An Examination of the Risk-Return Relationship for Pork Processing Companies in Canada and the United States

By
Carrie L. Bobowski

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Department of Agribusiness and Agricultural Economics
University of Manitoba
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THE UNIVERSITY OF MANITOBA

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TABLE OF CONTENTS

ABSTRACT

In recent years, Canadian and US pork industries have undergone significant restructuring and substantial consolidation. These changes have the potential to affect the risk-return relationship associated with pork processing companies and thereby influence portfolio construction decisions made by investors. Moreover, changes in the level of risk and/or return provides scope for hog producers to benefit from diversification through investment in pork processing companies. Given this, the objectives of this study are to determine whether the risk-return relationship for Schneider, Maple Leaf, Smithfield and IBP, which are four large pork processing companies in North America, varies over the period January 1990 to November 2000. In addition, this study will determine which factors affect the risk-return relationship for these companies and measure associated changes to systematic and nonsystematic risk.

These objectives are met using a single index model with a fundamental beta and time-varying parameters. Economic and/or market factors hypothesized to affect the risk-return relationship include the hog-feed grain price ratio, the real value of pork exports, exchange rates, the implementation of the Uruguay Round Agreement on Agriculture (URAA), removal of Manitoba Pork Marketing single-desk selling status, the Maple Leaf and Smithfield bidding war for Schneider and subsequent Schneider merger with Smithfield, the Maple Leaf merger with a subsidary of McCain, the announcement of the Maple Leaf pork processing facility in Brandon and the Maple Leaf merger with Landmark Feeds.

Results indicate the risk-return relationship for Schneider and IBP does not vary over time, while the risk-return relationship for Maple Leaf and Smithfield does vary

over time. Factors found to affect the risk-return relationship for the latter two companies are the real value of pork exports, removal of Manitoba Pork Marketing single-desk selling status, the URAA and the Maple Leaf and Smithfield bidding war for Schneider and subsequent Schneider merger with Smithfield. Moreover, Smithfield is classified as an "aggressive" stock (*i.e.*, a stock that tends to rise (fall) faster than the market in a rising (falling) market) while Schneider, Maple Leaf and IBP are classified as "defensive" stocks (*i.e.*, stocks that tend to fluctuate less than the market as a whole). As such, investors may view Schneider, Maple Leaf and IBP as lower risk stocks and Smithfield as a higher risk stock.

Furthermore, for companies with a time-varying risk-return relationship, total risk is comprised of three risk components, namely, systematic risk, alpha risk and nonsystematic risk, where alpha risk represents the portion of nonsystematic risk that can be explained by economic and/or market factors. Alpha risk was found to contribute negatively to nonsystematic risk for Maple Leaf while risk decomposition results for Smithfield were not influenced by alpha risk.

One limitation of the study is the single index model is sensitive to factors and time-periods considered in the analysis. Therefore, it is difficult to compare and contrast with other studies. Furthermore, attribution of effects to factors measured with binary dummy variables may be capturing other contemporaneous factors not incorporated into the model. Further research is needed to address differences in risk decomposition methodology and affect of "difficult to quantify" variables (*i.e.*, food safety, capacity utilization, environmental concerns, etc.) on the risk-return relationship.

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List of Figures, Tables and Equations

List of Figures

List of Tables

List of Equations

Chapter 1 – Introduction

1.1 The Canadian Pork Industry

In 2000 Canada became, for the first time in history, the world's leading exporter of pork. In fact, Figure 1.1 shows that Canadian pork exports have more than doubled in value from $687 million in 1990 to $1,713 million in 2000. All the while, Canada's pork exports, as illustrated by Figures 1.2 and 1.3, were primarily destined for the United States and Japan. Interestingly, exports to Japan have accounted for a larger share of Canadian pork exports. Furthermore, the distribution of Canadian pork exports among smaller countries is changing.

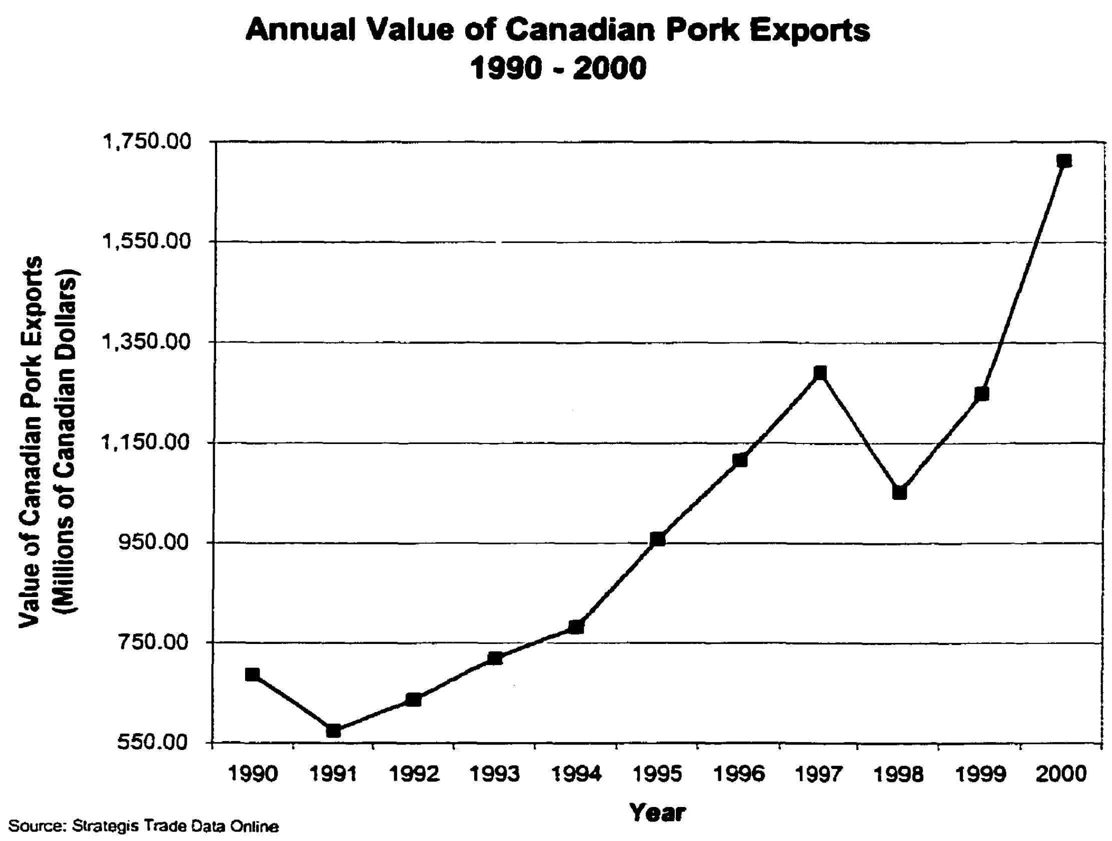

Figure 1.1 Annual Canadian Pork Exports, 1990 to 2000

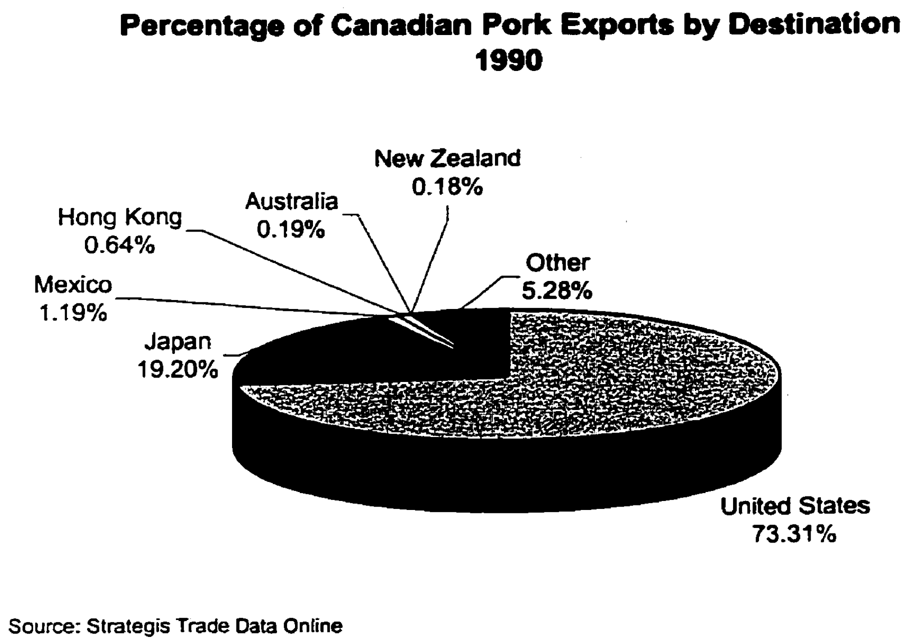

Figure 1.2 Canadian Pork Exports by Destination, 1990

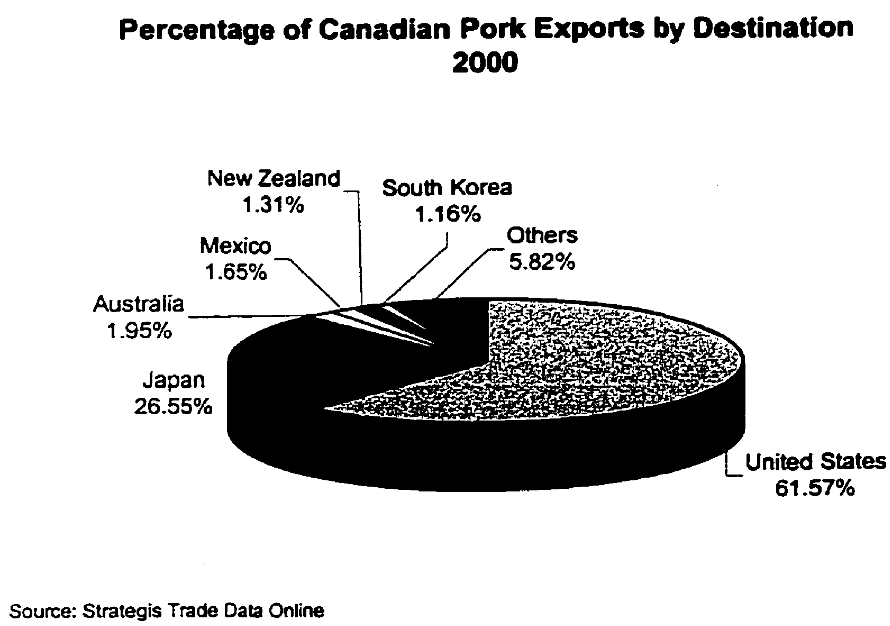

Figure 1.3 Canadian Pork Exports by Destination, 2000

Canada's ability to become a major pork exporter has been influenced by several factors. The first is exchange rates. Figure 1.4 shows that, in recent years, it has become more expensive for Canadians to purchase American currency. In other words, devaluation of the Canadian dollar has made it cheaper for international customers to purchase Canadian goods (assuming the transaction is denominated in U.S. dollars). Therefore, as long as the U.S.-Canada exchange rate is low, domestic residents will buy few imported goods and foreigners will buy many Canadian goods. As a result, the level of Canada's net exports would be expected to increase.

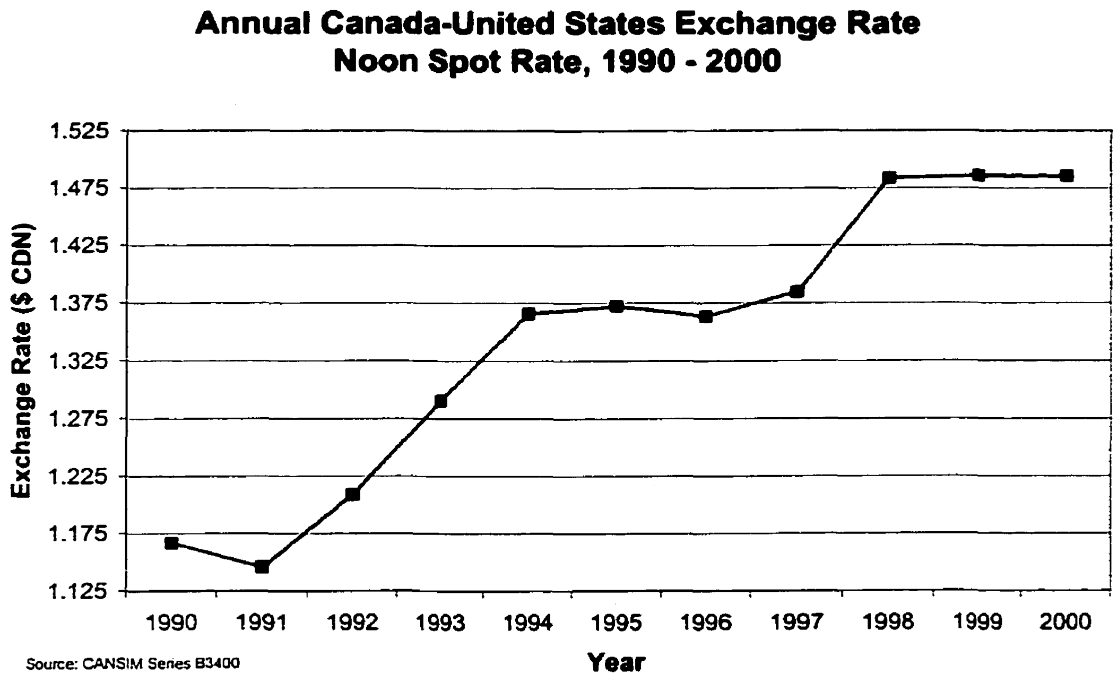

Figure 1.4 Annual Canada-United States Exchange Rate, 1990 to 2000

Structural changes in the Canadian red meat processing industry have also contributed to Canada's ability to become a major pork exporter. The Canadian red meat processing industry, traditionally comprised of a vast number of small slaughter and meatpacking facilities, has undergone significant consolidation and substantial restructuring. Changes in market structure lead to a 15 percent decline in the total number of processing facilities between 1988 and 1994. Table 1.1 shows that, over the same period, the market share among small plants decreased by 66 percent while the market share of large establishments increased by 30 percent. Furthermore, the share of very large plants rose by 60 percent. These structural changes have led to increased market concentration in the red meat processing sector.

Table 1.1 Red Meat Processing Industry – Market Structure

	1988	1994
Establishments		
Number of Establishments	*536*	*454*
Small Establishments as a Percent of Total Establishments	*60*	*50*
Percent of Market Share		
Small Establishments (less than 20 employees)	*5%*	*3%*
Medium Establishments (20-200 Employees)	*49%*	*37%*
Large Establishments (200+ employees)	*46%*	*60%*
Very Large Establishments (500+ employees)	*25%*	*40%*

Source: Food Bureau, Agriculture and Agri-Food Canada

1.2 The Manitoba Pork Industry

Manitoba has made substantial contributions to changes in Canada's red meat industry. For example, Figure 1.5 shows that, in 1990, Manitoba's share of Canadian beef and pork exports were approximately six percent and five percent, respectively. However, the closure of Canada Packers in 1987, East West Packers and Burns Meat (Brandon) in 1990, and Burns Meats (Winnipeg) in 1997 contributed to the demise of Manitoba's beef processing industry. Subsequently, much of the beef finishing industry moved to Alberta, and Manitoba's share of Canadian beef exports fell to less than one percent in 2000.

At the same time, however, Manitoba's share of Canadian pork exports rose to 22 percent. In fact, Manitoba has seen a dramatic rise in pork processing capacity in recent years. For example, in 1999 Maple Leaf Foods opened a state-of-the-art pork processing facility in Brandon and J.M. Schneider announced plans to expand their Winnipeg facility. Interestingly, in early 2001, Maple Leaf Foods acquired Schnieders' fresh pork facilities in Manitoba. Nonetheless, such expansion has not been unique to Manitoba. For instance, Mitchell's Gourmet Foods Inc. in Saskatoon, Saskatchewan and Fletcher's Fine Foods Ltd. in Red Deer, Alberta have also expanded their pork processing capacity.

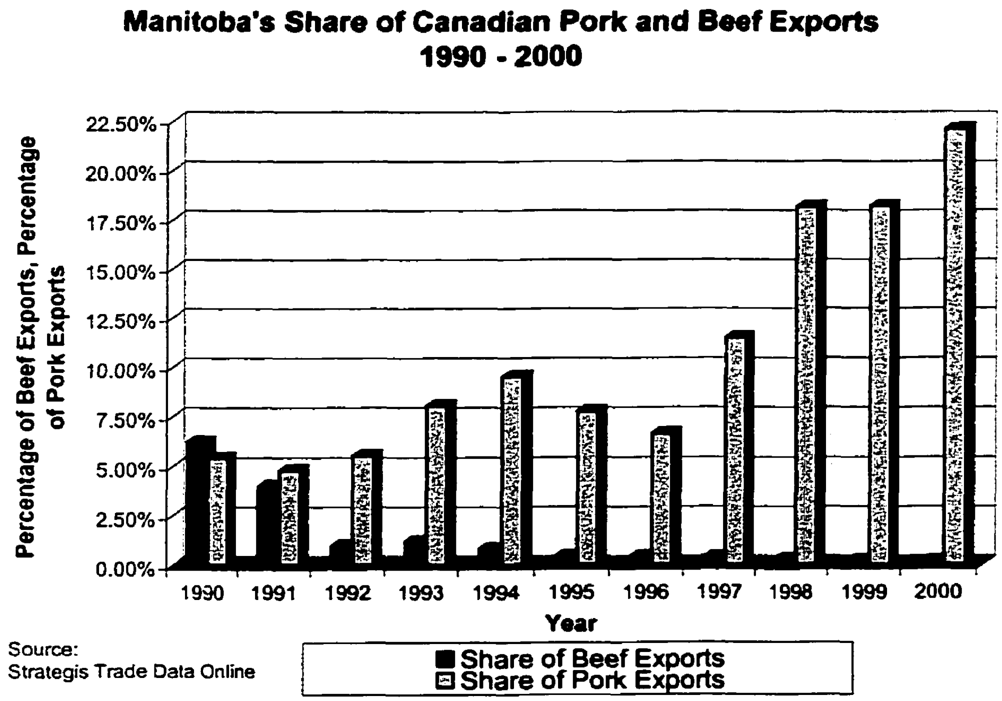

Figure 1.5 Manitoba's Share of Canadian Pork and Beef Exports, 1990 to 2000

1.3 Problem Statement

Investors construct portfolios to maximize their expected rate of return, given an assumed level of risk. To determine which assets to include in a portfolio, investors must be aware of the risk-return trade-off for each prospective asset considered for inclusion in their portfolio. However, structural change at the industry and firm level, merger and acquisition activity, and changes in market fundamentals can affect the risk-return relationship. This being said, the problem for investors becomes how to make informed decisions regarding portfolio selection. To do this, investors must be able to measure and understand the effect of structural adjustment, as well as economic and/or market factors on an asset's risk-return relationship. Measurement of this relationship can be accomplished by relating the asset's return to a market return. Moreover, estimates of systematic and nonsystematic risk can be derived from the decomposition of the measured relationship. Note that systematic risk is the portion of an asset's total risk that is related to the market and cannot be diversified away, and nonsystematic risk is an asset's unique risk that can be minimized or eliminated through diversification.

1.4 Objective of the Study

The objective of this study is to measure the risk-return relationship between the return to several pork-processing companies involved in structural change and a market return for the period January 1990 to November 2000. Specifically, the study will:

1. Determine whether the risk-return relationship changes over time.
2. Identify and examine the economic and/or market factors that affect the risk-return relationship.
3. Measure inter-temporal changes to systematic and nonsystematic risk.

The objectives of the study will be met using a single index model with a fundamental beta and time-varying parameters.

1.5 Pork Processing Companies

The companies considered in the study are J.M. Schneider, Maple Leaf Foods, Smithfield Foods and Iowa Beef Packers (IBP). Maple Leaf and Schneider are the leading pork processing companies in Canada, as well as Manitoba, while Smithfield and IBP are the largest meat processors in the United States.

Schneider is one of Canada's largest producers of processed meats, fresh meats, cheese, baked goods and poultry. Schneider reported $377 million worth of consumer foods sales, and $146 million worth of pork sales, for the six month period ended April 30, 2000. For the same period, Schneider earnings from consumer foods operations and pork operations were about $11 million and $2 million, respectively. Pork earnings in 2000 were lower than 1999 due to a substantial increase in hog costs compared to the exceptionally low cost of hogs the year before (Schneider Corporation, 2000).

Maple Leaf, one of the leading food processing companies in Canada, comprises three operating groups, namely, the meat products group, the bakery products group and the agribusiness group. Maple Leaf's sales in 2000 totaled approximately $3.9 billion. Of this, 62 percent or $2.5 billion in revenue can be attributed to meat product sales. At the same time, however, the meat products group suffered losses from operations of $11 million, compared to earnings of $67 million in 1999. Factors contributing to losses from operations were start-up costs and operating losses at the Brandon pork facility, high live hog costs and closure of the Winnipeg pork facility in November 1999 (Maple Leaf Foods, 2000).

Smithfield is the largest pork processor and hog producer in the United States. Smithfield's total sales in 2000 were almost US$6 billion, of which almost US$5 billion were sales of processed meat. Smithfield's operating profit from meat processing and hog production was about US$123 million and US$100 million, respectively. Smithfield, with purchases and investments in 12 companies over the past 2 years, has led the pork industry in merger and acquisition activity. In addition, Smithfield, owning approximately 50 percent of the hogs they slaughter, is a vertically integrated operation (Smithfield Foods, 2000). In fact, Smithfield owns 700,000 sows, four times the number of their nearest competitor (Smithfield Foods, 2000). This vertical integration offers Smithfield a number of benefits. For example:

> *"By controlling half of our hog supply, our processing operations are ensured of a consistent, high-quality source of raw materials for many of the Company's fresh and processed meat products. In addition, this vertical integration should provide a more predictable earnings stream because Smithfield Foods is now insulated from much of the cyclicality common to our business. Generally, pork processors make more money when hog prices are low - as witnessed in fiscal 1999 – and processing margins decline when hog prices rise. By participating in both ends of the business, we remove many of those peaks and valleys. In addition, productivity should climb as these formerly independent hog raising companies, all based within 25 miles of one another in North Carolina, pool their management talent and other resources to control costs and maximize efficiencies"* (Smithfield Foods, 2000, p. 4).

IBP is another large pork and beef processor in the United States. IBP conducts its business through two divisions, Foodbrands and Fresh Meats. In 1999, IBP Fresh Meats sales were US$12 billion and operating profits were US$438 million. At the same time, Foodbrands sales were almost US$2 billion and operating profits were US$90 million.

It is important to discuss American pork processing companies in addition to Canadian pork processing companies because structural changes in Canada are characteristic of changes that have been occurring in the United States over the past 30 years. In addition, there has been increased interaction between Canadian and American pork processing companies in recent years.

1.6 Chapter Summary

This study utilizes a single index model with a fundamental beta and time-varying parameters to examine the risk-return relationship for Schneider, Maple Leaf, Smithfield and IBP. The study will determine whether the risk-return relationship for these companies varies over time, identify and examine economic and/or market factors that affect the risk-return relationship and measure inter-temporal changes to systematic and nonsystematic risk.

Given this, the thesis proceeds as follows. Chapter 2 introduces the single index model as the conceptual framework used to meet the objectives of the study, and reviews the related literature. Variables and data utilized to introduce time-varying parameters to the single index model, as well as hypotheses regarding the affect of these variables on returns to pork processing companies, are presented in Chapter 3. Econometric estimates of the parameters of the single index model for each company, and results of model specification tests, are shown and discussed in Chapter 4. Chapter 5 utilizes these results to derive measures of systematic, nonsystematic and alpha risk (where alpha risk represents the portion of nonsystematic risk that can be explained by economic and/or market factors) for each company. Chapter 6 summarizes the thesis, states the limitations of the study and identifies opportunities for further research. Moreover, Chapter 6 describes how the knowledge gained through this study can be used by the agriculture industry.

Chapter 2 – Conceptual Framework and Literature Review

2.1 Introduction

Chapter 1 provided background to the research problem addressed by this study. This chapter will discuss the conceptual framework used to meet the objectives of the study. Chapter 3 will identify and examine explanatory variables and data used in the study.

2.2 Single Index Model

Sharpe's (1963) single index model (SIM) is based on the observation that stock prices tend to move in synchronization with the market. Given this, the SIM is used to examine the hypothesis that the relationship between a pork processor's return and a market return varies over time and is affected by economic factors and/or market characteristics. The SIM is a simplification of Markowitz's (1952) model of portfolio choice. One advantage of the SIM is that fewer parameters are needed to specify the variance-covariance matrix (compared to the Markowitz model). In addition, results obtained from the Markowitz model may be sensitive to the assumption regarding the risk aversion parameter. This being said, the SIM may be written as:

$$r_{it} = \alpha_i + \beta_i r_{mt} + e_{it} \tag{2.1}$$

where

r_{it} is the return on stock *i* at time *t*

α_i is the component of stock *i*'s return that is independent of the market's performance

r_{mt} is the rate of return on the market index at time *t*

β_i is a constant that measures the expected change in r_{it} given a change in r_{mt}

e_{it} is the deviation of the actual return from the predicted return at time t. It is an error term with Normal distribution, mean 0 and variance σ_{ei}^2.

