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Macroeconomic Conditions and Agribusiness Profitability: An Analysis Using Pooled Data

ABSTRACT: Theoretical and empirical insights into the linkages between firm profitability and macroeconomic conditions are developed for nineteen agribusinesses. The hypothesis investigated in this analysis is that firm financial performance is a function of firm specific factors and macroeconomic conditions common to all firms. Seemingly unrelated regression with an unequal number of observations is used to estimate macroeconomic linkages. Empirical results indicate that macroeconomic conditions have differing affects on firm profitability dependent on a firm's financial structure and the market segment in which it operates. Capital intensive industries and highly leveraged firms have higher business risk and are more susceptible to macroeconomic conditions.

INTRODUCTION

A number of empirical and theoretical models have been developed to analyze the affects of macroeconomic conditions on the agricultural sector. The ways in which macroeconomic conditions affect agribusiness profitability are numerous and complex. Monetary policy affects all sectors of the economy through the cost and availability of money and credit. Fiscal policies affect a firm's after-tax net cash flow, its cost of capital, and potentially the demand for its products. It has become obvious that analysis of agribusiness dynamics must take into account the affects of macroeconomic conditions. The magnitude of the 1980's agricultural financial

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crises, which has been linked to prevailing macroeconomic conditions (Andrews and Rausser, 1986; Rausser, Chalfant, Love, and Stramoulis, 1986), underscores the importance of examining linkages between macroeconomic conditions and firm financial performance.

Linkages between profitability and macroeconomic conditions depends upon which factors in the macro-economy are most strongly linked to the business and how these linkages function. Determining how macroeconomic linkages differentially affect firm profitability, would allow agribusinesses and policy makers to develop more efficient management strategies and policy recommendations. The objective of this paper is to investigate linkages between macroeconomic conditions and the financial performance of a select group of agribusinesses.

Firm financial performance can be analyzed in several ways to account for financial structure and returns to assets. Variation in firm returns can be broken down into business risk and systematic risk. Business risk is the variability in earnings before interest and taxes, and is influenced by microeconomic management decisions. Systematic risk stems from macroeconomic factors such as interest rates and fiscal policies influencing returns to all capital assets in the market.

MACROECONOMIC AND AGRICULTURAL SECTOR LINKAGES

The need to investigate macroeconomic linkages has long been identified as an important research field. As early as 1959, Hathaway, identified that major movements in agriculture are closely related to business cycles. Since the 1970's, the move to flexible exchange rates, the rapid expansion of international markets, changes in monetary policy from targeting the interest rate to targeting the money supply, energy price shocks and changes in fiscal policies resulted in structural changes in the agricultural sector. Extensive literature exits analyzing agricultural sector level response to macroeconomic conditions under two predominant methodologies.

The first approach employs vector autoregression (VAR) to test Granger (1969) causality between macroeconomic policy variables and the agricultural sector. Granger causality testing was applied by Sims (1972) to analyze monetary policy affects on national income. Several studies followed examining the relationship between money supply and agricultural prices (Bordo, 1980; Chambers and Just, 1982; Barnett, Bessler, and Thompson, 1983; Orden, 1986; Saunders and Basiley, 1986; Saunders, 1991; Han, Jansen, and Penson, 1990). White (1992) examined the relationship between farm subsidy programs and farm income and factor returns. Each of these VAR models, consistently identify the direction of causality from macroeconomic conditions initiating an economic response in the agricultural sector. Since the sector response is the aggregate response across firms, these studies identify that it is appropriate to focus on macroeconomic conditions as a causal agent to directional impacts on agribusiness profitability. This paper builds on this conclusion by examining firm financial performance in response to dynamic macroeconomic conditions.

The second agricultural-macroeconomic modeling approach develops structural multi-sector macroeconomic models that capture inter-sector supply, demand and capacity constraint linkages. These models typically take the form of a general equilibrium (GE) model (Rausser et al., 1986; Penson and Hughes, 1979; Penson and Taylor, 1990; Hertel, 1991; Kraybill, Johnson, and Orden, 1992; Forster, 1996). These large scale multi-sector models differ in terms of macroeconomic theories of adjustment to equilibrium within the model and identify major linkages between the agricultural sector and the rest of the economy.

