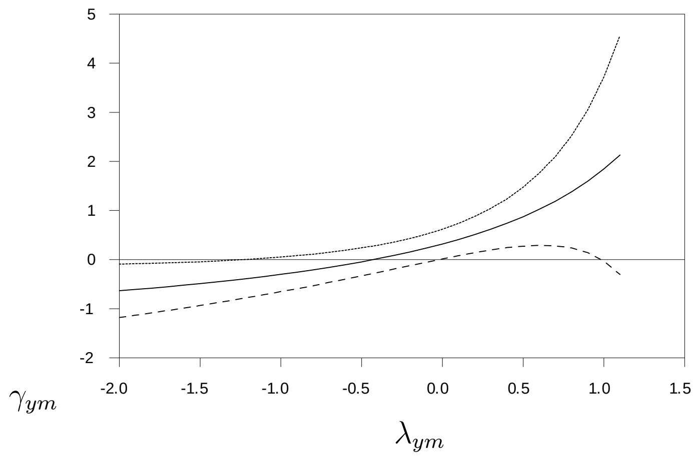
Aggregate	$\boldsymbol{z}_t$ in equation (3)	Estimates imposing $\gamma_{ym} = 0$		
		λ_{my}	λ_{ym}	γ_{my}
CFS Divisia M1	$(m_t, y_t)'$	0.55 (0.11)	−0.52 (0.23)	0.49 (0.29)
CFS Divisia M2M	$(m_t, y_t)'$	0.96 (0.15)	−0.58 (0.27)	0.16 (0.43)
CFS Divisia MZM	$(m_t, y_t)'$	0.78 (0.14)	−0.48 (0.21)	0.39 (0.37)
CFS Divisia M2	$(m_t, y_t)'$	0.74 (0.12)	−0.69 (0.32)	0.40 (0.30)
CFS Divisia ALL	$(m_t, y_t)'$	0.55 (0.10)	−0.52 (0.23)	0.49 (0.30)
CFS Divisia M3	$(m_t, y_t)'$	0.72 (0.11)	−0.63 (0.33)	0.95 (0.35)
CFS Divisia M4+	$(m_t, y_t)'$	0.58 (0.10)	−0.54 (0.29)	0.91 (0.34)
CFS Divisia M4-	$(m_t, y_t)'$	0.81 (0.12)	−0.73 (0.40)	1.28 (0.37)

Note: All of the models include six lags of the relevant variables. Numbers in parentheses are standard errors.

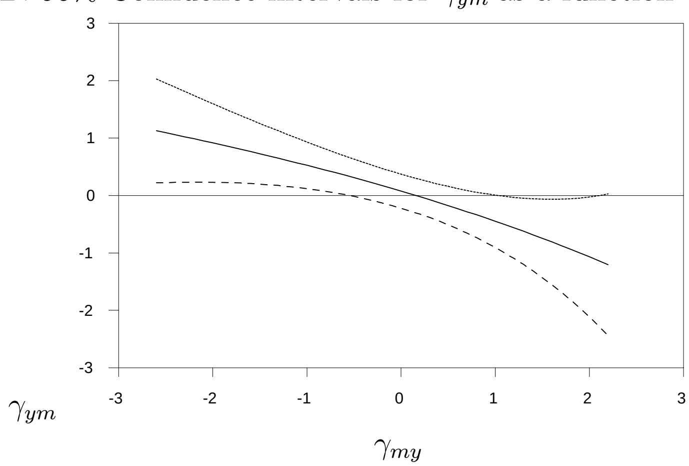
Figure 1. Neutrality Tests for CFS Divisia M1



