Policy Reform Impact on Food Manufacturing

Workshop on Agricultural Policy Reform and Adjustment
Imperial College, Wye, October 23-25, 2003

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Summary: The impact of agricultural policies and their reform is of major concern when addressing issues of growth, innovation and consolidation in the food manufacturing sector. Growth is one of the forces fueling the globalization of food manufacturing activities. Market- and policy-driven forces present a myriad of opportunities to influence growth and reorientation of patterns at the nexus where food manufacturing links the food system. The productivity and international competitiveness of the food manufacturing sector must be evaluated in the context of governmental incentives, international standards and the emerging supply- and value-chains.

KEY WORDS: Total Factor Productivity Growth, Intercountry Impacts, Dairy Products, Meat Products, Sugar

1 Introduction

Agricultural and food policies have affected the economic structure of agriculture and the food manufacturing and distribution. Traditionally, technological improvements in agricultural production led to important structural changes. However, a continuing trend in the U.S. and Europe (and emerging in Asia) is a transformation in the organization and management of production, processing and distribution. Most of the explanations of the changing structure of production focus on the nature of innovations at the farm, processing and distribution levels, and their interaction with the incentives generated from commodity and trade policies.

Questions relating to productivity and international competitiveness are prominent in pubic policy discussions. These issues are amenable to rigorous analysis. This paper addresses innovation, productivity and economic growth to elaborate on the linkages between growth and performance within and between economies.

A major component of this paper focuses on specifying and measuring technical change and productivity. Most nations have a de facto industrial policy. However, agricultural policy is broader than an industry-specific policy and encompasses support to agents all along the production chain and the communities supporting the linkage in primary production, processing and distribution activities. Some nations have a long history of state-supported research and development in agricultural production and management (at government laboratories and at agricultural colleges and universities) and state supported delivery of the research products. Consequently policy makers have a keen interest in the gains this research and development has generated.

An important issue for evaluating economic performance and growth of firms and industries is the role of scale economies and how innovations influence changes in factor use. This has been emphasized in the traditional approaches to productivity growth and in recent studies on endogenous growth. In the case of endogenous growth, these economies are more explicitly expressed as returns to some aspect of "capital" that generates externalities. This notion of capital encompasses both human and physical capital, which are said to embody new knowledge and contribute to scale economies. The external nature of capital returns is motivated by the hypothesis that a firm's investment capital is likely to have substantial beneficial spillover effects in reducing production costs to other firms. Thus, an increase in the capital stock of one firm will appear to lower the production cost of other firms.

These issues and the challenges they present to agricultural adjustment and reform will be illustrated by case studies for some of the most important commodities.

2 Patterns of Growth and Technological Progress in Food Manufacturing

2.1 Productivity growth and it's decomposition by 2-digit industry

The U.S. food processing and kindred products industry, which accounts for about one-sixth of the U.S. manufacturing sector's activity, has experienced significant reorganization. Harris (2002) reports that from 1993 to the first half of 1998 the food and kindred products sub-industries, meat processors accounted for 60 mergers and acquisitions, dairy processors accounted for 69, soft drink bottlers for 53, snack food processors for 44 and poultry processors for 32. These are on the heels of at least two decades of vigorous merger activity.

Manufacturers attempt to increase sales, profits and market share through consolidation, industrialization, expanding exports, foreign growth and new value-added product development (ERS, Harris, 2002). The food and kindred product industry has the sixth largest number of plants among twenty operating manufacturing industries in U.S. and produce nearly 14 percent of the total value of output in the manufacturing sector. The industry has been responsive to new technologies in processing, packaging and marketing of food product and has become increasingly high-tech over the past few decades (Morrison, 1997).

2.1.1 Mean Productivity Analysis

Table 1 presents an overview of productivity changes of the plants over the period 1973-95, summarizing the average Total Factor Productivity (TFP) growth by periods in the food products industry.

Table 1. Average TFP Growth without Ranking Plants in All Food Sub-Industries Together

Time Period	Mean TFP	Mean Scale	Mean Tech. Change	Mean Returns to Scale
1973-75	0.030091	-0.00072	0.031957	0.92236
1976-80	0.021557	-0.00039	0.022143	0.87745
1981-85	0.009311	-0.00491	0.01423	0.85173
1986-90	-0.00339	-0.01045	0.007044	0.89033
1991-95	-0.00223	-0.00117	-0.00112	0.94673
1973-95	0.009414	-0.00377	0.013363	0.895577

Source: Celikkol (2003), Chapter 13.

