Starving the Beast Revisited
Masoud Moghaddam

The determinants of government budget deficits have been studied extensively, especially during the years in which the discrepancy between federal income taxes and expenditures has widened. In that respect, it is of interest to explore the causal relationship between government revenues and expenditures. If the direction of causation is from taxes to spending, then enjoying tax cuts without cutting expenditures necessitates starving the beast, as suggested by Milton Friedman (1978) and confirmed by a number of studies including Garcia and Henin (1999), and Chang, Liu, and Caudill (2002). On the other hand, if a tax cut is perceived by rational agents to be a cut in the cost of public goods, then spending would increase. In that case, taxes and spending are inversely related. Support for that relationship—the so-called fiscal illusion hypothesis—is provided by Wagner (1976), Niskanen (1978, 2002, 2006), and more recently by New (2009) and Young (2009). There are also a few studies in which no significant causal relation between tax and spend variables has been reported (e.g., Baghestani and McNown (1994).

In this article, I revisit the evidence in favor of the fiscal illusion hypothesis, as presented in Young (2009) for the period 1959Q3–2007Q4. According to Young, the tax and spend variables are integrated of order one and share a long-term linear common trend (cointegration). He attempts to depict asymmetric behavior by incorporating interaction dummies in the standard expenditure regression model. Subsequently, he correctly states that the

---

Masoud Moghaddam is Professor of Economics at St. Cloud State University.

employed interaction dummies (eight dummies in a univariate model, four of which appear to be redundant) are incapable of capturing the essence of nonlinear dynamic adjustments.[1] Eventually, following the findings presented by Ewing et al. (2006), Young identifies residual thresholds and reestimates the regression model using the TAR (threshold autoregression) and M-TAR (momentum TAR) models. He concludes that while TAR and M-TAR estimate different speed of adjustment, the findings are not favorable to starving the beast. His findings reject the type of tax cuts that are not contingent on spending cuts of the same magnitude.

This article empirically demonstrates that the findings presented by Young are heavily plagued by the lack of an "attractor" (i.e., tendency toward budgetary long-run equilibrium) in the residual of the model he estimated within the utilized asymmetric framework. Indeed, the findings reported in Table 4 of his article do not include any evidence of an attractor—nor do they indicate asymmetry or the lack of residual autocorrelation. Consequently, his findings in Table 4 invalidate the results presented in Table 5 and overturn the main contention of his article.[2]

Anomalies in Young's Expenditure Model

The standard government expenditure model is specified as:

$$(1) \quad spe_t = a + b \, rev_t + e_t,$$

where spe and rev are the natural logarithm (ln) of total federal government spending and tax revenue scaled by ln GDP, respectively. Furthermore, a is the intercept, b is the regression coefficient, and e is a well-behaved error term (residual). Under asymmetric adjustments, the residual behaves in the following manner:

$$(2) \quad \Delta e_t = \rho 1 \, I_t \, [e_{t-1} - \tau] + \rho 2 \, (1 - I_t)[e_{t-1} - \tau] + e_{1t}$$

where Δ is the first differencing operator, $\rho 1$ and $\rho 2$ are the autoregression coefficients depicting the speed at which e_t adjusts to its

---

[1]In that spirit, since budgetary disequilibria are perceived differently by the general public, in the absence of a mechanism to depict this phenomenon, the findings of the model with interaction dummies might be predominantly due to the model's misspecification.

[2]Presenting such findings is routine for the residual equation in asymmetric adjustment studies (see Ewing et al. 2006).

long-run budgetary equilibrium given the threshold (τ), and e_{1t} is another white noise error term. The Heaviside indicator functions are such that I = 1 if the one period lagged residual $e_{t-1} \geq \tau$, and 0 otherwise (that is, $e_{t-1} < \tau$) for the TAR model. In like manner, I = 1 if $\Delta e_{t-1} \geq \tau$, and I = 0 if $\Delta e_{t-1} < \tau$ for the M-TAR model. In the TAR class of models proposed by Tong (1983), the autoregressive parameters decay over time (deepness), whereas in the M-TAR family of models suggested by Enders and Granger (1998), the decaying process has a clear tendency toward one way or the other (sharpness). In a typical business fluctuation (to which the government budget is sensitive), sharpness commonly implies a situation where a contraction is longer than an expansion and deepness is indicative of a more prolonged trough than peak.[3]

