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It has become popular in recent years to argue that macroeconomic variables are important, if not the primary, determinants of real farm income and prices. Chambers, for example, concludes that "a contractionary open market operation depresses the agricultural sector in the short run leading to lower relative prices, incomes and returns to factors specific to agriculture. Further, the short-run effects are not neutral since agricultural prices fall relative to nonagricultural prices" (p. 23). Starleaf argues that "the business cycle contractions of the postwar economy have been so mild that many economists are inclined to argue that short-run macroeconomic developments--including short-run macroeconomic policy actions--have had little impact upon the farm sector in the postwar period. However, this argument or impression is not borne out by empirical analysis" (p. 854). Tweeten also has presented evidence to support the notion that "the underachieving macroeconomy is the single most important characteristic of the economic environment facing agriculture in the 1980s". Other studies showing large effects running from macroeconomic policy variables to real magnitudes of agricultural variables include Chambers and Just, Schuh (1981, 1984) and Tweeten and Griffin.[1/]

Fellner, however, has noted that neither theory nor the record of business cycle history is very consistent with respect to how variations in agricultural output and nonfarm growth are related. Gardner also found that a survey of studies containing estimates of the effects of macroeconomic variables on agriculture reveals wide disparities in the size and significance of the effects. Thompson's review of Gardner's paper agreed that "much of the empirical evidence is not strong, and that the same data, appropriately massaged, can support contradictory hypotheses" (p. 888). Implicit in the comments of these and other authors is the point that macroeconomic studies of agriculture have been dominated by an ad hoc approach to model construction and estimation. The drawback, of course, is that models of this type do not offer a common ground on which the predictions of theory and the meaning of estimated coefficients can be evaluated in any systematic manner.

The objective of this note is to offer one theoretical avenue by which the effects of macroeconomic variables on real farm sector output can be estimated. We examine the business cycle of agriculture by comparing its performance to other sectors of the economy. Empirical tests are based on a variant of the capital asset pricing model (CAPM) as applied to output for 16 components of real GNP. Our results indicate that fluctuations in macroeconomic variables have not been the primary determinant of farm sector performance in recent years.

The Capital Asset Pricing Model as Applied to Output

Our interest is to isolate the differential effects of the business cycle on the output of individual sectors. One approach to this question applies the capital asset pricing model (CAPM) of Sharpe and Lintner in which the expected return to an asset (r_i) is a function of the return on a riskless asset (r), a risk premium which represents the market return (r_m) and the risk-free rate (r). Specifically, the CAPM can be expressed as:

(1) $E(r_i) = r + \beta_i [E(r_m - r)]$

where the beta coefficient, β_i, measures the response of returns on the i^{th} asset to the returns on a portfolio of all market assets. Under the assumption that future shocks to returns for individual assets are unforeseen ex ante, the CAPM implies that the returns to the i^{th} asset will be related one-to-one with the returns on the market portfolio.

This model has been tested by using realized returns and estimating the equation:

(2) $r_{it} = \alpha_o + \beta_1 r_{m,t} + \varepsilon_{i,t}$

where $r_{i,t}$ is the actual return on the ith asset in period t, $r_{m,t}$ is the return on the market portfolio in period t and $\varepsilon_{i,t}$ is the asset-specific residual return, which has an expected value of zero. The relevant test of the CAPM for some ith asset is $\hat{\beta}_i = 1$, which, if rejected, implies that the return on the ith asset does not vary one-for-one with the market return.

The CAPM can be applied to address the question of output growth in the agricultural sector relative to overall growth in real GNP.[2] We can begin by writing:

$$(3) \quad \dot{y}_{it} = \bar{y} + \beta_i \dot{y}_t + e_{it}$$

where $\dot{y}_{it}$ = growth of real output in sector i in year t; $\bar{y}$ = the natural rate of output; $\dot{y}_t$ = growth of real GNP; e_{it} = the residual output specific to sector i, which is a random variable $\sim (0, \sigma^2)$. Under the null hypothesis that all sectors follow the same business cycle, one would estimate a system of equations, each taking the form of (3). With one equation for each sector, the test of interest is whether $\hat{\beta}_i = 1$. In other words, is the growth of real output in sector i in year t the simple sum of the natural rate of output and a cyclical component represented by the contemporaneous growth rate of real GNP?