Each of the identified VAR and GE models address issues at the sector level. In contrast, analysis of firm response to macroeconomic conditions appears to have attracted little attention in the literature. A recent exception is Forster (1996) who analyzed the effects of capital structure and business risk on investors' rates of return for a number of agribusinesses.

MODEL SPECIFICATION

Macroeconomic factors such as interest rates, tax policies, and growth in the gross domestic product varies over time. Interest rates and tax policies affect both operating costs and the demand for capital items. Fluctuations in national income and employment affects the demand for the firm's product, unless it is income inelastic. This rationale is the basis for a theoretical analysis linking macroeconomic conditions to firm financial performance.

Firm profitability, Y_{it}, can be viewed in the context of a profit maximizing firm subject to a set of firm specific resource constraints, X_{it}, and a set of exogenously determined macroeconomic conditions common to all firms, Z_t, as follows:

$$MAX\ Y_{it}(X_{it}, Z_t) \tag{1}$$

Subject to:

$$X_{it} \leq X_{it}^*$$

$$Z_t = Z_t^*$$

$$i = 1, \ldots, N \qquad t = 1, \ldots, T$$

The subscripts i represents an individual firm, and t represent the time period. A period of time may pass between the economic decision making period that determines Y_{it} and the final impact of a change in macroeconomic conditions, Z_t. Essentially this means that the underlying firm profitability relationships are derived from some sort of inter-temporal optimization. Assuming that a firm's management goal is to maximize profitability subject to its available resources, and prevailing macroeconomic conditions; a firm will develop management strategies which results in a desired profitability level, Y^*_{it} as follows:

$$Y^*_{it} = \alpha_i + X_{it}\,\beta_t + Z_t\,\Phi_i + w_{it} \quad (2)$$

Where, α_i represents an intercept term, β_i represents profitability response coefficients for firm resources reflecting business risk, Φ_i represents macroeconomic conditions reflecting systematic risk, and u_{it} represents a random disturbance term. Y^*_{it} is not directly observable, but it can be assumed that a firm's management attempts to bring the actual level of Y_{it} to its desired level, Y^*_{it}. The profitability of a firm depends on a variety of anticipated and unanticipated events. Anticipated events in Z_t, can be incorporated by managers into their desired profit expectations while unanticipated events and stickiness in a firm's adjustment process prevents a firm from reaching Y^*_{it}. The relationship between the actual and the desired level of Y_{it} may be specified as:

$$Y_{it} - Y_{it-1} = \gamma_i(Y^*_{it} - Y_{it-1}) \qquad where\ 0 \leq \gamma_i < 1 \quad (3)$$

The coefficient of adjustment, γ_i, identifies the rate of adjustment of actual Y_{it} to desired Y^*_{it}, and reflects management's ability to achieve its desired profitability level. The requirement $0 \leq \gamma_i < 1$ is a stability condition necessary to establish stationary of an auto-regressive process. Directly substituting Y^*_{it} into Equation 2 and solvingl for Y_{it} specifies the following dynamic firm profitability response to macroeconomic conditions model. This model specification has been used to study dynamic behavioral relationships using pooled data (Nerlove, 1972).

$$Y_{it} = \alpha_i\gamma_i + (1 - \gamma_i)Y_{it-1} + X_{it}\beta_i\gamma_i + Z_t\Phi_i\gamma_i + u_{it}\gamma_i \quad (4)$$

