Farm-Level Evidence on the Sustainable Growth Paradigm from Grain and Livestock Farms

Cesar L. Escalante, Calum G. Turvey, and Peter J. Barry

Authors' Affiliations: Cesar L. Escalante is Assistant Professor at the Department of Agricultural and Applied Economics of the University of Georgia. Calum G. Turvey is W.I. Myers Professor of Agricultural Finance at the Department of Applied Economics and Management of Cornell University. Peter J. Barry is Professor Emeritus and Distinguished Chair of Agricultural Finance at the Department of Agricultural and Consumer Economics of the University of Illinois.

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Abstract

This study uses the sustainable growth rate model to investigate, measure, and analyze sustainable growth rates and trends for Illinois farmers. Results of farm-level econometric analyses indicate the relevance of the sustainable growth paradigm in explaining most farm financial decisions made each year. Grain farms have shown a greater tendency to balance growth through adjustments in production efficiencies while livestock farms rely more on financial leveraging strategies. In general, our results have shown that the farm sector has adapted to positive or negative sustainable growth challenges consistent with the Higgins' model and that, from an equilibrium point of view, countercyclical measures of the sustainable growth challenge indicate that there has been always a tendency towards balanced growth.

Key Words: agricultural finance, asset turnover, balanced growth, capital structure, panel corrected standard errors, random-effects model, sustainable growth challenge

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One of the enduring problems faced by the agricultural sector is its rate of growth. Yet beyond aggregate econometric analyses of supply, little attention has been paid to either optimal growth strategies or the sustainability of that growth at the individual farm level. Furthermore, the focal point of analyses at the firm level is quite different from that at the aggregate level. In this paper it is argued that changes in farm growth are as much a function of internal financial and operating decisions as it is of external markets and in fact the two must work in tandem; the market signals opportunities to the farm sector, and the farm sector evaluates its own operating and financing decisions to determine its response.

The importance of this paper is in how it relates to growth patterns in the aggregate supply of U.S. commodities. In previous analyses of farm supply decisions, the agricultural sector in the U.S. is typically assumed to be a price taker in which farmers' production decisions are expected to be heavily dependent on exogenously determined market conditions. However, empirical estimates obtained for various farm commodities do not always support perfect supply elasticity under various market conditions (Tauer, 1998; Weersink and Howard, 1990; Duffy Richardson, and Wohlgenant, 1987; LaFrance and Burt, 1983). Moreover, Ornelas and Shumway (1993) found significant bias effects attributed to asset fixity and technological change that reinforce the influence of resource endowments on farm supply decisions. That long run supply elasticities are not perfectly elastic strongly suggests that production decisions could not be entirely dependent on external market factors alone. The cause of inelasticity in supply must also reflect frictions within the farm sector that act as constraints upon farm production. These farm-level constraints may have as much to do with liquidity and balanced growth as they do with asset fixity.

This paper employs seemingly unrelated regression methods using a panel farm-level dataset to validate the relevance of the sustainable growth paradigm at the farm business setting. As a positivist approach to understanding financial leverage in agriculture, the use of sustainable growth in explaining debt is more than pragmatic. If sustainable growth rates fall relative to growth in sales, working capital shortfalls are inevitable. There are three benefits to using the sustainable growth model. First, from a business perspective, the model provides a useful yet simple approach to explaining financial leverage and working capital strategies to farmers; second, from a policy perspective, the inevitability principle provides some guidance as to how public policy can impact leverage decisions at the farm level; and third, from an academic perspective, this paper introduces as new, a tool that has been used by financial practitioners in the non-farm sector since the 1970's (e.g. Higgins, 1977).

The Sustainable Growth Paradigm

The sustainable growth rate equation is given by

$$(1)\quad g_s = \prod_{i=1}^{4} \gamma_i$$

where

$$\gamma_1 = \frac{Income}{Revenue}$$

$$\gamma_2 = \frac{Income - Withdrawls}{Income}$$

$$\gamma_3 = \frac{Revenue}{Assets}$$

$$\gamma_4 = \frac{Assets}{Equity_{beginning}} = \left[1 + \frac{Debt}{Equity_{beginning}}\right]$$

or

where $Equity_{beginning}$ is the beginning of period equity. The right hand side values of (1) represent the profit margin, retention ratio, asset turnover, and financial leverage, respectively. At the farm level, the revenue variable is a function of size, productivity, and prices. For purposes of this paper, the term “targeted sales growth” refers to intentional increases in the asset base (e.g. acres or head of livestock), prices (e.g. niche or contracted), or productivity (e.g. yield/acre).

