

Tax or Spend, What Causes What? Reconsidering Taiwan's Experience

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Abstract

Earlier research suggests that there has been one-way causality from government revenues to expenditures in Taiwan. This study measures linear feedback to (1) decompose the relationship between Taiwan's government spending and receipts and (2) account for contemporaneous association. Despite substantial fiscal synchronization, we still find one-way causality from government receipts to expenditures.

Key words: budget deficits; time-series methods

JEL classification: H62; H60; C32

1. Introduction and Selective Literature Review

Economists have long wondered: does government tax first and then figure out how to spend the proceeds or does it first make spending plans and then reckon how to raise funds? Or perhaps government taxing and spending are synchronized, that is, jointly determined. In this journal, Chang and Ho (2002) wrote that such questions have been studied for industrialized countries like the U.S. and the U.K., but they are also crucial for developing economies. In the case of Taiwan, an earlier tendency toward fiscal surplus has given way to persistent deficits. Considering the budget deficits that have occurred regularly since 1989, Chang and Ho sought to analyze the relationship between Taiwan's government expenditures and revenues. Specifically, they sought to identify whether government spending leads receipts or vice versa.

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With annual data for 1967-1999, Chang and Ho found cointegration among three key variables (all real variables and expressed in logs): (1) government expenditures, (2) government revenues, and (3) gross domestic product (GDP). According to Granger (1988), a cointegrating vector implies causality among variables, at least in one direction. Using a procedure developed by Engle and Granger (1987), Chang and Ho implemented causality tests based on an error correction model. According to their findings, there has been one-way causality from government revenues to expenditures. They concluded that Taiwan's government has exhibited "tax-and-spend" behavior. Therefore, to reduce persistent budget deficits, as they argued, the government should cut spending instead of finding new ways to raise revenue.

Cointegration signifies co-movement among the expenditure, revenue, and real GDP variables. This finding suggests a long-run equilibrium relationship among these variables, with causality running in at least one direction. But in any given year government spending and taxing are likely to be synchronized, perhaps to a substantial degree, meaning they are determined simultaneously. The error correction model specified by Chang and Ho does not explicitly measure the extent of contemporaneous association between expenditures and receipts. Upon accounting for any simultaneity, can the finding of "tax-and-spend" behavior be replicated? Fortunately, directional *and* contemporaneous feedback between government revenues and expenditures can be identified using a statistical technique developed by Geweke (1982, 1984).

Geweke extended Granger's (1969) concept of causality by developing measures of linear feedback that also account for any interdependence between time series. Because the method identifies directional feedback while controlling for any instantaneous association, it is unique in its ability to decompose the direction and magnitude of the linear relationships between series. Known to statisticians, economists too are using this method to clarify bi-directional relationships among variables (e.g., Cushing and McGarvey, 1990; Dheeriyaa, 1993; Hess and Kilduff, 1991; Kawaller et al., 1993; McGarvey, 1991; and Stam et al., 1991). Lin (1996) applied the Geweke method to analyze public finance in the U.S.

In assessing the relationship between government expenditures and receipts, Lin (1996, p. 84) suggested two distinct techniques are available: (1) error correction models and (2) measurement of linear feedback. For the case of Taiwan, Chang and Ho applied the first technique, while in this study we apply the other technique, namely, measurement of linear feedback. Specifically, we use the Geweke method to decompose the relationship between real government spending and receipts for Taiwan. Accounting for any simultaneous association between the variables, we ask whether Chang and Ho's finding of "tax-and-spend" behavior can be reproduced.

Chang and Ho used yearly observations for 1967-1999 from the AREMOS database (Ministry of Education, Taiwan). Likewise, we use revenue and expenditure data from AREMOS but for a longer sample period, 1955-2001. Observations for government revenues include receipts from all sources, both taxes and non-tax receipts (including capital revenue). Government expenditures include all types of

outlays, discretionary spending, debt repayments, and so on (including capital expenditures). To focus on the question of “tax-and-spend” versus “spend-and-tax,” we also use two other series from the AREMOS database, namely, current government revenues and expenditures, which are available only for 1967-2001. The Geweke feedback measures indicate substantial simultaneity between government outlays and receipts, hence fiscal synchronization in Taiwan. Nevertheless, there is also some meaningful directional feedback.