Before investigating nonlinear dynamic adjustments, an important question is whether or not there is a long-run equilibrium (attractor) toward which the residual time series variable moves. Unfortunately, it is impossible to utilize the commonly used integration tests because the majority of them are based on the linearity presumption. The presumed linearity might be a good approximation (starting point), but it is incapable of capturing the true dynamic adjustments of most time series variables. In fact, assuming the existence of an attractor by rejecting the null hypothesis that $\rho 1 = \rho 2 = 0$ (using the Φm critical values), then further rejecting $\rho 1 = \rho 2$ (based on the standard F-test), is indicative of asymmetric adjustments. Subsequently, the asymmetric error correction model (AECM) is a logical generalization of equation (2) by way of incorporating appropriate lagged values of both the dependent and independent variables in the form[4]

(3) $\Delta \mathrm{spe}_t = \mathrm{c} + \Sigma \mathrm{di}\ \Delta \mathrm{spe}_{t-i} + \Sigma \mathrm{fi}\ \Delta \mathrm{rev}_{t-i} + \rho 1\ \mathrm{I}_t$
$[e_{t-1} - \tau] + \rho 2\ (1 - \mathrm{I}_t)[e_{t-1} - \tau] + e_{2t};$

$\quad \mathrm{i} = 1, 2, 3, \ldots \mathrm{n}$

where c is the intercept, di and fi are regression coefficients, and e_{2t} is the error term. The numerical value of τ would have to be

[3]More recently, the focus appears to have been shifted from merely demonstrating asymmetric behavior of time series variables to exploring the exact nature of such asymmetry (Sichel 1993).
[4]The AECM can be designed for the revenue variable in the same fashion.

estimated in the same way as the numerical values of ρ1 and ρ2. A consistent estimate of τ has been obtained in accordance with the procedure explicated by Chan (1993). The Chan approach precludes ± 15 percent of the observations and also ranks them in an ascending fashion. Moreover, using OLS, equation (2) is estimated recursively within the ± 15 percent constraint. The estimated model whose residual sum of squared is minimal produces a consistent estimate of τ, which can be used to appropriately estimate equation (3).[5]

Empirical Findings

Equation (2) in the form of TAR and M-TAR has been estimated with lag-lengths of 2 and 4 based on the Akaike Information criterion (AIC) and the Schwarz Baysian criterion (SBC). The findings are reported in Table 1. The initial lag length is 13. Of the two model's selection criteria (AIC and SBC), the SBC appears to have a more clear alternative hypothesis, is more consistent in large samples, and tends to select less over-parameterized models. The expenditure, revenue, and GDP data are seasonally adjusted in billions of dollars and have been obtained from the Bureau of Economic Analysis (BEA) and the Federal Reserve Bank of St. Louis/Fred2. For comparison reasons, the sample period is the same as that used by Young (2009).

As can be seen, both AIC and SBC consistently choose the models with only 2 lags for which residual autocorrelation has been eliminated at any acceptable significance level. To test for the existence of an attractor (i.e., ρ1 = ρ2 = 0) at the 5 percent significance level, the reported critical value by Enders and Siklos (2001) is $\Phi m = 6.63$. As such, there is significant evidence of an attractor (long-term budgetary equilibrium) only in the M-TAR model for which τ = 0, and lag-length = 2. Most notably, we can reject the null hypothesis of symmetric (linear) adjustments (that is, ρ1 = ρ2) in favor of asymmetric (nonlinear) adjustments at any significance level only for the aforementioned M-TAR model. In short, it is essential to estimate the expenditure revenue nexus (equation 3) by allowing the residuals to follow the above M-TAR type adjustment.

---

[5]For brevity, Chan's procedure has not been discussed in depth. The detailed estimation and findings are available from the author on request.

TABLE 1
EMPIRICAL ESTIMATION OF THE ASYMMETRIC RESIDUAL

Model/Lag-length	AIC	SBC	$\rho1 = \rho2 = 0$	$\rho1 = \rho2$	$\chi^2 (4, 8)$
TAR (threshold = 0.0025)					
2	−8.228812	−8.160701	6.68	F = 1.96 (1,187, P = 0.16)	[0.64, 0.72]
4	−8.212118	−8.109206			
M-TAR (threshold = 0.0040)					
2	−8.219545	−8.151435	5.76	F = 0.22 (1,187, P = 0.64)	
4	−8.198917	−8.096004			
TAR (threshold = 0)					
2	−8.227616	−8.159505	6.57	F = 1.74 (1,187, P = 0.18)	[0.57, 0.67]
4	−8.210696	−8.107783			
M-TAR (threshold = 0)					
2	−8.266644	−8.198534	10.54	F = 9.25 (1,187, P = 0.002)	[0.98, 0.98]
4	−8.251439	−8.148527			

NOTES: F = the standard F-statistic, numbers in parentheses are the corresponding degrees of freedom, P = probability of rejecting the null hypothesis, and $\chi^2 (4, 8)$ is the estimated chi-square for the Breusch–Godfrey autocorrelation test with 4 and 8 quarterly lags, respectively. Numbers in brackets are the probability of rejecting the null hypothesis that the residual autocorrelation is zero. The threshold values are the same as those used by Young (2009) following Chan's (1993) approach.