Equation (1) is similar in structure to the well known DuPont formula but differs in the use of the variable $Equity_{beginning}$ rather than $Equity_{end}$. While subtle, this is not a trivial difference. For one, the DuPont formula is an identity and as such provides little economic information outside of explaining how the four levers of performance combined to determine the return on equity (ROE). The strategist can examine the levers and decide which one(s) can be adjusted and by how much to obtain (on expectation) a higher or lower ROE. In contrast, the Higgins model defines growth as the percentage change in equity from one period to another and what actions must be taken to accomplish this. Nonetheless the relationship between the DuPont model and the Higgins model is

(2) $$g_s = ROE\left[\frac{Equity_{end}}{Equity_{beginning}}\right],$$

which is obtained by the manipulation

(3) $$\gamma_4 = \frac{Assets}{Equity_{beginning}}\frac{Equity_{end}}{Equity_{end}} = \frac{Assets}{Equity_{end}}\frac{Equity_{end}}{Equity_{beginning}}.$$

To see that the Higgins model gives the percentage change, or growth, in equity, (1) can be compressed to

(4) $$g_s = \frac{Income - withdrawals}{Equity_{beginning}} = \frac{Equity_{end} - Equity_{beginning}}{Equity_{beginning}},$$

which uses the accounting identity

(5) $$Equity_{end} = Equity_{beginning} + Income - withdrawals \, .$$

Furthermore by examining (2) it can be seen that growth in equity is not necessarily the same as the return on equity except when ending and beginning equity are equal.

The sustainable growth relationships show how increases in sales via increased productivity or sophisticated marketing must be managed. Balanced growth occurs when the percentage change in sales from one period to the next is equal to the sustainable growth rate. If this happens, then no adjustments need to be made to the profit margin, owner withdrawals, asset turnover or leverage.

The difference between the growth in sales and the sustainable growth rate is referred to as the sustainable growth challenge (SGC) (Higgins, 2003), i.e.

$$SGC = \ln\left(\frac{\mathrm{Re}venue_t}{\mathrm{Re}venue_{t-1}}\right) - g_s$$

Ex ante, if targeted sales, or in this case revenues, increase faster than the sustainable growth rate, the SGC is positive and operating and financial adjustments need to be made in order to restore an accounting and operating balance such that SGC $\rightarrow$ 0. This is accomplished by increasing the sustainable growth rate g_s. For example, suppose a dairy farmer wanted to increase the number of milking cows, a beef farmer the number of calves in the feedlot, or a grain farmer the number of acres planted to a cash crop, any or all of the following must support the targeted increase in sales: an increase in profitability (decrease in costs), a decrease in owner withdrawals, an increase in asset turnover, or an increase in financial leverage. In contrast, if the SGC is negative such as might occur with scale inefficiencies in the utilization of existing resources, targeted sales growth will be lower than the sustainable growth rate. Consequently, unproductive cash surpluses will increase and to drive $SGC \rightarrow 0$, adjustments must be made to decrease the sustainable growth rate g_s: either sales must decrease (such as might occur when herd size or acres planted are reduced without changing the scale of the operation), owner withdrawals increase, asset turnover decreases, or financial leverage is reduced.

In terms of aggregate supply, the operating and financial decisions as discussed above illustrate how year-to-year changes in supply are far more complex, at least in the short run, than is suggested by a price-taking economy. In order to respond to market signals, farmers must weigh many internal operating and financial requirements before a response can be made. The inability of the farm sector to respond instantaneously is not a trivial factor in the inelasticity of supply.

Methods and Data Sources

We employ econometric techniques to determine the relevance of the sustainable growth paradigm in a farm business setting. In these analyses, we utilize a farm-level panel dataset consisting of 251 grain and livestock farms participating under the Illinois Farm Business Farm Management (FBFM) record-keeping program. The FBFM system has an annual membership of about 7,000 farmers. However, rigorous certification procedures implemented by FBFM field staff usually results in much fewer farms with certified financial and family living records. Moreover, an additional criterion restricts the panel dataset only to farms that received continuous record certification from the FBFM from 1995 to 2001.