Policy makers affect macroeconomic conditions, Z_t, through fiscal and monetary policies. The implicit cost of capital, ICC_t, can be used as a measure of fiscal tax policy (Hall and Jorgenson, 1967). The implicit cost of capital incorporates income tax rates, depreciation rates, investment tax credits, expense options and capital gains. It provides a valuable connection between the affects of tax policy and firm behavior. Monetary policies are designed to affect interest rates. The annual average prime interest rate is combined with a firm's leverage position to create firm specific leverage indexes, LVI_{it}, (LVI_{it}= average prime interest rate * debt/asset ratio of firm *i* for each year *t*). This variable combines a firm's susceptibility to monetary policy with its ability to manage financial risk and attract equity capital as needed. The percent growth in real gross domestic product, $GGDP_t$, measures general economic conditions. Firm profitability, Y_{it}, is measured using the income per asset ratio, IPA_{it}. This profitability ratio provides a basis to compare firms with differing total assets and capital structures (Nikolai and Bazley, 1988). The model incorporating the specific firm and macroeconomic variables is presented in equation five.

$$IPA_{it} + \alpha_{1i} + \alpha_{2i}IPA_{it-1} + \alpha_{3i}LVI_{it} + \alpha_{4i}GGDP_t + \alpha_{5i}ICC_t + u_{it} \quad (5)$$
$$i = 1, \dots, N \qquad t = 1, \dots, T$$

Data on variables to model business risk factors internal to the firm such as management decisions concerning production efficiency, product mix, product development, marketing, advertising, and human resource management are not available in the annual summary of financial data used in this study. The lagged endogenous variable, IPA_{it-1}, is a proxy of management's ability to respond to business risk factors, because the cumulative effects of management are embodied in IPA_t. Although response coefficients to individual components of business risk can not be quantified, $(1 - \alpha_{2i})$ is the coefficient of adjustment which measures management's ability to attain desired profitability levels. Large adjustment coefficients identify firms with the ability to rapidly adjust to dynamic macroeconomic conditions and business risk factors.

DATA AND METHODOLOGY

Nineteen agribusinesses were selected for the study based on a sampling frame using Moody's Industrial Manual, Annual Classification of Companies by Indus-

Table 1. Agribusiness Included in the Study

Food Manufactures	*Machinery-Equipment Manufacturers*
Archer Daniel Midland Co.	Allis Chalmers Manufacturing Corp. (1984)[6]
Beatrice Foods Co. (1984) [2]	Deere & Co. - John Deere
Borden Co.	Hesston Corp. (1987)[7]
Campbell Soups Co.	International Harvester Co. (1985)[8]
Con Agra Inc.	
General Mills Inc.	
Gerber Products Co. (1994)[3]	
Hershey Foods Corp.	
Heinz Co.	
Kellogg Co.	
Nabisco Inc.	
Philip Morris Co.	
Pillsbury Co. (1988)[4]	
Quaker Oats Co.	
Stokely-VanCamp Inc. (1983)[5]	

Notes: 1. A date behind the firm name indicates the last year it was operated as an independent business.
2. Acquired by BCI Holdings Company in 1985 and later by Con Agra in 1990.
3. Acquired by Sandoltz Company in 1994.
4. Acquired by Grand Metropolitan PLC in 1989.
5. Acquired by Quaker Oats Co. in 1984.
6. Agriculture segments acquired by Klockner-Humboldt-Deutz Ag. of West Germany in 1985.
7. Acquired by Fiat SPA in 1987.
8. Liquidated in 1986 with truck segment renamed Navistar International Corp.

tries and Products (Moody Investment Services, Inc., various years). This sampling frame identifies agribusinesses with publicly traded stock and classifies the companies by industries and products. Companies with publicly traded stock file financial reports with the Securities and Exchange Commission (SEC) based on generally accepted accounting principles. Therefore, the financial data are directly comparable across companies. Two industry classifications were used in this study, machinery-equipment and food manufacturers. To be included in the study, a firm had to exist at the start of the study, which was 1960, and have agribusiness as its primary focus. Nineteen firms meeting these criteria under the two industry classifications were included in the study, four machinery-equipment and fifteen food manufacturers. Annual financial data was collected for the firms listed in Table 1 from 1960 to 1995 or until the last year they were in business.