Young estimated the residual equation with 2 and 4 lags, but did not subject it to the attractor, asymmetry, and autocorrelation tests. He further imposed two types of interaction dummies (D1 and D2) on equation (3) in such a manner that D1 = 1 when rev > 0 and zero otherwise, along with D2 = 1 if rev < 0, and zero otherwise. Based on the redundancy test, $D1^*rev_{t-1} - D1^*rev_{t-4}$ are redundant because the estimated χ^2 with 4 degrees of freedom is 4.97 and probability = 0.28; thus, accepting the null hypothesis that $D1^*rev_{t-1} - D1^*rev_{t-4} = 0$.[6] Although his equation (4) suffers from over-parameterization (dummy trap) and misspecification, a reestimation with only D2 interaction dummies, and the previously identified M-TAR ($\tau = 0$ and lag-length = 2) residual structure is reported in Table 2.

Demonstrably, decreasing taxes "Granger causes" a decline in government spending only when the budgetary situation worsens. At the conventional 5 percent level, a significant direct relation between changes in revenue and expenditure (starving the beast) after one quarter and inverse relations (fiscal illusion) in the third and fourth quarter have been observed implying that the findings are at best inconclusive. Moreover, the asymmetric dynamic adjustment toward the long-run budgetary equilibrium is significant only when changes in the budgetary disequilibrium are below the zero threshold. However, if it is believed that the residual of equation (1) depicts the average effect of other factors affecting government expenditures excluding tax revenues, then its asymmetric dynamic adjustments mechanism should suffice without incorporating dummies in the AECM. Therefore, as is commonly practiced, excluding the interaction dummies and estimating the expenditure-revenue nexus—equation (3)—by allowing the residuals to follow the M-TAR adjustment ($\tau = 0$ and lag-length = 2) produces the findings summarized in Table 3.

Evidently, the speed of adjustment is insignificant when the budgetary disequilibrium is above zero, but quite significant otherwise. Furthermore, since $\rho2 > \rho1$ in absolute value, long-run dynamic adjustments toward balance positions are more pronounced when

---

[6]The redundancy test for $D2^*rev_{t-1} - D2^*rev_{t-4} = 0$ suggests that χ^2 with 4 degrees of freedom is 16.58, probability = 0.002, and thus resoundingly rejects the null hypothesis.

TABLE 2
THE ESTIMATED M-TAR ERROR CORRECTION MODEL
WITH INTERACTION DUMMIES

Variable	Coefficient	t-Statistic	Probability
Intercept	0.0004	2.72	0.007
Δspe_{t-1}	−0.0718	−0.98	0.323
Δspe_{t-2}	0.1935	2.73	0.006
Δspe_{t-3}	0.0667	0.93	0.352
Δspe_{t-4}	0.1197	1.69	0.091
$D2^*\Delta rev_{t-1}$	−0.2784	−3.07	0.002
$D2^*\Delta rev_{t-2}$	−0.0940	−1.09	0.275
$D2^*\Delta rev_{t-3}$	0.1859	2.08	0.038
$D2^*\Delta rev_{t-4}$	0.1867	2.25	0.025
$\rho 1$	−0.0064	−0.25	0.796
$\rho 2$	0.0586	2.46	0.014

$R^2 = 0.17$
AIC = −9.419105
SBC = −9.230432
χ^2 (2, 4, and 8), P = 0.62, P = 0.34, and P = 0.65, respectively
Granger Causality Test:
$D2^*\Delta rev_{t-1} = D2^*\Delta rev_{t-2} = D2^*\Delta rev_{t-3} = D2^*\Delta rev_{t-4} = 0$, F = 3.90
(degrees of freedom 4, 178), P = 0.004

the federal government's budget is worsening compared to when it is improving. The estimated χ^2 (2, 4, and 8) are indicative of nearly white noise residuals at the 5 percent significance level, which is essential if the empirical findings are to be reliable. The estimated incremental F-value suggests that at the 6 percent significance level, government revenue Granger causes spending after 3 and 4 quarterly lags. Consequently, the tax-spend (starving the beast) hypothesis has been confirmed based on positive and significant regression coefficients for the third and fourth quarterly lagged values of revenue.[7]

[7]The AECM has also been estimated with Δrev_t as the dependent variable. The corresponding incremental F-test implies that changes in expenditure do not Granger cause revenue—F = 0.93 (4, 178), P = 0.44.