A. 95% Confidence intervals for γ_{ym} as a function of λ_{my}

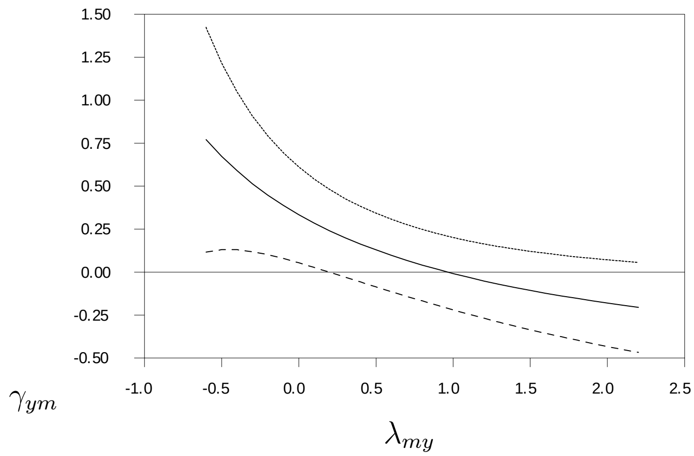


B. 95% Confidence intervals for γ_{ym} as a function of λ_{ym}

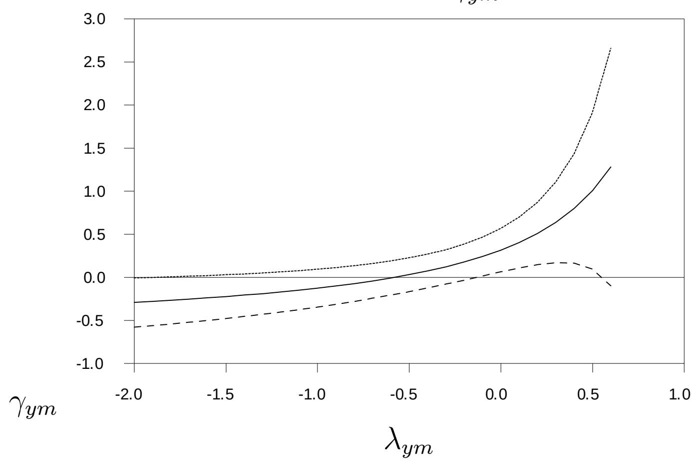


C. 95% Confidence intervals for γ_{ym} as a function of γ_{my}

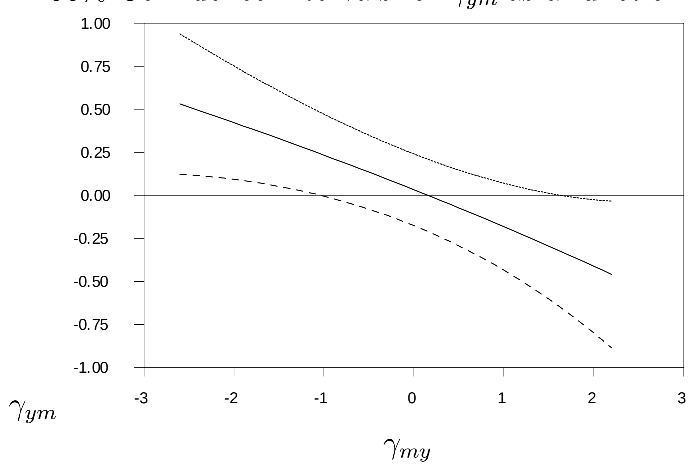
Figure 2. Neutrality Tests for CFS Divisia M2M



