Using APT to Assess the Impact of Farm Policy on Agribusiness Stocks

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Abstract

This study investigates the impact of differing U. S. Farm Policy regimes on the stock prices of publicly traded agribusinesses. Following the Roll and Ross approach, we apply a two step Arbitrage Pricing Model (APM). We analyze the effect of agricultural policy on returns to agribusiness by applying a modified APM to agricultural returns to test for the presence of an agribusiness premium or discount. We further augment our analysis by dividing the sample into two time periods around the implementation of the 1996. The differences in agribusiness premium can then be tested using a paired *t*-test. The empirical evidence lends support to a switch from negative returns to agribusiness stocks pre-FAIR Act to positive returns to agribusiness stocks after its enactment.

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U.S. farm policy has changed over time, often setting objectives related to the production sector of this broad industry. U.S. farm policy has traditionally been shaped by the goals of a consistent food supply and has often provided income support to farmers in times of low commodity prices. Domestic farm policy, directly affects the financial and risk characteristics of farmers. One of the most compelling examples of this linkage may be found in the enactment of the Payment in Kind (PIK) program. Zulauf, Guither, and Henderson (1985) note that while the PIK program provided income to farmers benefiting rural communities it hurt agribusinesses by reducing business volume. While this example is extreme, other policies such as program set-asides, the substitution of Agricultural Marketing Transition Act payments for Deficiency Payments in 1995, and Loan Deficiency Payments each have different implications for agricultural input demand and output supply. This secondary impact should be considered in the discussions of the 2007 Farm Bill.

It is of interest to investors and managers of agribusiness firms the impact farm policy has on input suppliers and output processors. In particular, the farm policies influence production levels and as a result influence the demand for production inputs. Furthermore, guaranteed price supports influence the prices buyers of producers' outputs pay (Schmitz, Furtan, and Baylis 2002). As a result, these farm policies should influence the value of firms that are engaged in operations that supply to or buy from agricultural producers. Different policy regimes should have differing impacts depending on their influence on production quantities and prices.

Changes in firms' values will likely only occur with substantial shifts in government policies that influence their returns. The farm policy debate that occurred in 1995 and resulted in the 1996 Federal Agricultural Improvement and Reform Act was widely viewed a dramatic shift in U.S. farm policy (Paarlberg and Orden 1996). Due to changes in the political environment in the legislative branch (the Republican Party captured majorities in both the House and the Senate for the first time in 40 years) and rising market prices in the mid-1990s, farm policy made a shift to decoupling government payments from production decisions. Though Paarlberg and Orden speculate on the differences in policy that would have occurred without changes in political party majorities or run-ups in agricultural commodity market prices, there is no empirical analysis of these policy changes on agribusiness values.

The similarities in the lead-up to the 2007 farm bill and the 1996 farm bill are striking. The 2006 elections saw the majority return to the Democratic Party in both chambers and again there is a substantial run-up in the price of agricultural commodities. As a result, a careful analysis might help to inform the debate on agricultural policy during this 2007 year. In a summary of farm bill forums sponsored by the U.S. Department of Agriculture, Secretary Johanns has identified more than 40 broad areas for discussion during the 2007 debate including agricultural concentration, farm family income, farm safety net, and federal crop insurance. These are among the issues that will impact agribusiness firm values most directly. The results of this study will serve to inform agricultural policy makers, assist agribusinesses managers in understanding the impact of various policy regimes, and contribute to the understanding of the consequences of policy on the financial success of firms.

This study examines whether changes in agricultural policies affect the return on agribusiness stocks after adjusting for relative risk using the Arbitrage Pricing Model (APM) proposed by Roll and Ross (1980). Changes in agricultural policy affect not only farmers, but also rural communities and associated industries. The passage of the Federal Agricultural Improvement and Reform (FAIR) Act of 1996 provided Agricultural Marketing Transition Payments (AMTPs) which were largely fixed based on past program participation. This was an attempt to decouple agricultural policy (Paarlberg and Orden 1996) to reduce the distortions in production incentives. This study examines whether the implementation of FAIR yielded a non-systematic shift in returns to agribusinesses.