The sensitivity of stock i's return to the return on the market is measured by β_i, while α_i represents the component of the return that is independent of the market return. An important assumption is that the right hand side variables of the model and the errors are statistically independent (*i.e.*, cov (r_{mt}, e_{it}) =0).

Estimates of β_i can be used to obtain an estimate of total risk to the i^{th} stock:

$$\hat{\sigma}_i^2 = \hat{\beta}_i^2 \sigma_m^2 + \hat{\sigma}_{ei}^2 \qquad (2.2)$$

where $\hat{\beta}_i^2 \sigma_m^2$ and $\hat{\sigma}_{ei}^2$ represent systematic and nonsystematic risk, respectively. Furthermore, $\hat{\beta}_i$ is the estimated value of β_i, $\hat{\sigma}_{ei}^2$ is the estimated variance of e_{it}, and σ_m^2 is the variance of the return to the market. Systematic risk is the portion of total risk that is related to the market and cannot be diversified away. Diversification, however, can lead to the elimination of nonsystematic risk.

The relationship between the return to a stock and the return to the market will be characterized by a fundamental beta. In other words, some combination of the firm's fundamentals and the market characteristics of the firm's stock will be used to explain why the systematic relationship between r_{it} and r_{mt} (*i.e.*, β_i) may vary over time. Determination of these relationships would contribute to the ability to better understand and forecast betas and therefore the risk-return relationship (Elton and Gruber, 1984).

Fundamental betas may be incorporated into the analysis by relating α_i and β_i to factors thought to influence their value. For example, α_i and β_i can be expressed as follows:

$$\alpha_{it} = \mathbf{W}_t^{'}\gamma_i \tag{2.3}$$

$$\beta_{it} = \mathbf{W}_t^{'}\delta_i \tag{2.4}$$

where $\mathbf{W}_t$ is a vector of z observable factors, including a column of ones, hypothesized to affect α_i and β_i, and γ_i and δ_i are z-vectors of parameters to be estimated. Given this, α_i and β_i become time-varying and the SIM may be written as:

$$r_{it} = \mathbf{W}_t^{'}\gamma_i + r_{mt}\mathbf{W}_t^{'}\delta_i + e_{it} \tag{2.5}$$

Equation 2.5 may also be written as:

$$r_{it} = \sum_z W_{zt}\gamma_{iz} + r_{mt}\sum_z W_{zt}\delta_{iz} + e_{it} \tag{2.6}$$

where $\sum_z W_{zt}\gamma_{iz}$ represents the intercept shift and $\sum_z W_{zt}\delta_{iz}$ represents the slope shift. Note that the right hand side variables of the model and errors are assumed to be statistically independent (*i.e.*, cov (r_{mt}, e_{it}) = 0 and cov (W_{it}, e_{it}) = 0). Econometric estimates of parameters (from equation 2.5 or 2.6) can be used to derive estimates of systematic and nonsystematic risk using the following decomposition of the time-varying SIM:

$$\hat{\sigma}_i^2 = \sum_z \hat{\gamma}_{iz}^2\sigma_{wz}^2 + \sigma_m^2\sum_z \hat{\delta}_{iz}^2\sigma_{wz}^2 + \hat{\sigma}_{ei}^2 \tag{2.7}$$

or

$$\hat{\sigma}_i^2 = \hat{\alpha}_{it}^2 + \hat{\beta}_{it}^2\sigma_m^2 + \hat{\sigma}_{ei}^2 \tag{2.8}$$

where σ_{wz}^2 is an estimate of the variance of z^{th}-variable of $\mathbf{W}_t$ and $\hat{\alpha}_{it}^2$ and $\hat{\beta}_{it}^2$ are time-varying parameter estimates. Given this, $\hat{\beta}_{it}^2\sigma_m^2$ is an estimate of time-varying systematic risk, $\hat{\alpha}_{it}^2$, referred to as alpha risk, is an estimate of the portion of nonsystematic risk that can be predicted by factors in $\mathbf{W}_t$ and $\hat{\sigma}_{ei}^2$ is an estimate of pure nonsystematic risk.

2.3 Literature Review

The SIM has been used in varying capacities in agricultural, economic and financial literature. For example, Turvey et al. (1988) used the SIM to express farm activity revenue as a function of a reference farm; Collins and Barry (1986) used the SIM to express the expected returns from crop production as a function of a generalized measure of regional income. Both of these studies concluded that the SIM closely approximates the mean-variance frontier of the full variance-covariance model.

Additionally, the SIM has been used to examine the affect of changes in market conditions on β_i. For instance, Francis and Fabozzi (1979) examined the impact of inter-temporal changes in the market factor and changes in the macroeconomic environment on the SIM. Their study used a dummy variable regression model to test whether the SIM was a robust model or if α_i and/or β_i change with overall business conditions. The model was specified as follows:

$$r_{it} = \alpha_{1i} + \alpha_{2i}d_t + \beta_{1i}r_{mt} + \beta_{2i}r_{mt}d_t + u_{it} \text{ for } E(u_{it}) = 0. \qquad (2.9)$$

where d_t is a dummy variable and α_{2i} and β_{2i} measure any differential effects of conditions in the two subsets on the alpha, α_{1i} and beta, β_{1i} for the i^{th} stock. Results support the hypothesis that the SIM is affected by macroeconomic conditions. Consequently, Francis and Fabozzi (1979) concluded the inter-temporal instability of beta can be partially attributed to changes associated with business cycle economics. Moreover, Francis and Fabozzi's model (1979) can be decomposed to arrive at estimates of systematic and nonsystematic risk:

$$\sigma_i^2 = \hat{\beta}_{1i}^2\sigma_m^2 + \hat{\beta}_{2i}^2\sigma_m^2 d_t + \sigma_{ei}^2 = \sigma_m^2(\hat{\beta}_{1i}^2 + d_t\hat{\beta}_{2i}^2) + \sigma_{ei}^2 \qquad (2.10)$$

where $\sigma_m^2(\hat{\beta}_{1i}^2 + d_t\hat{\beta}_{2i}^2)$ is time-varying systematic risk delineated by d_t.

In a related piece, Schaller and Van Norden (1997) utilized four specifications of a Markov switching model to test for evidence of regime switching in CRSP value-weighted monthly stock market returns for the period January 1929 to December 1989. In the null hypothesis, stock market returns are drawn from a single Gaussian distribution with mean α_0 and variance σ_0: $R_t = \alpha_0 + \sigma_0\varepsilon_t$. The alternative hypotheses drew stock returns from distributions:

1. With different means (α_0 and α_1).
2. With the same mean but different variances (σ_0 and σ_1).
3. With different means and variances.

Using the likelihood ratio test, Schaller and Van Norden (1997) found strong evidence for rejection of the null hypothesis against the alternative hypothesis of different means. The evidence was even stronger for rejection of the null hypothesis against the second and third alternative hypotheses. Schaller and Van Norden (1997) concluded there was strong evidence of regime switching in US stock returns.

Cheng (1997) also used a switching regression method to explore the stationarity of systematic and non-systematic risk of Hong Kong's common stocks. The Markov model for regime switching, introduced by Goldfeld and Quandt (1973), explicitly allows for a switch to depend upon the regime that is in effect. The two-regime (one switch point) model is specified as follows:

$$R_{pt} = \alpha_1 + \beta_1 R_{mt} + e_{1t} \qquad Z_t=1,\ldots,Z^* \qquad (2.11)$$

$$R_{pt} = \alpha_2 + \beta_2 R_{mt} + e_{2t} \qquad Z_t=Z^*+1,\ldots,T \qquad (2.12)$$

Switching between two equations or regimes is facilitated by the assumption that $(\beta_1,\sigma_1^2) \neq (\beta_2,\sigma_2^2)$. Equation 2.11 holds when $Z_t<Z^*$ and equation 2.12 holds when $Z_t>Z^*$, where Z_t is taken to be time. Hence, the switch occurs at the unknown date Z^*. Combining equations 2.11 and 2.12 produces equation 2.13.

$$R_{pt} = \alpha_1(1-D_t) + \alpha_2 D_t + [\beta_1(1-D_t) + \beta_2 D_t]R_{mt} + e_{1t}(1-D_t) + e_{2t}D_t \quad (2.13)$$

where $D_t = \begin{cases} 0 & if Z_t \leq Z^* \\ 1 & otherwise \end{cases}$ (2.14)

Note that equation 2.14 implies the regime switches abruptly at Z^*. By relaxing equation 2.14 and recognizing a positive variance for Z*, gradual shifts are permitted. Estimates of systematic and nonsystematic risk can be obtained from the following decomposition:

$$\hat{\sigma}_p^2 = [\hat{\beta}_1(1-D_t) + \hat{\beta}_2 D_t]\hat{\sigma}_m^2 + \hat{\sigma}_1^2(1-D_t) + \hat{\sigma}_2^2 D_t \quad (2.15)$$

where $[\hat{\beta}_1(1-D_t) + \hat{\beta}_2 D_t]\hat{\sigma}_m^2$ is time-varying systematic risk and $\hat{\sigma}_1^2(1-D_t) + \hat{\sigma}_2^2 D_t$ is time-varying nonsystematic risk. The study concluded:

> "*...the systematic risk component of the industry portfolios is fairly stable throughout the sample period. However, non-systematic risk tends to decline over the 13-year horizon from February 1980 to December 1992. This decline may imply a reduction in the industry's unique risk proportion relative to its total risk level. The evidence of a reduction in industry-specific risk may further suggest that the benefits of diversifying across different industry sectors appear to be diminishing over the past decade*" (Cheng, 1997, p. 57).

Cheng's (1997) observation that the benefits of diversification may be decreasing leads to the debate over the performance of conglomerate firms. Although substantial research has been conducted in this area, the effect of merger and acquisition activity on systematic and non-systematic risk of conglomerate firms remains unclear.

> *"Because of the many problems associated with the application of the capital asset pricing model to individual firm performance, studies are sensitive to even minor differences in experimental design"* (Brennar and Downes, 1979, p. 295).

Thus it is difficult to generalize the effect of merger and acquisition activity on the performance of conglomerate and consolidated firms.

Another related study concluded:

> *"...although beta measures of investment risk show that conglomerates are associated with significantly higher degrees of systematic risk, the traditional standard deviation measure of total investment risk indicates that the two groups are quite comparable"* (Melicher and Rush, 1973, p. 388).

For that reason, conglomerate and non-conglomerate firms possess comparable levels of returns and total risk. Similarly, Brennar and Downes (1979, p. 295) found that "... conglomerate firms have not performed better than the average firm in the same risk class."

Conversely, Weston et al. (1972) found that although the major objective of conglomerate mergers was not diversification in a risk-reducing sense alone, conglomerate firms were successful in improving return/systematic risk ratios. This implies investors may be able to reduce the remaining degree of nonsystematic risk by including conglomerate firms in their portfolios. This is because

> *"...conglomerate firms provided the investor with portfolios that were 'inefficient' in the sense that much non-systematic risk remained"* (Weston et al., 1972, p. 362).

Alternatively, Lanetieg et al. (1980) concluded that levels of systematic, total and nonsystematic risk tend, on average, to increase with merger activity.

> *"However, a risk increase is not necessarily inconsistent with stockholder wealth maximization if capital markets are reasonably perfect and complete and providing that expected profits increase in commensurate amount"* (Lanetieg et al., 1980, p. 709).

2.4 Chapter Summary

The preceding literature review provides the groundwork from which this study is built. Past research has shown that parameters in the single index model can vary inter-temporally and can be affected by macroeconomic variables. However, it is also evident that the effect of merger activity is not clearly understood. Thus, the intent of this study is to expand investor's knowledge and understanding of the dynamics of the risk-return relationship in the Manitoba pork processing industry.

Chapter 3 will identify the variables, and their hypothesized affect on the risk-return relationship, utilized to vary the parameters of the SIM over time. Chapter 3 will also discuss data requirements and sources used in the study.

Chapter 3 – Hypotheses and Data

3.1 Introduction

Chapter 2 introduced the single index model (SIM) as the conceptual framework for the study and reviewed the related literature. This chapter discusses the variables and data required to allow α_i and β_i to vary over time. Hypotheses regarding the affect of these variables on returns to pork processing companies will also be presented in this chapter. Chapter 4 will present results of the econometric analysis.

3.2 Continuous Variables

The W-matrix of variables that enable α_i and β_i to vary over time comprises continuous and binary variables. This section introduces and discusses hypotheses and data associated with the continuous variables, while the next section discusses the same issues for binary variables. Note that all data was obtained in April 2001. Furthermore, hypotheses presented in this chapter are assumed to apply to both intercept and slope parameters.

Market Index

The SIM relates the return on a stock to the return on a market index. A variety of indices are available to represent the market index. For example, Canadian indices are available from the Toronto Stock Exchange (TSE) and American indices are available from the New York Stock Exchange (NYSE) and the Nasdaq. Furthermore, the generally accepted "North American" index is available from Standard and Poor (S&P).

As such, this study uses the S&P 500 to represent the market index. The S&P 500, a "North American" index, was deemed most suitable because this study considers both Canadian and American companies.

The return to the S&P 500 for the period January 1, 1990 to December 31, 1999 and January 1, 2000 to November 30, 2000 was obtained from the Center for Research in Security Prices (CRSP) database and Yahoo!Finance[1], respectively. Returns to the S&P 500 were calculated as:

$$\left(\frac{Index_t}{Index_{t-1}}\right)-1 \qquad (3.1)$$

where $Index_t$ represents the index of the S&P 500 Composite at time t and $Index_{t-1}$ represents the index of the S&P 500 Composite at time t-1.

The relationship between the return to pork processing companies and the return to the S&P 500 is expected to be positive. This is because the SIM is based on the observation that stock prices tend to move in synchronization with the market. Thus, when the return to the S&P 500 increases, the return to pork processing companies is also expected to increase.

Return to Pork Processing Companies

Data utilized to calculate the return to pork processing companies include daily stock prices and volumes for the period January 1, 1990 to November 30, 2000. Daily closing stock prices and volumes for Maple Leaf, for the period January 1, 1990 to December 31, 1999, were obtained from the Canadian Financial Markets Research Centre (CFMRC) Toronto Stock Exchange (TSE) database. Daily closing stock prices and volumes for Schneider, for the period January 1, 1990 to January 12, 1999, were also

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[1] It is important to note the TSE database and the Yahoo!Finance database did not always yield the same data. The databases did not always record trades on the same day and the Yahoo!Finance database rounds volumes traded to the nearest hundred. The rational behind these differences is unknown. The Yahoo!Finance database was still utilized for approximately 12 observations because it was readily available. The change in data source did not seem to affect the statistical properties of the model as shown by results of specification tests presented in Chapter 4.

obtained from CFRMC TSE. Daily returns and volumes for Smithfield and IBP, for the period January 1, 1990 to December 31, 1999 were obtained from CRSP. The remaining data for Maple Leaf, Schneider, Smithfield and IBP were obtained from Yahoo!Finance.

The return to each of Schneider, Maple Leaf, Smithfield and IBP was calculated using equation 3.1:

$$R_t = \{[P_t + D_t]S_t - P_{t-1}\} / P_{t-1} \qquad (3.2)$$

where R_t = fully adjusted daily return at time t
P_t = closing price at time t
D_t = cash or cash equivalent dividend (in dollars) at time t
S_t = stock split factor for a stock dividend or split at time t; if no stock dividend or split S_t=1

Daily closing stock prices were converted to monthly closing stock prices using a volume-weighted average. This procedure did not return a monthly stock price for Schneider for July 1990 and May 1993. This is because Schneider stock was not traded in these months. The missing stock prices were obtained by interpolating between preceding and succeeding months. The time series for the returns to Schneider, Maple Leaf, Smithfield, IBP and the S&P 500 are shown in Figures 3.1, 3.2, 3.3, 3.4 and 3.5, respectively.