A. 95% Confidence intervals for γ_{ym} as a function of λ_{my}

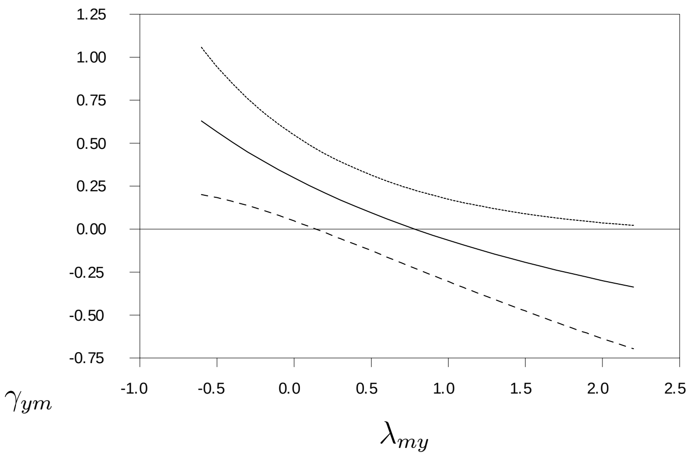


B. 95% Confidence intervals for γ_{ym} as a function of λ_{ym}

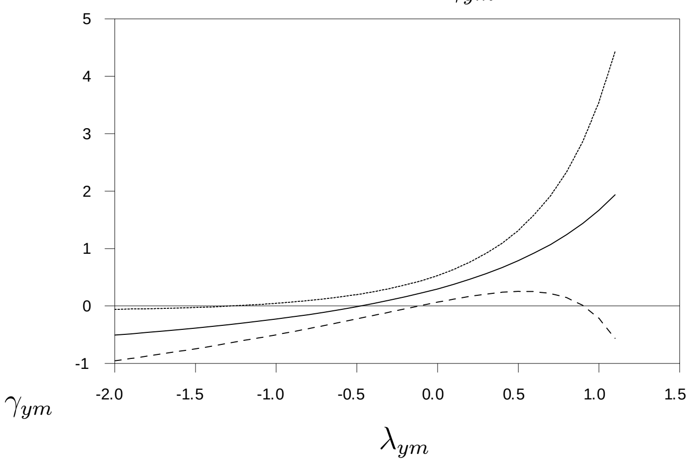


C. 95% Confidence intervals for γ_{ym} as a function of γ_{my}

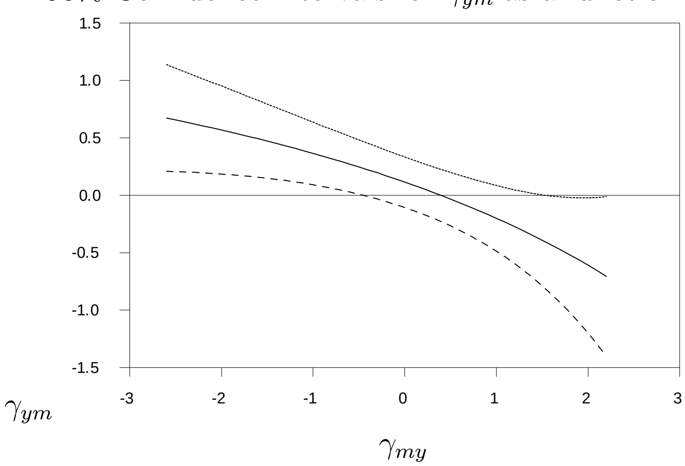
Figure 3. Neutrality Tests for CFS Divisia MZM