In this analysis, we examine in more detail the levers of performance at the farm level using data from Illinois. Because of the interrelationships between the four levers of growth, we use a seemingly unrelated regression model to determine which of the four levers of performance are most commonly used to adjust for growth challenges. We are also able to determine if there are significant differences in adjustment between grain and livestock farmers.

Farm-Level Econometric Analysis

Table 1 presents a summary of the mean values of the financial performance and growth measures for 197 grain and 54 livestock farms that consistently received FBFM record certification during the period 1995-2001. The results indicate that, on average, livestock farms, relative to crop farms, have lower financial efficiency ratios, higher proportions of assets to equity, and higher earnings retention rates. Livestock farms registered a higher average revenue growth rate of 9.06% per year, but lower sustainable growth rate of -1.57%, than crop farms during the period. Figure 1 plots the revenue and sustainable growth rates along with the resulting SGC rates for all 251 grain and livestock Illinois farms in the sample. The trends in figure 2 indicate less fluctuation in average sustainable growth rates that mostly settle along the x-axis. The highly volatile conditions of commodity prices experienced by farmers in 1998 to 2001 resulted in wide swings in average revenues which consequently influenced the SGC values.

Developing the Econometric Model

One of the issues not explained by Higgins is the issue of signaling and causality. What is clear is that any discrepancy between sustainable and actual growth must be remedied. This is not simply an economic argument but an accounting argument as well. The economic question is whether the adjustment to the levers of performance occurs ex ante to put a strategy in place, or as a response ex post to the outcomes of strategies, or indeed a combination of the two. It seems reasonable, given uncertainties in production, costs and market prices that farmers make cropping and stocking decisions in advance based on reasonable expectations rooted in production economics. These decisions will also take into account owner withdrawals for family living expenses. Hence it is reasonable to assume, ex ante, that those expected values of financial efficiency and retention are determined. Decisions might also be made with respect to asset turnover, leaving the leverage ratio to pick up the slack. The amount of debt requested will be no less than that required to maintain balanced growth. Farm plans submitted to lenders to acquire sufficient loans or credit lines is evidence of the order in which the levers of performance are determined ex ante.

At harvest, with uncertainties resolved, the true parameters of growth are known and growth is rebalanced. For example, if financial efficiency is high (e.g. higher sales and/or lower costs) and sustainable growth exceeds actual growth then decisions could involve reducing debt, acquiring capital, or increasing withdrawals. This framework requires a continuous balancing of sustainable and actual (or expected growth) and suggests that the balancing is simultaneously determined. Ex ante decisions determine the sustainable growth rate based on expectations of actual growth, and ex post the sustainable growth rate is brought into balance based on observable outcomes of actual growth. Since sustainable growth rates determine production decisions and production decisions ultimately determine sustainable growth, it is necessary to measure the influences jointly using seemingly unrelated regressions.

The Seemingly Unrelated Regression (SUR) Model

The basic SUR system assumes that for each individual observation *i* there are M cross-sectional units, each with its own linear regression model (Greene):

(3) $$y_{ij} = X_{ij}\ \beta_j + \varepsilon_{ij}, \qquad i=1,\ \ldots,\ N,\ j=1,\ \ldots,\ M.$$

The distinct property of the SUR model is that it allows nonzero covariance between error terms ε_{ij} and ε_{ik} for a given individual *i* across equations *j* and *k*:

(4) $$Cov(\varepsilon_{ij}, \varepsilon_{ik}) = \sigma_{ij}$$

(5) $$Cov(\varepsilon_{ij}, \varepsilon_{i'k}) = 0 \qquad if\ i \neq i'.$$

In this study, we employ the *sureg* procedure available in Stata which uses the asymptotically efficient, feasible generalized least-squares algorithm developed in Greene (pages 340-362). The resulting GLS estimator, which was designed to address heteroscedastic and autocorrelated disturbances, is given by the following:

(6) $$\beta = [X'\Omega^{1}X]^{-1} X' \Omega^{1} y = [X' (\Sigma^{1} \otimes I) X]^{-1} X' (\Sigma^{1} \otimes I) y.$$

Our model includes the following five equations, one for each of the four levers of performance as the dependent variable and lagged dependent and SGC as independent variables, plus a fifth equation with SGC as the dependent variable with the year-to-year changes in the levers of performance as independent variables:

(7) $$FINRAT_t = \beta_{01} + \beta_{11} FINRAT_{t-1} + \beta_{21} SGC_t + \beta_{31} LVSTK + \varepsilon_1$$

$$ATO_t = \beta_{02} + \beta_{12} ATO_{t-1} + \beta_{22} SGC_t + \beta_{32} LVSTK + \varepsilon_2$$

$$LEV_t = \beta_{03} + \beta_{13} LEV_{t-1} + \beta_{23} SGC_t + \beta_{33} LVSTK + \varepsilon_3$$

$$ERR_t = \beta_{04} + \beta_{14} ERR_{t-1} + \beta_{24} SGC_t + \beta_{34} LVSTK + \varepsilon_4$$

$$SGC_t = \beta_{05} + \beta_{15} CHGFINRAT_{t-1\ to\ t} + \beta_{25} CHGATO_{t-1\ to\ t} + \beta_{35} CHGLEV_{t-1\ to\ t} + \beta_{45} CHGERR_{t-1\ to\ t} + \beta_{55} LVSTK + \varepsilon_5$$

where FINRAT is the financial efficiency ratio, SGC is the rate of sustainable growth challenge, LVSTK is the farm enterprise dummy variable (taking on a value of 1 for livestock farms and 0 for grain farms), ATO is the asset turnover ratio. LEV is the asset-beginning equity ratio, ERR is the earnings retention rate, and CHG prefixes denote rate of annual change in the values of the financial performance variables.

This system of equations is estimated for a general model based on all farm observations in the sample as well as two enterprise models, grain and livestock, that are estimated without the farm enterprise dummy variable. The SUR approach to this empirical issue is justified by the results of the Breusch and Pagan test of independence conducted on the different models. The tests indicate the presence of contemporaneous correlation between residuals of the equations in each system/model.

Econometric Results

The results of the SUR models reported in Table 2 provide interesting and intuitive implications. The lagged financial efficiency variable is positively related to observed financial efficiency but not on a one-to-one basis. The current year's financial efficiency is about 43% and 50% of the lagged value for grain and livestock farms, respectively. The rate of sustainable growth challenge is an additional significant positive indicator of variations of financial efficiency ratios for both types of farms.

On the other hand, the effects of lagged asset turnover rates on observed asset turnover rates are much higher at 83% and 72% for grain and livestock farms, respectively. This is expected given asset fixities and the comparative results among farm types suggest that livestock producers have greater flexibility in production throughout the year. Moreover, grain farmers appear to use the asset turnover ratio to balance growth given the significant positive coefficient of the sustainable growth challenge variable. This is consistent with the results obtained by Escalante and Barry confirming the grain farmers' use of asset productivity-enhancing strategies to attain higher business growth rates.

The evidence here also suggests that livestock farms do not use the asset productivity-related strategies for balancing growth. Rather, livestock farms rely more on leverage-related strategies.

In the leverage equations, the sustainable growth challenge variable is significantly positive for livestock farms, but insignificant for grain farms. Among livestock farms, there is little, albeit significant, relationship (at 14%) between debts in two consecutive periods, perhaps suggesting a flow from revolving lines of credit. These farmers, however, are more likely to balance growth using financial leverage than operating efficiencies. Grain farmers, on the other hand, rely more heavily on production efficiency-related strategies (affecting financial efficiency and asset turnover rates) to balance growth. This may be because grain farmers have greater opportunities to employ enterprise or production diversification plans than livestock farmers.

Earnings retention is a significant growth balancing strategy only among livestock farmers. Notably, the earnings retention equation for grain farms does not have any overall significant explanatory power. This suggests that grain farmers do not relate retentions or withdrawals in one period to the next. Decisions on earnings retention are not also consciously made to balance growth.

Among the estimating equations for the four levers of performance, only the leverage equation for livestock farms and the asset turnover equations for all farms and both farm types produced R^2 values that exceed 30%. The rest of the estimating equations produced marginal R^2 values ranging from 3.6% to 16.5%. Consistent with these results, the significant regressors in the 5th estimating equation for sustainable growth challenge are asset turnover and leverage ratios.