Six of the nineteen, or 32%, of the firms listed in Table 1, went out of business in response to economic conditions in the 1980's, thereby creating an unequal number of time series observations across firms. Traditional pooled data methodology requires the data set to have equal number of observations in each cross-section. Therefore, pooled data analysis would require either the data set to be truncated as of the earliest date that a firm went out of business, or firms that went out of business would have to be dropped from the study in order to analyze current observations. An extension of traditional pooled data was applied to account for both firm financial failure and current observations, through application of seemingly unrelated regression (SUR) with unequal number of observations (Schmidt, 1977). Appendix one details the assumptions and methodology used to obtain parameter estimates.

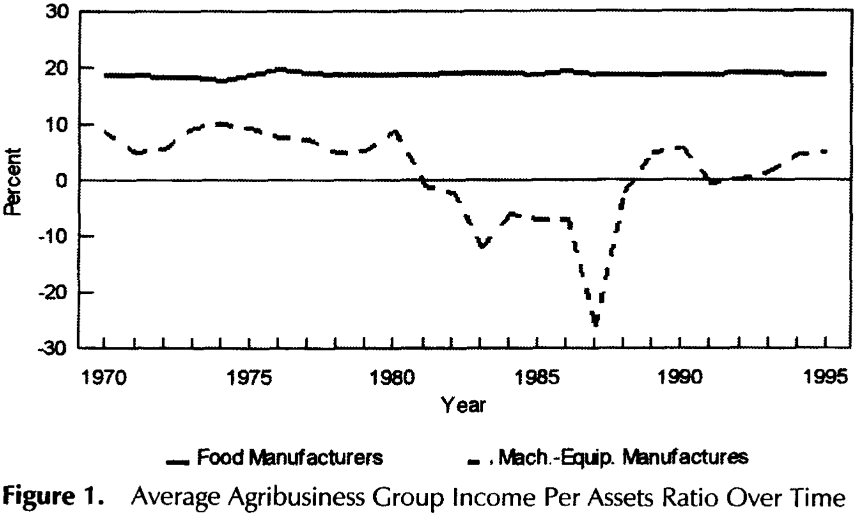

Figure 1. Average Agribusiness Group Income Per Assets Ratio Over Time

Table 2. Agribusiness Group Average Financial Statistics

Agribusiness Group	Net Income Before Taxes	Total Assets	Income per Assets Ratio	Debt/ Asset Ratio	Curren t Ratio
	Millions $		Percent		Ratio
Food	136.371	774.187	18.34	38.97	2.54
Manufacturers	82.567	522.458	3.63	5.22	0.74
Mach.- Equip.	45.358	2,544.364	1.61	60.22	1.76
Manufacturers	257.236	2,761.514	11.07	16.07	0.49

Notes: The top number is the average value over time and across firms.
The bottom number is the standard deviation.

ANALYSIS AND RESULTS

Summary financial statistics averaged across agribusiness groups over time is presented in Table 2. Major differences exist between food and machinery-equipment manufacturers. Food manufacturers on average have less total assets at $0.8 billion, versus the machinery-equipment manufacturers average asset holdings of $2.5 billion. Food manufacturer profitability is much higher and more stable with average net income before taxes and extraordinary items of $136.4 million and an income per assets ratio of 18.34% a standard deviation of only 3.63%. Food manufacturers have strong solvency and liquidity positions as measured by an average debt/asset ratio of 38.97% and a current ratio of 2.54. The machinery-equipment manufacturers have an average net income before taxes and extraordinary items of $45.4 million and an income per asset ratio of only 1.61 percent with a large standard deviation of 11.07%. They also have higher leverage and lower liquidity with an average debt to asset ratio of 60.22% and a current ratio of 1.76.

Additional detail on the differences between these two agribusiness groups can be analyzed by examining the profitability of each agribusiness groups over time. Figure 1 illustrates the high and low variation in profitability of the machinery-equipment manufactures in comparison to the food manufacturers over time. These agribusiness groups are clearly divided in their response to macroeconomic conditions. Recessions occurring in 1970 and 1982 had little affect on the food manufacturers, but had depressing affects on machinery-equipment manufacturers profitability. From 1980 to 1988, the machinery-equipment manufactures on average operated at a loss which resulted in the financial failure of three of the four machinery-equipment manufacturing firms included in the study: Allis Chalmers, International Harvester, and the Hesston Corporation. While no single factor can be identified as the causal factor of these firm failures, the combination of high leverage, high interest rates, unfavorable changes in fiscal policies, and depressed farm profitability contributed to their financial failure.