2. Measuring Conditional Linear Feedback: Overview of the Geweke Method

Consider two time series vectors: *tax* (real government revenues) and *spend* (real government expenditures). Geweke (1982) decomposes linear dependence between the series into three separate components: (1) feedback from *tax* to *spend*, (2) feedback from *spend* to *tax*, and (3) contemporaneous (simultaneous) association between the series. Feedback from *tax* to *spend* shows whether government receipts affect outlays, coined as tax-and-spend behavior. Feedback from *spend* to *tax* illustrates whether government spending leads receipts, called spend-and-tax behavior. Contemporaneous association between the variables would be evidence of fiscal synchronization.

The interrelationship between government revenues and expenditures is likely to differ according to the economic climate. The basic method described below can be extended to include what Geweke (1984) calls *conditioning information*, which is a control variable. Including such a control variable enables us to decompose the relationship between *tax* and *spend*, conditional on economic conditions. To capture the state of the economy, we used Taiwan’s real GDP (signified in lower cases as *gdp*) as the conditioning variable.

To measure linear dependence, consider the following forecasting (projection) equations. A forecast of government spending at time t ($spend_t$) can be made using past expenditure values ($spend_{t-s}$) as well as past government revenues (tax_{t-s}) and real GDP (gdp_{t-s}):

$$spend_t = \sum_{s=1} a_1(s)spend_{t-s} + \sum_{s=1} a_2(s)tax_{t-s} + \sum_{s=1} a_3(s)gdp_{t-s} + \epsilon_{1t}, \quad (1a)$$

where the a ’s are coefficient vectors and ϵ_{1t} is the random prediction error with variance σ_1^2 .

Identifying conditional feedback from revenues to spending, $F_{tax \rightarrow spend | gdp}$, means we must account for the marginal contribution of *tax* in the *spend* projection. So we compare the $spend_t$ forecast generated *with* the revenue series to a prediction created *without* the series. Therefore we modify (1a) and estimate $spend_t$ again as follows:

$$spend_t = \sum_{s=1} b_1(s)spend_{t-s} + \sum_{s=1} b_2(s)gdp_{t-s} + \epsilon_{2t}, \quad (1b)$$

where $\text{var}(\epsilon_{2t}) = \sigma_2^2$. Feedback from revenues to expenditures is determined by comparing the prediction error variance from (1b) with that of (1a). Specifically,

conditional feedback from *tax* to *spend* is defined as

$$F_{tax \rightarrow spend | gdp} \equiv \log (\sigma^2_2 / \sigma^2_1). \quad (2)$$

If the two variances are the same, then tax_{t-s} values do not improve the precision of the expenditures forecast. That is, if $\sigma^2_2 = \sigma^2_1$, then $F_{tax \rightarrow spend | gdp} = 0$ and past receipts do *not* influence current outlays.

Estimating feedback from expenditures to revenues, $F_{spend \rightarrow tax | gdp}$, follows a similar process. We estimate tax_t as a function of past revenues, expenditures, and GDP, obtaining the prediction error variance σ^2_3 . Then we re-estimate tax_t without $spend_{t-s}$, obtaining the error variance σ^2_4 . Thus, feedback from *spend* to *tax* can be written as follows:

$$F_{spend \rightarrow tax | gdp} \equiv \log (\sigma^2_4 / \sigma^2_3). \quad (3)$$