The period averages without ranking TFP growth show that food manufacturing plants start with a 3% productivity growth and gradually declines in the later periods finishing with a -0.2% growth rate during the period 1991-95. The general trend of the industry indicates that average TFP growth follows a declining productivity growth pattern with a considerable fluctuation especially after 1983, averaging 0.9% productivity growth throughout the years.

Studies investigating productivity change in the U.S. food processing sector report negative productivity growth during some years. For example, Heien (1983) reports negative productivity growth in the aggregate food sector during the ten of the years between 1958 and 1977, Chan-Kang, Buccola and Kerkvliet (2002) during five of the years between 1963 and 1992, and Morrison (1997) during seven of the years between 1966 and 1991. The plant-level productivity study by Celikkol (2003) is the source of productivity results and patterns that follow. When all plants are pooled together, average productivity growth in the food industry is 0.9%. This is slightly higher than the estimate of 0.82% average productivity growth rate in the U.S. processes food sector (SIC 20) between 1963 and 1992 by Chan-Kang, Buccola and Kerkvliet (1999), and 0.78% growth between 1965 and 1991 by Morrison (1997). However, when we analyze each sub-industry in food and kindred products industry separately, our estimates indicate wide variation in the productivity growth rates and patterns of the industries at the plant-level.

2.1.2 TFP Decomposition According to Quartile Ranks

The plants are ranked in quartiles according to their TFP growth rates and studied further. Table 2 presents the average TFP growth and its components (scale and technical change effect) for each rank with an average returns to scale during the five prescribed time periods.

Table 2. Total Factor Productivity Growth Rankings and TFP Growth Components through 1973-95

TFP RANK 0				
Time Period	TFP Growth	Scale Effect	Technical Change Effect	Average Returns to Scale
1973-75	-0.07384	-0.09467	0.020834	0.86432
1976-80	-0.04082	-0.05589	0.015073	0.76736
1981-85	-0.06889	-0.08006	0.011173	0.75908
1986-90	-0.09543	-0.10062	0.005194	0.8485
1991-95	-0.08038	-0.06657	-0.01381	0.95971
1973-95	-0.0717	-0.07825	0.00655	0.837663
TFP RANK 1				
Time Period	TFP Growth	Scale Effect	Technical Change Effect	Average Returns to Scale
1973-75	0.014029	-0.00401	0.018039	0.90473
1976-80	0.011053	-0.00472	0.015773	0.885
1981-85	0.005138	-0.00574	0.010873	0.88517
1986-90	-0.00133	-0.00534	0.004014	0.91394
1991-95	-0.00583	-0.00422	-0.00161	0.93548
1973-95	0.003794	-0.00487	0.008668	0.904875
TFP RANK 2				
Time Period	TFP Growth	Scale Effect	Technical Change Effect	Average Returns to Scale
1973-75	0.037874	0.009334	0.02854	0.92449
1976-80	0.027991	0.006321	0.02167	0.91697
1981-85	0.019723	0.005365	0.014358	0.89894

1986-90	0.011933	0.0036	0.008333	0.92023
1991-95	0.007633	0.003073	0.00456	0.94882
1973-95	0.019566	0.005209	0.014357	0.921663
TFP RANK 3				
Time Period	TFP Growth	Scale Effect	Technical Change Effect	Average Returns to Scale
1973-75	0.14231	0.086438	0.055868	0.98983
1976-80	0.08795	0.052677	0.035271	0.93916
1981-85	0.08122	0.060749	0.020468	0.86557
1986-90	0.07115	0.060466	0.010681	0.87915
1991-95	0.06966	0.063033	0.006628	0.94219
1973-95	0.085948	0.06278	0.023167	0.917385

Source: Celikkol (2003), Chapter 13.