The test results also have important interpretations concerning the neutrality of macroeconomic policies.[3] Finding $\hat{\beta}_i = 1$ implies that policies affecting the aggregate business cycle have impacts of equal magnitude on the growth of real output in individual sectors. For our purposes, failure to reject $\hat{\beta}_i = 1$ across all sectors indicates that changes in macro policy variables are neutral with respect to real output. Conversely, finding $\hat{\beta}_i \neq 1$ suggests that policy actions do not influence the growth of individual sectors

equally. This result, if found, would be consistent with the non-neutral impacts of policy described by Tweeten, Chambers and Just, and Chambers and others. Finally, finding $\beta_i = 0$ implies that the growth of output in sector i is unrelated to the cyclical component of aggregate output growth; that is, the covariance between aggregate and sectoral real output growth is zero. In this case it is possible to conclude that macro policies and sectoral output are independent.

Testing the Business Cycle Behavior of Agriculture

Equation (3) provides the basis for testing whether agriculture has exhibited unique business cycle behavior in recent years. A system of equations following this specification is applied to real output data for 16 sectors of the economy. The data are annual and cover the 1950-1983 period. Real output for each sector is defined as nominal sector income deflated by that sector's price deflator. Farm sector income does not include government program payments or CCC loans so that receipts from actual production represent the bulk of this measure; farm transfer payments also are deleted from aggregate real income.[4/] The system of equations based on (3) is estimated by Zellner's seemingly unrelated regressions technique. A list of sectors included in the study and descriptive statistics for sectoral output growth are shown in table 1.

The results for the system of equations based on (3) are presented in Table 2. The null hypothesis is that $\hat{\beta}_i$ is equal to one in each of the 16 equations. Failure to reject this hypothesis would imply that the ith sector follows the same business cycle as the aggregate economy through time. Since our main interest is the behavior of the agricultural sector, failure to reject the hypothesis that $\hat{\beta}_i = 1$ for the two agricultural sector equations of the system would at least imply agricultural output does not follow a pattern significantly different from the general trend of GNP.

The results presented in Table 2 indicate that the null hypothesis $\hat{\beta} = 1$ can be rejected for all sectors except Agricultural Services and Forestries and Fisheries, Mining, Construction, and Finance and Insurance. In all other cases, the results indicate that the real output growth of individual sectors does not move one-for-one with the growth of the economy as a whole.

Our specific interest, however, is in the performance of the agricultural sectors relative to the cyclical path of aggregate output. For farm sector output, it is possible to reject the hypothesis that $\hat{\beta} = 1$ ($t = 2.44$) and conclude that real farm output follows a growth path significantly different from the aggregate business cycle. More important, it is not possible to reject the hypothesis that $\hat{\beta} = 0$, which implies a stronger conclusion: farm output not only follows a different

cycle but is unrelated statistically to the cyclical path of real GNP. This latter result indicates that changes in macroeconomic policy variables which alter the cyclical course of real GNP will not affect the path of real farm sector output. This conclusion is reinforced by the equation's low $\bar{R}^2$.

With respect to output in the "Agricultural Services, etc.," category of GNP, it has already been noted that $\hat{\beta} = 1$ is not rejected by the results in Table 2. Interpretation of this result is complicated, however, because the coefficient's large estimated standard error does not permit rejection of the alternative hypothesis, $\hat{\beta} = 0$. In other words, imprecision in the estimation of $\hat{\beta}$ for this sector precludes making any inference on the relationship between the cyclical performance of this sector and GNP. As with the farm sector case, however, this equation's small $\bar{R}^2$ reinforces the notion of little relationship between sectoral output and the business cycle over the past three decades.