A distinguishing feature of the Geweke method is that it also accounts for any contemporaneous (simultaneous) association between two series, that is, linear association that cannot be disentangled. To identify this simultaneous component, we modify the forecast of $spend_t$ by also including tax from period t :

$$spend_t = \sum_{s=1} c_1(s)spend_{t-s} + \sum_{s=0} c_2(s)tax_{t-s} + \sum_{s=1} c_3(s)gdp_{t-s} + \varepsilon_{5t}, \quad (4)$$

where $\text{var}(\varepsilon_{5t}) = \sigma^2_5$. Inclusion of period t revenues may improve the precision of the $spend_t$ forecast. Thus, the measure of contemporaneous association becomes:

$$F_{tax \cdot spend | gdp} \equiv \log (\sigma^2_1 / \sigma^2_5). \quad (5)$$

If including period t receipts does not reduce the prediction error, then $\sigma^2_5 = \sigma^2_1$ and $F_{tax \cdot spend | gdp} = 0$, meaning that there is no contemporaneous association between the series.

Given the different types of feedback defined above, we can assess the revenue-spending relationship. The conditional feedback measure $F_{tax \cdot spend | gdp}$ indicates whether government revenues lead spending (tax-and-spend). The measure $F_{spend \rightarrow tax | gdp}$ shows whether expenditures drive receipts (spend-and-tax). Finally, $F_{tax \cdot spend | gdp}$ shows the extent of simultaneity between receipts and outlays (fiscal synchronization).

The feedback measures defined above can be transformed into growth rates using the formula $1 - \exp(-F)$. For example, transforming $F_{tax \rightarrow spend | gdp}$ shows the proportional reduction in the error variance of the $spend_t$ forecast that can be attributed to tax_{t-s} values, given real GDP. In other words, the transformation illustrates the capacity of past receipts in reducing the variance of the prediction error in the expenditures projection.

3. Decomposing Government Expenditures and Revenues: Conditional Feedback Measures

3.1 Data and Sample

We begin the empirical analysis using annual data on government expenditures, government revenues, and GDP for Taiwan. All data series are from the AREMOS database (Ministry of Education, Taiwan). The *spend* series is “Net Government (All) Expenditures.” The *tax* series is represented by “Net Government (All) Revenues.” Both *spend* and *tax* are for all levels of government. The figures are expressed in thousands of New Taiwan dollars (NT\$). We use the GDP deflator (1996 = 1.00) to generate observations for real spending, real revenues, and real GDP.

Like Chang and Ho, we conduct our analysis using the logarithms of real expenditures (denoted by $spend_t^*$), revenues (tax_t^*), and GDP (gdp_t^*). Annual observations are available back to 1955; the most recent observation available is for 2001.

3.2 Implementing the Geweke Method

We implement the Geweke method to identify conditional feedback, bi-directional and contemporaneous, between $spend^*$ and tax^* . To estimate the $spend_t^*$ and tax_t^* projections we use OLS regression. Then we compute the conditional feedback measures $F_{tax^* \rightarrow spend^* | gdp^*}$, $F_{spend^* \rightarrow tax^* | gdp^*}$, and $F_{tax^* \cdot spend^* | gdp^*}$.

Neither Dickey-Fuller (1981) nor Phillips-Perron (1987, 1988) tests can reject the null hypothesis of a unit root (90-percent confidence level, using an intercept and trend) for the log of real net expenditures, net revenues, or GDP. According to the Johansen-Juselius (1990) test, however, these series are cointegrated (see Appendix A.1 for test results). Consequently, the forecasting equations can be estimated with $spend_t^*$, tax_t^* , and gdp_t^* . For optimal lag lengths in the forecast equations, we rely on the Schwarz information criterion. In all cases, the optimal lag length is two.

The feedback estimators are consistent, but because they are based on variances they are nonnegative by construction, which may bias the estimates upward. Thus, we adjust the point estimates for potential bias by following the correction technique used by Cushing and McGarvey (1990). We simulate sampling distributions for each feedback measure; then we use the mean from each distribution to adjust the feedback point estimate and the tails of each distribution to construct 90-percent confidence bands (see Appendix A.2 for technical details). Because the adjusted feedback point estimates do not have associated test statistics, there is no procedure for direct hypothesis testing. But the 90-percent bands do indicate the potential magnitude of the feedback measures.