Table 2 indicates that on average, the food industry exhibits decreasing returns to scale for each rank, ranging from 0.84-0.92. Average returns to scale is calculated by finding the point estimates of the returns to scale for each plants, grouping them according to their TFP quartiles, and then taking the average for the time period for each rank. The TFP growth and its components indicate that on average scale effect has the most significant contribution to the TFP growth measurement for the lowest quartile (rank 0) and the highest quartile (rank 3) plants. These scale effect contributions to TFP measurement are in the opposite (negative) direction for the plants in group 0 and in the same direction (positive) for the plants in group 3. For the rank 1, the technical change effect has the most significant contribution to the TFP growth measurement except during the 1986-90 and 1991-95 periods and this effect is in the same direction (positive) as TFP growth measurement. For the plants in rank 2, the technical change effect has the larger impact on TFP growth in each period and the contribution of technical change effect to TFP growth is in the same direction (positive) for all periods. When the scale effect dominates th technical change effect, plants or firms in the industry extract scale efficiencies over technical gains (technological progress). For example, the scale effect dominates the technical change effect for food industry plants in the lowest and the highest TFP categories. For the lowest ranked plants, the situation can suggest that these plants cannot afford to be more productive but they have some potential productivity gains to be realized by organizing allocations. For the highest ranked plants, these plants are extracting more out of their capacity. On the other hand, for the plants in rank 1 and 2 the technical change dominates the scale effect indicating that these plants are looking toward technical change to realize technical gains.

2.2 Input Bias of Technical Change in the Food Industry

Table 3 summarizes exogenous input bias results. These results show that technical change is biased toward capital (capital-using) except in the 1976-80 period with a fluctuating magnitude, averaging 73% through out this time period. Technical change is labor-saving except in the 1973-75 and 1991-95 periods with a magnitude fluctuating from 1.3% to 0.9% and averaging 0.4% in all periods. Technical change is material-using in all periods with a magnitude declining from 6.2% to 3.6% and averaging 3.7%. The direction of technical change is toward energy except in the last period with a magnitude declining from 32.8% to 0.4% and averaging 6.6% throughout the years. Capital-using and labor-saving directions of technical change have been encouraged by a significant expansion of high-tech capital and increased labor costs that have occurred in the food and kindred products industry.

Table 3. Multifactor Bias in Technical Change for Sub-Period Averages in Food Industry

Time Period	Mean Capital Input	Mean Labor Input	Mean Material Input	Mean Energy Input
1973-75	3.98278	0.012566	0.061488	0.32815
1976-80	-0.28936	-0.00657	0.040683	0.05812
1981-85	0.91239	-0.0259	0.027701	0.03694
1986-90	0.22082	-0.004	0.027351	0.0172
1991-95	0.13236	0.009364	0.035487	-0.00393
1973-95	0.731711	-0.00425	0.036547	0.066349

Source: Celikkol 2003, Chapter 13.

This section compares our findings from each food sub-industries and all food manufacturing plants pooled together based on quartile ranks of TFP growth and corresponding scale and technical change components during the prescribed time periods. A common finding across sub-industries and all food manufacturing plants together is that the scale effect makes the most significant contribution to the TFP growth measurement for the plants that are in the lowest TFP quartile group (rank 0) and the highest TFP quartile group (rank 3). These effects and the average contributions of scale and technical change effects to TFP growth are shown in Table 4. Scale effect dominancy over technical change effect indicates that plants or firms in the industry extract scale efficiencies over technical gains (technological progress). For the lowest ranked plants, scale dominance can be explained since these plants cannot afford to realize higher productivity growth through technological adoption but they have the potential to reorganize input allocations to achieve productivity growth. The exogenous technical change effect has the most significant contribution to TFP growth measurement for half of the sub-industries for the plants in TFP rank 1 and all of the sub-industries for the plants in TFP rank 2.

Table 4. Contributions of Scale and Technical Change Effects on TFP Growth Across Sub-industries and All Food Industry Plants Together

INDUSTRIES	TFP RANK 0	TFP RANK 1	TFP RANK 2	TFP RANK 3
201	Scale Effect	Technical Change Effect	Technical Change Effect	Scale Effect
202	Scale Effect	Scale Effect	Technical Change Effect	Scale Effect
203	Scale Effect	Scale Effect	Technical Change Effect	Scale Effect
204	Scale Effect	Technical Change Effect	Technical Change Effect	Scale Effect
205	Scale Effect	Technical Change Effect	Technical Change Effect	Scale Effect
206	Scale Effect	Scale Effect	Technical Change Effect	Scale Effect

207	Scale Effect	Technical Change Effect	Technical Change Effect	Scale Effect
208	Scale Effect	Scale Effect	Technical Change Effect	Technical Change Effect
209	Scale Effect	Scale Effect	Technical Change Effect	Scale Effect
All Food Plants Together	Scale Effect	Technical Change Effect	Technical Change Effect	Scale Effect

Source: Celikkol (2003), Chapter 14.