Differences in market characteristics contributes to the profitability differences between the two agribusiness groups. Food manufacturers have an inelastic demand for their low cost, short life products. Food manufacturers have a relatively stable market and compet for market share based on product development and advertising. Knowing their profitability is relatively stable, food manufacturers can make better decisions regarding equity structure and competitive strategies. The low variation and high profitability levels plays a key role in risk management plans for food manufacturers. Typically, gains in business planning and risk efficiency occur by following the principles of diversification (Barry, Baker and Sanint, 1961). However, the financial strategy of many food manufacturers is not none of diversification, but rather one of consolidation through the acquisition of competitive food manufacturing firms. Con Agra Inc. typifies the firm acquisition strategy of asset growth by acquiring competitive food manufacturing firms such as: Banquet Foods Corp., Sea Alaska Products, Imperial Foods, Amour Food Co., Monfort Inc., and Beatrice Foods to name a few.

In comparison, machinery-equipment manufacturers have an elastic market demand for high cost products with a long life that can be extended by increased repair expense. The large capital investment with high asset fixity required for machinery and equipment production further limits mangement's ability to respond to dynamic macroeconomic conditions.

Empirical Results

By simultaneously estimating the linkages between firm profitability and macroeconomic conditions across the selected firms, the model specification given by equation five takes advantage of the availability of data on macroeconomic conditions, firm specific factors and any cross-firm correlation in profitability response to macroeconomic conditions. Table 3 presents the results of the analysis of covariance model to determine the appropriate pooled data solution methodology (Hsiao, 1986). The results strongly reject the null hypothesis of homogeneous slope and intercept parameters, indicating that SUR is an appropriate solution methodology.

Table 3. Analysis of Covariance Model Results

Null Hypothesis	*Test Statistic*	*Mach.- Equip. Manufacturers*	*Food Manufactures*
H_0: $\alpha_1 = \alpha_2 = \ldots = \alpha_n$	F Test	3^{**}	2^{*}
$\beta_{1i} = \beta_{2i} = \ldots = \beta_{kn}$	Wald χ^2	51^{**}	43^{**}
H_0: $\beta_{1i} = \beta_{2i} = \ldots = \beta_{kn}$	F Test	3^{**}	1^{*}
	Wald χ^2	35^{**}	29^{**}
H_0: $\alpha_1 = \alpha_2 = \ldots = \alpha_n$	F Test	4^{**}	1^{*}
	Wald χ^2	13^{**}	5^{*}

Notes: k = the number of independent variables and n = the number of firms
*Significant at the 5 percent level
**Significant at the 1 percent level

Table 4. Machinery-Equipment Manufacturers Estimation Results

	SUR With Unequal Number of Observation Regression Results[1]					
Agribusiness	*Constant*	IPA_{t-1}	*LVI*	*GGDP*	*ICC*	
Allis Chalmers	0.17	0.80	-1.24	0.02	-0.10	R^2=0.85
	3.54	5.02	-2.57	0.07	-2.35	D-H = 0.15
International	0.20	0.60	-1.26	0.69	-0.12	R^2=0.87
Harvester	3.80	0.35	-3.38	2.16	-2.82	D-H = 0.13
Hesston	0.15	0.39	-0.60	0.43	-0.06	R^2=0.85
	5.18	6.21	-1.77	1.70	-3.04	D-H = 0.85
John Deere Co.	0.09	0.61	-0.21	0.50	-0.05	R^2=0.83
	3.99	6.83	-1.18	4.64	-4.44	D-H = 1.02

Note: 1. The top number is the estimated parameter, the bottom number is the t value.