With data for 1955-2001, we estimate forecasts for $spend_t^*$ and tax_t^* . Taking the prediction error variances from these forecasts, we compute conditional feedback point estimates, adjust them for potential bias, and create 90-percent confidence bands. Using $1 - \exp(-F)$, we transform the adjusted conditional feedback measures (and associated confidence bands), which allows us to gauge the rate of change in the prediction error variance of a projection.

3.3 Conditional Feedback Results

Table 1 reports the conditional feedback results. According to the estimates reported in Panel A of the table, there is a substantial contemporaneous association between government spending and revenues. The point estimate shows that including tax_t^* reduces the prediction error variance of the $spend_t^*$ forecast by 67.8 percent. According to the confidence band, which is based on the simulated sampling distribution for $F_{tax^* \rightarrow spend^* | gdp^*}$, tax_t^* improves the $spend_t^*$ forecast by at least 46.9 percent. Clearly there is considerable fiscal synchronization in Taiwan, government outlays and receipts are largely contemporaneous. Simultaneity notwithstanding, there is also meaningful directional feedback.

Table 1. Disentangling Government Expenditures and Revenues in Taiwan: Geweke Conditional Linear Feedback Measures.

Percent Reduction in the Prediction Error Variance of the Expenditure ($spend_t^*$) and Revenue (tax_t^*) Projections			
Adjusted Point Estimates (90-Percent Confidence Bands)			
Panel A. Net Government Revenues and Expenditures, 1955-2001.			
Feedback Measure:	$F_{tax^* \rightarrow spend^* gdp^*}$	$F_{spend^* \rightarrow tax^* gdp^*}$	$F_{tax^* \cdot spend^* gdp^*}$
	14.16	2.91	67.76
	(8.41, 31.90)	(1.12, 33.90)	(46.94, 96.23)
Panel B. Current Government Revenues and Expenditures, 1967-2001.			
Feedback Measure:	$F_{tax^* \rightarrow spend^* gdp^*}$	$F_{spend^* \rightarrow tax^* gdp^*}$	$F_{tax^* \cdot spend^* gdp^*}$
	30.04	5.32	66.34
	(20.13, 50.63)	(2.39, 58.72)	(38.87, 99.97)

Note: Series are defined as follows: (1) $tax^* \equiv \log(\text{real tax})$, (2) $spend^* \equiv \log(\text{real spend})$, (3) $gdp^* \equiv \log(\text{real gdp})$. Observations for government revenues and expenditures and Taiwan's GDP are from the AREMOS database (Ministry of Education, Taiwan). The GDP deflator (1996 = 1.00) is used to convert nominal figures to real figures. $F_{tax^* \rightarrow spend^* | gdp^*}$ is conditional feedback from tax^* to $spend^*$; see equation (2). $F_{spend^* \rightarrow tax^* | gdp^*}$ is conditional feedback from $spend^*$ to tax^* ; see equation (3). $F_{tax^* \cdot spend^* | gdp^*}$ is conditional contemporaneous association between tax^* and $spend^*$; see equation (5).

We now ask whether government revenues lead outlays, that is, feedback from tax_{t-s}^* to $spend_t^*$. The point estimate shows that the prediction error variance of $spend_t^*$ falls 14.2 percent when including tax_{t-s}^* in the projection. Looking at the confidence band, the improvement is at least 8.4 percent, ranging as high as 31.9 percent. These results support tax-and-spend behavior in Taiwan, confirming Chang and Ho's aforementioned finding of causality from revenues to expenditures.

To see whether government spending drives receipts, we analyze feedback from $spend_{t-s}^*$ to tax_t^* . The point estimate suggests that expenditures have a comparatively small impact on the revenues forecast, reducing the variance of the prediction error by only 2.9 percent. But the confidence band suggests that spend-and-tax be-

havior cannot be ruled out altogether. Nevertheless, the point estimates and confidence interval lower bounds suggest that evidence of spend-and-tax behavior is less compelling than that of tax-and-spend behavior.