TABLE 3
The Estimated M-TAR Error Correction Model without Interaction Dummies

Variable	Coefficient	t-Statistic	Probability
Intercept	0.0003	1.68	0.093
Δspe_{t-1}	−0.0550	−0.74	0.459
Δspe_{t-2}	0.2028	2.77	0.006
Δspe_{t-3}	0.1328	1.81	0.070
Δspe_{t-4}	0.1575	2.14	0.033
Δrev_{t-1}	−0.0422	−0.82	0.411
Δrev_{t-2}	−0.0206	−0.40	0.684
Δrev_{t-3}	0.1176	2.36	0.019
Δrev_{t-4}	0.1027	2.06	0.040
$\rho 1$	−0.0062	−0.24	0.804
$\rho 2$	0.0669	2.71	0.007

$R^2 = 0.14$
AIC = −9.385524
SBC = −9.196851
χ^2 (2, 4, and 8), P = 0.25, P = 0.08, and P = 0.18, respectively
Granger Causality Test:
d1 = d2 = d3 = d4 = 0, F = 2.31 (degrees of freedom 4, 178),
P = 0.06

Conclusion

The controversial causal relation between tax and spend variables has been addressed in this article. The findings suggest that in a co-integrated space and the M-TAR type asymmetric dynamic adjustments, higher tax revenue implies higher government spending. Indeed, as Milton Friedman stated more than three decades ago, starving the beast appears to be a plausible way of enjoying tax cuts similar to those implemented by Ronald Reagan and George W. Bush. However, contrary to Young's argument, the results do not lend credence to the fiscal illusion theory in that allowing appropriate lag structures (at least three quarters) changes in government revenue and expenditure tend to move in the same direction.

References

Baghestani, H., and McNown, R. (1994) "Do Revenues or Expenditures Respond to Budgetary Disequilibria?" *Southern Economic Journal* 60 (2): 311–22.

Chan, K. (1993) "Consistency and Limiting Distribution of the Least Squares Estimator of a Threshold Autoregressive Model." *Annals of Statistics* 21 (1): 520–33.

Chang, T.; Liu, W. R.; and Caudill, S. B. (2002) "Tax-and-Spend, Spend-and-Tax, or Fiscal Synchronization." *Applied Economics* 34 (12): 1553–61.

Enders, W., and Granger, C. W. J. (1998) "Unit Root Tests and Asymmetric Adjustment with an Example Using the Term Structure of Interest Rates." *Journal of Business and Economic Statistics* 16 (3): 304–11.

Enders, W., and Siklos, P. (2001) "Cointegration and Threshold Adjustment." *Journal of Business and Economic Statistics* 19 (2):166–76.

Ewing, B. T.; Payne, J. E.; Thompson, M. A.; and Al-Zoubi, O. M. (2006) "Government Expenditures and Revenues: Evidence from Asymmetric Modeling." *Southern Economic Journal* 73 (1): 190–200.

Friedman, M. J. (1978) "The Limitations of Tax Limitation." *Policy Review* (Summer): 7–14.

Garcia, S., and Henin, P. Y. (1999) "Balancing Budget through Tax Increases or Expenditure Cuts: Is It Neutral?" *Economic Modeling* 16 (4): 591–612.

New, M. (2009) "Starve the Beast: A Further Examination." *Cato Journal* 29 (3): 487–95.

Niskanen, W. A. (1978) "Deficits, Government Spending, and Inflation: What Is the Evidence?" *Journal of Monetary Economics* 4 (3): 591–602.

_____ (2002) "Comments." In J. A. Frankel and P. R. Orszag (eds.) *American Economic Policies in the 1990s.* Cambridge, Mass.: MIT Press.

_____ (2006) "Limiting Government: The Failure of 'Starve the Beast.'" *Cato Journal* 26 (3): 553–58.

Sichel, D. E. (1993) "Business Cycle Asymmetry: A Deeper Look." *Economic Inquiry* 31: 224–36.

Tong, H. (1983) "Threshold Models in Non-Linear Time Series Analysis," New York: Springer-Verlag.

Wagner, R. E. (1976) "Revenue Structure, Fiscal Illusion, and Budgetary Choice." *Public Choice* 25 (Spring): 30–61.

Young, A. T. (2009) "Tax-Spending or Fiscal Illusion," *Cato Journal* 29 (3): 469–85.