2.3 Productivity Dispersion across Industries

Some plant-level studies have examined the degree of productivity dispersion in different industries by measuring the ratio of average TFP for the plants in the higher rank of the productivity distribution relative to the average in the lower ranks in some years (see Dhrymes (1991), Dwyer (1996) and Olley and Pakes (1996)). Celikkol (2003) measures productivity dispersion across industries by calculating the absolute difference in TFP between the highest ranked plants (rank 3) and the lowest ranked plants (rank 0) and the comparison across industries are based on the coefficient of variation for each sub- industry's absolute difference between these extreme ranks.

We focus on whether a persistent increasing, decreasing or fluctuating difference exists between the lowest ranked and the highest ranked plants throughout the time period across industries. For this analysis, we ran a simple regression for each industry against time and time squared (in some cases) to measure the trends in each industry's productivity dispersion. Table 5 summarizes the gap and trend based on the regression estimation.

Table 5. Trend Analysis for Productivity Growth Gap between Lowest and Highest Quartile Plants

Industries	Pattern of gap over time	Source of gap change
201	decreasing to increasing	Rank 3: decreasing & Rank 0: stable, then Rank 3: stable & Rank 0: decreasing
202	Decreasing	Rank 3: decreasing & Rank 0: stable
203	decreasing to increasing	Rank 3: increasing < Rank 0 increasing, then Rank 3: decreasing < Rank 0: decreasing
204	decreasing to increasing	Rank 3: decreasing > Rank 0: decreasing Then Rank 3: decreasing < Rank 0: increasing
205	Decreasing	Rank 3: decreasing & Rank 0: stable
206	Decreasing	Rank 3: decreasing < Rank 0: decreasing
207	decreasing to increasing	Rank 3: decreasing > Rank 0 decreasing, then Rank 3: decreasing < Rank 0 decreasing
208	Decreasing	Rank 3: increasing < Rank 0: increasing,

209	decreasing to increasing	Rank 3: decreasing < Rank 0: decreasing, then Rank 3: stable & Rank 0: decreasing
All Food Industry	Constant	Rank 3: decreasing = Rank 0: decreasing

Source: Celikkol (2003), Chapter 14.

The most obvious fluctuating case is the grain mills products sub-industry (SIC = 204). In this sub-industry, the productivity gap starts to shrink at the beginning of the time period since the productivity in the highest ranked plants starts to decrease while the productivity in the lowest ranked plants increases. The gap then starts to increase while the most productive plants maintain their position but the lowest ranked plants get worse in their productivity growth. The trend in the productivity difference for the dairy products, bakery products, sugar and confectionery products and beverages products sub-industries are decreasing for different reasons. For the dairy products sub-industry (SIC = 202) and bakery products (SIC = 205), the lowest ranked plants remain fairly stable over time, but the highest ranked plants exhibit declining productivity growth. The sugar and confectionary sub-industry (SIC = 206) finds both the highest and lowest ranked plants exhibiting falling productivity growth rates with the fall in the lowest ranked plants dominating. The beverage products sub-industry (SIC = 208) has the opposite situation with both the highest and lowest ranked plants exhibiting increasing productivity growth rates with the increase in the lowest ranked plants dominating. In other sub- industries, the gap between the most productive and the least productivity plants fluctuates for various reasons which are summarized in Table 5.

3 Sub-Industry Cases

The previous section provides an aggregate view point of the food manufacturing sector's growth and technical change patterns, but Table 4 and 5 suggest a wide variation at the sub-industry level. Since policies focus on commodity categories, the initial impacts are likely to manifest themselves in the related sub-industries. The focus in this section is on the productivity patterns for the Meat Products, Dairy Products and Sugar and Confectionary Products sub-industries.

3.1 Meat

3.1.1 Background

The U.S. meat products sub-industry is a significant sub-industry within the food and kindred products industry. This sub-industry has the highest average employment accounting for 19% of total industry's average employment, the highest total value of shipments with 21.1% of total industry' total value shipments, the highest material input expenditure as a 28.6% of total industry's material expenditure, the highest labor expenditure as a 25.2% of total industry's labor expenditure, and the highest percent of total surviving plants (together with Grain Mill products sub-industry) with 16% when compared with the other sub-industries. In the meat products sub-industry, increased consolidation and concentration over the past two decades has raised great concern for policy makers. This issue has existed since the late 1800s but it has became a greater concern in recent decades with the development of new production processes and products ("boxed beef" production) and lower red meat demand leading to substantial consolidation [Morrison Paul (2001)]. The four largest firms in the meat packing industry handled 36% of slaughter in 1960, but by 1994, only three firms handled the 81% of slaughter (Nguyen and Ollinger, 2002). In addition to these structural developments of the industry, meat and poultry firms' engagement in numerous mergers and acquisitions activities over the 1977-82 period.