Note that the data series analyzed so far are for all types of revenues and expenditures for all levels of government. Observations for tax^* include both current revenues and capital receipts. Likewise, the $spend^*$ series includes both current and capital expenditures. To exclude any influence of capital transactions and work more narrowly on the question of tax-and-spend *versus* spend-and-tax, we study two other series from the AREMOS database, namely, *current* government revenues and expenditures.

Current revenues include tax receipts, monopoly revenue, surpluses of public enterprises and utilities, revenues from public property, fees and fines (by far, most revenues come from tax receipts). Current expenditures are for administration, defense, education, science, culture, and economic development; debt repayments and other obligations are included as well. Yearly observations are available back to 1967, so the sample is 1967-2001.

We use current expenditures and receipts to generate forecasts for $spend_t^*$ and tax_t^* . For 1967-2001, both Dickey-Fuller (1981) and Phillips-Perron (1987, 1988) tests reject the null hypothesis of a unit root (90-percent confidence level, using an intercept and trend) for the log of real current expenditures, current revenues, and GDP (see Appendix A.1 for test results). So the forecasting equations are estimated by using levels of $spend_t^*$, tax_t^* , and gdp_t^* . In all forecast equations, the optimal lag length is two (using the Schwarz criterion). We report the conditional feedback estimates in Table 1, Panel B.

In light of current government spending and receipts, it is clear that there is substantial fiscal simultaneity. Consider a projection of $spend_t^*$ that already includes both $spend_{t-s}^*$ and tax_{t-s}^* . Adding the period t observation for revenues reduces the $spend_t^*$ forecast error variance by 66.3 percent. According to the confidence interval, the improvement is at least 38.9 percent. These measures of simultaneous association are nearly identical to those generated by using net receipts and outlays (compare Panel B with Panel A).

Excluding capital revenues and expenditures, there is now much stronger evidence of tax-and-spend behavior. Including observations for past government revenues lowers the prediction error variance of $spend_t^*$ by 30.0 percent. The confidence interval shows that improvement is at least 20.1 percent and can range as high as 50.6 percent. These measures are roughly twice as large as those reported in Panel A.

If we focus only on current outlays and receipts, there will be stronger support for spend-and-tax behavior. Including past spending improves the tax_t^* forecast by 5.3 percent. Comparing the point estimates and confidence interval lower bounds, we see that spend-and-tax still appears to be less prominent than tax-and-spend behavior.

4. Summary and Concluding Remarks

Economic research is strengthened when empirical findings can be reproduced. If different estimation methods or sample data can replicate original findings, we might have more confidence in drawing conclusions. In analyzing the relationship between government taxing and spending, researchers can use different techniques: error correction models or measurement of linear feedback. In their study of Taiwan, Chang and Ho (2002) used the error correction approach and concluded that Taiwan's government has engaged in "tax-and-spend" behavior. But their analysis did not identify the extent to which government spending and receipts may be determined jointly. In order to identify any fiscal synchronization and check the earlier findings of Chang and Ho, we use the approach of measuring linear feedback.

Employing an innovative technique developed by Geweke (1982, 1984), this study has identified both directional feedback and contemporaneous association between government expenditures and receipts in Taiwan. We report evidence of substantial simultaneity between government outlays and receipts. Fiscal synchronization notwithstanding, our findings reinforce and extend those of Chang and Ho. We report feedback from government revenues to expenditures, which indicates "tax-and-spend" behavior. Moreover, when only current government revenues and expenditures are analyzed, there is relatively modest feedback from government spending to receipts, indicating some element of "spend-and-tax" behavior too. In the case of Taiwan, receipts drive government spending; current spending influences current tax revenues somewhat. Thus, our findings reinforce Chang and Ho's original policy prescription: to reduce chronic budget deficits, Taiwan's government should focus more on controlling spending than boosting revenues.