Machinery—Equipment Manufacturers Modeling Results

Empirical results strongly identify linkages between macroeconomic conditions and the profitability of machinery-equipment manufactures, see Table 4. Despite large variation in the data, and three of the four firms going out of business, the estimation results are robust indicating significant linkages between machinery-equipment manufacturer profitability and macroeconomic conditions. The adjusted R^2 indicates that the amount of the amount of variation explained by the model ranges from 83 to 89%. The signs on all of the estimated coefficients are consistent with a priori hypothesis and almost all of the estimated parameters are statistically significant at a five percent level of confidence or greater. Evaluation of the Durbin-H statistic indicates that serial correlation is not a problem. The implicit cost of capital, ICC, has a significant negative impact on all firms indicating that fiscal tax policies directly affect the profitability of these firms. All estimates of IPA_{it-1} met the stability requirement of being between zero and one. Firms with a high leverage position, namely Allis Chalmers and International Harvester, were significantly impacted by the leverage index. Although John Deere's LVI is insignificant, it had a relatively low debt to asset ratio in comparison to the other machinery-equipment manufacturing firms.

Food Manufacturer Modeling Results

In comparison to the machinery manufacturers, results for food manufacturers indicate that the linkages between a food manufacturer's profitability and macroeconomic conditions are statistically weak. Empirical results for the food manufacturers are consistently poor across firms. Estimated coefficients are mostly insignificant, and the adjusted R^2 values are consistently low. The results are provided in Appendix 2. Alternative model specifications and alternative macroeconomic variables were tested without finding a statistically valid model. Although statistical results for the food manufacturers are insignificant, they are valuable in analyzing differences in agribusiness group profitability response to macroeconomic conditions. The difference in the robust estimates for the machinery-equipment manufacturers versus the insignificant results of the food manufacturers identifies differences in macroeconomic linkages between the agribusiness groups.

DISCUSSION AND CONCLUSIONS

Macroeconomic analysis targeting the sector level can mask the true impacts of changes in macroeconomic policies on firm level profitability. Empirical results indicate that macroeconomic linkages are critical for machinery-equipment manufacturers, and statistically insignificant for food manufacturers. The differential impacts between agribusiness groups stem from differences in product demand elasticity in the market segments in which they operate, differences in financial structure, and differences in response to macroeconomic conditions.

The coefficient of adjustment measuring management's ability to affect IPA_i ranges from 0.20 for Allis Chalmers, 0.40 for John Deere and International Harvester, and 0.61 for the Hesston Corporation. Hesston's total assets are lower than one-tenth the total assets of the other machinery-equipment firms. The smaller size may account for its faster response to changes in macroeconomic conditions. The large capital investment, high asset fixity required and difficulty in changing product mix for machinery and equipment production limits management's ability to respond to changes in macroeconomic conditions.

Fiscal tax policies, as modeled through ICC, had a significant affect on the machinery-equipment manufacturers. The ICC captures the combined effects of changes in fiscal policies concerning marginal tax rates, depreciation, and tax deductions or credits associated with fixed capital investments. The elasticity of ICC, calculated at the mean, ranged from 5 for John Deere to 12 for International Harvester indicating a highly elastic response. The Tax Reform Act of 1986 altered depreciation schedules, decreased marginal tax rates, and eliminated the investment tax credit had the greatest impact on ICC. Machinery-equipment manufacturing profitability is directly impacted by ICC in both its costs of production and the demand for its products. Fiscal tax policies were found to have an insignificant affect on food manufacturers' profitability before taxes. Additional research is needed to examine fiscal spending policies which may be linked to food manufacturers through welfare and food assistance programs.

All machinery-equipment and most food manufacturers profitability were negatively impacted by LVI. The LVI models a linkage between firm leverage and the prime interest rate. The importance of this variable increased relative to a firm's leverage position. In general, firms with debt to asset ratios in excess of sixty percent were significantly impacted by LVI. The elasticity of LVI across these firms ranged from -1.26 to -0.60. Firm profitability was shown to be sensitive to the firm's debt to asset ratio as incorporated into the leverage index. A potential expansion of this research would be to use the developed firm financial and macroeconomic data in combination with stock price data to examine optimal capital structure.