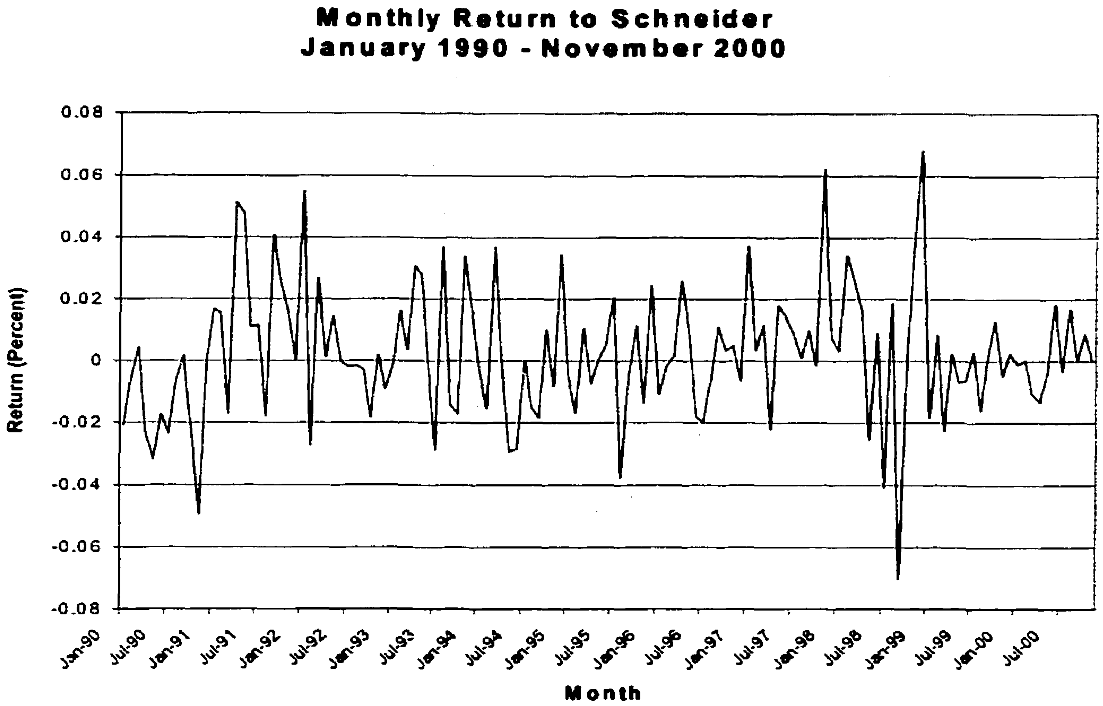

Figure 3.1 Monthly Return to Schneider, January 1990 to November 2000

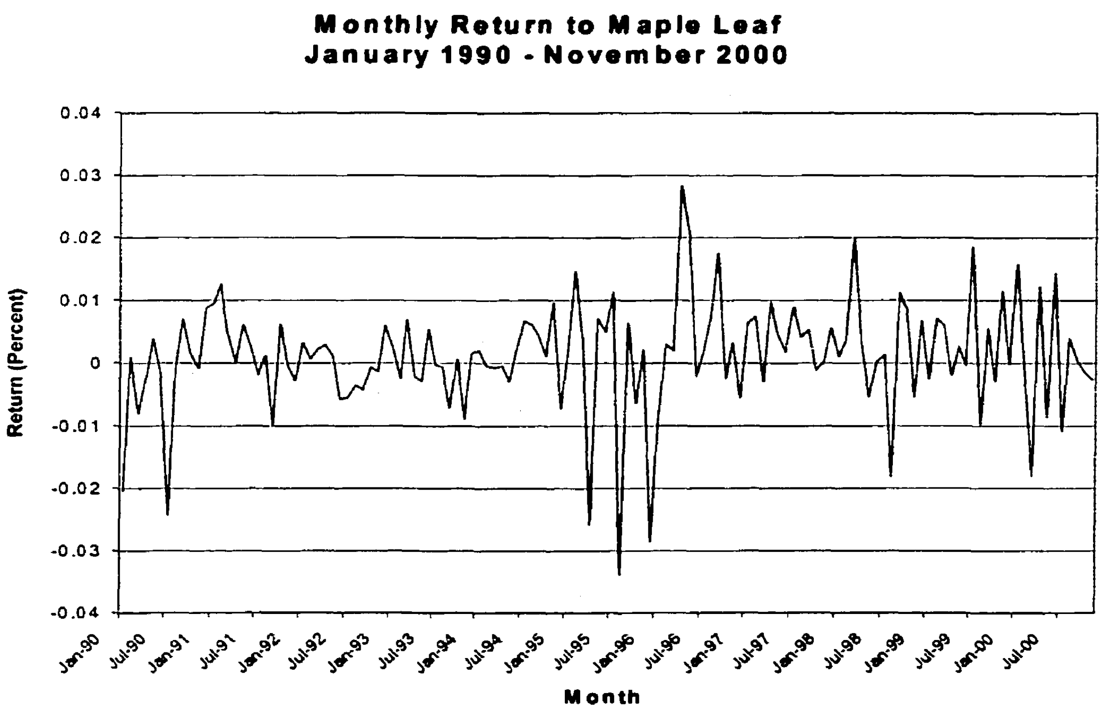

Figure 3.2 Monthly Return to Maple Leaf, January 1990 to November 2000

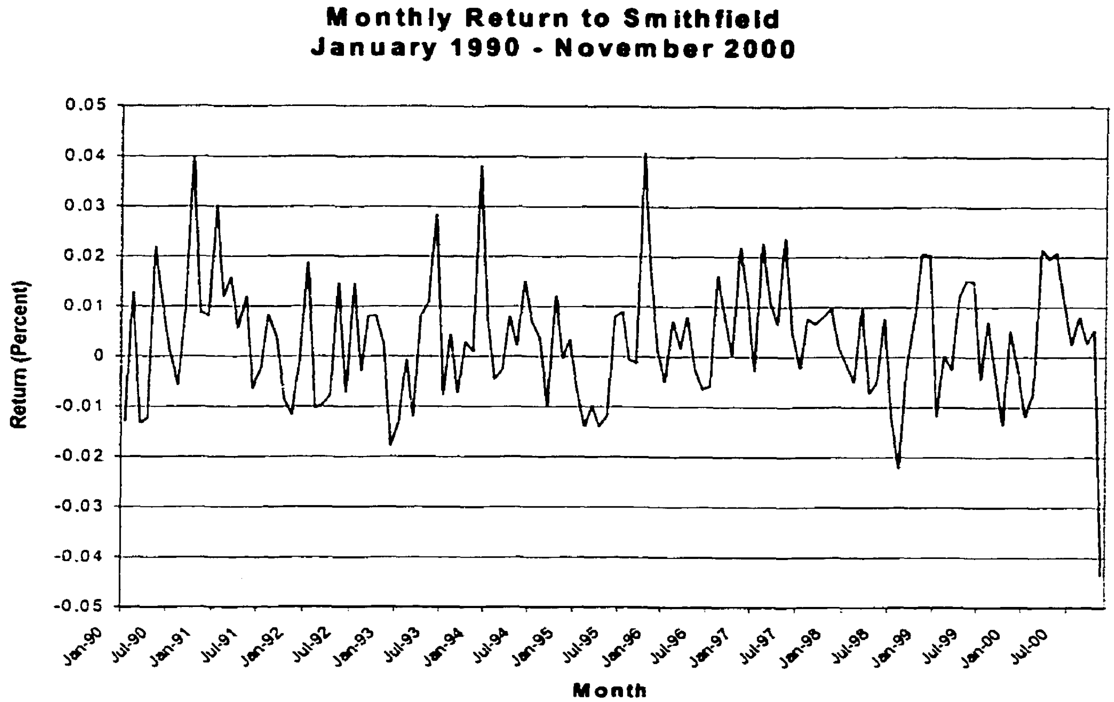

Figure 3.3 Monthly Return to Smithfield, January 1990 to November 2000

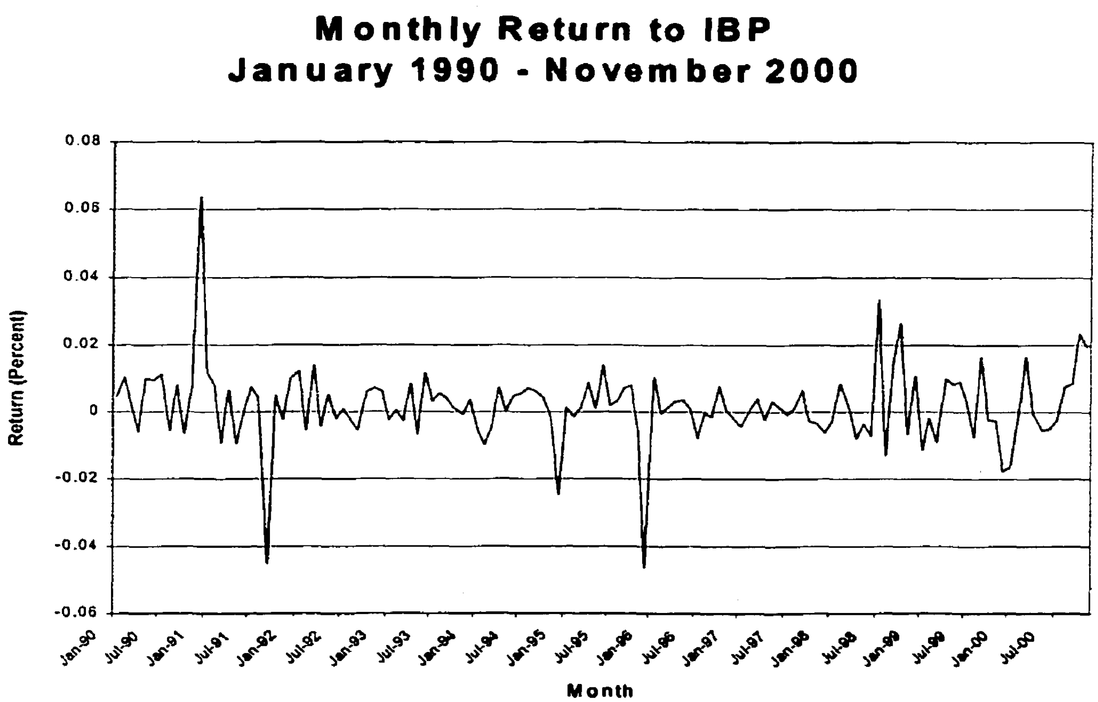

Figure 3.4 Monthly Return to IBP, January 1990 to November 2000

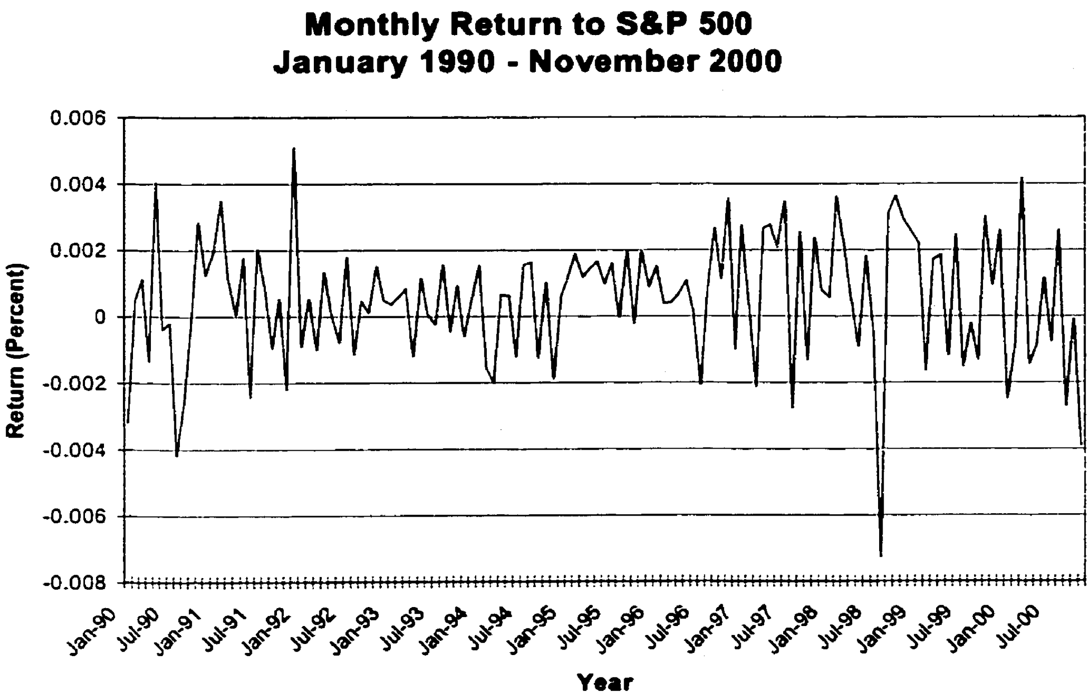

Figure 3.5 Monthly Return to S&P 500, January 1990 to November 2000

Hog-feed grain price ratio

The first continuous factor thought to influence α_i and β_i is the hog-feed grain price ratio. This ratio is an indicator of the profitability of producing hogs. As a high hog-feed grain price ratio is indicative of high returns to hog producers, a positive relationship exists between the hog-feed grain price ratio and returns to hog producers. Given this, one would expect the relationship between the hog-feed grain price ratio and returns to processing companies to be negative. This is because it becomes more expensive for processing companies to acquire hogs as the price of hogs and/or producer profits increase.

Further to this, the hog-feed grain price ratio may respond to and reflect changes in hog and feed grain markets. For example, in the hog market, the four-year hog price cycle and the hog price crisis in late 1998 and early 1999 will be reflected in the hog-feed grain price ratio. Figure 3.6 shows that the hog-feed grain price ratio in Canada and the U.S. was very low during this period. An example from the feed grain market is the removal of the Western Grain Transportation Act (WGTA) in August 1995. This occurrence was expected to decrease feed grain costs for Prairie producers and should therefore be reflected in the hog/feed grain price ratio. However, the impact may be hard to detect as the benefits to producers may not have been as great as anticipated (Kraft and Doiron, 2000).

Canada does not report a countrywide hog-feed grain price ratio. This is because producers in the east tend to feed their hogs corn while producers in the west tend to feed their hogs barley. Given that Manitoba is Canada's second largest pork exporter, and that the data was readily available, the Manitoba hog-barley price ratio was selected to represent the Canadian hog-feed grain price ratio. Monthly Manitoba hog-barley price ratios were obtained from the Statistics and Market Analysis Branch of Manitoba Agriculture and Food.

The United States reports a countrywide hog-corn price ratio. Monthly US hog-corn price ratios were obtained from the National Agricultural Statistics Service (NASS) of the United States Department of Agriculture (USDA).

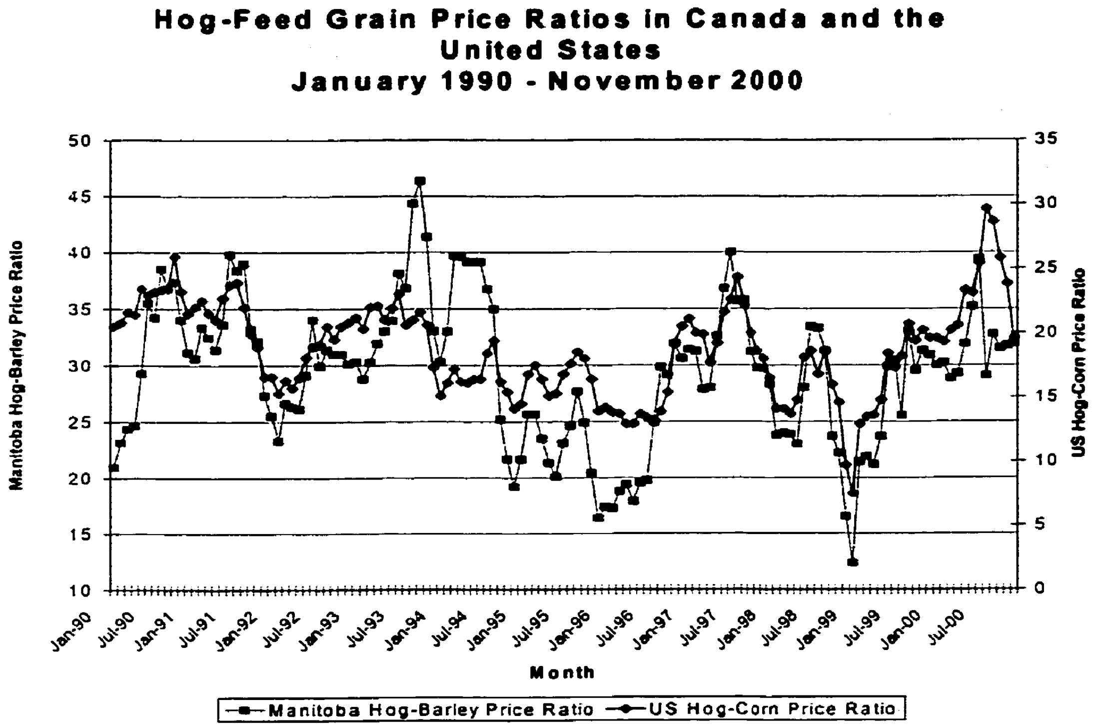

Figure 3.6 Monthly Hog-Feed Grain Price Ratios, January 1990 to November 2000

Pork Exports

The second continuous factor is pork exports. This variable provides a measure of international demand. Therefore, as pork exports increase, one would expect returns to pork processing companies to also increase. However, the increase in pork exports may be the result of a redistribution of sales away from the domestic market. Given that the Canadian pork market is relatively saturated, it is reasonable to expect a positive relationship between the level of pork exports and the returns to Canadian pork processing companies. For the same reasons, a positive relationship is also expected between the level of pork exports and the returns to American pork processing companies.

The study utilizes the value of exports to each countries' (*i.e.*, Canada and the United States) largest pork trading partner to estimate the effect of exports on the return to pork processing companies. The largest importer of Canadian pork is the United States, while Japan is the largest importer of American pork. The value of pork exports, as opposed to the quantity of exports, is used to facilitate the inclusion of the value of pork cuts exported. Monthly values of Canadian pork exports to the United States were obtained from the International Markets Bureau of Agriculture and Agri-food Canada (AAFC). These values were converted into real terms using the Canadian consumer price index (CPI) for all items (which was obtained from Statistics Canada's CANSIM Database, Series P100000). Monthly values of American pork exports to Japan were obtained from the Foreign Agricultural Trade of the United States (FATUS) Database of United States Department of Agriculture (USDA). These values were converted into real terms using the American CPI for all items (which was obtained from Statistics Canada's CANSIM Database, Series D139105). The American CPI for January and February 1998 was not available. Thus, the average of the CPI for December 1997 and March 1998 was used to replace the missing data. Figure 3.7 shows the real value of Canadian and American pork exports to their largest respective trading partner.

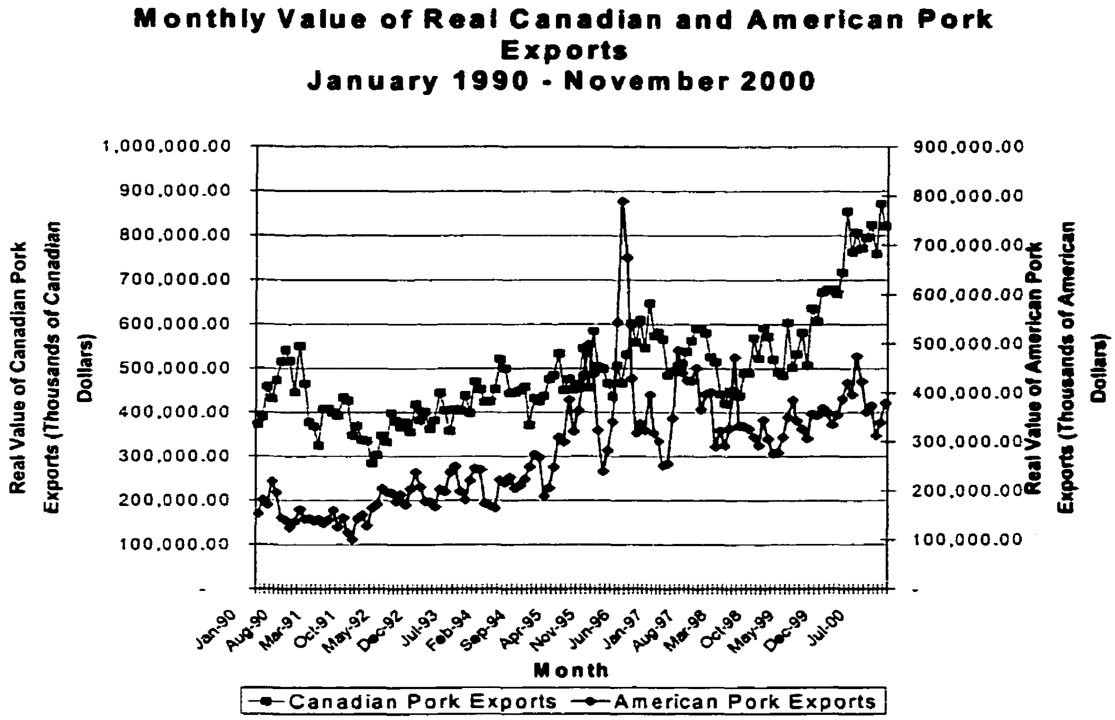

Figure 3.7 Monthly Value of Real Pork Exports, January 1990 to November 2000

Exchange Rates

As in the case of exports, the exchange rate for the most important pork market for each country was used. Therefore the Canada-US and US-Japan exchange rates were utilized in the SIM for the Canadian and American companies, respectively. Exchange rates play an important role in determining the level of exports. In fact, devaluation of one country's currency makes it cheaper for other countries to import goods from the other country, thereby increasing exports. For example, in Canada, the devaluation of the Canadian dollar makes it cheaper for the United States to import pork from Canada, thereby increasing Canadian pork exports. This means there is an inverse relationship between exchange rates and pork exports. In other words, as the value of the Canadian dollar falls (*ceteris paribus*), international demand for Canadian pork rises (assuming Canadian pork is desirable). This in turn, as per the exports discussion, increases returns to Canadian pork processing companies. Given this, one would expect a negative relationship between exchange rates and returns to Canadian pork processing companies.

Similarly, a negative relationship is expected between exchange rates and returns to American pork processing companies. This is because Figure 3.8 shows that between July 1995 and August 1998, the American dollar was depreciating relative to the Japanese Yen. At the same time, Figure 3.7 shows the real value of American pork exports to Japan was increasing. Thus, as the value of the American dollar falls relative to the Japanese Yen (assuming all else remains constant), Japanese demand for American pork rises (assuming American pork is desirable). This in turn, as per the exports discussion, increases returns to American pork processing companies. As such, a negative relationship between exchange rates and returns to American pork processing companies is expected.

Monthly US noon spot rates, in Canadian dollars, were obtained from Statistics Canada's CANSIM Database. The CANSIM series B3400 provides daily USA noon spot rate in unadjusted Canadian dollars. Daily exchange rates were converted into a monthly frequency by calculating the average exchange rate for the month. Monthly exchange rates from American dollars to Japanese Yen were obtained from the Pacific Exchange Rate Service (PERS) website. This website provides "volume notation" exchange rates. This means the value of the exchange rate is expressed in units of Japanese Yen per units of American dollars (Pacific Exchange Rate Service, 2001). This concludes the discussion of the continuous variables utilized in the study. Summary statistics for each of the continuous variables are provided in Tables 3.1 and 3.2.

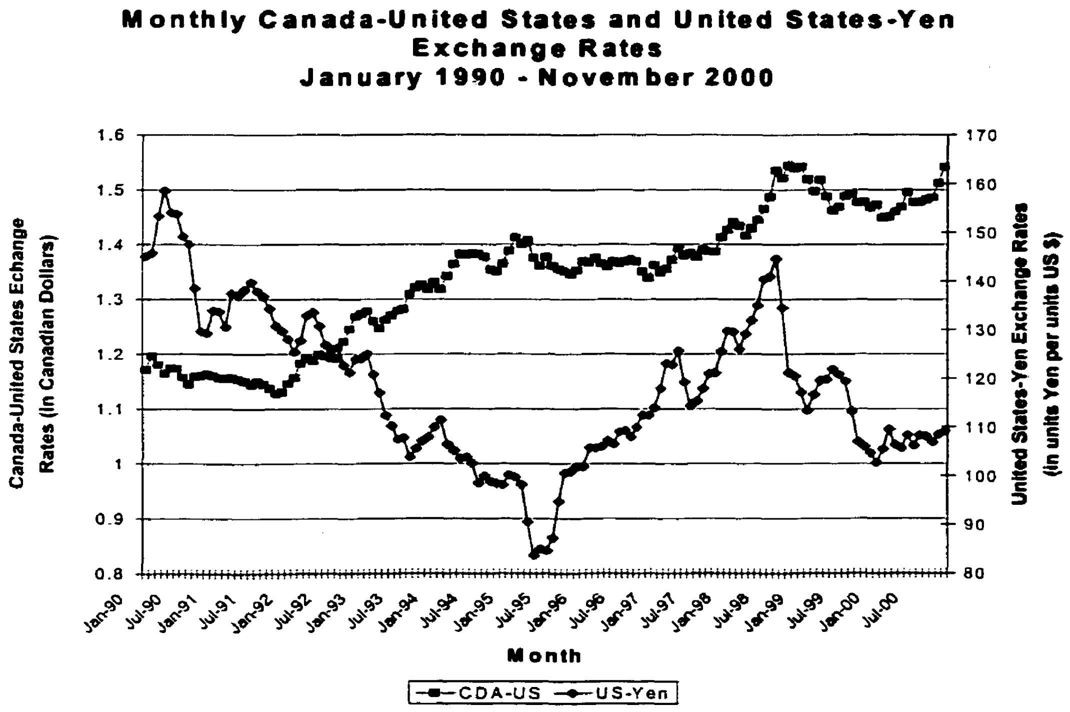

Figure 3.8 Monthly Exchange Rates, January 1990 to November 2000

Table 3.1 Summary Statistics for Continuous Variables, Canadian Companies

Statistic	**Return to Schneider** (%)	**Return to Maple Leaf** (%)	**Return to S&P 500** (%)	**Hog-Barley Price Ratio**	**Pork Exports** ($ '000 CDN)	**Exchange Rate** ($ CDN)
Mean	0.002	0.001	0.513×10^{-3}	29.434	0.500×10^6	1.340
Standard Deviation	0.002	0.009	0.002	6.448	0.121×10^6	0.121
Minimum	-0.070	-0.034	-0.007	12.371	0.284×10^6	1.128
Maximum	0.068	0.028	0.005	46.325	0.872×10^6	1.545

Table 3.2 Summary Statistics for Continuous Variables, American Companies

Statistic	**Return to Smithfield** (%)	**Return to IBP** (%)	**Return to S&P 500** (%)	**Hog-Corn Price Ratio**	**Pork Exports** ($ '000 US)	**Exchange Rate** (Yen/ $ US)
Mean	0.003	0.002	0.513×10^{-3}	18.721	0.281×10^6	117.83
Standard Deviation	0.002	0.011	0.002	3.713	0.116×10^6	15.729
Minimum	-0.043	-0.046	-0.007	7.500	0.100×10^6	83.654
Maximum	0.041	0.064	0.005	29.600	0.789×10^6	158.46

3.3 Binary Variables

Several variables included in the model are represented by binary dummy variables assuming a value of zero or one. This allows the variable to be considered in the model for one period but not another. As such, this section will introduce and discuss the hypotheses and data associated with the binary dummy variables included in $\mathbf{W}_t$. Note that hypotheses for binary dummy variables are expected to be the same for both the intercept and slope terms.

Removal of Manitoba Pork single desk selling status

The first binary dummy variable represents removal of the Manitoba Pork marketing monopoly. The single desk selling status of Manitoba Pork was removed effective July 1, 1996. Thus, this variable receives a value of zero from January 1990 to June 1996 and a value of one from July 1996 to November 2000.

The introduction of a flexible marketing system enabled Manitoba hog producers to market hogs for slaughter, either through Manitoba Pork or directly to the processing company. This effectively transformed hog producers from price makers to price takers which means hog producers and pork processing companies are now operating in a more competitive environment. Thus, hog producers and pork processors must carefully weigh their marketing and risk management options as the potential to receive/pay higher or lower prices for hogs exists. This means that pork processors may have increased potential to set the price they want to pay for hogs. Removal of the monopoly is expected to increase returns to the pork processor assuming hog prices decline. Therefore, a positive relationship is expected to exist between returns to pork processing companies and the removal of Manitoba Pork's single-desk selling status.

Schneider Bidding War and Merger

The second binary dummy variable represents the bidding war between Maple Leaf and Smithfield for Schneider, and the actual Schneider-Smithfield merger. The bidding war between Smithfield and Maple Leaf for Schneider began November 1997 and ended December 1998. The actual take-over of Schneider by Smithfield occurred in January 1999. Therefore, the dummy variable assigns a value of zero to the periods January 1990 to October 1997 and February 1999 to November 2000 and a value of one to the period November 1997 to January 1999.

The take-over of Schneider by Smithfield is one of the most significant acquisitions in the pork processing industry in recent years. The events leading up to the merger had a huge impact on the stock prices of Schneider, Maple Leaf and Smithfield. In fact Figure 3.8 shows that the bidding war between Smithfield Foods and Maple Leaf Foods drove the price of Schneider stock up to $29 per share from $13 per share. After the take-over was completed, the price of Schneider stock fell to and remained stagnant at $20 per share. Given this, the returns to Schneider and the merger activity are expected to have a positive relationship. Casual observation suggests that the stock prices for Maple Leaf, Smithfield and IBP were also positively impacted. As such, the relationship between returns to Maple Leaf, Smithfield and IBP and the merger activity is also expected to be positive.

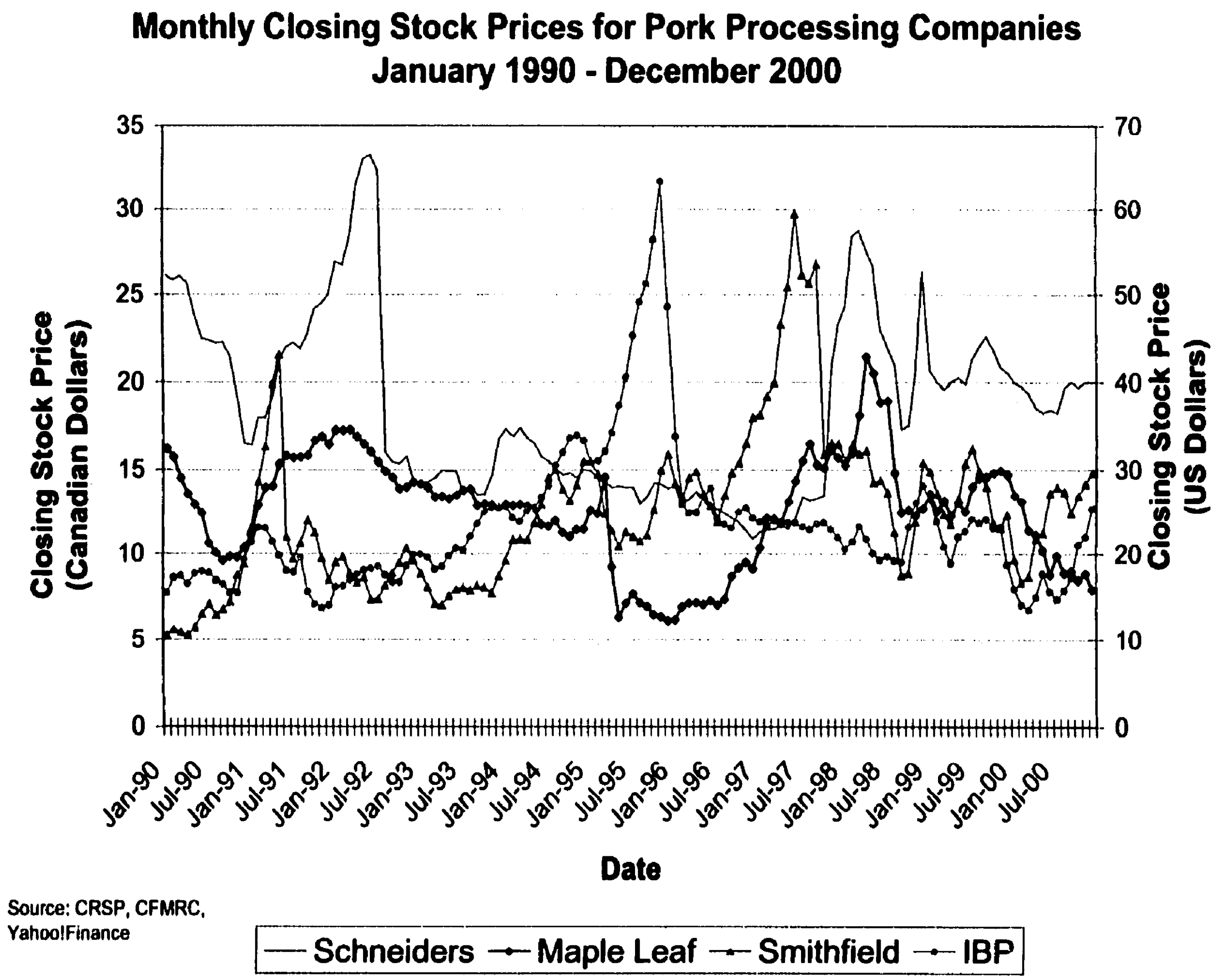

Figure 3.9 Monthly Closing Stock Prices for Schneider, Maple Leaf, Smithfield and IBP

It is important to note the Schneider bidding war and merger variable was later split into two separate binary dummy variables. The first represents the bidding war period only and does not consider the actual merger. As mentioned above, the bidding war between Smithfield and Maple Leaf for Schneider took place between November 1997 and December 1998. Thus, the bidding war only dummy variable assigns a value of one to this period and a value of zero to the remaining periods. The relationship between the bidding war and the return to all pork processing companies is expected to be positive.

The second variable considers the pre and post merger periods. Schneider's merger with Smithfield occurred in January 1999. Therefore, the dummy variable assigns a value of zero to the period January 1990 to December 1998 and a value of one to the period January 1999 to November 2000.