Appendix

A.1. Unit Root Tests

Focus first on the 1955-2001 sample period. Using two lags (indicated by the Schwarz criterion), we confirm cointegration between real net expenditures, real net revenues, and real GDP (1955-2001). Using the Johansen-Juselius (1990) test, the results are as follows:

	Trace Test	Test Statistic
$H_0: \gamma=0$	34.97*	31.42
$H_0: \gamma \leq 1$	11.44	16.06
$H_0: \gamma \leq 2$	4.58	2.37

*Indicates 1 cointegrating equation at the 10 percent significance level.

$$tax^* + 0.012 spend^* - 1.521 gdp^* + 0.038 trend + 1.003. \quad (A.1.1)$$

(0.130) (0.175) (0.010)

For the 1967-2001 sample period, the unit root test results are below. In all

cases, the optimal lag length is two; tests include a constant and time trend.

Variable	Dickey-Fuller Test Statistic	Phillips-Perron Test Statistic
<i>tax</i> *	-3.42 [‡]	-3.40 [‡]
<i>spend</i> *	-3.51 [‡]	-3.53 [‡]
<i>gdp</i> *	-3.18 [‡]	-3.19 [‡]

[‡]Indicates significance at the 90-percent confidence level.

A.2. Small Sample Bias Correction and Construction of Confidence Bands

Geweke linear feedback measures are based on prediction error variances, the latter of which are nonnegative. To correct for potential small sample bias, we simulated a sampling distribution for each feedback measure and obtained the mean and the fifth- and ninety-fifth percentiles. Following the procedure used by Cushing and McGarvey (1990), we used the mean to adjust each feedback point estimate. To indicate the potential magnitude of the adjusted estimate, we used the upper and lower percentiles to create 90-percent confidence bands.

Correcting the conditional feedback measures involves the following steps. Using equation (1a) as the model, we specify a system of projections, one for $spend_t^*$ and one for tax_t^* . Specifically, we estimated a tri-variate autoregressive (AR) system using gdp^* as the conditioning information. With the estimated coefficient matrix that resulted, we simulated observations according to

$$\tilde{B}(L)W_t = e_t, \text{ where } e_t \sim N(0, \tilde{\Omega}) \tag{A.2.1}$$

where $\tilde{B}(L)$ is the estimated coefficient matrix of the tri-variate AR system, W_t is the data matrix (containing $spend^*$, tax^* , and gdp^* observations) and $\tilde{\Omega}$ is the estimated variance of the conditional system. The lag length used in the simulated AR system is two, the same used to generate the feedback measures. The simulated data are then used to generate feedback measures and the sampling distribution of the feedback point estimates.

The simulated data provide k_i estimates of type i feedback calculated from the data ($i = 1, 2, 3$; the three types of feedback are $F_{tax^* \rightarrow spend^* | gdp^*}$, $F_{spend^* \rightarrow tax^* | gdp^*}$, and $F_{tax^* \cdot spend^* | gdp^*}$). These sets of k_i estimates provide the sampling distribution of the estimator, f_i , given the “population,” that is, the actual data. Following Cushing and McGarvey, we simulated 200 estimates ($k_i = 200$) to create sampling distributions for each of the feedback measures.

The simulated mean, $E(f_i)$, fifth percentile, C_{i5} , and ninety-fifth percentile, C_{i95} , of the feedback sampling distribution can be used to adjust the feedback measures. Let $l_i \equiv C_{i5} / E(f_i)$, $u_i \equiv C_{i95} / E(f_i)$, and $a_i \equiv F_i / E(f_i)$, where F_i is the unadjusted feedback measure. With 90-percent probability, f_i lies between C_{i5} and C_{i95} :

$$\Pr \{ l_i E(f_i) < f_i < u_i E(f_i) \} = 0.90. \tag{A.2.2}$$

To adjust the estimates for small sample bias, multiply (A.2.2) through by a_i :

$$\Pr\{a_i l_i E(f_i) < a_{f_i} < a_i u_i E(f_i)\} = 0.90, \quad (\text{A.2.3})$$

where a_{f_i} is the adjusted, unbiased estimator of F_i , which can be rewritten as:

$$\Pr\{l_i F_i < a_{f_i} < u_i F_i\} = \Pr\{a_{f_i} / u_i < F_i < a_{f_i} / l_i\} = 0.90. \quad (\text{A.2.4})$$