Models using pooled data are becoming increasingly important as economists seek to identify behavioral response to economic stimuli. The successful empirical application of SUR with unequal observations illustrates the value of this pooled data analysis technique. SUR with unequal observations relaxes the restrictive requirement of equal observations per cross section. This allowed the model to integrate all of the available information on firms going out of business plus data on current macroeconomic conditions.

This study presented analysis regarding agribusiness profitability in response to macroeconomic conditions. The empirical results sheds light on the relative importance of fiscal and monetary policies influencing firm profitability, and the differential impacts between machinery-equipment and food manufacturing agribusiness groups. Macroeconomic conditions were critical for machinery-equipment manufacturers and were statistically insignificant to food manufacturers. These results illustrate the differential impact of macroeconomic policies within the agricultural sector, and the potential of sector level models to underestimate the impact of proposed macroeconomic policies across individual firms. Differences in the response coefficients identify differences in management's ability to attain desired profitability levels. Additional work remains to further explore linkages between macroeconomic conditions and firm profitability, to expand the specified model to include management decisions affecting business risk, and to apply that knowledge to agricultural policy development. Managers could increase expected returns and minimize risk by incorporating macroeconomic conditions into strategic management plans.

APPENDIX ONE

Derivation of SUR with Unequal Number of Observation Parameter Estimates

To illustrate the SUR with unequal observations methodology consider the machinery-equipment manufacturers which require a set of four seemingly unrelated regressions:

$$Y_1 = X_1\beta_1 + u_1,\ Y_2 = X_2\beta_2 + u_2,\ Y_3 = X_3\beta_3 + u_3,\ Y_4 = X_4\beta_4 + u_4 \qquad \text{(A.1)}$$

There are S observations on Y_1 and X_1, S+T observations on Y_2 and X_2, S+T+U observations on Y_3 and X_3, and S+T+U+V observations on Y_4 and X_4. The S observations in all four equations match in time, the T observations match in time between equations two, three and four, the U observations match in time between equations three and four, and there are V observations available for the forth equation. There are K independent variables associated with each equation. The system of equations in matrix form is given in A.2 and can be represented in general as Y = XB + u.

$$\begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \\ Y_4 \end{bmatrix}_{ax1} = \begin{bmatrix} X_1 & 0 & 0 & 0 \\ 0 & X_2 & 0 & 0 \\ 0 & 0 & X_3 & 0 \\ 0 & 0 & 0 & X_4 \end{bmatrix}_{axb} \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \end{bmatrix}_{bx1} + \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \end{bmatrix}_{ax1} \tag{A.2}$$

The matrix dimensions are: a=S*4 +T*3 + U*2 + V and b=K * 4. Under the assumption that the disturbance terms u_i are iid N(0,1) we can generate Ω to use in a generalized least squares estimator as:

$$= \begin{bmatrix} \sigma_{11}I_s & \sigma_{12}I_s & \sigma_{13}I_s & \sigma_{14}I_s & 0 & 0 & 0 & 0 & 0 & 0 \\ \sigma_{21}I_s & \sigma_{22}I_s & \sigma_{23}I_s & \sigma_{24}I_s & 0 & 0 & 0 & 0 & 0 & 0 \\ \sigma_{31}I_s & \sigma_{32}I_s & \sigma_{33}I_s & \sigma_{34}I_s & 0 & 0 & 0 & 0 & 0 & 0 \\ \sigma_{41}I_s & \sigma_{42}I_s & \sigma_{43}I_s & \sigma_{44}I_s & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \sigma_{22}I_T & \sigma_{23}I_T & \sigma_{24}I_T & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \sigma_{32}I_T & \sigma_{33}I_T & \sigma_{34}I_T & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \sigma_{42}I_T & \sigma_{43}I_T & \sigma_{44}I_T & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \sigma_{33}I_U & \sigma_{34}I_U & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \sigma_{43}I_U & \sigma_{44}I_U & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \sigma_{44} \end{bmatrix} \tag{A.3}$$