The acquisition of Schneider by Smithfield was intended to strengthen Smithfield's market position by enabling Smithfield to be a "low-cost producer with clear leads in technology and facility quality." (Smithfield website, 2001) In addition, the market position of Schneider is expected to improve as the acquisition enables Schneider to take advantage of Smithfield's resources. Given this, the merger between Schneider and Smithfield is expected to have a positive relationship with the returns to Schneider and Smithfield and a negative relationship with the returns to Maple Leaf and IBP.

Trade Agreements

The third binary dummy variable represents the Uruguay Round Agreement on Agriculture (URAA). The URAA, created during the Uruguay Round of the World Trade Organization (WTO) negotiations, comprises commitments by WTO member countries to reduce agricultural support and protection for market access, domestic support, and export subsidies.

Several significant trade agreements including the Canada-United States Trade Agreement (CUSTA), the North American Free Trade Agreement (NAFTA), the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO) agreement have also been formed in recent years. Of these, the URAA, representing the beginning of the liberalization of agricultural trade, is perhaps the most significant to agriculture. Although the GATT, formed before the URAA, addressed agricultural trade, it contained several loopholes (WTO website, 2001). For this reason, the URAA was selected to represent trade agreements.

The URAA, through the liberalization and globalization of world trade, is expected to promote fairer trade by "leveling the playing field". This means, for example, improving international market access for pork while, at the same time, providing non trade-distorting protection to the domestic pork market. Given this, a positive relationship is expected between trade agreements and returns to processing companies.

The URAA was implemented January 1, 1995. Therefore, the dummy variable assigns a value of zero to the period January 1990 to December 1994, and a value of one to the period January 1995 to November 2000.

Maple Leaf-McCain Amalgamation

The fourth binary dummy variable is the amalgamation of Maple Leaf and McCain Capital Corporation, including the Ontario Teachers' Pension Plan Board on April 24, 1995. As such, the dummy variable assigns a value of zero to the pre-merger period of January 1990 to March 1995 and a value of one the post-merger period of April 1995 to November 2000.

The amalgamation included the purchase of all issued and outstanding shares of Maple Leaf by Castlefin Inc (a company controlled by the Wallace F. McCain family), pursuant to which the shareholders of Maple Leaf received a combination of cash and shares of the amalgamated corporation. (Maple Leaf Foods, 1995) The amalgamation of Maple Leaf and McCain was expected to strengthen Maple Leaf's position in the market. Consequently this variable is expected to have a positive relationship with returns to Maple Leaf and a negative relationship with returns to Schneider, Smithfield and IBP.

Maple Leaf Brandon Plant

The fifth binary dummy variable represents Maple Leaf's decision and subsequent establishment of a $112-million pork processing facility in Brandon, Manitoba. Maple Leaf became serious about building a new processing plant in Manitoba when they made a bid for a site in Brandon, Manitoba on March 27, 1997. For this reason the dummy variable assigns a value of zero to the period January 1990 to February 1997. A value of one is assigned to the period March 1997 to November 2000.

The plant, with capacity to process 1,200 hogs per hour, opened in September 1999. As this plant expands Maple Leaf's processing capacity, the new processing plant is expected to have a positive relationship with returns to Maple Leaf and a negative relationship with returns to Schneider, Smithfield and IBP.

Maple Leaf-Landmark Feeds Merger

The Maple Leaf-Landmark Feeds merger is the sixth binary dummy variable. On September 10, 1999 Maple Leaf acquired all of the outstanding shares of the Landmark

Group and debt of the Landmark Group. Thus the dummy variable assigns a value of zero to the period January 1990 to August 1999 and a value of one to the period September 1999 to November 2000.

Landmark Feeds is the "largest and most progressive feed company in Western Canada" and Elite Swine is the "largest and most advanced hog genetics and marketing organization in Western Canada" (Maple Leaf Annual Report, 1999). This venture gives Maple Leaf more control over the hogs it purchases on the open market. Essentially it is a movement towards a more vertically integrated operation. For these reasons, the relationship between the Maple Leaf merger with Landmark and the returns to Maple Leaf is expected to be positive. Moreover, the relationship between the merger and returns to Schneider, Smithfield and IBP is expected to be negative.

This concludes the discussion of binary dummy variables included in the study. Summary statistics for each of the binary dummy variables are presented in Table 3.3.

Table 3.3 Summary Statistics for Binary Variables, All Companies

Variable	Period Assigned a Value of Zero	Period Assigned a Value of One	Mean
Manitoba Pork Marketing	Jan 90 – Jun 96	Jul 96 – Nov 00	0.405
Schneider Bidding War	Jan 90 – Oct 97 and Jan 99 – Nov 00	Nov 97 – Dec 98	0.107
URAA	Jan 90 – Dec 94	Jan 95 – Nov 00	0.542
Maple Leaf Merger with McCain	Jan 90 – Mar 95	Apr 95 – Nov 00	0.520
Maple Leaf Brandon Plant	Jan 90 – Feb 97	Mar 97 – Nov 00	0.344
Maple Leaf Merger with Landmark Feeds	Jan 90 – Aug 99	Sep 99 – Nov 00	0.115
Schneider Merger with Smithfield	Jan 90 – Dec 98	Jan 99 – Nov 00	0.176
Schneider Bidding War and Merger	Jan 90 – Oct 97 and Feb 99 – Nov 00	Nov 97 – Jan 99	0.115

3.4 Other Considerations

It is important to note the model developed in Chapter 2 does not include an exhaustive list of variables that may allow α_i and β_i to vary over time. Examples of factors that play an important role in the pork industry, but were not included in the model, are mergers and acquisitions within the feed industry, pork grading systems, labor disputes, capacity utilization, industry concentration, food safety and environmental considerations. Variables included in the model were selected on the basis that they were easily measurable, important factors in the pork industry and deemed likely to shift α_i and β_i.

3.5 Chapter Summary

This chapter introduced the variables and data that comprise the W-matrix of observable factors that enable α_i and β_i to vary over time. In addition, this chapter presented hypotheses regarding the effect of these variables on the returns to Schneider, Maple Leaf, Smithfield and IBP. Table 3.4 summarizes the hypotheses. Chapter 4 presents and discusses results of model specification tests and econometric estimates of the parameters of the single index model.

Table 3.4 Summary of Hypotheses

	Hypothesis Regarding Relationship with Returns to Company *i*			
Variable	**Schneider**	**Maple Leaf**	**Smithfield**	**IBP**
Market Return	Positive	Positive	Positive	Positive
Hog-Feedgrain Price Ratio	Negative	Negative	Negative	Negative
Pork Exports	Positive	Positive	Positive	Positive
Exchange Rate	Negative	Negative	Negative	Negative
Removal of Manitoba Pork Single-desk Selling	Positive	Positive	Positive	Positive
Schneider Bidding War and Merger with Smithfield	Positive	Positive	Positive	Positive
Schneider Bidding War Only	Positive	Positive	Positive	Positive
Schneider Merger with Smithfield Only	Positive	Positive	Negative	Negative
URAA	Positive	Positive	Positive	Positive
Maple Leaf Merger with McCain	Negative	Positive	Negative	Negative
Maple Leaf Brandon Plant	Negative	Positive	Negative	Negative
Maple Leaf Merger with Landmark	Negative	Positive	Negative	Negative

Chapter 4 – Results

4.1 Introduction

The last two chapters introduced the single index model as the conceptual framework for the study and discussed procedures used to allow α_i and β_i to vary over time. This chapter presents econometric estimates of the parameters of the single index model. To validate inferences and conclusions based on model estimates, results of model specification and hypothesis tests are also reviewed in this chapter. Chapter 5 uses parameter estimates presented in this chapter to derive estimates of systematic and nonsystematic risk for each model and each company.

4.2 Matrix Evolution

A myriad of results obtained from an "evolution" of the matrix of variables hypothesized to affect α_i and β_i are presented in this chapter. The initial model, referred to as model 1, utilized a W-matrix of variables believed to cause the parameters of the SIM to vary over time. These variables include: hog-feed grain price ratio, the real value of pork exports, exchange rates, removal of Manitoba Pork single-desk selling status, the bidding war leading up to and including the Schneider-Smithfield merger and the Uruguay Round Agreement on Agriculture (URAA). The second model, referred to as model 2, also includes a variable to account for the acquisition of Maple Leaf Foods by McCain Capital Corporation and the Ontario Teachers' Pension Plan Board. However, model 2's estimation results, to be discussed at a later time, were questionable. Consequently, a new model, referred to as model 3, was estimated using a modified Schneider-Smithfield merger variable and two additional variables. Specifically, the Schneider-Smithfield merger variable was split into two separate variables - one denoting the bidding war period and the other representing pre and post merger periods. The two additional variables account for the period following the announcement that Maple Leaf was to construct a new pork processing plant in Brandon and the announcement of the Maple Leaf merger with Landmark Feeds. It is important to note results for each of the three models for each company are independently considered. Results, presented in sections 4.4 and 4.5, will be considered one company at a time, after which they will be compared and contrasted.

4.3 Estimation of the Single Index Model

Econometric methods are utilized to analyze the relationship between the rate of return on stock *i*, the rate of return on the market and $\mathbf{W}_t$. The SIM, presented as a linear regression model, provides the foundation for the analysis. This model is built upon the observation that stock prices tend to move in conjunction with the market. That is, when the market rises, most stocks tend to increase in price, and when the market falls, most stocks tend to decrease in price. Thus, the single index model provides a measure of the correlation between stock *i*'s return and the market return.

A measure of this correlation is obtained by estimating the parameters of the SIM. Ordinary least squares (OLS), one of the most widely used econometric methods, is utilized to estimate the parameters of the model. The OLS estimator seeks to minimize the sum of the squared deviations of the actual observations from the regression line.

There are several statistical assumptions associated with the OLS estimation procedure:

1. The disturbance, ε_i, has a zero mean at every observation; $E[\varepsilon_i | \mathbf{X}] = 0$.
2. $\mathbf{X}$ is a nonstochastic matrix of regressors.

3. $\text{var}[\varepsilon_i|\mathbf{X}] = \sigma^2$ for all $i = 1,..,n$; errors are identically distributed.

4. $\text{cov}[\varepsilon_i,\varepsilon_j \mid \mathbf{X}] = 0$ for all $i \neq j$; errors are independent across observations.

5. $\varepsilon \mid \mathbf{X} \sim N[\mathbf{0},\sigma^2\mathbf{I}]$; disturbances are normally distributed with zero mean and constant variance (where $\mathbf{I}$ is an identity matrix).

Provided these assumptions hold, the OLS estimator will yield the best linear unbiased estimates (BLUE). This means that OLS estimates have the smallest variance compared to all other linear, unbiased estimators of the true value of the least squares estimate of the population mean.

4.4 Statistical Specification Tests

Parameter estimates obtained from the time-varying SIM must be evaluated to ensure they satisfy the statistical assumptions of the model. The theoretical validity and the statistical soundness of the linear regression model will be maintained provided the statistical assumptions of the model hold. Statistical specification tests help determine whether the model has been correctly specified. It is imperative that the statistical assumptions of the linear regression model are adhered to so that the integrity of hypothesis tests and inferences based on the estimated model is preserved.

Specification errors may arise from:

1. Omission of a relevant explanatory variable.
2. Inclusion of an irrelevant explanatory variable.
3. Incorrect mathematical form of the regression equation.
4. Incorrect specification of the properties of the errors.

Autocorrelation and heteroskedasticity tests are used to determine whether estimated errors satisfy the independence and identical distribution properties of the OLS estimator, respectively. In addition, RESET tests are used to ascertain that the model has been correctly specified. Given the model in question adheres to these conditions, joint tests to determine whether the independent variables have explanatory power in the regression equation can be conducted. That is, testing the hypothesis that the joint list of variables believed to allow α_i and β_i to vary over time equal zero. If these variables are jointly equal to zero, they should be dropped from the equation and the model should be re-estimated without them. In other words, there is no evidence that the SIM is time-varying. As such, the SIM with constant α_i and β_i should be estimated.

The first diagnostic test addresses serial dependence of the errors (*i.e.*, autocorrelation). Autocorrelation occurs when the error terms are correlated over successive time periods. One test for autocorrelation calculates the residual autocorrelations ($\hat{\rho}_j$) as (White, 1997):

$$\hat{\rho}_j = \frac{\sum_{t=j+1}^{N} e_t e_{t-j}}{\sum_{t=1}^{N} e_t^2} \quad \text{for } j=1,\ldots,p \qquad (4.1)$$

where j = autoregressive order
p = lag order

The null hypothesis is that ρ_j is equal to zero for all j. It is important to note that two autocorrelation tests were conducted, the first for a lag order equal to one and the second for a lag order equal to twelve. First-order autocorrelation arises when the error terms are correlated over successive time periods, while twelfth-order autocorrelation occurs when error terms for monthly data are correlated month-to-month (*i.e.*, January-to-January). Table 4.1 shows that the null hypotheses of no first-order autocorrelation and no twelfth-order autocorrelation were accepted in all instances at the five percent significance level. This means that the error terms do not appear to be correlated across successive time periods or responsive to monthly effects.

Table 4.1 Autocorrelation Test Results

Model	1st order *t*-statistic[a]	12th order *t*-statistic[a]	Conclusion
		Schneiders	
1	-0.747	-1.193	No autocorrelation
2	-0.753	-1.263	No autocorrelation
3	-0.900	-1.280	No autocorrelation
		Maple Leaf	
1	-0.164	-1.872	No autocorrelation
2	-0.344	-1.813	No autocorrelation
3	-0.051	-1.324	No autocorrelation
		Smithfield	
1	1.033	-0.078	No autocorrelation
2	0.841	-0.152	No autocorrelation
3	0.625	-0.421	No autocorrelation
		IBP	
1	-0.068	0.508	No autocorrelation
2	-0.025	0.492	No autocorrelation
3	-0.186	0.465	No autocorrelation

a. * denotes 0.10 level of significance, ** denotes 0.05 level of significance and *** denotes 0.01 level of significance.

The second diagnostic test is for heteroskedasticity. Errors are said to be heteroskedastic if their variance changes over time. One heteroskedasticity test statistic is NR^2, where N is the number of observations and R^2 is the coefficient of determination from the auxiliary regression of $\hat{Y}_t^2$ on a constant and e_t^2. This test statistic is distributed as χ^2 with one degree of freedom. The null hypothesis of homoskedasticity, or constant variance, is compared against the alternative hypothesis of heteroskedasticity. Table 4.2 shows that the null hypothesis of homoskedasticity was accepted in all instances at the ten percent significance level. This implies the variance of the error term is constant over time.

Table 4.2 Heteroskedasticity Test Results

Model	χ^2 test statistic[a]	Conclusion
Schneiders		
1	4.774	Homoskedastic
2	3.369	Homoskedastic
3	1.059	Homoskedastic
Maple Leaf		
1	0.004	Homoskedastic
2	0.088	Homoskedastic
3	0.143	Homoskedastic
Smithfield		
1	0.004	Homoskedastic
2	0.046	Homoskedastic
3	0.589	Homoskedastic
IBP		
1	0.127	Homoskedastic
2	0.107	Homoskedastic
3	0.031	Homoskedastic

a. There is one degree of freedom for the χ^2-statistics. Thus, the χ^2-critical value at the five and ten percent level of significance is 3.841 and 6.644, respectively.

The third diagnostic test is for specification error. The specification error test is comprised of a set of three Ramsey RESET tests. Furthermore,

> *"These tests are computed by running three additional regressions of the dependent variable on the independent variables and on the powers of $\hat{Y}$ (the predicted dependent variable - $\hat{Y}^2, \hat{Y}^3, \hat{Y}^4$) included in the same regression"* (White, 1997, p.182).

An F-test is then used to test the null hypothesis that the estimated coefficients on each power of $\hat{Y}$ are jointly equal to zero. Table 4.3 shows the null hypothesis of no specification error was accepted in all cases, except for Models 1 and 2 for Schneiders, at the five percent significance level. Nonetheless, the null hypothesis of no specification error was accepted for Models 1 and 2 for Schneiders at the one percent significance level. This implies the functional form of the model is not mis-specified.

Table 4.3 RESET Test Results

Model	RESET (2) F-statistic[a]	RESET(3) F-statistic[a]	RESET(4) F-statistic[a]	Conclusion
		Schneider		
1	6.216	3.196	2.688	No specification error
2	5.716	2.888	2.386	No specification error
3	0.301	0.157	0.588	No specification error
		Maple Leaf		
1	0.553	0.423	0.305	No specification error
2	0.582	0.429	0.293	No specification error
3	0.043	0.022	0.021	No specification error
		Smithfield		
1	0.262	0.484	0.343	No specification error
2	0.328	0.543	0.488	No specification error
3	1.626	1.115	1.833	No specification error
		IBP		
1	0.508	0.294	0.751	No specification error
2	0.677	0.390	0.983	No specification error
3	0.846	0.488	1.892	No specification error

a. The F-statistic critical values are based on (1,120), (2,120) and (3,120) degrees of freedom for the RESET(2), RESET (3) and RESET(4) tests, respectively. Thus the F-statistic critical values at the five percent level of significance are 3.92, 3.07 and 2.68 for RESET(2), RESET (3) and RESET(4) tests, respectively. In addition, the F-statistic critical values at the one percent significance level are 6.85, 4.79 and 3.95 for RESET(2), RESET (3) and RESET(4) tests, respectively.

Results of the model mis-specification tests indicate OLS residuals are serially independent and identically distributed. Furthermore, RESET tests do not indicate inappropriate specification of the functional form. Assuming the errors are normally distributed, one can then proceed to conduct various hypothesis tests on the estimated parameters using traditional t and F based tests. In fact, the next tests conducted are joint hypothesis tests. The purpose of the joint hypothesis tests is to determine whether the variables included in the W-matrix jointly cause the intercept (α_i) and/or slope (β_i) parameter in the SIM to shift over time. The null hypothesis is that the joint list of explanatory variables do not statistically differ from zero. Table 4.4 shows the null hypothesis was accepted in all cases at the five percent significance level.

Table 4.4 Joint Hypothesis Test Results

Model	Constant α F-statistic[a]	Constant β F-statistic[a]	Constant α and β F-statistic[b]	Conclusion
Schneider				
1	0.552	0.432	0.600	Accept H_0
2	0.518	0.431	0.542	Accept H_0
3	0.679	0.578	0.708	Accept H_0
Maple Leaf				
1	1.721	1.450	1.513	Accept H_0
2	1.505	1.210	1.408	Accept H_0
3	1.067	1.064	1.148	Accept H_0
Smithfield				
1	0.950	1.340	1.149	Accept H_0
2	0.854	0.927	1.085	Accept H_0
3	1.287	1.478	1.347	Accept H_0
IBP				
1	0.569	0.522	0.545	Accept H_0
2	0.503	0.458	0.471	Accept H_0
3	0.338	0.375	0.388	Accept H_0

a. The F-statistic critical values for the constant α_i (and constant β_i tests) are based on (6,120), (7,120) and (10,120) degrees of freedom for Model 1, Model 2 and Model 3, respectively. Thus, the F-statistic critical values at the five percent significance level are 2.17, 2.09 and 1.91 for Model 1, Model 2 and Model 3, respectively.
b. The F-statistic critical values for the constant α_i and β_i are based on (12,120), (14,120) and (20,120) degrees of freedom for Model 1, Model 2 and Model 3, respectively. Thus, the F-statistic critical values at the five percent significance level are 1.83, 1.75 and 1.66 for Model 1, Model 2 and Model 3, respectively.

Results of these tests suggest the parameters of the single index model do not vary over time. However, a study by Francis and Fabozzi (1979) that used a dummy variable technique to introduce time-varying parameters to the SIM suggests that in some cases a form of stepwise regression be used to specify the model. In their study, Francis and Fabozzi (1979) examined whether α_i and β_i vary with overall business conditions. To do this, they introduced a binary dummy variable to differentiate between periods of recession and economic expansion. Francis and Fabozzi (1979) state that while the initial model should allow for both intercept and slope shifts,

> *"a reduced model allowing for only one parameter shift should be estimated if it is found that one of the differential parameters is significant while the other is not. This will improve the precision of the estimate and save on degree of freedom"* (Francis and Fabozzi, 1979, p. 353).

This implies a form of stepwise regression should be utilized to specify the model.

Stepwise regression procedures define the model to be estimated by sequentially adding or deleting variables on the basis of their significance level (Greene, 2000). However, deleting a variable because it is statistically insignificant may bias the remaining regression coefficients (Wonnacott and Wonnacott, 1981). Moreover, as a model is estimated, tested and re-estimated, traditional t and F-tests are invalidated due to the fact that the sampling and testing distribution changes as variables are added to the regression equation. One method to adjust the test distribution is the Bonferroni Limit. This procedure widens the t-distribution by replacing $t(v, 1 - \alpha/2)$ by $t(v, 1 - \alpha/(2p))$ where α is the specified significance level and p is the number of parameters in the regression.

In addition to the inference difficulties associated with stepwise regression procedures, there is a methodological dilemma. Classical regression procedures assume the form of the "true model" is known *a priori*. This implies that the model is estimated once and the results are reported. In light of this, stepwise regression procedures that let the data select the model undermine classical regression procedures. After considering the advantages and disadvantages of the two regression procedures, it was concluded that the costs of the stepwise regression procedure outweighed the benefits. As such, classical regression procedures were utilized to obtain parameter estimates. Given this, it is extremely important to note that each of the three models, for each company, are considered in isolation. That is, the models are assumed completely independent of each other.

Although joint hypothesis tests suggest the explanatory variables of each company's model do not jointly vary over time, this does not mean individual variables are constant over time. The significance of individual variables may be examined using one or two-tailed *t*-tests. This study utilizes two-tailed *t*-tests to determine the statistical significance of individual variables. The use of one-tailed *t*-tests was rejected for two reasons. The first is that one-tailed tests require that the relationship between the dependent and independent variable considered is known *a priori*. This is a problem for slope parameters whose relationships with the dependent variable are not clearly understood. For example, as discussed in Chapter 3, the relationship between company returns and merger and acquisition activity is unclear. In addition, it is often difficult to predict relationships for intercept parameters. The second reason is that a ten percent significance level was selected to determine the statistical significance of individual variables. At a ten percent significance level, there is a 1 in 10 chance of accepting that a variable is statistically significant when in fact it does not statistically differ from zero. The critical values for two-tailed and one-tailed *t*-statistics are 1.645 and 1.282, respectively, at the ten percent significance level. By using a one-tailed *t*-test with a ten percent significance level, the rejection region is isolated in one tail of the *t*-distribution. This lowers the critical *t*-value and effectively increases the chances of concluding that a variable is statistically significant. This lowers the power of the test utilized to determine the statistical significance of explanatory variables and is equivalent to manipulating the model to achieve a desired result. This being said, regression results for time-varying models will be presented in Section 4.5 and discussed in Section 4.6.

4.5 Time-Varying Single Index Model Parameter Estimates

Schneider

Table 4.5 shows the time-varying parameter estimates for each model for Schneider. From this table it is evident there are no statistically significant variables in each time-varying SIM for Schneider. This means regression results do not provide evidence to support the hypothesis that returns to Schneider are affected by these variables. Thus, the hypothesis that the SIM for Schneider varies over time is rejected. Given this, a SIM with constant α_i and β_i should be estimated for Schneider. Results for the constant model will be presented in Section 4.7.

Maple Leaf

Regression results presented in Table 4.6 show that the models for Maple Leaf contain several statistically significant variables. Specifically, in Model 1, the real value of pork exports, removal of Manitoba Pork single-desk selling status and the Smithfield-Schneider bidding war/merger are significant intercept shifters while the URAA is a significant slope shifter. In Model 2, the real value of pork exports, removal of Manitoba Pork marketing single-desk selling status and the Schneider bidding war/merger are significant intercept shifters. However, the URAA is not a significant slope shifter for Model 2. Rather Model 2's significant slope shifter is the Schneider bidding war/merger. Interestingly, the only significant variables for Model 3 are intercept shifters, namely, the real value of exports and removal of Manitoba Pork marketing single-desk selling status. Thus, the hypothesis that parameters of the SIM for

Maple Leaf vary over time is accepted. The hypotheses presented in Chapter 3 for each of the statistically significant variables will be discussed in Section 4.6.

Smithfield

Regression results presented in Table 4.7 show that models for Smithfield have several statistically significant slope parameters. Interestingly, there are no statistically significant intercept shifters for Smithfield Models 1 and 2. This means that intercepts in Models 1 and 2 do not vary over time. The statistically significant slope shifters for Model 1 are removal of Manitoba Pork single-desk selling status and the URAA. For Model 2, removal of Manitoba Pork single-desk selling status is the only significant slope shifter. The statistically significant intercept shifters for Model 3 are hog-corn feed grain ratio and exchange rates. Additionally, removal of Manitoba Pork single-desk selling status and Maple Leaf merger with Landmark Feeds are statistically significant slope shifters. Thus, the hypothesis that the parameters of the SIM for Smithfield vary over time is accepted. The hypotheses presented in Chapter 3 for each of the statistically significant variables will be discussed in Section 4.6.