A. 95% Confidence intervals for γ_{ym} as a function of λ_{my}

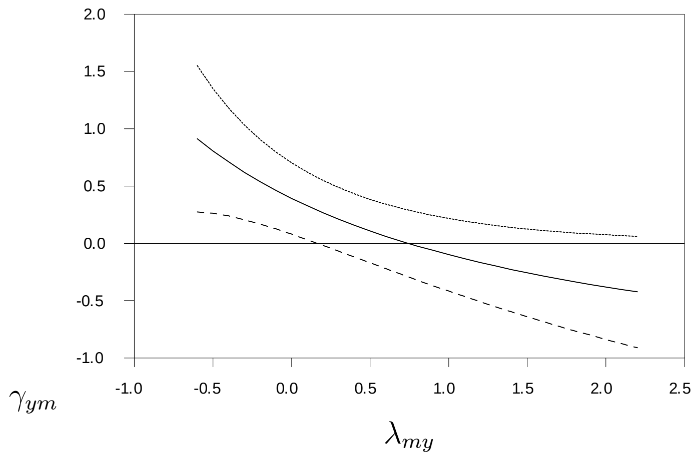


B. 95% Confidence intervals for γ_{ym} as a function of λ_{ym}

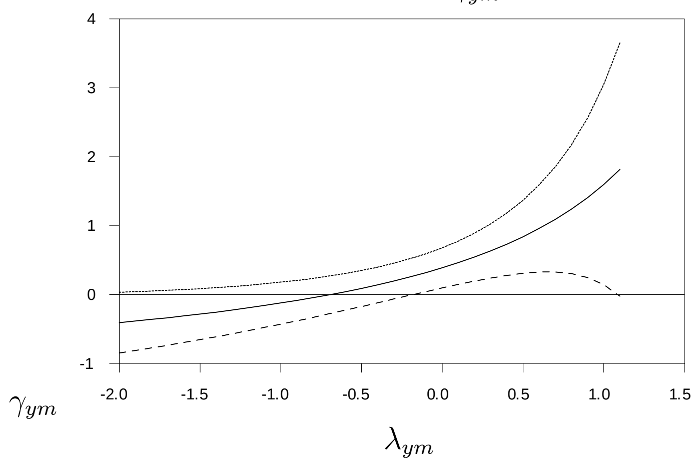


C. 95% Confidence intervals for γ_{ym} as a function of γ_{my}

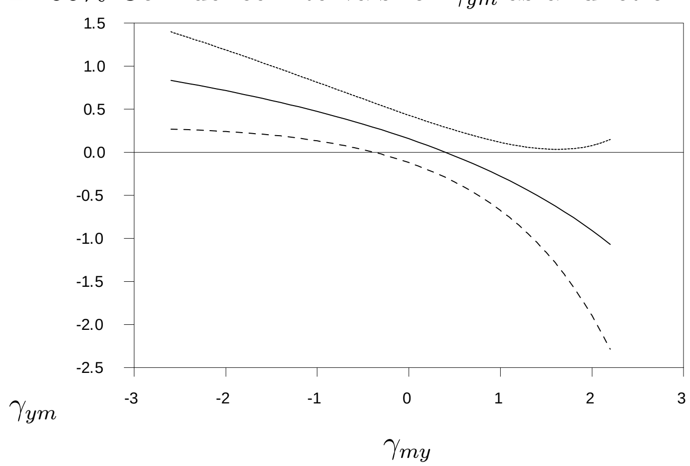
Figure 4. Neutrality Tests for CFS Divisia M2