We analyze the effect of agricultural policy on returns to agribusiness by applying a modified APM to agricultural returns to test for the presence of an agribusiness premium or discount. We further augment our analysis by dividing the sample into two time periods around the implementation of the 1996. The differences in agribusiness premium can then be tested using a paired *t*-test.

Arbitrage Pricing Model

Roll and Ross (1980) derive an empirical implementation of the Arbitrage Pricing Theory (APT) proposed by Ross (1976). Ross's insight in the development of the APT was that in equilibrium it would be impossible to buy and sell assets (stocks) without adding more capital in a way that would yield a riskless profit. His formulation is largely based on a factor model of asset returns. Specifically, the vector of returns on assets are hypothesized to be driven by a number of common economic factors affecting the economy

$$r_t = E_t + \beta f_t + \varepsilon_t \tag{1}$$

where r_t is a vector ($r_t \in M_{N*1}$) of N returns on assets in period t, E_t is a vector ($E_t \in M_{N*1}$) expected returns on those assets, β is a matrix ($\beta \in M_{N*k}$) of factor loading, f_t is a vector ($f_t \in M_{k*1}$) of common factors, and ε_t is a vector ($\varepsilon_t \in M_{N*1}$) of idiosyncratic variation. Given the factor representation of asset returns in Equation 1 and the efficiency conditions specified by Ross, the expected returns must be linear functions of the common factors

$$E = E_0 + \beta\lambda \tag{2}$$

where E_0 can be interpreted as the risk-free rate of return (or zero-beta rate of return) and λ is a vector ($\lambda \in M_{k*1}$) of constants.

The implementation of the APT is largely dependent on the specification of the common factors and estimation of the factor loadings. The literature supports two approaches. First, Roll and Ross suggest estimating the factor loadings by treating the factors as unobservable and using confirmatory factor analysis (Bollen 1989). The alternative approach developed in Chen, Roll, and Ross (1986) is to directly specify proxies for the latent factors. In this study, we apply the confirmatory factor analysis approach suggested by Roll and Ross.

The variance matrix (Σ) implied by the factor model presented in Equation 1 becomes

$$\Sigma = \beta\Psi\beta' + \Theta \tag{3}$$

where Ψ is a diagonal matrix ($\Psi \in M_{k*k}$) variances of the common factors and Θ is a diagonal matrix ($\Theta \in M_{N*N}$) of idiosyncratic variances. For simplicity, we set Ψ to the identity matrix.

The matrix of factor loading and idiosyncratic risk are then estimated using maximum likelihood by maximizing

$$\max_{\beta,\Theta} L = \ln\left|\beta\beta' + \Theta\right| + tr\left[S\left(\beta\beta' + \Theta\right)^{-1}\right] \tag{4}$$

where $tr(.)$ is the trace operator and S is the sample variance matrix. Given the estimated vector of factor loadings, λ can be estimated using Feasible Generalized Least Squares

$$\hat{\lambda} = \left(\tilde{\beta}'\left(\hat{\beta}\hat{\beta}' + \hat{\Theta}\right)\tilde{\beta}\right)^{-1}\tilde{\beta}'\left(\hat{\beta}\hat{\beta}' + \hat{\Theta}\right)\bar{r} \tag{5}$$

where $\hat{\lambda}$ is the vector ($\hat{\lambda} \in M_{(k+1)*1}$) of estimated risk-free return and risk premia, $\tilde{\beta}$ is matrix of estimated factor loadings augmented with a vector of ones to estimate the risk-free rate of return, $\hat{\beta}$ is the estimated matrix of factor loadings, $\hat{\Theta}$ is the estimated matrix of idiosyncratic risk, and $\bar{r}$ is the vector ($\bar{r} \in M_{N*1}$) of average returns for the assets. To test for the presence of an agribusiness premia or discount, we append an additional dummy variable vector to $\tilde{\beta}$ which takes on the value of one if the stock is an agribusiness asset and zero otherwise. Further, we consider two different regimes by estimating a the factor loading matrices and risk premia for the period between January 1986 and December 1995 and a second for the period between January 1996 and December 2006.