IBP

Table 4.8 shows the time-varying parameter estimates for each model for IBP. From this table it is evident there are no statistically significant variables in each time-varying SIM for IBP. This means regression results do not provide evidence to support the hypothesis that these variables individually affect the return to IBP. Thus, the hypothesis that SIM for IBP varies over time is rejected. Given this, the SIM with α_i and β_i should be estimated for IBP. Results for the constant model will be presented in Section 4.7.

Table 4.5 Time-Varying Model Parameter Estimates for Schneider

Variable	Model 1	Model 2	Model 3
	Estimated Coefficient (*t*-ratio)[a]	Estimated Coefficient (*t*-ratio)[a]	Estimated Coefficient (*t*-ratio)[a]
Intercept: Hog-Feed Grain Price Ratio	-0.382×10^{-3} (-0.905)	-0.381×10^{-3} (-0.894)	-0.454×10^{-3} (-1.018)
Intercept: Pork Exports	-0.228×10^{-7} (-0.757)	-0.223×10^{-7} (-0.735)	-0.537×10^{-7} (-1.298)
Intercept: Exchange Rate	-0.016 (-0.509)	-0.016 (-0.517)	-0.007 (-0.204)
Intercept: Manitoba Pork Single-Desk Selling	0.008 (0.715)	0.009 (0.801)	0.004 (0.323)
Intercept: Schneider Bidding War			-0.004 (-0.316)
Intercept: URAA	-0.002 (-0.017)	0.034 (0.613)	-0.036 (0.647)
Intercept: Maple Leaf-McCain Amalgamation		-0.037 (-0.667)	-0.037 (-0.668)
Intercept: Maple Leaf Brandon Plant			0.009 (0.681)
Intercept: Maple Leaf-Landmark Merger			0.021 (1.600)
Intercept: Post Schneider-Smithfield Merger			-0.013 (-1.043)
Intercept: Schneider Bidding War & Merger	0.122×10^{-3} (0.014)	0.276×10^{-3} (0.030)	
Return on S&P 500	22.799 (1.017)	22.328 (0.985)	16.475 (0.661)
Slope: Hog-Feed Grain Price Ratio	-0.136 (-0.609)	-0.130 (-0.576)	-0.132 (-0.539)
Slope: Pork Exports	-0.328×10^{-5} (-0.230)	-0.352×10^{-5} (-0.246)	-0.149×10^{-4} (-0.719)
Slope: Exchange Rate	-15.156 (-0.789)	-14.835 (-0.765)	-6.051 (-0.285)
Slope: Manitoba Pork Single-Desk Selling	4.505 (0.530)	3.241 (0.359)	9.388 (0.959)

a. * denotes 0.10 level of significance, ** denotes 0.05 level of significance and *** denotes 0.01 level of significance.

Table 4.5 continued

Variable	Model 1 Estimated Coefficient (*t*-ratio)[a]	Model 2 Estimated Coefficient (*t*-ratio)[a]	Model 3 Estimated Coefficient (*t*-ratio)[a]
Slope: Schneider Bidding War			0.667 (0.132)
Slope: URAA	2.102 (0.237)	-23.633 (-0.615)	-25.328 (-0.659)
Slope: Maple Leaf-McCain Amalgamation		26.979 (0.689)	26.668 (0.682)
Slope: Maple Leaf Brandon Plant			-5.690 (-1.004)
Slope: Maple Leaf-Landmark Merger			8.574 (1.197)
Slope: Post Schneider-Smithfield Merger			-4.325 (-0.667)
Slope: Schneider Bidding War & Merger	0.165 (0.043)	0.135 (0.035)	
Constant	0.043 (1.143)	0.043 (1.135)	0.047 (1.140)
Adjusted R^2	-0.0425	-0.0562	-0.0513

a. * denotes 0.10 level of significance, ** denotes 0.05 level of significance and *** denotes 0.01 level of significance.

Table 4.6 Time-Varying Model Parameter Estimates for Maple Leaf

Variable	Model 1	Model 2	Model 3
	Estimated Coefficient (*t*-ratio)[a]	**Estimated Coefficient (*t*-ratio)[a]**	**Estimated Coefficient (*t*-ratio)[a]**
Intercept: Hog-Feed Grain Price Ratio	0.768×10^{-4} (0.469)	0.598×10^{-4} (0.363)	0.843×10^{-4} (0.483)
Intercept: Pork Exports	**-0.249×10^{-7}** (-2.131)**	**-0.250×10^{-7}** (-2.138)**	**-0.352×10^{-7}** (-2.176)**
Intercept: Exchange Rate	0.010 (0.794)	0.009 (0.725)	0.009 (0.718)
Intercept: Manitoba Pork Single-Desk Selling	**0.010** (2.325)**	**0.010** (2.261)**	**0.009* (1.745)**
Intercept: Schneider Bidding War			-0.005 (-1.070)
Intercept: URAA	-0.004 (-0.772)	-0.013 (-0.618)	-0.012 (-0.567)
Intercept: Maple Leaf-McCain Amalgamation		0.010 (0.457)	0.010 (0.473)
Intercept: Maple Leaf Brandon Plant			-0.001 (-0.234)
Intercept: Maple Leaf-Landmark Merger			0.005 (0.934)
Intercept: Post Schneider-Smithfield Merger			0.480×10^{-4} (0.010)
Intercept: Schneider Bidding War & Merger	**-0.007* (-1.867)**	**-0.007* (-1.914)**	
Return on S&P 500	6.512 (0.748)	7.500 (0.857)	1.703 (0.175)
Slope: Hog-Feed Grain Price Ratio	0.034 (0.388)	0.024 (0.277)	-0.010 (-0.102)
Slope: Pork Exports	-0.351×10^{-5} (-0.635)	-0.330×10^{-5} (-0.595)	-0.902×10^{-6} (-0.111)
Slope: Exchange Rate	-4.472 (-0.560)	-5.127 (-0.684)	-0.228 (-0.003)
Slope: Manitoba Pork Single-Desk Selling	-4.964 (-1.506)	-3.543 (-1.106)	-1.769 (-0.462)

a. * denotes 0.10 level of significance, ** denotes 0.05 level of significance and *** denotes 0.01 level of significance.

Table 4.6 continued

Variable	Model 1	Model 2	Model 3
	Estimated Coefficient (*t*-ratio)[a]	**Estimated Coefficient (*t*-ratio)[a]**	**Estimated Coefficient (*t*-ratio)[a]**
Slope: Schneider Bidding War			1.186 (0.599)
Slope: URAA	**6.012* (1.743)**	16.074 (1.083)	14.638 (0.974)
Slope: Maple Leaf-McCain Amalgamation		-11.376 (-0.752)	-11.645 (-0.762)
Slope: Maple Leaf Brandon Plant			-0.705 (-0.318)
Slope: Maple Leaf-Landmark Merger			1.263 (0.450)
Slope: Post Schneider-Smithfield Merger			-3.129 (-1.234)
Slope: Schneider Bidding War & Merger	2.448 (1.637)	**2.475* (1.652)**	
Constant	-0.004 (-0.287)	-0.003 (-0.178)	-0.169×10^{-4} (-0.001)
Adjusted R^2	0.076	0.0733	0.054

a. * denotes 0.10 level of significance, ** denotes 0.05 level of significance and *** denotes 0.01 level of significance.

Table 4.7 Time-Varying Model Parameter Estimates for Smithfield

Variable	Model 1	Model 2	Model 3
	Estimated Coefficient (*t*-ratio)[a]	**Estimated Coefficient (*t*-ratio)[a]**	**Estimated Coefficient (*t*-ratio)[a]**
Intercept: Hog-Feed Grain Price Ratio	0.367×10^{-3} (0.984)	0.402×10^{-3} (1.073)	**0.001**** **(2.316)**
Intercept: Pork Exports	-0.128×10^{-8} (-0.065)	-0.580×10^{-8} (-0.286)	-0.996×10^{-8} (-0.453)
Intercept: Exchange Rate	-0.490×10^{-4} (-0.520)	-0.549×10^{-4} (-0.579)	$\mathbf{-0.174 \times 10^{-3}}$* **(-1.722)**
Intercept: Manitoba Pork Single-Desk Selling	-0.006 (-1.023)	-0.007 (1.142)	-0.003 (-0.350)
Intercept: Schneider Bidding War			-0.005 (-0.805)
Intercept: URAA	0.006 (0.854)	-0.002 (-0.079)	-0.004 (-0.122)
Intercept: Maple Leaf-McCain Amalgamation		0.010 (0.341)	0.013 (0.420)
Intercept: Maple Leaf Brandon Plant			0.293×10^{-4} (0.004)
Intercept: Maple Leaf-Landmark Merger			-0.010 (-1.545)
Intercept: Post Schneider-Smithfield Merger			-0.003 (-0.492)
Intercept: Schneider Bidding War & Merger	-0.005 (-1.008)	-0.005 (-0.966)	
Return on S&P 500	-0.318 (-0.041)	-0.285 (-0.037)	-7.179 (-0.830)
Slope: Hog-Feed Grain Price Ratio	-0.285 (-1.400)	-0.268 (-1.312)	**-0.493**** **(-2.107)**
Slope: Pork Exports	0.107×10^{-4} (0.780)	0.866×10^{-5} (0.623)	0.195×10^{-4} (1.166)
Slope: Exchange Rate	0.050 (0.865)	0.050 (0.855)	**0.122*** **(1.881)**

a. * denotes 0.10 level of significance, ** denotes 0.05 level of significance and *** denotes 0.01 level of significance.

Table 4.7 continued

Variable	Model 1	Model 2	Model 3
	Estimated Coefficient (*t*-ratio)[a]	**Estimated Coefficient (*t*-ratio)[a]**	**Estimated Coefficient (*t*-ratio)[a]**
Slope: Manitoba Pork Single-Desk Selling	**10.394** (2.267)**	**9.370* (1.954)**	**9.013* (1.692)**
Slope: Schneider Bidding War			1.728 (0.545)
Slope: URAA	**-11.836** (-2.132)**	-10.126 (-0.490)	-9.369 (-0.463)
Slope: Maple Leaf-McCain Amalgamation		-0.249 (-0.012)	-2.337 (-0.112)
Slope: Maple Leaf Brandon Plant			-3.159 (-0.890)
Slope: Maple Leaf-Landmark Merger			**5.672* (1.656)**
Slope: Post Schneider-Smithfield Merger			0.618 (0.171)
Slope: Schneider Bidding War & Merger	-0.572 (-0.246)	-0.633 (-0.272)	
Constant	0.003 (0.183)	0.003 (0.244)	0.007 (0.489)
Adjusted R^2	0.089	0.085	0.1237

a. * denotes 0.10 level of significance, ** denotes 0.05 level of significance and *** denotes 0.01 level of significance.

Table 4.8 Time-Varying Model Parameter Estimates for IBP

Variable	Model 1	Model 2	Model 3
	Estimated Coefficient (*t*-ratio)[a]	**Estimated Coefficient (*t*-ratio)[a]**	**Estimated Coefficient (*t*-ratio)[a]**
Intercept: Hog-Feed Grain Price Ratio	0.425×10^{-3} (1.172)	0.422×10^{-3} (1.150)	0.431×10^{-3} (0.973)
Intercept: Pork Exports	0.226×10^{-7} (1.176)	0.239×10^{-7} (1.207)	0.253×10^{-7} (1.129)
Intercept: Exchange Rate	0.678×10^{-4} (0.740)	0.708×10^{-4} (0.764)	0.680×10^{-4} (0.661)
Intercept: Manitoba Pork Single-Desk Selling	0.136×10^{-3} (0.023)	0.607×10^{-3} (0.100)	-0.335×10^{-3} (-0.043)
Intercept: Schneider Bidding War			0.003 (0.500)
Intercept: URAA	-0.004 (-0.558)	0.007 (0.242)	0.007 (0.236)
Intercept: Maple Leaf-McCain Amalgamation		-0.012 (-0.397)	-0.012 (-0.394)
Intercept: Maple Leaf Brandon Plant			-0.001 (-0.174)
Intercept: Maple Leaf-Landmark Merger			-0.920×10^{-3} (-0.146)
Intercept: Post Schneider-Smithfield Merger			0.003 (0.267)
Intercept: Schneider Bidding War & Merger	0.205×10^{-3} (0.043)	0.167×10^{-3} (0.034)	
Return on S&P 500	2.671 (0.356)	2.793 (0.369)	4.150 (0.471)
Slope: Hog-Feed Grain Price Ratio	0.008 (0.041)	0.008 (0.041)	0.108 (0.453)
Slope: Pork Exports	-0.546×10^{-5} (-0.411)	-0.578×10^{-5} (-0.425)	-0.569×10^{-5} (-0.334)
Slope: Exchange Rate	-0.004 (-0.076)	-0.005 (-0.086)	-0.031 (-0.463)

a. * denotes 0.10 level of significance, ** denotes 0.05 level of significance and *** denotes 0.01 level of significance.

Table 4.8 continued

Variable	Model 1	Model 2	Model 3
	Estimated Coefficient (*t*-ratio)[a]	**Estimated Coefficient (*t*-ratio)[a]**	**Estimated Coefficient (*t*-ratio)[a]**
Slope: Manitoba Pork Single-Desk Selling	-1.819 (-0.408)	-2.063 (-0.440)	-1.343 (-0.247)
Slope: Schneider Bidding War			2.849 (0.914)
Slope: URAA	1.195 (0.221)	-6.110 (-0.302)	-6.713 (-0.325)
Slope: Maple Leaf-McCain Amalgamation		7.600 (0.366)	7.711 (0.362)
Slope: Maple Leaf Brandon Plant			-0.325 (-0.090)
Slope: Maple Leaf-Landmark Merger			-1.224 (-0.351)
Slope: Post Schneider-Smithfield Merger			0.126 (0.034)
Slope: Schneider Bidding War & Merger	2.119 (0.939)	2.125 (0.934)	
Constant	-0.019 (-1.422)	-0.020 (-1.444)	-0.020 (-1.333)
Adjusted R^2	-0.035	-0.051	-0.095

a. * denotes 0.10 level of significance, ** denotes 0.05 level of significance and *** denotes 0.01 level of significance.

4.6 Time-Varying Models Hypotheses Discussion

Section 4.5 concluded the parameters of the SIM for Schneider and IBP do not vary over time and the parameters of the SIM for Maple Leaf and Smithfield do vary over time. Given this, hypotheses associated with the statistically significant variables of the time-varying SIMs are discussed in this section. At this point it is important to note that the following discussion makes conjectures based on the estimated model. Thus, the following discussion is not representative of the universal truth. In addition, variables found to be statistically insignificant are not discussed. This is because parameter estimates for statistically insignificant variables do not statistically differ from zero. Thus, statistically insignificant variables do not affect returns to company *i*.

Chapter 2 demonstrated that relating α_i and β_i to $\mathbf{W_t}$ enables the parameters of the SIM to vary from one period to another. Given this, the relationship observed between $\mathbf{W_t}$ and the return to company *i* is described by econometric parameter estimates (presented in section 4.5). Figure 4.1 shows how the z^{th} variable in $\mathbf{W_t}$ affects the intercept parameter, α_i, causing either a positive (a) or negative (b) parallel shift in the risk-return relationship. The direction and size of the shift depends on the sign and magnitude, respectively, of the parameter estimate of the z^{th} variable in $\mathbf{W_t}$, γ_{iz}. Figure 4.2 shows how the z^{th} variable in $\mathbf{W_t}$ and the market return interact to affect the slope parameter, β_i, causing either a positive (a) or negative (b) pivot in the risk-return relationship. The direction and size of the pivot depends on the sign and magnitude, respectively, of the parameter estimate of the product of the market return and the z^{th} variable in $\mathbf{W_t}$, δ_{iz}.

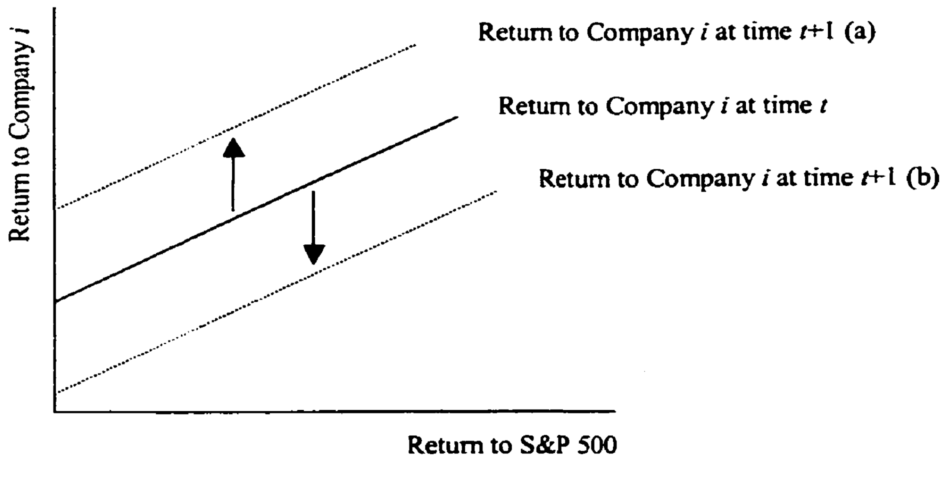

Figure 4.1 Intercept Parameter Shift

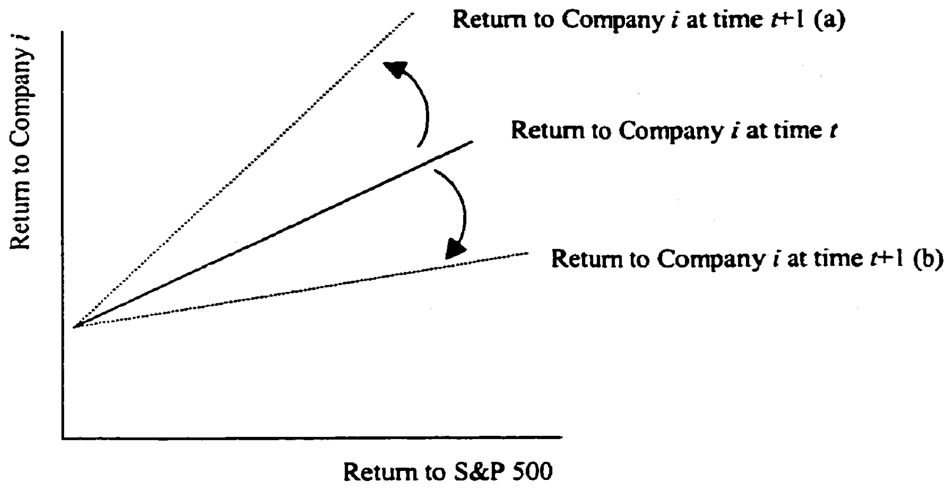

Figure 4.2 Slope Parameter Shift

Maple Leaf Model 1

Intercept: Pork Exports

Returns to Maple Leaf were expected to have a positive relationship with the pork exports intercept coefficient. The parameter estimate of -0.249×10^{-7} does not support this hypothesis. One explanation is the Canadian pork market is not as saturated as expected.

Intercept: Removal of Manitoba Pork Single-Desk Selling

Returns to Maple Leaf were expected to have a positive relationship with the intercept coefficient representing the removal of Manitoba Pork's single-desk selling status. The parameter estimate of 0.010 supports this hypothesis. One interpretation is that removal of Manitoba Pork's single-desk selling status enables pork processors to negotiate lower prices for Manitoba hogs. Therefore, as the price pork processors pay for Manitoba hogs decreases, returns to pork processing companies increase, *ceteris paribus*.

Intercept: Schneider Bidding War / Merger with Smithfield

As the bidding war between Maple Leaf and Smithfield for Schneider drove the price of Maple Leaf stock up from 15.018 in October 1997 to 21.523 in May 1998 (see Figure 1.5), returns to Maple Leaf were expected to be positively related to the Schneider bidding war/merger variable. The parameter estimate of –0.007 does not support this hypothesis.

Given that returns are a function of price in time *t* and *t-1*, it is possible that returns to Maple Leaf were negatively impacted by the bidding war/merger period. In fact, a negative relationship would exist if marginal increases in price were diminishing over the bidding war/merger period. Alternatively, the Schneider bidding war/merger dummy variable may have picked up the effect of some other variable unique to Maple Leaf that was not included in the model.

Slope: URAA

Returns to Maple Leaf were expected to have a positive relationship with the slope coefficient for the interaction between the URAA and the market return. The parameter estimate of 6.012 supports this hypothesis. One possible explanation is freer trade enabled Maple Leaf to increase their returns by selling their products internationally.

Maple Leaf Model 2

Intercept Parameters

The statistically significant intercept shifters for Maple Leaf Model 2 are basically equivalent to Maple Leaf Model 1. In fact, the statistically significant $\mathbf{W}_t$ intercept parameter estimates, γ_{iz}, for Maple Leaf Model 2 are the same as for Maple Leaf Model 1 (except for pork exports where the parameter estimate for model 1 was -0.249×10^{-7} and the parameter estimate for model 2 was -0.250×10^{-7}). Given this, the intercept parameter discussion presented for Maple Leaf model 1 is also applicable for Maple Leaf model 2.

Slope: Schneider Bidding War / Merger with Smithfield

Returns to Maple Leaf were expected to have a positive relationship with slope coefficient representing the interaction between the Schneider bidding war/merger and the market return. This is because the bidding war between Maple Leaf and Smithfield for Schneider drove the price of Maple Leaf stock up from 15.018 in October 1997 to 21.523 in May 1998 (see Figure 1.5). The slope parameter estimate of 2.475 supports this hypothesis.

It is plausible that returns to Maple Leaf were positively impacted by the bidding war/merger period. Because returns are a function of price in time t and $t-1$, a positive relationship would exist if marginal increases in price grew over the bidding war/merger period. Another interpretation is that the effect some other variable not included in the model was picked up by the Schneider bidding war/merger dummy variable.

Therefore, in an effort to determine whether the positive relationship was the result of the bidding war period, the actual merger and/or another variable omitted from the regression, a new model, referred to as Model 3, was estimated. In Model 3, the Schneider bidding war/merger dummy variable was split into two separate variables. The first represents the bidding war period only and the second represents the post merger period. In addition, Maple Leaf's plans to construct a new pork processing plant in Brandon, Manitoba as well as their merger with Landmark Feeds were announced during the same time period. As such, two separate dummy variables representing these occurrences were also included in Model 3.

Maple Leaf Model 3

Intercept: Removal of Manitoba Pork Single-Desk Selling

Returns to Maple Leaf were expected to have a positive relationship with the intercept coefficient representing removal of Manitoba Pork's single-desk selling status. The parameter estimate of 0.009 supports this hypothesis. As in Maple Leaf Models 1 and 2, one explanation is the removal of Manitoba Pork's single-desk selling status enables pork processors to negotiate lower prices for Manitoba hogs. Thus, as the price pork processors pay for Manitoba hogs decreases, returns to pork processing companies increase, *ceteris paribus*.

Slope Parameters

There were no statistically significant slope shifters for Maple Leaf Model 3. This implies the portion of Maple Leaf returns that are related to the market are not affected by the interaction between $\mathbf{W_t}$ and the market return. This suggests, for Maple Leaf Model 3, β_i does not vary over time.

Smithfield Model 1

Intercept Parameters

There were no statistically significant intercept shifters for Smithfield Model 1. This implies the portion of returns to Smithfield that are independent of the market, are not affected by $\mathbf{W_t}$. This suggests, for Smithfield Model 1, α_i does not vary over time.

Slope: Removal of Manitoba Pork Single-Desk Selling

Returns to Smithfield were expected to have a positive relationship with the slope coefficient for the interaction between removal of Manitoba Pork single-desk selling status and the market return. The parameter estimate of 10.394 supports this hypothesis. One interpretation is removal of the Manitoba Pork single-desk selling status enables pork processors to negotiate a lower price for Manitoba hogs. However, at the time the single-desk selling status of Manitoba Pork was removed, Smtihfield did not have operations in Manitoba. Further to this, because Smithfield is a very large company, other factors may have been at play. As such, the dummy variable representing removal of Manitoba Pork's single-desk selling status may have picked up the effect of some other variable that was not included in the model. In fact, this may explain the large magnitude of the estimated slope coefficient for the Manitoba Pork dummy variable relative to the other parameter estimates.

Slope: URAA

Returns to Smithfield were expected to have a positive relationship with the slope coefficient for the URAA. The return to Smithfield was expected to have a positive relationship with the URAA variable because the liberalization of world trade contributed to increased opportunities for international market access. The parameter estimate of – 11.836 does not support the hypothesis of a positive relationship. One interpretation is, under the URAA, Smithfield faces increased competition by other companies for domestic and/or international market share.

Smithfield Model 2

Intercept Parameters

There were no statistically significant intercept shifters for Smithfield Model 2. As in Smithfield Model 1, this implies the portion of returns to Smithfield that are independent of the market, are not affected by $\mathbf{W_t}$. This suggests, for Smithfield Model 1, α_i does not vary over time.

Slope: Removal of Manitoba Pork Single-Desk Selling

Returns to Smithfield were expected to have a positive relationship with the slope coefficient for the interaction between removal of the Manitoba Pork single-desk selling status and the market return. The slope parameter estimate of 9.370 supports this hypothesis. The discussion regarding this variable presented in Smithfield Model 1 is also applicable for Model 2. Note the parameter estimate for the removal of Manitoba Pork single-desk selling status variable decreased from 10.394 in Model 1 to 9.370 in Model 2. However, relative to the other parameter estimates, the Manitoba Pork slope parameter estimate of 9.370 is still large.