The 90-percent confidence band for F_i is

$$f_i a_i / u_i < F_i < f_i a_i / l_i, \quad (\text{A.2.5})$$

where f_i is a feedback point estimate. This procedure ensures that the adjusted point estimate of the feedback, a_{f_i} , always falls within the confidence band.

Applying the adjustment method to the transformed feedback measures, the proportional reduction in forecast error variance for each conditional feedback measure has a 90-percent confidence interval defined as:

$$\{1 - \exp[-(f_i a_i) / u_i]\} < [1 - \exp(-F_i)] < \{1 - \exp[-(f_i a_i) / l_i]\}. \quad (\text{A.2.6})$$

References

- Chang, T. and Y. H. Ho, (2002), "Tax or Spend, What Causes What: Taiwan's Experience," *International Journal of Business and Economics*, 1, 157-165.
- Cushing, M. J. and M. G. McGarvey, (1990), "Feedback between Wholesale and Consumer Price Inflation: A Reexamination of the Evidence," *Southern Economic Journal*, 56, 1059-1072.
- Dheeriyaa, P. L., (1993), "Further Evidence on Causality and Feedback across International Stocks," *Journal of Economics and Finance*, 17, 161-167.
- Dickey, D. A. and W. A. Fuller, (1981), "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root," *Econometrica*, 49, 1057-1072.
- Engle, R. F. and C. W. J. Granger, (1987), "Cointegration and Error Correction: Representation, Estimation, and Testing," *Econometrica*, 55, 251-276.
- Geweke, J., (1982), "Measurement of Linear Dependence and Feedback between Multiple Time Series," *Journal of the American Statistical Association*, 77, 304-313.
- Geweke, J., (1984), "Measurement of Conditional Linear Dependence and Feedback between Time Series," *Journal of the American Statistical Association*, 79, 907-915.
- Granger, C. W. J., (1969), "Investigating Causal Relationships by Econometric Models and Cross-Spectral Methods," *Econometrica*, 37, 424-438.
- Granger, C. W. J., (1988), "Some Recent Developments in a Concept of Causality," *Journal of Econometrics*, 39, 199-211.
- Hess, D. W. and A. P. Kilduff, (1991), "Price Change Causation across International Stock Markets," *Journal of International Financial Markets*, 1, 123-136.
- Johansen, S. and K. Juselius, (1990), "Maximum Likelihood Estimation and Inference on Cointegration—with Applications to the Demand for Money," *Oxford Bulletin of Economics and Statistics*, 52, 169-210.

- Kawaller, I. G., P. D. Koch, and T. W. Koch, (1993), "Intraday Market Behavior and the Extent of Feedback between S&P 500 Futures Prices and the S&P 500 Index," *Journal of Financial Research*, 16, 107-121.
- Lin, C. A., (1996), "Empirical Analysis of the Size and Growth of Government: Wagner's Law and Beyond," Ph.D. Dissertation, University of Nebraska.
- McGarvey, M. G., (1991), "The Neutrality Properties of Competing Relative Price Models: Tests Using Linear Feedback," *Journal of Business and Economic Statistics*, 9, 15-25.
- Perron, P., (1988), "Trends and Random Walks in Macroeconomic Time Series," *Journal of Economic Dynamics and Control*, 12, 297-332.
- Phillips, P. C. B., (1987), "Time Series Regression with a Unit Root," *Econometrica*, 55, 277-301.
- Stam, A., C. D. DeLorme, and B. Finkenstadt, (1991), "Cross National Money-Income Causality for the Floating Exchange Rate Period: Has the Influence of U.S. and German Money Persisted?" *Journal of Macroeconomics*, 13, 207-237.