A. 95% Confidence intervals for γ_{ym} as a function of λ_{my}

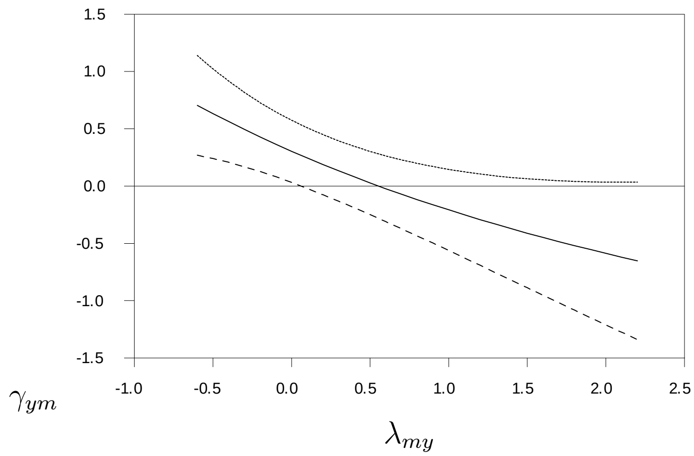


B. 95% Confidence intervals for γ_{ym} as a function of λ_{ym}

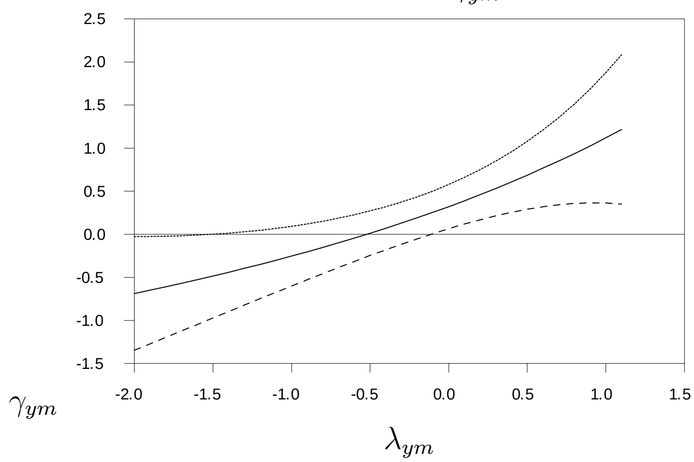


C. 95% Confidence intervals for γ_{ym} as a function of γ_{my}

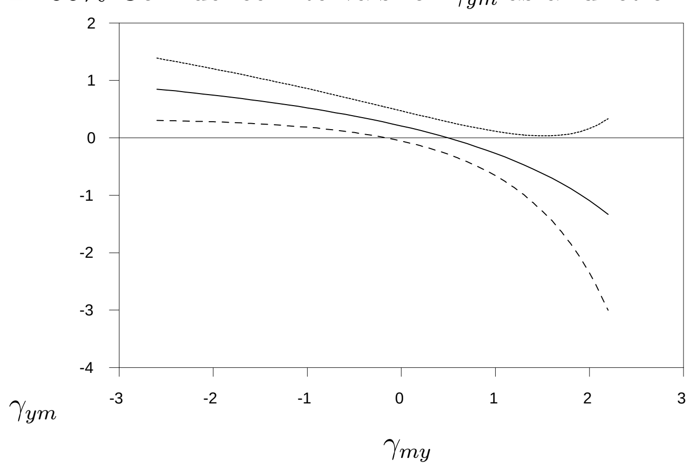
Figure 5. Neutrality Tests for CFS Divisia ALL