Smithfield Model 3

Intercept and Slope: Hog-Feed Grain Price Ratio

Returns to Smithfield were expected to have a negative relationship with parameter estimates for the hog-feed grain price ratio. The intercept parameter estimate of 0.001 does not support this hypothesis. The slope parameter estimate of –0.493 supports this hypothesis. The combined effect of the intercept and slope supports the hypothesis that the hog-feed grain price ratio is negatively related to the return to

Smithfield. Thus, when the profitability of producing hogs is low (*i.e.*, low hog-feed grain price ratio) returns to Smithfield are expected to be high, and vice versa.

Intercept and Slope: Exchange Rate

Returns to Smithfield were expected to have a negative relationship with the exchange rates coefficient. This hypothesis is supported by the intercept parameter estimate of -0.174×10^{-3}. The slope parameter estimate of 0.122 does not support this hypothesis. The combined effect of the intercept and slope does not support the hypothesis of a negative relationship between exchange rates and the return to Smithfield.

One explanation is appreciation of the American dollar relative to the Japanese Yen, leads to a decrease in American pork exports to Japan. However, pork sales to other international markets and/or the domestic market may increase. Therefore, returns to Smithfield may also increase.

Slope: Removal of Manitoba Pork Single-Desk Selling

Returns to Smithfield were expected to have a positive relationship with the slope coefficient for the interaction between removal of Manitoba Pork single-desk selling status and the market return. The parameter estimate of 9.013 supports this hypothesis. The Smithfield Model 1 discussion presented for this variable also applies to Smithfield Model 3.

Slope: Maple Leaf Merger with Landmark Feeds

Returns to Smithfield were expected to have a positive relationship with the slope coefficient for the interaction between the Maple Leaf merger with Landmark Feeds and the market return. The parameter estimate of 5.672 supports this hypothesis. One interpretation is this variable may have picked up the effect of some other variable unique to Smithfield (that was not included in the model). For example, at the same time Maple Leaf announced their merger with Landmark Feeds, Smithfield announced that it had reached agreements to acquire the Murphy Family Farms hog production company and the hog production operations of Tyson Foods.

4.7 Single Index Model with Constant α_i and β_i Parameter Estimates

Section 4.6 discussed relationships between each statistically significant variable in $\mathbf{W}_t$ and the return to pork processing companies for each time-varying SIM. This section presents parameter estimates for each company's SIM with constant α_i and β_i. Section 4.8 will compared and contrasted results for each model and each company.

Given that results presented in Section 4.5 suggest that the SIM for Schneider and IBP do not vary over time, the SIM with constant α_i and β_i was estimated for these companies. To facilitate comparisons between the time-varying models and the constant models, SIM's with constant α_i and β_i were also estimated for Maple Leaf and Smithfield. Results for the SIM with constant α_i and β_i, for all companies, are presented in Table 4.9.

Table 4.9 shows that returns to all pork processing companies considered in the study are positively related to the return on the S&P 500. However, the market return coefficient is only statistically significant for Maple Leaf and Smithfield. The conclusion that the return to the market coefficient is not statistically significant for Schneider and IBP implies that the market coefficient does not statistically differ from zero. However, this does not mean that coefficient estimates are not economically significant.

Table 4.9 shows that the market coefficient for Smithfield is 1.907. When compared to the other pork processing companies considered in the study, this is the highest value the market coefficient received. This implies that over all companies, returns to Smithfield are the most sensitive to the market return. The sensitivity of the remaining companies, in decreasing order are Maple Leaf, IBP and Schneider with market return coefficients of 0.936, 0.775 and 0.719, respectively.

Table 4.9 Constant Model Parameter Estimates for All Companies

Company	**Estimated Coefficient (*t*-ratio)[a]**		
	Return on S&P 500	**Constant**	**R^2**
Schneider	0.719 (0.718)	0.002 (0.889)	0.004
Maple Leaf	0.936** (2.311)	0.541×10^{-3} (0.682)	0.040
Smithfield	1.907*** (3.431)	0.002** (2.271)	0.084
IBP	0.775 (1.476)	0.001 (1.359)	0.017

a. * denotes 0.10 level of significance, ** denotes 0.05 level of significance and *** denotes 0.01 level of significance.

4.8 Model Comparison

Investors utilize estimates of β_i to help determine which assets to include in their portfolio. Stocks with $\beta_i > 1$ are classified as "aggressive" stocks[1], that tend to rise faster than the market in "bull" markets, *i.e.*, rising market, and fall faster than the market in "bear" markets, *i.e.*, falling market. Stocks with $\beta_i < 1$ are classified as "defensive" stocks, that tend to fluctuate less than the market as a whole. Stocks with $\beta_i = 1$ are classified as "neutral" stocks. Returns to "neutral" stocks that fluctuate, on average, with the market.

[1] "Aggressive", "defensive" and "neutral" terminology was obtained from Levy and Sarnat (1984).

From an investors' perspective, market return coefficient estimates for the SIM with constant α_i and β_i imply that Smithfield is an "aggressive" stock while Maple Leaf, IBP and Schneider are "defensive" stocks. Given this, investor seeking to add higher risk stocks in their portfolio would choose to include Smithfield in their portfolio while investors seeking to add lower risk stocks in their portfolio would choose to include one or more of the remaining companies in their portfolio.

Considering the models with a time-varying beta, a stock may be classified, for example, as "aggressive" in one period and as "defensive" in another. Figures 4.1, 4.2, 4.3 and 4.4 show that over sub-samples of the period, January 1990 to November 2000, some of the models for some of the companies approximate the SIM with constant α_i and β_i. However, differences between the models and companies occur for a variety of reasons.

Schneider

Figure 4.1 shows monthly estimates of beta for Schneider over the period January 1990 to November 2000. From Figure 4.1, beta estimates for models 1 and 2, in general, appear to approximate beta estimates obtained from the SIM with constant α_i and β_i. In addition, model 3 tends to follow the same general trend as model 2, but at a systematically higher level. However, there are a few instances where models 2 and 3 deviate from the SIM with constant α_i and β_i.

Perhaps most obvious deviation occurred between January 1995 and March 1995. The dip in beta estimates for Schneider, models 2 and 3, may be (partially) attributed to the implementation of the URAA, while the recovery of beta estimate corresponds with Maple Leaf's amalgamation with McCain. A jump in the beta estimate, in July 1996, coincides with the removal of Manitoba Pork's single-desk selling status. However, concurrent with the announcement of Maple Leaf's intention to build a pork processing facility in Brandon (March 1997), the beta estimate returned to lower values. The next dip occurred in January 1999, at the same time the Schneider merger with Smithfield was completed. The beta estimate increased in September 1999, simultaneous with Maple Leaf's merger with Landmark Feeds.

In spite of these casual observations, Models 1, 2 and 3 are rejected. This is because the coefficient estimates for each of these models are not statistically significant. Thus, the model with constant α_i and β_i is taken to be the true model. Accordingly, investors may view Schneider as a company with "defensive" stock.

Maple Leaf

Figure 4.2 shows monthly estimates of beta for Maple Leaf for January 1990 to November 2000. Note that, over several sub-samples of the period considered, beta estimates for models 1, 2 and 3 appear to approximate beta estimates obtained from the SIM with constant α_i and β_i. However, this observation is not without exception.

For example, between January 1995 and March 1995, a substantial jump in the beta estimates for each of Maple Leaf model 2 and model 3 occurred. This jump may have been a response to the implementation of the URAA on January 1, 1995. However, this response was offset in April 1995 when Maple Leaf amalgamated with McCain.

Aside from this occurrence, Models 1, 2 and 3 for Maple Leaf seem to follow the same trend. Beta estimates for Maple Leaf appear to be relatively stagnant until the July 1996 removal of the single-desk selling status of Manitoba Pork triggered a dip in Maple Leaf's beta estimates. Again, Maple Leaf beta estimates remain fairly stagnant, with a slight dip occurring with the announcement of the Maple Leaf Brandon processing facility in March 1997, until November 1997. At this point in time, the initiation of the bidding war between Maple Leaf and Smithfield for Schneider stimulated a slight increase in Maple Leaf beta estimates. However, the January 1999 merger between Schneider and Smithfield was associated with a large dip in Maple Leaf beta estimates. In September 1999, the Maple Leaf merger with Landmark Feeds may have contributed to the slight recovery of Maple Leaf beta estimates.

Maple Leaf models 1, 2 and 3 appear to generate approximately equivalent results. One exception is the statistically significant URAA variable for Maple Leaf model 1 does not yield the outlier beta estimate produced by Maple Leaf models 2 and 3. Given this, model 1 is assumed to best describe the sensitivity of returns to Maple Leaf, to the return on the market.

Model 1 describes Maple Leaf stock as "defensive" prior to January 1995 and as "aggressive" between January 1995 and June 1996. Following the removal of Manitoba Pork Marketing's single-desk selling status on July 1, 1996, Maple Leaf's stock may be classified as "defensive". During the Maple Leaf – Smithfield bidding war for Schneider, October 1997 through December 1998, Maple Leaf stock was once again classified as "aggressive". Following the Smithfield merger with Schneider, Maple Leaf stock regained its "defensive" classification. Based on this discussion, it appears that Maple Leaf stock is fairly volatile, however, over the period January 1990 to November 2000, Maple Leaf stock is best described as "defensive".

Smithfield

Figure 4.3 shows monthly estimates of beta for Smithfield for January 1990 to November 2000. From this figure, it appears that over the period of the study, with one exception, the SIM with constant α_i and β_i approximates the beta estimates for models 1 and 2. In addition, models 1, 2 and 3 appear to follow the same general trend, although model 3's estimates of beta are systematically lower than models 1 and 2. This may be the result of spurious correlation between variables in model 3. In other words, the independent and dependent variables in model 3 may be associated with some other extraneous variable. The result is the coefficients of model 3 are indicative of a relationship that really isn't there. Given this, model 3 is rejected for Smithfield.

Models 1 and 2 classify Smithfield as an "aggressive" stock between January 1990 and December 1994. However, between January 1995 and June 1996, Smithfield stock was classified as "defensive". The dip in Smithfield beta estimates coincides with the January 1, 1995 implementation of the URAA. However, the removal of Manitoba Pork single-desk selling status on July 1, 1996 offset this effect. Following the removal of Manitoba Pork Marketing's single-desk selling status, Smithfield stock is classified as "aggressive". However, beginning in September 1999, concurrent with the Maple Leaf merger with Landmark Feeds (or some other occurrence unique to Smithfield), Smithfield stock is classified as "defensive".

Based on this discussion, it appears that Smithfield stock is somewhat volatile, however, over the period of the study, Smithfield stock is best described as "aggressive". In addition, model 1 and model 2 appear to yield approximately equivalent estimates of beta for Smithfield.

IBP

Figure 4.4 shows monthly estimates of beta for IBP for January 1990 to November 2000. From figure 4.1 it is evident that models 1, 2 and 3, over the period of the study, generally follow the same trend. In addition, the beta estimate for the model with constant α_i and β_i, over the period January 1990 to November 2000, generally approximate the beta estimates for the time-varying models. However, models 1, 2 and 3 are rejected as the coefficient estimates for theses models are not statistically significant. Thus, the model with constant α_i and β_i is taken to be the true model. Accordingly, investors may view IBP as a company with "defensive" stock.

Schneider
Monthly Beta Estimates
January 1990 - November 2000

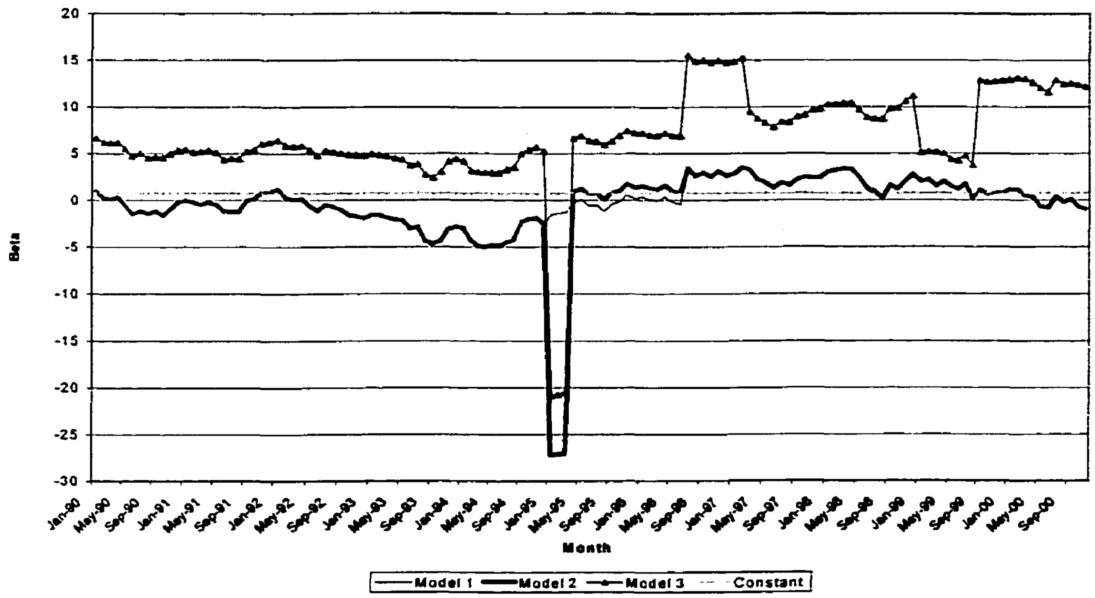

Figure 4.3 Beta estimates for Schneider for all models.

Maple Leaf
Monthly Beta Estimates
January 1990 - November 2000

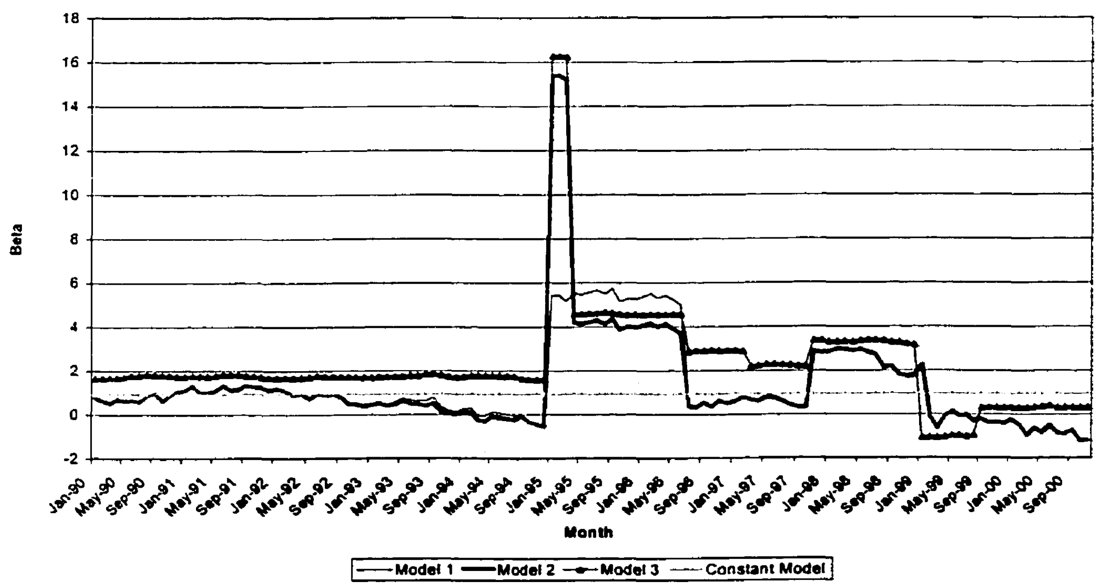

Figure 4.4 Beta estimates for Maple Leaf for all models.

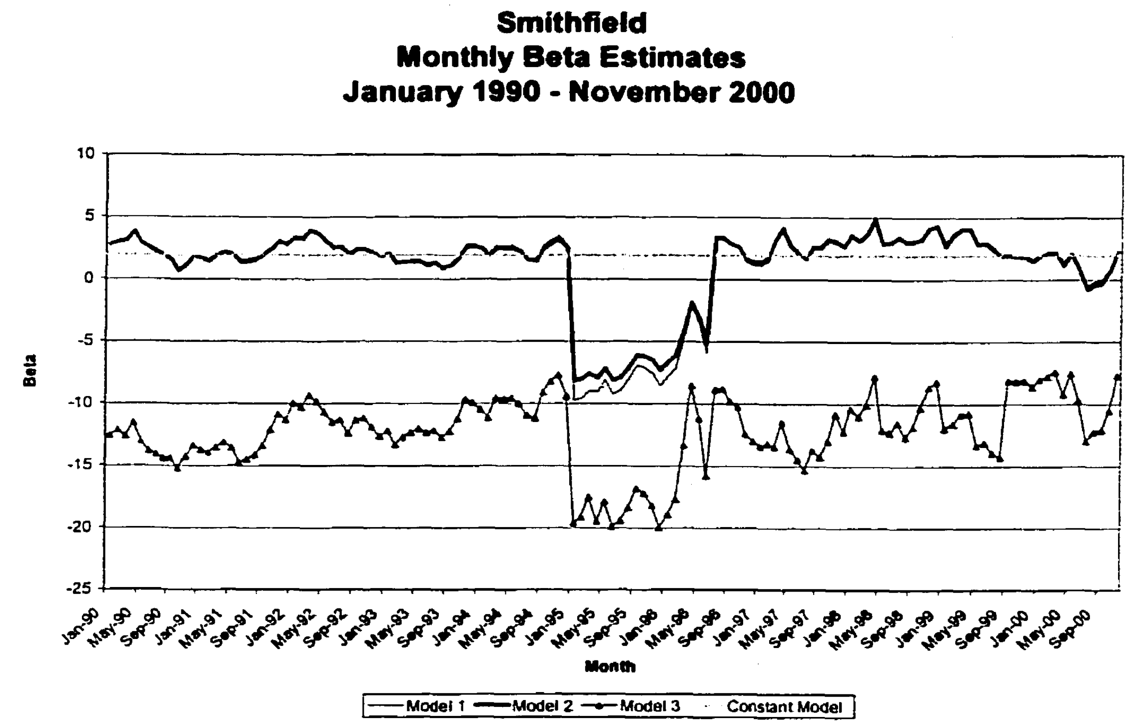

Figure 4.5 Beta estimates for Smithfield for all models.

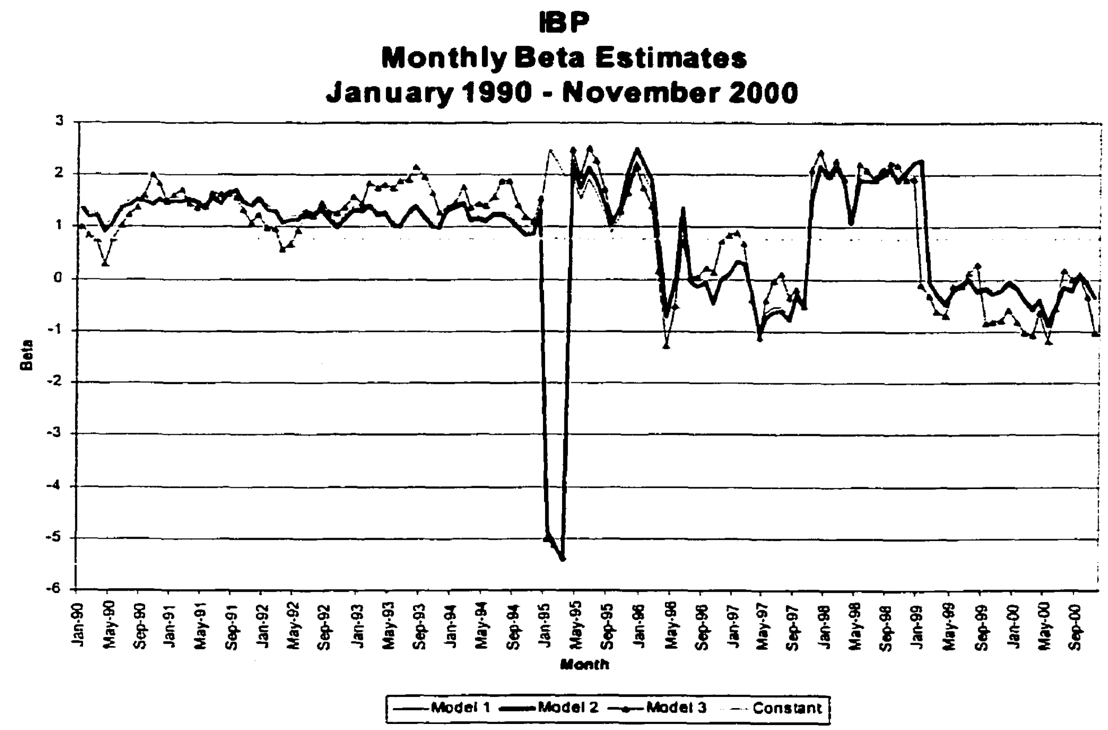

Figure 4.6 Beta estimates for IBP for all models.

4.9 Chapter Summary

This chapter tested the statistical properties of each time-varying SIM, for each company. Parameter estimates for each time-varying SIM, and SIM with constant α_i and β_i, for each company, were also presented and discussed in this chapter.

For each model, for each company, statistical specification tests found no evidence of autocorrelation, heteroskedasticity or specification error. In addition, joint hypothesis tests concluded factors included in $\mathbf{W_t}$, for each model and company, do not jointly vary the parameters of the SIM over time. However, this does not mean individual factors included in $\mathbf{W_t}$ are statistically insignificant. In fact, in the Maple Leaf and Smithfield time-varying models, several factors included in $\mathbf{W_t}$ were found to be statistically significant. There were, however, no statistically significant $\mathbf{W_t}$ factors in the Schneider and IBP models. This suggests the appropriate model specification for Maple Leaf and Smithfield is a time-varying SIM while the appropriate model specification for Schneider and IBP is a SIM with constant α_i and β_i.

Overall, SIM estimation results indicate Schneider, IBP and Maple Leaf, over the period of the study, are "defensive" stocks and Smithfield is an "aggressive" stock (although the classification of Maple Leaf and Smithfield stock may vary over time). This means investors seeking to minimize risk should consider adding Schneider, IBP or Maple Leaf stock to their portfolio. In addition, investors interested in higher risk stocks should consider including Smithfield stock in their portfolio. At the same time, investors must be aware the risk-return relationship for Maple Leaf and Smithfield stock varies over time. In fact, factors consistently found to vary the risk-return relationship for one or more models for Maple Leaf and/or Smithfield are: pork exports, removal of Manitoba

Pork single-desk selling status, the URAA and the Schneider bidding war/merger with Smithfield.

For each Maple Leaf model, pork exports and the removal of Manitoba Pork single-desk selling status shifted α_i downward and upward, respectively. In addition, for models 1 and 2, the Schneider bidding war/merger with Smithfield was found to shift α_i downward. The URAA and the Schneider bidding war/merger with Smithfield were found to positively pivot β_i for Maple Leaf models 1 and 2, respectively. The slope parameter (β_i) for Maple Leaf model 3, was not affected by $\mathbf{W}_t$.

Furthermore, $\mathbf{W}_t$ did not affect α_i for Smithfield models 1 and 2. However, for Smithfield models 1 and 2, removal of Manitoba Pork single-desk selling status was found to positively pivot β_i. In addition, β_i for Smithfield model 1 was negatively pivoted by the URAA. Smithfield model 3 was rejected because factors included in $\mathbf{W}_t$ appear to be spuriously correlated.

A general conclusion is over the period of the study, for some models and some companies, SIM with constant α_i and β_i approximate time-varying estimates of β_i. Thus, models with constant α_i and β_i are useful for determining the general classification (*i.e.*, defensive, aggressive or neutral) of a company's stock. Moreover, models with time-varying α_i and β_i can be utilized to explain and/or forecast the reaction of a company's β_i to different firm fundamentals and market occurrences.

Chapter 5 will use the parameter estimates presented in this chapter to obtain estimates of systematic and nonsystematic risk.

Chapter 5 – Risk Decomposition

5.1 Introduction

This chapter utilizes parameter estimates presented in Chapter 4 to derive measures of systematic and nonsystematic risk for constant and time-varying SIMs. The conclusions of the study are presented in Chapter 6.