Conclusions

Using a variant of the capital asset pricing model and real output data for the 16 major components of GNP, we find that real farm sector output is unrelated to the cyclical component of output in nonfarm sectors of the economy. Our results indicate that arguments attributing the poor performance of agriculture in recent years to exogenous macroeconomic fluctuations are not supported by the data.

FOOTNOTES

1/ Note that these views differ sharply from earlier findings on the relationship between agricultural output and nonfarm aggregate activity. Clark, for example, argued that "the timing of agricultural activity is markedly different from that of industry and trade; ... Agriculture appears to have its own cycles, whose timing has no clear or regular relation to the cycles of general business" (p. 61). The original business cycle research of Burns and Mitchell also indicated that cycles in agriculture often were substantially different from those followed by the rest of the U.S. economy. Other references on the business cycle of agriculture that pre-date the demand shocks and inflation of the 1970s include Doll, Francis, and Gramm and Nash.

2/ A recent example of how the CAPM can be applied to evaluate the neutrality of macro policy shocks is provided by Bonomo and Tanner.

3/ See Barro for a discussion of the effect of monetary policy shocks on output in a rational expectations framework.

4/ Estimating the same equations with program payments and CCC loans added to farm income and national income yields results qualitatively identical to those reported.

Table 1
DESCRIPTIVE STATISTICS FOR SECTORAL REAL OUTPUT GROWTH

Sector	Mean	Standard Deviation	Minimum	Maximum
Agricultural Services and Forestries and Fisheries	2.613	5.554	-14.953	15.562
Farm	0.360	8.433	-15.597	24.472
Mining	0.675	5.915	-12.171	9.704
Construction	1.471	5.853	-11.806	11.611
Durables Manufacturing	3.024	8.620	-14.653	14.953
Nondurables Manufacturing	3.151	4.310	-7.790	11.276
Transportation	1.584	5.771	-9.233	9.090
Communications	7.053	3.173	0.194	14.636
Electric and Gas and Sanitary Services	4.729	4.614	-7.923	15.482
Wholesale Trade	4.170	2.911	-2.391	10.632
Retail Trade	2.483	3.123	-4.652	8.004
Finance and Insurance	3.563	3.860	-5.926	11.243
Real Estate	4.704	1.985	0.950	9.124
Government	2.860	4.035	-0.990	21.922
Government Enterprises	2.608	5.762	-8.995	11.181
Services	3.897	1.979	-0.168	8.745
Aggregate Output	3.072	3.049	-3.274	8.451

Table 2
SECTORAL RESPONSES TO THE BUSINESS CYCLE[1/]

Sector	Intercept	β_i	$\bar{R}^2$	D-W
Agricultural Services and Forestries and Fisheries	0.856 (1.36)	0.572 (0.32)	0.07	2.30
Farm	1.039 (2.16)	-0.221 (0.50)	-0.03	2.46
Mining	-2.715 (1.25)	1.104 (0.29)	0.30	1.98
Construction	-2.617 (1.08)	1.331 (0.25)	0.46	1.40
Durables Manufacturing	-5.401 (0.54)	2.743 (0.13)	0.94	2.03
Nondurables Manufacturing	-0.793 (0.46)	1.284 (0.11)	0.82	1.58
Transportation	-3.618 (0.66)	1.694 (0.15)	0.79	1.65
Communications	5.153 (0.66)	0.619 (0.15)	0.33	1.45
Electric and Gas and Sanitary Services	3.481 (1.14)	0.406 (0.27)	0.04	2.16
Wholesale Trade	1.767 (0.43)	0.782 (0.10)	0.66	2.01
Retail Trade	0.219 (0.56)	0.737 (0.13)	0.50	1.72
Finance and Insurance	1.440 (0.83)	0.691 (0.19)	0.28	2.09
Real Estate	4.665 (0.51)	0.013 (0.12)	-0.03	1.62
Government	1.251 (0.95)	0.524 (0.22)	0.13	0.84
Government Enterprises	3.316 (1.47)	-0.231 (0.34)	-0.02	2.33
Services	2.577 (0.38)	0.430 (0.09)	0.42	1.40

1/ Standard errors in parentheses

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