A. 95% Confidence intervals for γ_{ym} as a function of λ_{my}

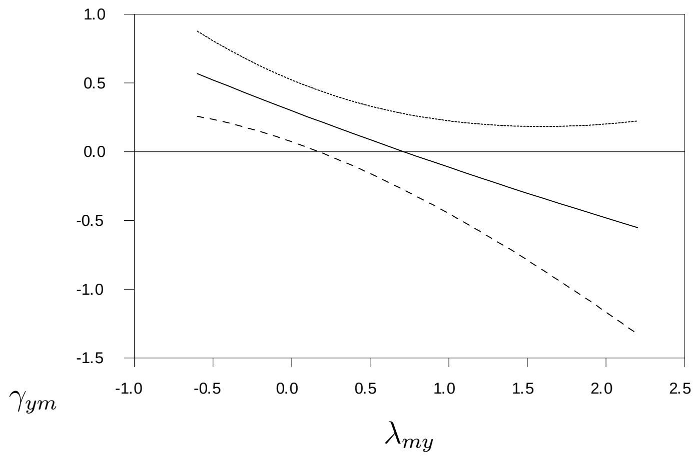


B. 95% Confidence intervals for γ_{ym} as a function of λ_{ym}

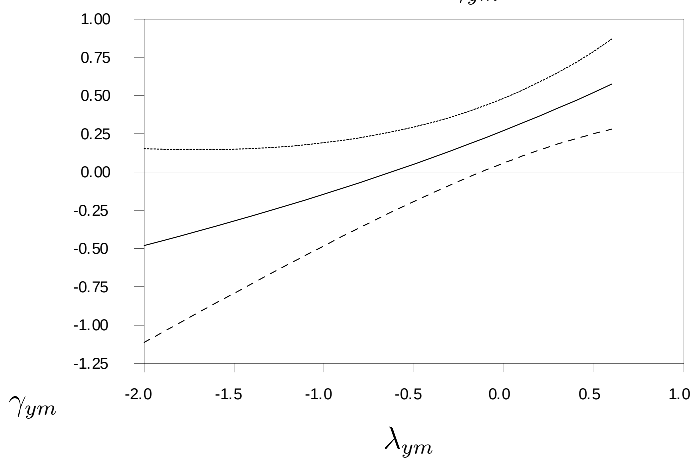


C. 95% Confidence intervals for γ_{ym} as a function of γ_{my}

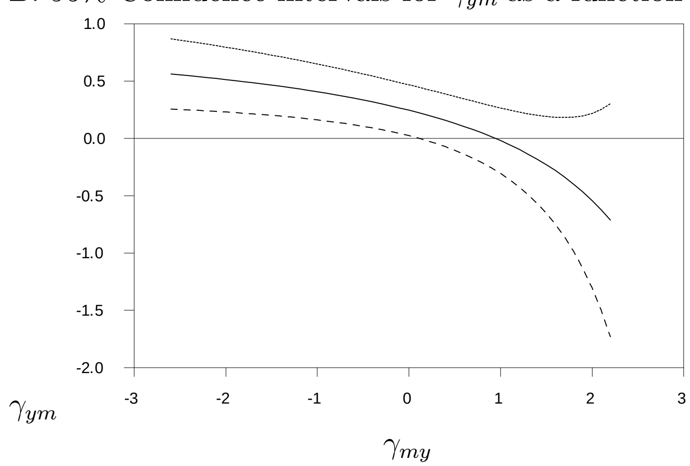
Figure 6. Neutrality Tests for CFS Divisia M3



A. 95% Confidence intervals for γ_{ym} as a function of λ_{my}

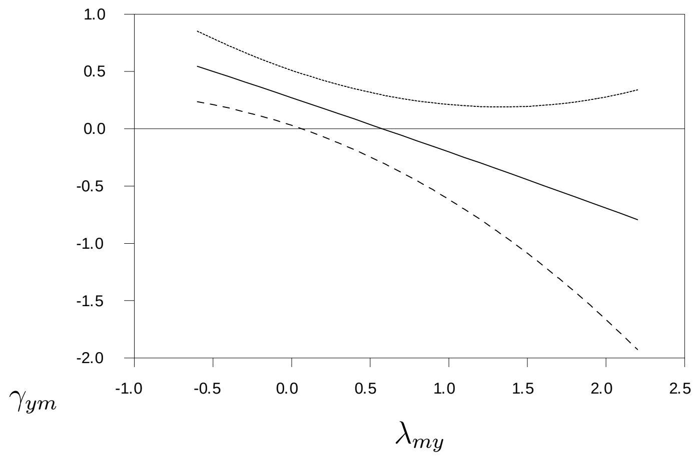


B. 95% Confidence intervals for γ_{ym} as a function of λ_{ym}

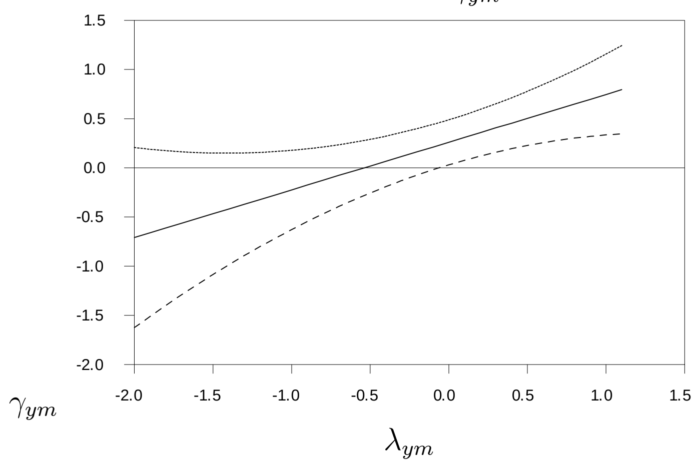


C. 95% Confidence intervals for γ_{ym} as a function of γ_{my}

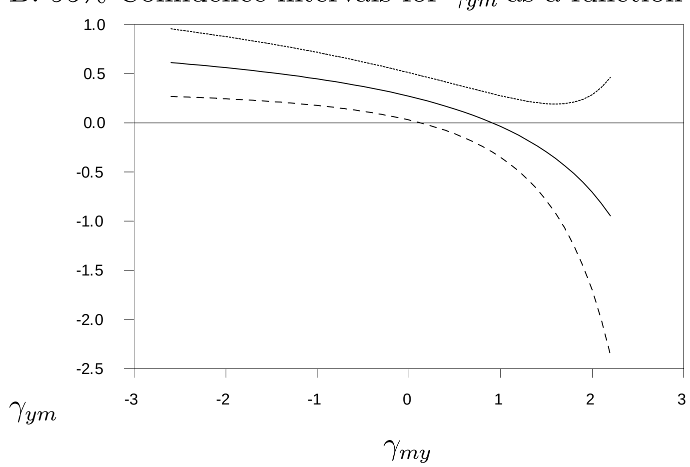
Figure 7. Neutrality Tests for CFS Divisia M4+