5.2 Risk Decomposition Methodology for Models with Constant α_i and β_i

Generally, total risk for the i^{th} stock for models with constant α_i and β_i is decomposed into estimates of systematic and nonsystematic risk using the following variance-based approach:

$$\sigma_i^2 = \beta_i^2\sigma_m^2 + \sigma_{ei}^2 \qquad (5.1)$$

where $\beta_i^2\sigma_m^2$ and σ_{ei}^2 represent constant systematic and nonsystematic risk, respectively. Note that σ_i^2 and σ_m^2 represent the variance of the return to stock i and the variance of the market return, respectively. The variance of the error term, σ_{ei}^2, may be defined as the variance of the regression residuals or the residual variance of equation 5.1. Inherent in variance-based approach to risk decomposition is the fact that, because each of the terms in equation 5.1 is squared, risk cannot be negative. Consequently, stocks i and j, with the same variance and one with $\beta_i = 1$ and the other $\beta_i = -1$, would yield the same measure of systematic risk, thereby implying the same proportion of the two variances can be eliminated through diversification. It is important to account for stocks with a negative β_i's because they do not add to portfolio risk and they lend stability to the portfolio (Ben-Horim and Levy, 1980). Conversely, stocks with positive β_i add to portfolio risk and lend to the instability of the portfolio. Ben-Horim and Levy (1980) suggest that, to allow for negative β_i, a standard-deviation approach be used to decompose total risk into systematic and nonsystematic risk. Given this equation 5.1 may be written as follows:

$$\sigma_i = \beta_i \sigma_m + \sigma_{ei} \tag{5.2}$$

where $\beta_i \sigma_m$ and σ_{ei} represent constant systematic and non-systematic risk, respectively. Note that σ_i and σ_m represent the standard deviation of the return to stock i and the standard deviation of the market return, respectively. The standard deviation of the error term, σ_{ei}, is defined as the standard deviation of the variance of the regression residuals. By definition, the standard deviation approach to risk decomposition yields smaller estimates of systematic risk for $\beta_i < 0$ than the variance-based approach. In addition, estimates of nonsystematic risk obtained using the variance-based approach are downward biased for $\beta_i > 0$ (Ben-Horim and Levy, 1980). Therefore, in order to take into account the effect of negative parameter estimates, the standard deviation-approach to risk decomposition will be utilized.

Further to this, nonsystematic risk may be calculated as the residual of equation 5.1, (*i.e.*, $\sigma_i - \beta_i \sigma_m$) or as the standard deviation of the regression residuals. However, given the residual of equation 5.1 may yield negative estimates of nonsystematic risk, this approach was rejected. This is because, intuitively, negative measures of nonsystematic or diversifiable risk do not make sense. Thus, to ensure a positive measure of nonsystematic risk, this study calculates nonsystematic risk as the standard deviation of the variance of the regression residuals. Given this, risk decomposition results for models with constant α_i and β_i are presented in Section 5.3. Results for the time-varying models are presented in Section 5.4.

5.3 Risk Decomposition Results for Models with Constant α_i and β_i

Results for the decomposition of total risk for models with constant α_i and β_i are presented in Figure 5.1 and Table 5.1. Clearly, Schneider, at 0.023, has the highest level of total risk of all companies. Smithfield, at 0.016, has the second highest level of total risk while IBP, at 0.013, has the third highest level of total risk. Maple Leaf, at 0.011 has the lowest level of total risk. Table 5.1 shows that Schneider can eliminate 94.02 percent of their total risk through diversification. A large portion of IBP's and Maple Leaf's total risk is also in the form of nonsystematic risk. In fact, 88.50 percent of IBP's total risk and 83.10 percent of Maple Leaf's total risk is diversifiable. However, it is also evident from Table 5.1 that Smithfield, at 76.80 percent, has the lowest percentage of total risk that can be eliminated through diversification. This may be due to the fact that Smithfield has been involved in extensive merger and acquisition activity.

A general conclusion is that the less (more) sensitive returns to a company are to the return on the market, the higher (lower) the portion of total risk that can be eliminated through diversification. In other words, the more sensitive returns to a company are to the market return, the more systematic risk the stock will bring to a portfolio. This being said, Smithfield will contribute the largest portion of systematic risk to a portfolio. This is not unexpected as the higher the risk, the higher the potential returns. Recall from Chapter 4, Smithfield's β_i estimate of 1.907 classified Smithfield stock as "aggressive". Schneider, Maple Leaf and IBP were all classified as "defensive" stocks. Note these companies bring relatively lower levels of systematic risk to a portfolio (*i.e.*, the share of total risk attributable to the systematic portion is smaller). In conclusion, "aggressive" stocks yield higher estimates of systematic risk than "defensive" stocks. In turn, "defensive" stocks yield higher estimates of nonsystematic risk than "aggressive" stocks.

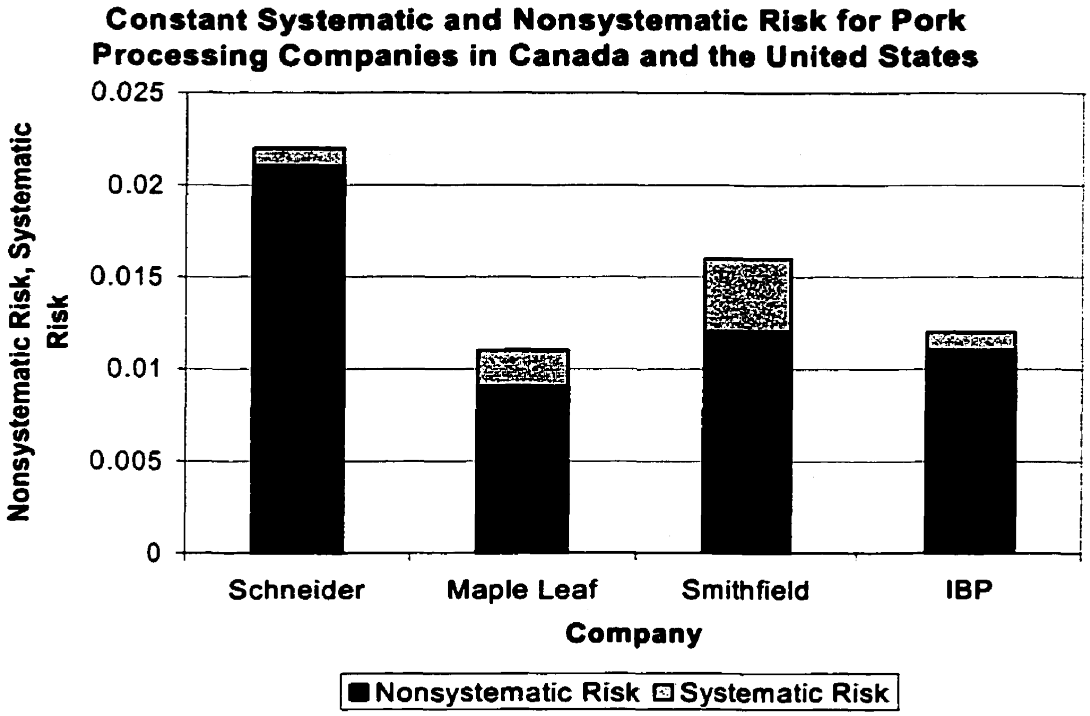

Figure 5.1 Risk Decomposition for Models with Constant α_i and β_i.

Table 5.1 Risk Decomposition for Models with Constant α_i and β_i

Company	Systematic Risk (% of total risk)	Nonsystematic Risk (% of total risk)	Total Risk
Schneider	*0.001 (5.98)*	*0.021 (94.02)*	*0.023*
Maple Leaf	*0.002 (16.90)*	*0.009 (83.10)*	*0.011*
Smithfield	*0.004 (23.20)*	*0.012 (76.80)*	*0.016*
IBP	*0.001 (11.50)*	*0.011 (88.50)*	*0.013*

5.4 Risk Decomposition Methodology for Time-Varying Models

This section presents the results of the risk decomposition for time-varying models. Given the discussion in Section 5.2, total risk, σ_i, for time-varying models may be decomposed into systematic and nonsystematic risk using the following standard deviation approach:

$$\hat{\sigma}_i = \hat{\alpha}_{it} + \hat{\beta}_{it}\sigma_m + \hat{\sigma}_{ei} \quad (5.3)$$

or

$$\hat{\sigma}_i = \sum_z \hat{\gamma}_{it}\sigma_{wz} + \sigma_m \sum_z \hat{\delta}_{it}\sigma_{wz} + \hat{\sigma}_{ei} \quad (5.4)$$

where σ_{wz} is an estimate of the standard deviation of z^{th}-variable of $\boldsymbol{W}$ and $\hat{\alpha}_{it}$ and $\hat{\beta}_{it}$ are time-varying parameter estimates. Given this, $\hat{\beta}_{it}\sigma_m$ is an estimate of time-varying systematic risk and $\hat{\alpha}_{it} + \hat{\sigma}_{ei}$ is an estimate of time-varying nonsystematic risk. The decomposition of total risk for time-varying models presented in this study differs from past research because nonsystematic risk is comprised of two components, namely, $\hat{\alpha}_{it}$, referred to as alpha risk, and $\hat{\sigma}_{ei}$, referred to as pure nonsystematic risk. Alpha risk is defined as the portion of nonsystematic risk that can be explained by firm fundamentals and/or market characteristics. Alpha risk is included in the measure of nonsystematic risk because, alpha and nonsystematic risk, respectively represent the portion of a stock's return and risk that is not related to the market. The remaining term, $\hat{\sigma}_{ei}$, represents pure nonsystematic risk or residual risk. This is the portion of total risk that cannot be attributed to the market, firm fundamentals or market characteristics. As in the case of models with constant α_i and β_i, nonsystematic risk is calculated as the standard deviation of the variance of the regression residuals.

For ease of calculation, only statistically significant variables were considered in the time-varying model risk decomposition. This modification should not influence results because statistically insignificant variables are not significantly different from zero. Given that both continuous and binary variables are included in $\mathbf{W_t}$, time-varying systematic risk and time-varying alpha risk must be calculated for several different periods. Note that constant intercept terms do not effect alpha risk. For this reason, the effect of the constant and binary intercept terms are not considered. However, binary intercept terms are used to determine time-varying periods. The different periods arise from the fact that binary variables will only affect the risk measures when they assume a value of one. Moreover, σ_m and σ_{wz} will differ for different periods.

In light of this, it should follow that pure nonsystematic risk also varies across periods. However, regression methods utilized to obtain estimates of α_i and β_i assume error terms are homoskedastic. This implies the variance of the error term is constant over all periods. Thus, the standard deviation of the variance of the error term is also constant. Given this, results of the decomposition of total risk for time-varying models with statistically significant variables are presented and discussed in Section 5.5.

5.5 Risk Decomposition Results for Time-Varying Models

Chapter 2 discussed procedures used to vary the parameters of the SIM over time and Chapter 3 introduced the factors believed to affect the risk-return relationship over time. Results presented in Chapter 4 concluded that Models 1, 2 and 3 for Maple Leaf and Smithfield contain statistically significant variables, while Models 1, 2 and 3 for Schneider and IBP do not contain statistically significant variables.

Given this, it appears the SIM with constant α_i and β_i is the appropriate model for Schneider and IBP, while the SIM with time-varying parameters is the appropriate model for Maple Leaf and Smithfield. For this reason, the time-varying risk decomposition will only be calculated for Maple Leaf, models 1, 2 and 3, and Smithfield, models 1 and 2 (Recall model 3 for Smithfield was rejected in Chapter 4).

The time-varying risk decomposition for Maple Leaf and Smithfield comprises several sub-periods. This is because, by definition, risk-return relationships estimated using time-varying SIMs vary with the parameters of the model. In other words, as the statistically significant factors in $\mathbf{W}_t$ vary, the risk-return relationship will also vary. Results of the time-varying risk decomposition for Maple Leaf and Smithfield are presented in Table 5.2 and Figures 5.2 through 5.7.

Table 5.2 shows that pure nonsystematic risk for each company's model is constant across periods. This result adheres to the assumption of homoskedasticity. Note the standard deviation of the error variance assumed a value of 0.008 for each of the Maple Leaf models (*i.e.*, models 1, 2 and 3). Also, the standard deviation of the error variance assumed a value of 0.011 for each of the Smithfield models (*i.e.*, models 1 and 2). Furthermore, Table 5.2 shows, consistent with the assumption of time-varying parameters, systematic risk and alpha risk vary over time. In addition, Table 5.2 demonstrates that inclusion of time-varying parameters in the SIM may lead to time-varying estimates of total risk.

Maple Leaf Model 1

Maple Leaf model 1 comprises five periods. Period 1 considers the effect of exports on α_i and the market return on β_i. In Period 2 the affect of the interaction between the URAA and the market return on β_i is added to the model. Periods 3 and 4 add the affect of the removal of Manitoba Pork Marketing single-desk selling status and the Schneider bidding war and merger with Smithfield on α_i to the model. In Period 5, the affect of the Schneider bidding war and merger with Smithfield on α_i is removed from the model. Note the affect of the removal of Manitoba Pork Marketing single-desk selling status and the Schneider bidding war and merger do not directly enter the risk decomposition because these variables are constants. However, these variables help define the time-varying periods.

Table 5.2 shows the value of pure nonsystematic risk remains constant at 0.008 over all periods. In addition, the value of alpha risk remains at –0.001 for periods 1 to 4. However, during period 5 the negative value of alpha risk increases to –0.003. Moreover, Table 5.2 and Figure 5.2 demonstrate that the value of systematic risk and total risk varies across the five periods. Furthermore, the contribution of each risk component to total risk varies from period to period.

For Maple Leaf Model 1, period 1 considers the affect of exports on α_i and the market return on β_i. Note the pork exports and market return parameter estimates are –0.249 × 10^{-7} and 6.512, respectively. During this period, systematic risk, valued at 0.011, accounted for 62 percent of total risk. At the same time, alpha risk and pure nonsystematic risk comprised –8 percent and 46 percent of total risk, respectively.

Period 2 takes into account the affect of the factors included in Period 1, as well as, the affect of the interaction between the URAA and the market return on β_i. This interaction (with a parameter estimate of 6.012), combined with the factors included in period 1, contributes to a decrease in total risk from 0.018 in period 1 to 0.016 in period 2. Moreover, the value of systematic risk falls from 0.011 to 0.009 and the contribution of systematic risk to total risk decreases from 62 percent to 55 percent. The value and percentage contribution of alpha risk remained constant at –0.001 and 8 percent, respectively. The value of pure nonsystematic risk also remained constant at 0.008, however, the percentage contribution of nonsystematic risk rose to 52 percent (from 46 percent).

Period 3 adds the affect of the removal of Manitoba Pork's single-desk selling status on α_i to the model. This factor (with a parameter estimate of 0.010) works with the variables considered in periods 1 and 2, to more than double the value of total risk in period 2 to 0.034 in period 3. Moreover, the value of systematic risk tripled from 0.09 in period 2 to 0.027 in period 3. The percentage contribution of systematic risk to total risk was 80 percent in period 3, compared to 55 percent in period 2. At the same time, the value of alpha risk and pure nonsystematic risk remained unchanged at –0.001 and 0.008, respectively. However, the percentage contribution of alpha risk rose to –3 percent (from –8 percent). The percentage contribution of pure nonsystematic risk fell from 52 percent in period 2 to 24 percent in period 3.

Period 4 adds the affect of the Schneider bidding war/merger with Smithfield on α_i to the model. This factor (with a parameter estimate of -0.007) works with the variables considered in prior periods, to increase the value of total risk by 0.007 over period 3, to 0.041 in period 4. The value and percentage contribution of alpha risk remain (as in period 3), at -0.001 and –3 percent, respectively. Although the value of pure nonsystematic risk remains at 0.008, the percentage contribution to total risk falls to 20 percent (from 24 percent). In addition, the value and percentage contribution of systematic risk increase from 0.027 and 80 percent, in period 3, to 0.034 to 83 percent in period 4, respectively.

In Period 5, the affect of the Schneider bidding war/merger with Smithfield on α_i is removed from the model. This occurrence, combined with the factors considered in prior periods, decreased total risk from 0.041 in period 4 to 0.032 in period 5. Further to this, the value of systematic risk decreased by 0.007 to 0.027. However, the percentage contribution of systematic risk to total risk increased slightly, from 83 percent to 84 percent. Moreover, the value of alpha risk decreased from –0.001 to –0.003 and the percentage contribution of alpha risk decreased from –3 percent to –9 percent. At the same time, the value of pure nonsystematic risk remained at 0.008 and the percentage contribution to total risk increased from 20 percent to 26 percent.

Maple Leaf Model 2

Maple Leaf model 2 comprises four periods. Period 1 considers the affect of exports on α_i and the market return on β_i. Period 2 adds the affect of the removal of the single-desk selling status on α_i to the model and Period 3 adds the affect of the Schneider bidding war and merger with Smithfield on α_i, as well as β_i, to the model. The affect of the Schneider bidding war/merger with Smithfield is removed from the model in Period 4. Note the affect of the removal of Manitoba Pork's single-desk selling status and the Schneider bidding war/merger with Smithfield on α_i are not directly considered in the decomposition of risk because these variables are constants. However, the affect of the Schneider bidding war/merger with Smithfield on β_i is considered in the risk decomposition. This variable enters the risk decomposition because it is multiplied by the return on the market.

Table 5.2 shows the value of pure nonsystematic risk remains constant at 0.008 over all periods. Table 5.2 and Figure 5.3 demonstrate that the value of systematic risk and total risk varies across the four periods. Furthermore, the contribution of each risk component to total risk varies from period to period.

For Maple Leaf Model 2, period 1 considers the affect of exports on α_i and the market return on β_i. Note the pork exports and market return parameter estimates are –0.250 × 10^{-7} and 7.500, respectively. During this period, systematic risk, valued at 0.012, accounted for 64 percent of total risk. At the same time, alpha risk valued at –0.002 and pure nonsystematic risk valued at 0.008, comprise –9 percent and 46 percent of total risk, respectively.

Period 2 adds the affect of the removal of Manitoba Pork's single-desk selling status on α_i to the model. This factor (with a parameter estimate of 0.010) works with the variables considered in periods 1, to increase the value of total risk from 0.018 on period 1 to 0.023 in period 2. In addition, the value of systematic risk rose from 0.012 in period 1 to 0.016 in period 2. The percentage contribution of systematic risk to total risk was 70 percent in period 2, compared to 64 percent in period 1. At the same time, the value of alpha risk rose to –0.001 and the value of pure nonsystematic risk remained unchanged at 0.008. The percentage contribution of alpha risk rose to –5 percent (from –9 percent) and the percentage contribution of pure nonsystematic risk fell from 46 percent in period 1 to 35 percent in period 2.

Period 3 adds the affect of the Schneider bidding war/merger with Smithfield on α_i to the model as well as the affect of the interaction between Schneider bidding war/merger with Smithfield and the market return on β_i. This factor (with an intercept parameter estimate of -0.007 and a slope parameter estimate of 2.475) works with the variables considered in prior periods, to increase the value of total risk by 0.011 over period 2, to 0.034 in period 3. The value of alpha risk remained (as in period 2), at -0.001 and the percentage contribution of alpha risk fell from –5 percent to –4 percent. Although the value of pure nonsystematic risk remained at 0.008, the percentage contribution to total risk fell from 35 percent to 24 percent. In addition, the value and percentage contribution of systematic risk increased from 0.016 and 70 percent, in period 2, to 0.027 to 80 percent in period 3, respectively.

In Period 4, the affect of the Schneider bidding war/merger with Smithfield on α_i and β_i is removed from the model. This occurrence, combined with the factors considered in prior periods, decreased total risk from 0.034 in period 3 to 0.021 in period 4. Further to this, the value of systematic risk decreased by 0.011 to 0.016. Also, the percentage contribution of systematic risk to total risk decreased from 80 percent to 76 percent. Moreover, the value of alpha risk decreased from –0.001 to –0.003 and the percentage contribution of alpha risk decreased from –4 percent to –14 percent. At the same time, the value of pure nonsystematic risk remained at 0.008 and the percentage contribution to total risk increased from 24 percent to 38 percent.

Maple Leaf Model 3

Maple Leaf model 3 comprises two periods. Period 1 considers the effect of exports on α_i and the market return on β_i. In Period 2 the effect of the removal of the single-desk selling status on α_i is added to the model. Recall removal of the single-desk selling status on α_i does not effect the decomposition of risk and is only utilized to define time-varying periods.

Table 5.2 shows the value of pure nonsystematic risk remains constant at 0.008 over all periods. Table 5.2 and Figure 5.4 demonstrate that the value of systematic risk and total risk varies across the two periods. Furthermore, the contribution of each risk component to total risk varies from period to period.

For Maple Leaf Model 3, period 1 considers the affect of exports on α_i and the market return on β_i. Note the pork exports and market return parameter estimates are -0.352×10^{-7} and 1.703, respectively. During this period, systematic risk, valued at 0.003, accounted for 32 percent of total risk. At the same time, alpha risk valued at –0.002 and pure nonsystematic risk valued at 0.008, comprise –28 percent and 96 percent of total risk, respectively.

Period 2 adds the affect of the removal of Manitoba Pork's single-desk selling status on α_i to the model. This factor (with a parameter estimate of 0.009) works with the variables considered in the first period, does not change the value of total risk from period 1 to period 2. However, the value of systematic risk rose from 0.003 in period 1 to 0.004 in period 2. The percentage contribution of systematic risk to total risk was 51 percent in period 2, compared to 32 percent in period 1. At the same time, the value of alpha risk fell to –0.004 and the value of pure nonsystematic risk remained unchanged at 0.008. The percentage contribution of alpha risk fell to –54 percent (from –28 percent) and the percentage contribution of pure nonsystematic risk rose from 96 percent in period 1 to 102 percent in period 2.

Smithfield Model 1

Models 1 and 2 for Smithfield do not contain any statistically significant intercept variables. This means alpha risk will not appear in the risk decomposition for Smithfield. The intercept constant does not affect alpha risk because constant terms do not enter the alpha risk calculation. Recall nonsystematic risk remains constant over all periods. This means, changes to systematic risk necessarily lead to changes in total risk. However, the contribution of systematic and nonsystematic risk to total risk need not remain constant.

Smithfield model 1 comprises three periods. Period 1 comprises the effect of the constant on α_i and the market return on β_i. In Period 2 and Period 3, the effect of the URAA and the effect of the removal of the single-desk selling status on β_i, respectively, are added to the model.

Table 5.2 shows the value of pure nonsystematic risk remains constant at 0.011 over all periods. Table 5.2 and Figure 5.5 demonstrate that the value of systematic risk and total risk varies across the three periods. Furthermore, the contribution of each risk component to total risk varies from period to period.

For Smithfield Model 1, period 1 considers the affect the market return on β_i. Note the market return parameter estimate is –0.318. During this period, systematic risk, valued at -0.001, accounted for –5 percent of total risk. At the same time, pure nonsystematic risk valued at 0.011 comprises 105 percent of total risk.

Period 2 takes into account the affect of the factors included in Period 1, as well as the affect of the interaction between the URAA and the market return on β_i. This interaction (with a parameter estimate of –11.836), combined with the factors included in period 1, contributes to a decrease in total risk from 0.011 in period 1 to 0.003 in period 2. Moreover, the value of systematic risk falls from –0.001 to –0.008 and the contribution of systematic risk to total risk decreases from -5 percent to -276 percent. The value of pure nonsystematic risk remained constant at 0.011, however, the percentage contribution of nonsystematic risk rose to 376 percent (from 105 percent).

Period 3 adds the affect of the interaction between the removal of Manitoba Pork's single-desk selling status and the market return on β_i to the model. This factor (with a parameter estimate of 10.394) works with the variables considered in the period 2, to increase the value of total risk from 0.003 in period 2 to 0.007 in period 3. In addition, the value of systematic risk rose from -0.008 in period 2 to -0.004 in period 3. The percentage contribution of systematic risk to total risk was –57 percent in period 3, compared to –276 percent in period 2. At the same time, the value of pure nonsystematic risk remained unchanged at 0.011. However, the percentage contribution of pure nonsystematic risk fell from 376 percent in period 2 to 157 percent in period 3.

Smithfield Model 2

Smithfield model 2 comprises two periods. Period 1 considers the effect of the market return on β_i. In Period 2 the effect of the interaction between the removal of Manitoba Pork's the single-desk selling status and the market return on β_i is added to the model.

Table 5.2 shows the value of pure nonsystematic risk remains constant at 0.011 over all periods. Table 5.2 and Figure 5.6 demonstrate that the value of systematic risk and total risk varies across the two periods. Furthermore, the contribution of each risk component to total risk varies from period to period.

For Smithfield Model 1, period 1 considers the affect the market return on β_i. Note the market return parameter estimate is –0.285. During this period, systematic risk, valued at -4.393×10^{-4}, accounted for –4 percent of total risk. At the same time, pure nonsystematic risk valued at 0.011 comprises 104 percent of total risk.

Period 2 adds the affect of the interaction between the removal of Manitoba Pork's single-desk selling status and the market return on β_i to the model. This factor (with a parameter estimate of 9.370) works with the variables considered in the first period, to increase the value of total risk from 0.011 in period 1 to 0.032 in period 2. In addition, the value of systematic risk rose from -4.393×10^{-4} in period 1 to 0.021 in period 2. The percentage contribution of systematic risk to total risk was 65 percent in period 2, compared to –4 percent in period 1. At the same time, the value of pure nonsystematic risk remained unchanged at 0.011. However, the percentage contribution of pure nonsystematic risk fell from 104 percent in period 1 to 35 percent in period 2.