Data

The data used in this study are taken from the Center for Research in Security Prices (CRSP) accessed through the Wharton Research Data Services (WRDS). We divided the set of all stocks active in December 2006 into those stocks with SIC codes that were agricultural or agribusiness (including production agriculture, processing, and sales) and those which were not primarily associated with agriculture. We then drew randomly from this separation to get 8 agribusiness stocks and 24 non-agribusiness stocks. A list of the stocks used is presented in Table 1.

Results

The estimated risk-free return and risk premia for each time period are presented in Table 2. Given that the exclusion of a significant common factor tends to bias any estimated non-systematic premia downward, we have over-fit the common factor model allowing for five common factors in each time period. Unlike the results of the Capital Asset Pricing Model, analysis of the estimated risk premia requires some finesse. Specifically, the common factor model presented in Equation 3 implies squaring of each estimated factor loading. Thus, each factor is invariant to sign (i.e., multiplying any factor by -1 changes the interpretation of the factor, but not its significance). Thus, the estimates of the full sample imply the presence of four significant common factors, with one significant common factor in the sample before 1996 and three significant common factors in the post-FAIR sample. For our purposes here, the important factor is that each factor model is overspecified (i.e., a statistically significant agribusiness effect could not simply be a manifestation of an excluded common factor).

Next, we introduce a dummy variable into each regression to test for an agribusiness effect. The results for each individual sample are rather unimpressive. Across the whole sample, we reject the significance of the agribusiness affect at any conventional level of confidence. Similarly, we reject the significance of the agribusiness effect in the sample before FAIR. Also, we would fail to reject the significance of the agribusiness effect in the later sample for only the most tolerant confidence levels. However, the split sample does produce some support for the change in agribusiness effects. Specifically, the estimated effect of the agribusiness stocks in the period before FAIR is negative while the same effect shifts to a positive in the years since the implementation of FAIR. The paired *t*-test for an equality of the two effects is -1.8628 which is statistically significant at the 0.10 level of confidence. Hence, the effect of agribusiness may be averaged out between regimes.

Discussion and Implications

The goal of the 1996 FAIR Act was to decouple payments from production decisions, i.e. reduce the impact of the government subsidy on over production of some agricultural goods. If indeed agriculture input suppliers had been benefitting from overproduction through farmers use of additional agricultural inputs, then one would have anticipated the agribusiness effect post FAIR to be negative. This is also true for food processors that may have been paying lower market prices for overproduced agricultural commodities. Yet, the results indicate that the FAIR Act had the opposite impact. This is not completely unexpected when one considers that indeed many agribusinesses had been lobbying in favor of the FAIR Act policies (Schertz and Doering 1999).

One possible reason for this improvement in returns to agribusiness stocks post-FAIR could be related to the exit of high-cost marginal farmers either through retirement or lack of competitiveness in the market, a speculative scenario posited by Paarlberg and Orden. Input suppliers in particular may have benefitted from a replacement of many small, inefficient producers with a few, very-large producers. Paarlberg and Orden suggested that this scenario was unlikely because it was contingent upon an unprecedented run of high and/or stable market commodity prices. Indeed the period between the FAIR Act and the 2002 Farm Bill saw the USDA make emergency relief payments in excess of $26 billion (Westcott, Young, and Price 2002).

This replacement of smaller farms with larger operations could lend other additional efficiencies in the supply chain. Processors might be able to source a consistent supply easier by working with one large supplier rather than using a market composed of many smaller operations. It also could potentially have reflected a shift in acreage to less heavily subsidized agricultural commodities that are of greater value, viz. fruits and vegetables. Having these products available at lower prices may have buoyed processor profits more than the negative impact of rising row crop commodities.

The non-systematic components of the model are much larger than anticipated. This problem potentially could be resolved by defining the common factors *a priori* (Chen, Roll, and Ross 1986). This approach could potentially yield an improved model if several common factors shared by many industries and agricultural suppliers and processors could be identified. It is also possible that the regime switch pre-1996 and post-1996 is more closely related to the overvaluation of technology stocks in the late-1990s than to that of a change in agricultural policy. It is possible that investors, weary of the high risks associated with these technology stocks, sought to invest in safer food and agribusiness firms.