The Aitken generalized least squares estimator of β is:

$$\beta = (X'\Omega^{-1}X)^{-1}\, X'\Omega^{-1}Y \tag{A.4}$$

β is a **bxl** vector of estimated coefficients whose variance-covariance matrix is:

$$V(B_{sur}) = (X'\Omega^{-1}X)^{-1} \tag{A.5}$$

In application, Ω is not known, so Ω must be estimated. If Ω in Equation A.4 is replaced by a consistent estimate, the resulting estimator of Ω is consistent and has the same asymptotic distribution as the estimator of Ω which used Ω itself. Several alternatives exist to estimate Ω. The method used in this study is to run the system of equations as an SUR system using only the T common observations. Then the variance-covariance components of Ω are calculated using the resulting disturbance terms as follows:

$$\sigma_{ij} = \frac{1}{T}\, u_i{'} u_j \qquad i,j = 1, \ldots, N \tag{A.6}$$

This methodology relaxes the restrictive requirement of pooled data analysis that all cross sections must contain an equal number of observations and results in consistent and asymptotically efficient parameter estimates. Parameter estimates were obtained using the matrix programming commands available in the Shazam Econometrics Computer Program (White, Wong, Whistler, and Haun, 1990).

APPENDIX TWO
Food Manufacturers Estimation Results

	SUR With Unequal Number of Observation Regression Results[1]					
Agribusiness	*Constant*	*IPA_{t-1}*	*LVI*	*GGDP*	*ICC*	
Archer Daniel	0.20	0.18	-0.49	-0.01	-1.43	R^2=0.21
Midland	2.36	0.71	-0.96	-0.27	-1.43	D-H=0.54
Beatrice Foods	0.29	-0.53	-0.61	-0.02	-0.38	R^2=0.77
	8.00	-3.14	-2.13	-1.74	-0.64	D-H=0.92
Borden	0.07	0.33	-0.27	0.01	0.13	R^2=0.69
	3.04	1.49	-2.17	1.66	0.50	D-H=0.59
Campbell Soups	0.03	0.93	-0.53	-0.01	0.41	R^2=0.63
	0.35	2.59	-1.07	-0.46	0.45	D-H=1.30
Con Agra Inc.	0.14	0.63	-0.51	0.24	-0.13	R^2=0.68
	2.69	1.86	0.70	3.10	0.52	D-H=0.27
General Mills Inc.	0.22	0.08	0.21	0.04	0.29	R^2=0.79
	6.40	0.49	0.99	4.80	0.78	D-H=-1.07
Gerber Products Co.	0.20	0.14	-0.72	0.00	-1.65	R^2=0.79
	8.27	1.42	-3.10	0.00	-3.37	D-H=-1.29
Hershey Foods Co.	0.21	0.34	-0.88	-0.02	-1.82	R^2=0.38
	3.67	1.68	-1.66	-1.67	-1.82	D-H=0.38
Heinz Co.	0.03	0.44	0.01	0.03	0.59	R^2=0.93
	3.25	4.23	0.12	4.82	2.14	D-H=-0.99
Kellogg Co.	-0.00	1.07	-0.05	-0.01	-0.91	R^2=0.48
	-0.02	4.14	-0.11	-0.82	-1.11	D-H=0.13
Nabisco Inc.	0.15	-0.03	-0.24	0.01	0.41	R^2=0.90
	12.2	-0.34	-3.25	2.20	1.42	D-H=-1.01
Philip Morris Co.	0.11	0.11	-0.25	0.02	0.71	R^2=0.82
	3.97	0.53	-1.51	2.09	1.35	D-H=0.90
Pillsbury Co.	0.02	0.90	-0.05	-0.01	0.59	R^2=0.83
	1.23	6.73	-0.35	-1.17	1.24	D-H=0.62
Quaker Oats Co	.0.08	0.10	0.04	0.01	1.30	R^2=0.19
	3.05	0.41	0.17	1.17	2.26	D-H=0.69
Stokely-VanCamp Inc.	0.13	-0.45	0.31	-0.03	-0.44	R^2=0.38
	3.94	-1.67	1.00	-1.67	-0.78	D-H=-0.89

Note: 1. The top number is the estimated parameter, the bottom number is the t value.

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