Table 5.2 Time-Varying Risk Decomposition

Period	Factor Added / Removed (Parameter Estimate)	Systematic Risk (% of total risk)	Alpha Risk (% of total risk)	Nonsystematic Risk (% of total risk)	Total Risk
		Maple Leaf Model 1			
Period 1 Jan 90 – Dec 94		0.011 (62.00)	-0.001 (-8.00)	0.008 (46.10)	0.018
Period 2 Jan 95 – Jun 96	**Add URAA (6.012)**	0.009 (55.20)	-0.001 (-7.50)	0.008 (52.30)	0.016
Period 3 Jul 96 – Oct 97	**Add MB Pork (0.010)**	0.027 (79.50)	-0.001 (-3.20)	0.008 (23.70)	0.034
Period 4 Nov 97 – Jan 99	**Add Bidding War/Merger (-0.007)**	0.034 (83.40)	-0.001 (-3.30)	0.008 (19.80)	0.041
Period 5 Feb 99 – Nov 00	**Remove Bidding War/Merger**	0.027 (83.80)	-0.003 (-9.40)	0.008 (25.50)	0.032
		Maple Leaf Model 2			
Period 1 Jan 90 – Jun 96		0.012 (64.20)	-0.002 (-9.00)	0.008 (46.10)	0.018
Period 2 Jul 96 – Oct 97	**Add MB Pork (0.010)**	0.016 (70.10)	-0.001 (-4.80)	0.008 (34.70)	0.023
Period 3 Nov 97 – Jan 99	**Add Bidding War/Merger (-0.007 and 2.475)**	0.027 (80.20)	-0.001 (-4.00)	0.008 (23.80)	0.034
Period 4 Feb 99 – Nov 00	**Remove Bidding War/Merger**	0.016 (75.90)	-0.003 (-14.30)	0.008 (38.40)	0.021
		Maple Leaf Model 3			
Period 1 Jan 90 – Jun 96		0.003 (31.70)	-0.002 (-27.60)	0.008 (95.90)	0.008
Period 2 Jul 96 – Nov 00	**Add MB Pork (0.009)**	0.004 (51.20)	-0.004 (-53.50)	0.008 (102.20)	0.008

Table 5.3 continued

Period	Factor Added / Removed (Parameter Estimate)	Systematic Risk (% of total risk)	Alpha Risk (% of total risk)	Nonsystematic Risk (% of total risk)	Total Risk
		Smithfield Model 1			
Period 1 Jan 90 – Dec 94		-0.001 (-4.90)	-	0.011 (104.90)	0.011
Period 2 Jan 95 – Jun 96	**Add URAA (-11.836)**	-0.008 (-275.60)	-	0.011 (375.60)	0.003
Period 3 Jul 96 – Nov 00	**Add MB Pork (10.394)**	-0.004 (-57.00)	-	0.011 (157.00)	0.007
		Smithfield Model 2			
Period 1 Jan 90 – Jun 96		-4.393×10^{-4} (-4.10)	-	0.011 (104.10)	0.011
Period 2 Jul 96 – Nov 00	**Add MB Pork (9.370)**	0.021 (65.30)	-	0.011 (34.70)	0.032

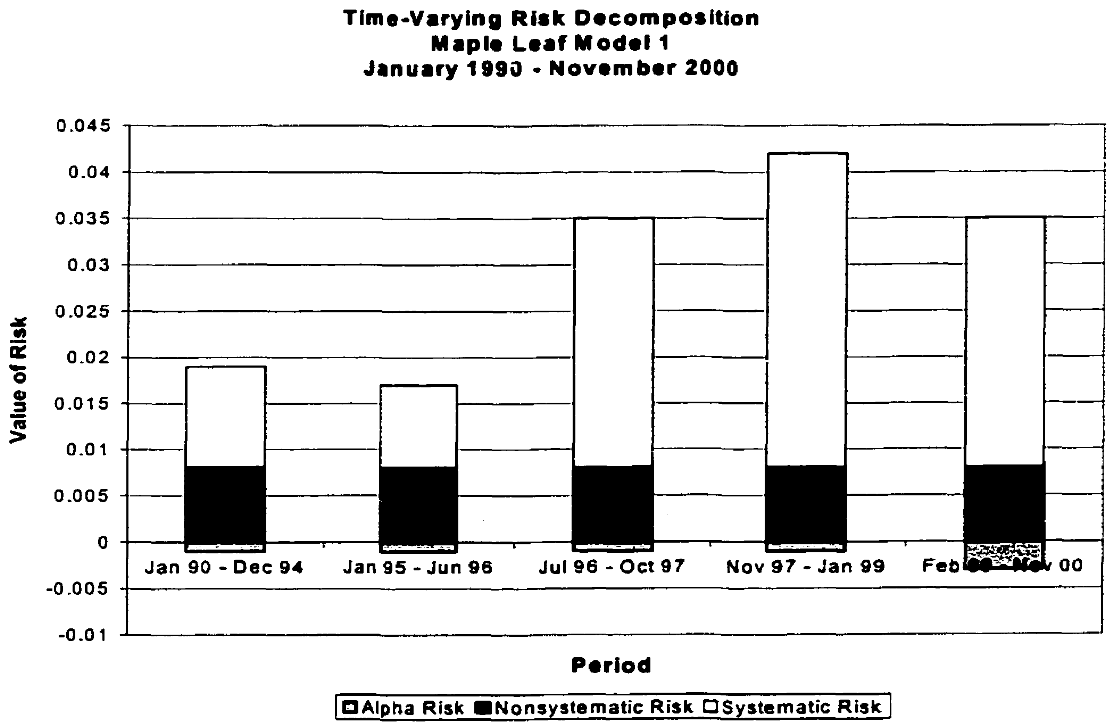

Figure 5.2 Time-Varying Risk Decomposition for Maple Leaf Model 1

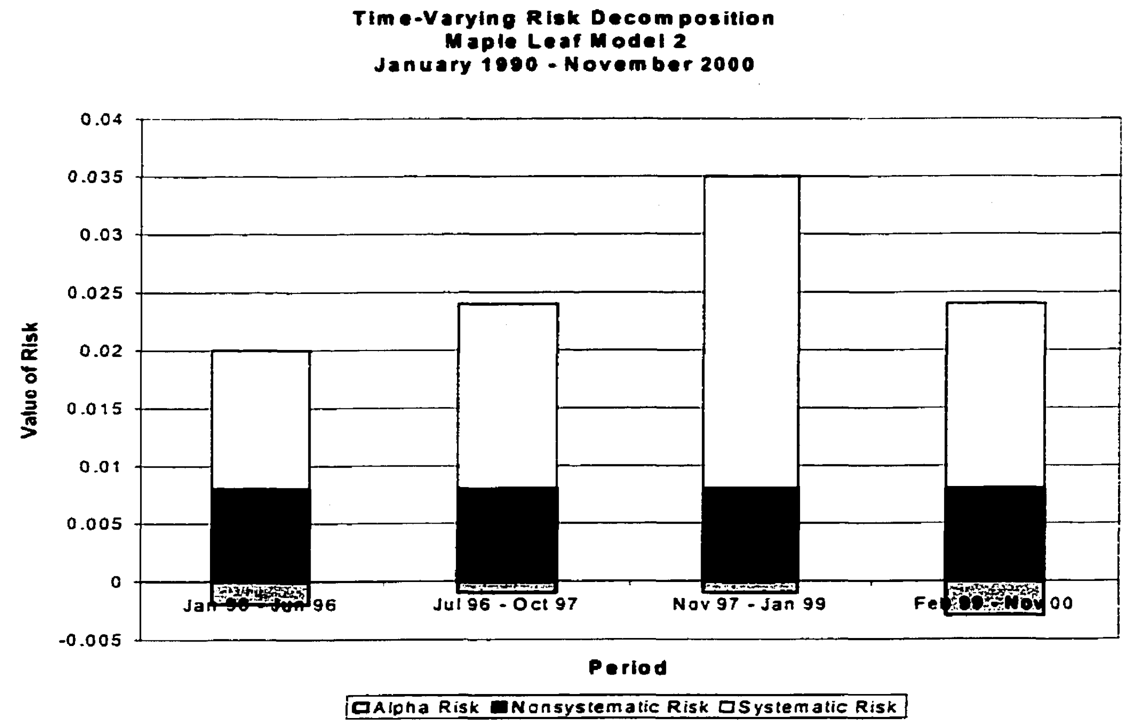

Figure 5.3 Time-Varying Risk Decomposition for Maple Leaf Model 2

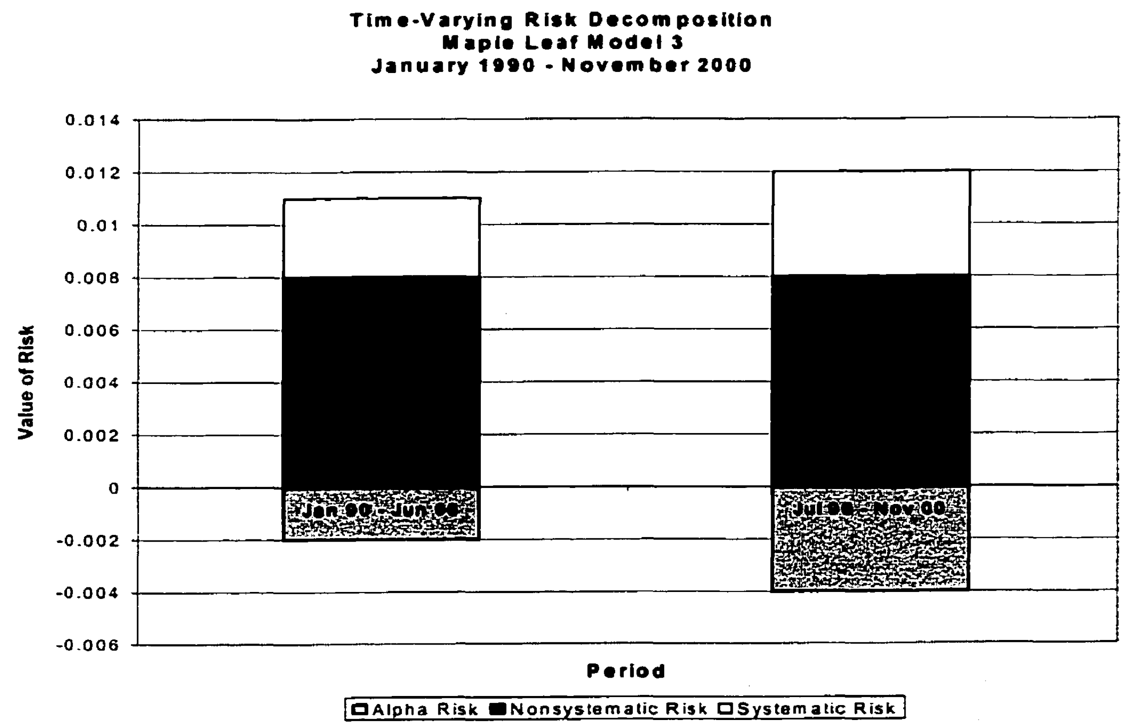

Figure 5.4 Time-Varying Risk Decomposition for Maple Leaf Model 3

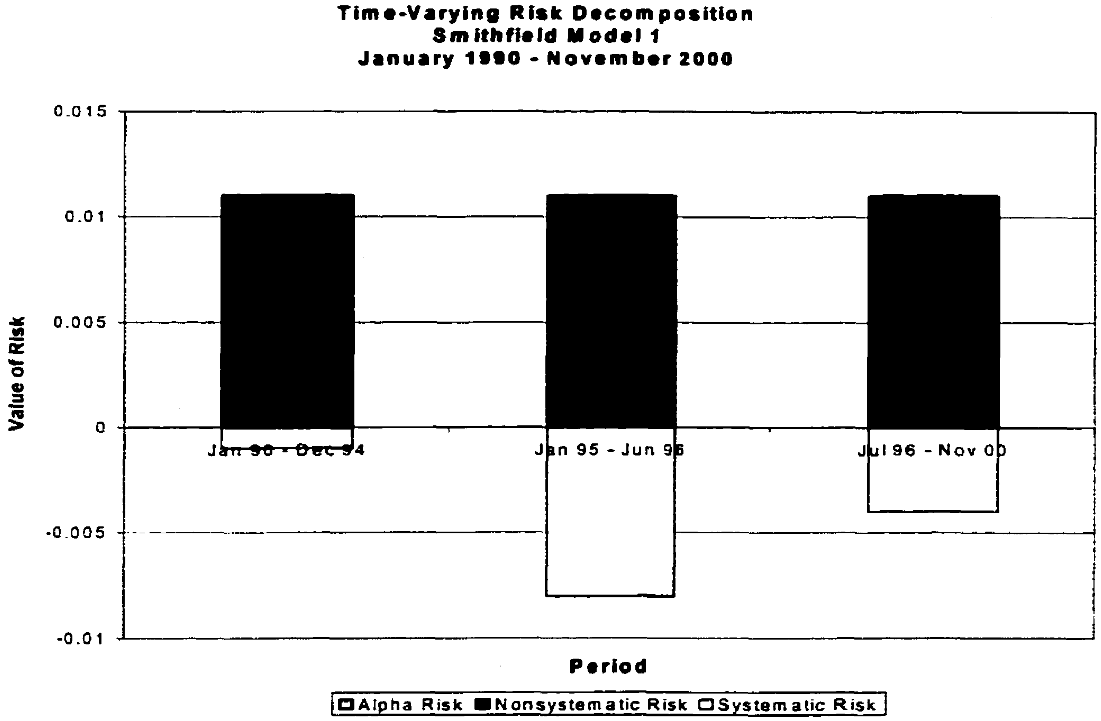

Figure 5.5 Time-Varying Risk Decomposition for Smithfield Model 1

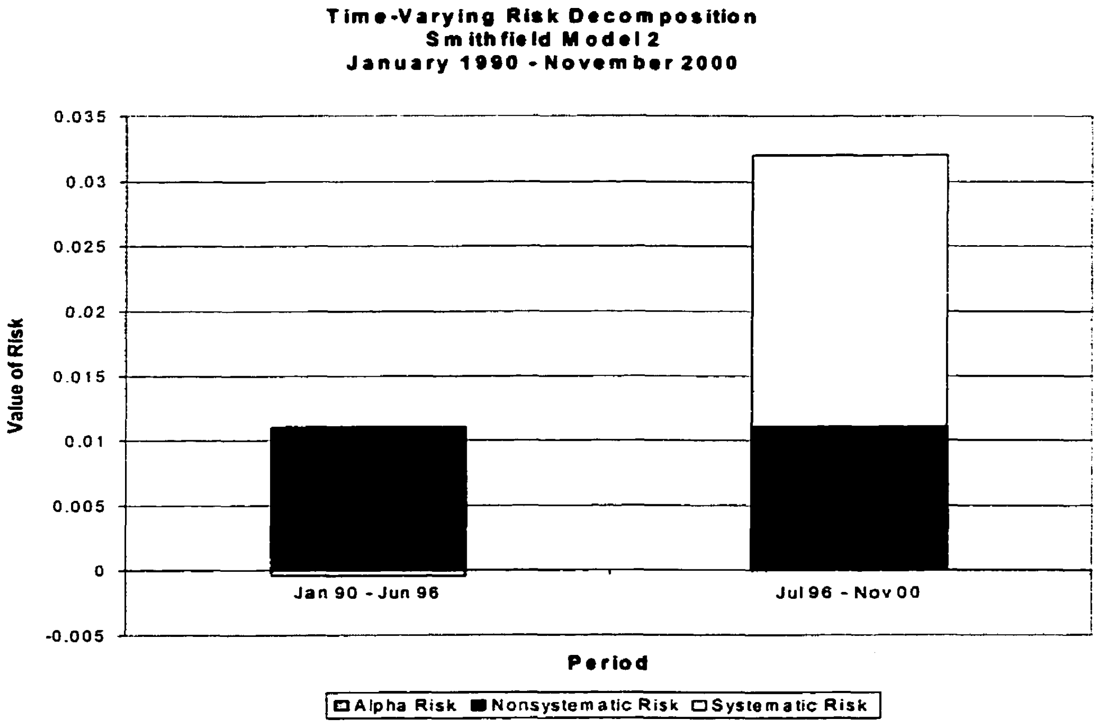

Figure 5.6 Time-Varying Risk Decomposition for Smithfield Model 2

5.6 Chapter Summary

Results obtained from time-varying risk decompositions are dependent upon the methodology, explanatory variables and time periods utilized. Given this, it is difficult to generalize results to all pork processing companies and market occurrences.

Results show the value of total risk for some models for Maple Leaf and Smithfield vary over time. For Maple Leaf, total risk decreases with the inclusion of the URAA, increases with the addition of the removal of Manitoba Pork's single-desk selling status and the Schneider bidding war/merger with Smithfield and decreases with the removal of the Schneider bidding war/merger with Smithfield. For Smithfield, total risk decreases with the addition of the URAA and increases with the removal of Manitoba Pork's single-desk selling status.

Total risk for Maple Leaf comprises systematic risk, alpha risk and pure nonsystematic risk. Alpha risk describes the predictable portion of nonsystematic risk that can be explained by economic and/or market factors. For Maple Leaf, alpha risk appears to capture the effect of pork exports on nonsystematic risk. Results indicate alpha risk has a relatively low percentage contribution to total risk for Maple Leaf. Total risk for Smithfield comprises systematic risk and pure nonsystematic risk. This means, for Smithfield, nonsystematic risk cannot be explained by economic and/or market factors.

Further to this, results show systematic risk is the most volatile component of total risk for Maple Leaf and Smithfield. For Maple Leaf, periods considering the effect of the removal of Manitoba Pork's single-desk selling status and the Schneider bidding war/merger with Smithfield have the largest increases in systematic risk. Results for

Smithfield are less conclusive. Results for Smithfield Model 1 show systematic risk contributes negatively to total risk. Results for Smithfield Model 2 show systematic risk contributes negatively to total risk in period 1 and positively in period 2.

Over the period of the study, "defensive" stocks (*i.e.*, Schneider, Maple Leaf and IBP) were found to have lower percentage contributions of systematic risk to total risk than "aggressive" stocks (*i.e.*, Smithfield). This means, the portion of total risk that cannot be diversified away is larger for "aggressive" stocks than "defensive" stocks. Thus, investors seeking to add "riskier" stocks to their portfolio should consider Smithfield. Investors seeking less risky stocks should consider adding one or more of Schneider, Maple Leaf and IBP to their portfolio. However, investors need to be aware that risk levels and types for Maple Leaf and Smithfield vary over time. Thus, Maple Leaf and Smithfield may exhibit higher or lower levels of systematic and nonsystematic over different sub-periods.

Conclusions of the study will be presented in Chapter 6.

Chapter 6 – Summary and Conclusion

6.1 Summary and Conclusions

The general objective of this study was to measure the risk-return relationship for Schneider, Maple Leaf, Smithfield and IBP, which are four large pork processing companies in North America. Specifically, the study was designed to determine whether the risk-return relationship for these companies changes over time, to determine which economic and market factors affect the risk-return relationship and to measure inter-temporal changes to systematic and nonsystematic risk. To meet the objectives of the study, a fundamental beta comprising economic and market factors was utilized to incorporate time-varying parameters in a single index model.

Factors included in the fundamental beta were the hog-feedgrain price ratio, the real value of pork exports, exchange rates, implementation of the Uruguay Agreement on Agriculture (URAA), removal of Manitoba Pork single-desk selling status, the Maple Leaf and Smithfield bidding war for Schneider and the subsequent merger between Schneider and Smithfield, the Maple Leaf merger with a subsidary of McCain, the announcement of the Maple Leaf pork processing facility in Brandon and the Maple Leaf merger with Landmark Feeds.

Regression results, obtained by ordinary least squares, were utilized to determine whether the risk-return relationship varies over time and if so, which variables contribute to any measure variation over time. Results were also used to derive measures of systematic risk and nonsystematic risk.

Econometric results show the risk-return relationship for Schneider and IBP does not vary over time, while the risk-return relationship for Maple Leaf and Smithfield does vary over time. Factors found to vary the risk-return relationship for Maple Leaf and/or Smithfield are the real value of pork exports, removal of Manitoba Pork Marketing single-desk selling status, the Maple Leaf and Smithfield bidding war for Schneider and the subsequent merger between Schneider and Smithfield and the implementation of the Uruguay Round Agreement on Agriculture (URAA).

A general conclusion is that time-varying single index models seem to best portray the *short-run* relationship between a company's return with the return to a market index, while the single index models with constant α_i and β_i seem to best describe the *long-run* relationships. Therefore single index models with constant α_i and β_i suggest, in the long-run, Schneider, Maple Leaf and IBP are "defensive" stocks (*i.e.*, stocks that fluctuate less than the market as a whole) and Smithfield is an "aggressive" stock (*i.e.*, a stock that tends to rise (fall) faster than the market in rising (falling) markets). In spite of this, the time-varying single index models imply Maple Leaf and Smithfield exhibit "defensive" behavior in one period and "aggressive" behavior in another.

The classification of stock behavior as "aggressive", "defensive" or "neutral" was developed by Levy and Sarnat (1984). Although this classification of stock behavior is a natural extension to the commonly reported (although not clearly understood) beta estimates for publicly traded companies, it has not received much attention in the finance and economic literature. One possible explanation is that the classification scheme is not perfect. In particular, this classification scheme does not account for stocks that tend to run counter to the market. For example,

> *"...Maple Leaf's shares have risen 63 percent so far this year, outperforming the Toronto Stock Exchange 300 composite index, which has slumped about 15 percent"* (Reuters, 2001).

Nonetheless, such information enhances an investor's understanding of how their stock or portfolio of stocks is performing relative to the market as a whole.

Furthermore, models with a time-varying relationship have time-varying levels of total risk and systematic risk. Although nonsystematic risk, does not vary over time, the relative contribution of nonsystematic risk to total risk varies over time. Moreover, "aggressive" stocks contribute the highest levels of systematic risk to portfolios while "defensive" stocks contribute the highest levels of nonsystematic risk to portfolios. Specifically, Smithfield had the highest percentage of systematic risk while, in decreasing order Maple Leaf, IBP and Schneider had the highest levels of nonsystematic risk.

Overall, investors may view Schneider, Maple Leaf and IBP as stocks that would lower the risk of a portfolio, and Smithfield as a stock that would add risk to a portfolio. In addition, investors should be aware that Maple Leaf and Smithfield stock may exhibit higher (lower) levels of systematic and nonsystematic risk across different periods.

6.2 Limitations of Study

This study has provided evidence to support the hypothesis that the risk-return relationship and components of total risk for some pork processing companies varies over time. However, results regarding the effect of economic and/or market factors on the risk-return relationship are less conclusive. In fact, different versions of each company's model yielded different results. Given this, the SIM displays sensitivities to variables and time-periods considered in the analysis. Consequently, it is difficult to generalize results across companies, factors and periods. Thus, results presented in this study ought to be viewed as unique to the companies, variables and time period considered. This may be partially due to the perception in the research community that the single index model may not accurately depict the risk-return relationship for single stock portfolios.

Another limitation of this study concerns the use of binary dummy variables. Dummy variables were utilized to permit parameters to differ between periods. This was accomplished by assigning a variable a value of one in one period and a value of zero in another. The problem is that it is not 100 percent certain the dummy variable captured the effect of the occurrence it was intended to model. This is because dummy variables may pick up the effect of another occurrence not considered in the model. In fact, this may explain why the Maple Leaf merger with Landmark was a statistically significant variable in one of the Smithfield models.

A further limitation of this study is the analysis presented is based on a static model. As such, further research, using a dynamic framework, is required to validate the assertion that the time-varying single index model is representative of short-run relationships and that the single index model with constant parameters is characteristic of the long-run relationships.

6.3 Opportunities for Further Research

This study made a unique contribution to risk-return relationship literature by applying existing concepts and methodology to the pork processing industry. But, more importantly, this research introduced the notion of alpha risk, the portion of total risk, not related to the market return, that may be explained by economic and/or market factors. However, several questions remained unanswered.

The first concerns the inclusion of variables that are difficult to value. For example, what is the effect of capacity utilization, market/industry concentration, strikes/labor disputes, environmental concerns or food safety on the risk-return relationship. These variables are believed to be important components of the risk-return relationship but are difficult to measure and/or quantify.

Further research may involve the use of valuation methods, developed in the natural resource or environmental branches of economics, to value intangible assets. For instance, a form of contingent valuation may be used quantify environmental concerns. This may be accomplished by calculating society's willingness to pay for "environmentally friendly" hog production and/or processing. As there are several methodological issues associated with this valuation procedure, another option is to use dummy variables to represent environment-related news releases. An example of a news release that could be characterized by a dummy variable is the announcement that IBP was required to take steps to eliminate a public health threat posed by hydrogen sulfide emissions. (Multex.com, 2001)

The second question arises from the range of methods available to measure systematic and nonsystematic risk. Should a measure of total risk be obtained from the summation of estimates of systematic and nonsystematic risk? Should nonsystematic risk be defined as the residual of the decomposition of total risk or as the (standard deviation) of the variance of regression residuals? Is a measure of negative nonsystematic risk plausible? Current literature has not reached a consensus regarding methodology for measuring systematic and nonsystematic risk. As there is no evidence supporting the superiority of one approach, the reliability of results published to date is questionable. Moreover, this makes it difficult to compare and contrast results between studies.

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