Conclusions

This paper has presented a different approach to examining certain aspects of agriculture finance using the concept of sustainable growth as presented by Higgins (1977, 2003). The sustainable growth model requires a balance between increased sales at the farm level and changes in corresponding accounting measures such as profit margin, owner withdrawals or business retention rates, asset turnover, and financial leverage. Results of econometric analyses using farm-level financial data indicate the relevance of the sustainable growth paradigm in explaining most financial and operating decisions made by farm businesses in each year. The farms' tendencies to attain balanced growth seem to be more influenced by asset productivity and leverage decisions, which are given different emphases by grain and livestock farms due to differing operational structures and constraints. Specifically, grain farms, which enjoy greater flexibility to implement diversification strategies, are more inclined to balance growth through adjustments in production efficiencies. Livestock farms, on the other hand, tend to use more financial leveraging to attain the same goal.

In general, it has been shown that the farm sector has adapted to positive or negative sustainable growth challenges in a manner consistent with the model. Most importantly, from an equilibrium point of view, countercyclical measures of the sustainable growth challenge indicate that there is always a tendency towards balanced growth. Our analyses show a general contribution to the sustainable growth paradigm.

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Table 1. Mean values of farm-level financial performance and growth measures, Illinois grain and livestock farms, 1997-2001

Measures	All farms	Grain farms	Livestock farms
Number of farms	251	197	54
Financial efficiency ratio	0.15	0.16	0.13
Asset turnover ratio	0.26	0.26	0.26
Leverage ratio	1.89	1.77	2.33
Earnings retention rate (%)	43.96	40.66	56.01
Annual revenue growth (%)	4.64	3.42	9.06
Sustainable growth rate (%)	-0.39	-0.07	-1.57
Sustainable growth challenge (%)	5.03	3.49	10.63

Table 2. Results of farm-level econometric analyses using seemingly unrelated regressions (SUR), 1995-2001 (standard errors in parentheses)

Variables	All farms	Grain farms	Livestock farms
A. Dependent Variable: Financial efficiency ratio			
Intercept	0.07580[a]	0.07529[a]	0.03927[a]
	(0.00715)	(0.00732)	(0.01528)
Lagged financial efficiency ratio	0.42875[a]	0.43284[a]	0.49667[a]
	(0.02607)	(0.02940)	(0.05190)
Sustainable growth challenge	0.12445[a]	0.11841[a]	0.12397[a]
	(0.01295)	(0.01590)	(0.02410)
Livestock dummy variable	-0.02656[a]		
	(0.01135)		
χ^2	290.44[2]	220.38[a]	94.66[a]
R^2	0.1414	0.1655	0.0627
B. Dependent Variable: Asset turnover ratio			
Intercept	0.03180[a]	0.02450[a]	0.06434[a]
	(0.00461)	(0.00456)	(0.01205)
Lagged asset turnover ratio	0.81551[a]	0.83363[a]	0.71876[a]
	(0.01314)	(0.01327)	(0.03989)
Sustainable growth challenge	0.08963[a]	0.15264[a]	-0.00547
	(0.00613)	(0.00758)	(0.01007)
Livestock dummy variable	-0.00356		
	(0.00593)		
χ^2	4,003.68[a]	4,184.23[a]	325.25[a]
R^2	0.6785	0.7418	0.3765
C. Dependent Variable: Leverage ratio (Assets/Beginning Equity)			
Intercept	1.33523[a]	1.36766[a]	1.42652[a]
	(0.09326)	(0.06659)	(0.24059)
Lagged leverage ratio	0.19434[a]	0.21328[a]	0.14367[a]
	(0.02150)	(0.02231)	(0.04286)
Sustainable growth challenge	2.10445[a]	0.16769	5.18184[a]
	(0.17006)	(0.15713)	(0.38333)
Livestock dummy variable	0.29475[c]		
	(0.16199)		
χ^2	240.23[a]	92.36[a]	189.78[a]
R^2	0.1520	0.0366	0.4001
D. Dependent Variable: Earnings retention rate			
Intercept	0.37690	0.39525	0.38088
	(0.44436)	(0.49483)	(0.32482)
Lagged earnings retention rate	-0.00212	-0.00125	-0.02435
	(0.03103)	(0.03504)	(0.06436)
Sustainable growth challenge	0.89890	0.35361	1.82391[a]
	(1.01032)	(1.49623)	(0.57214)
Livestock dummy variable	0.08889		
	(0.95616)		
χ^2	0.83	0.06	10.130[a]
R^2	0.0003	-0.0002	0.0505