In addition, it seems that food processors are over represented in the sample and input suppliers appear to be underrepresented. There is some difficulty in identifying returns agribusiness stocks due to the large number of privately held firms such as Cargill. Furthermore, some of the publically traded agribusiness firms have periods of inactivity associated with re-organization periods. It is also not clear that all firms classified as agribusiness firms would be equally impacted by the changes in agricultural policy. For example, food retailers such as Kroger and Marsh Supermarkets are classified as agribusinesses by the SIC codes identified by the USDA as part of the agribusiness industry. Another potential improvement to the model to consider is measuring the returns to the stock beginning at a time that corresponds to the implementation of the legislation rather than the date corresponding to it become law.

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Table 1. Companies Used in APM Estimation and SIC Code

Permanent Company Number	Ticker Symbol	Company Name	SIC Code
10517	RNT	AARON RENTS INC	7359
14868	ARDNA	ARDEN GROUP INC	5410*
15472	WWY	WRIGLEY WILLIAM JR CO	2067*
16126	AZZ	A Z Z INC	3646
16600	HSY	HERSHEY CO	2064*
18403	JCP	PENNEY J C CO INC	5311
18729	CL	COLGATE PALMOLIVE CO	2844
20618	CRS	CARPENTER TECHNOLOGY CORP	3312
21573	IP	INTERNATIONAL PAPER CO	2621
21742	CASY	CASEYS GENERAL STORES INC	5330
22921	CKP	CHECKPOINT SYSTEMS INC	3669
25320	CPB	CAMPBELL SOUP CO	2032*
29938	BF	BROWN FORMAN CORP	2084*
34367	FARM	FARMER BROTHERS CO	2095*
39328	GLDC	GOLDEN ENTERPRISES INC	2099*
39571	GGG	GRACO INC	3561
42796	MDP	MEREDITH CORP	2721
44506	IDTI	INTEGRATED DEVICE TECHNOLOGY	3670
54818	RDK	RUDDICK CORP	5411*
54973	BCV	BANCROFT FUND LTD	6723
55984	IHT	INNSUITES HOSPITALITY TRUST	6798
56696	TAI	TRANSAMERICA INCOME SHS INC	6123
59184	BUD	ANHEUSER BUSCH COS INC	2082*
59483	YRCW	Y R C WORLDWIDE INC	4213
59774	LDL	LYDALL INC	3825
61313	DCI	DONALDSON INC	3564
61621	PAYX	PAYCHEX INC	8700
62958	SENEB	SENECA FOODS CORP NEW	2033*
63715	POWL	POWELL INDUSTRIES INC	3820
68427	IAF	ABERDEEN AUSTRALIA EQUITY FD INC	6726
72005	SEH	SPARTECH CORP	3081
75110	WGNR	WEGENER CORP	3663

*indicates an agribusiness as classified by the USDA using SIC codes

Table 2. Arbitrage Pricing Model Results

	Full Sample		Before 1996		After 1996	
	Original APT	With Dummy	Original APT	With Dummy	Original APT	With Dummy
Constant	0.0012	0.0004	0.0000	0.0011	0.0034	0.0013
	(0.0021)	(0.0025)	(0.0033)	(0.0036)	(0.0026)	(0.0032)
Factor 1	0.2132	0.2202	-0.0134	0.0116	0.1484	0.1602
	(0.0619)	(0.0633)	(0.0590)	(0.0674)	(0.0523)	(0.0533)
Factor 2	-0.1578	-0.1714	-0.0445	-0.0485	0.1645	0.1860
	(0.0350)	(0.0405)	(0.0469)	(0.0476)	(0.0947)	(0.0966)
Factor 3	-0.0721	-0.0551	0.0468	0.0382	0.0547	0.0569
	(0.0498)	(0.0560)	(0.0553)	(0.0568)	(0.0517)	(0.0516)
Factor 4	0.2565	0.2649	-0.4009	-0.3961	-0.0179	-0.0322
	(0.0589)	(0.0607)	(0.0844)	(0.0853)	(0.0495)	(0.0512)
Factor 5	0.1295	0.1400	-0.0059	-0.0032	0.1511	0.1822
	(0.0511)	(0.0538)	(0.0438)	(0.0443)	(0.0745)	(0.0798)
Agribusiness		0.0013		-0.0021		0.0031
		(0.0019)		(0.0027)		(0.0029)