A. 95% Confidence intervals for γ_{ym} as a function of λ_{my}

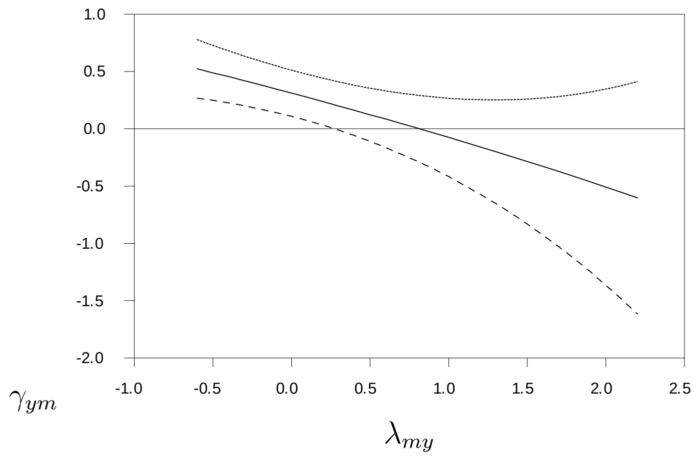


B. 95% Confidence intervals for γ_{ym} as a function of λ_{ym}

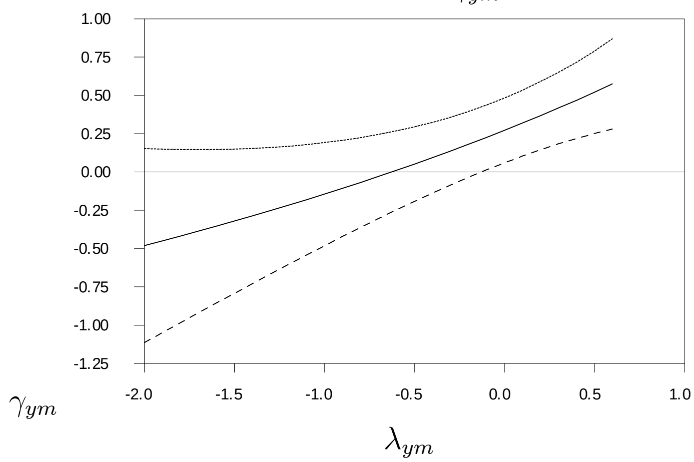


C. 95% Confidence intervals for γ_{ym} as a function of γ_{my}

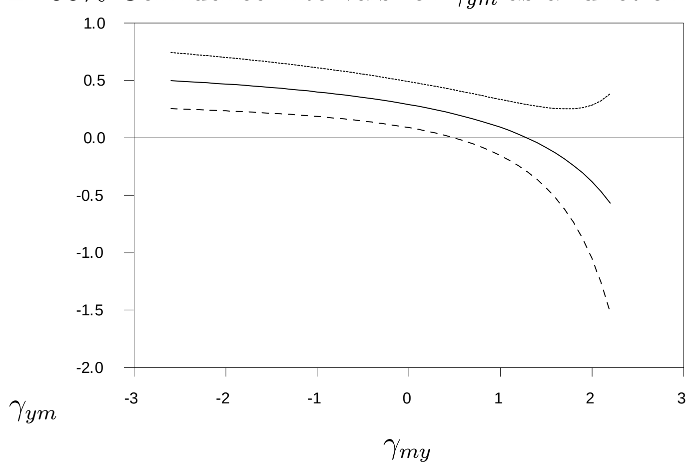
Figure 8. Neutrality Tests for CFS Divisia M4-



A. 95% Confidence intervals for γ_{ym} as a function of λ_{my}



B. 95% Confidence intervals for γ_{ym} as a function of λ_{ym}



C. 95% Confidence intervals for γ_{ym} as a function of γ_{my}