E. Dependent Variable: Sustainable Growth Challenge			
Intercept	0.03888[a]	0.03778[a]	0.07360[a]
	(0.01049)	(0.00813)	(0.03017)
Change in financial efficiency ratio	0.00092	0.00087	-0.00128
	(0.00073)	(0.00055)	(0.00831)
Change in asset turnover ratio	0.46054[a]	0.53436[a]	0.17847[a]
	(0.01939)	(0.01787)	(0.05424)
Change in leverage ratio	0.01764[a]	0.05558[a]	0.01964[a]
	(0.00151)	(0.01141)	(0.00233)
Change in earnings retention rate	0.00003	-0.00002	0.00004
	(0.00003)	(0.00011)	(0.00005)
Livestock dummy variable	0.03108		
	(0.02274)		
χ^2	677.92[a]	902.50[a]	78.13[a]
R^2	0.2671	0.3824	0.2201

Note: [a,b,c] denote significance at the 1%, 5%, and 10% (*) confidence levels, respectively.

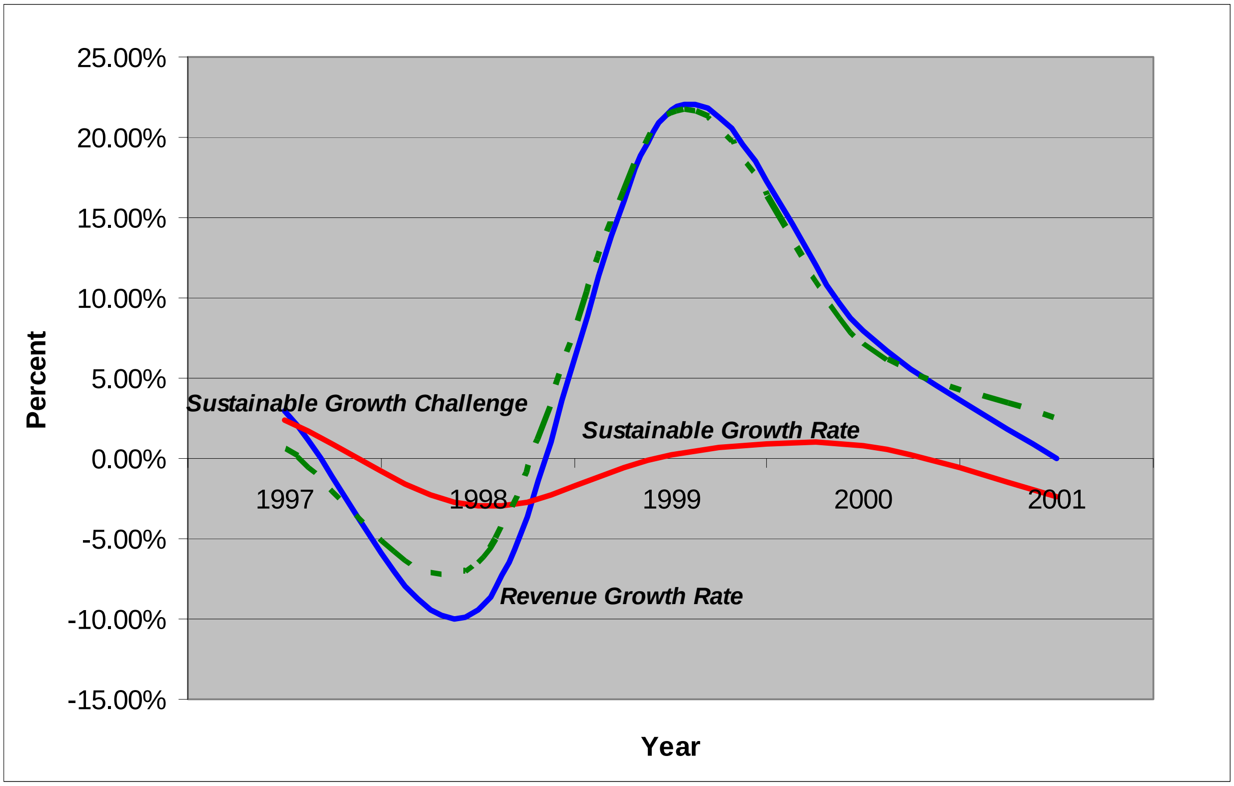

Figure 1. Rates of Revenue Growth, Sustainable Growth & Sustainable Growth Challenge, Illinois Grain and Livestock Farms, 1997-2001