Increased concentration and related merger and acquisitions activities for these industries suggest the emergence of monopsony and monopoly power, specifically in meat slaughter plants, which would harm animal producers as processors pay low input prices to suppliers and harm meat consumers by charging high prices while generating excess profits for firms is a result of these market structure patterns. There have been recent studies focusing on the food industry using plant-level data taken from the LRD and an analysis of merger and acquisition activities and this relationship to productivity. McGuckin and Nguygen (1995) analyze the U.S. food and beverage industry to study the relationship between ownership change and productivity for the period 1977-87, finding that ownership change is typically positively related to both initial productivity and productivity growth after acquisitions. The ownership change is negatively related to initial productivity for a sample of large continuing production plants, but for smaller plants they find a positive relationship. The most recent study by Nguyen and Ollinger (2002) investigated the relationship between the merger and acquisitions activity and productivity performance of plants in three 4-digit SIC meat product industries: meat packing (SIC 2011), sausages and other prepared meats (SIC 2013) and poultry slaughtering and processing (SIC 2015) for the period 1977-92. They find that firms in the meat and poultry products industries preferred to acquire highly productive plants. These acquired plants experienced significant improvements in productivity during the post-merger period except for those in the poultry slaughtering and processing industry. They conclude that synergies associated with firm managers achieving efficiency gains by combining the business of the acquired and acquiring firms and related efficiencies are important motives for mergers and acquisitions and they place less emphasis on the proposition that a drive for monopoly power encourages merger and acquisitions.

Paul (2001) finds significant but declining market power and cost economies in the U.S. meat packing industry. While the markups of output price from monopoly power are apparent, evidence of markdowns from monopsony behavior in livestock input markets is weak. Increasing size of establishments and the resulting concentration in the industry may be the consequence of scale economies arising from technological factors embodied in plant and equipments. Paul's results show that the increased consolidation and concentration in this industry has been motivated by cost economies, but the existence of excess profitability and the potential for taking further advantage of such economies is minimal.

Paul's investigation into the market and cost structure of U.S. beef packing industry using the plant-level data finds the absence of excess profitability in the industry and suggests the market power and consolidation may be due to effective competition driving a monopolistically competitive or contestable markets type of equilibrium. The increase in the size of plants and firms may also suggest the efficiency potential from scale, scope, multi-plant and other types of cost economies that can allow larger and more diverse or specialized plants or firms to increase their cost effectiveness. Paul's estimates indicate little if any depression of cattle prices or excess profitability and significant cost (utilization scale and scope) economies in this industry. Larger and more diversified plants embody even more potential technological economies than smaller plants.

3.1.2 Productivity Patterns

Recent studies in the meat products sub-industry lead us to investigate the productivity issues in more detail which relates to these recent changes in the industry. Precise measurement of productivity contributes to understanding the important issues motivating merger and acquisition activities, the exercise of market power, characterizing the industry's general structure based on the analysis of the plants and firms' size, age and single or multiunit firm characteristics as well as the industry's pre-and post-merger productivity patterns.

In the TFP growth decomposition, the scale effect is the most significant component of the TFP growth for the plants, which are in the lowest rank throughout the time periods and in the highest rank except in the time period 1976-80. The average contributions of scale effects to TFP growth for these ranks are 115.5% and 66%, respectively. The exogenous technical change effect presents the most significant contribution for the plants in the middle rank groups (rank 1 and rank 2), with an average of 133.7% and 85%, respectively. Plants that are in the lowest and the highest ranks extract scale efficiencies over technological progress. For the lowest ranked plants, this situation can suggest that these plants cannot afford to realize higher productivity growth through technological adoption but they have the potential to reorganize input allocations to achieve productivity growth.

In the meat products sub-industry, exogenous input bias results show that technical change is biased toward capital except in the 1981-85 period and against materials except in the 1973-75 period. For energy, technical change is biased toward energy after 1976-80 and toward labor in all time periods.

The time profile of productivity growth in meat products indicates that the plants in rank 1 and rank 2 quartile groups follow a similar pattern with an almost no gap between one other. However, the plants in the highest ranked group (rank 3) and the lowest ranked group (rank 0) exhibit productivity pattern changes and maintain the gap from other quartile groups. The lowest ranked plants catch the plants that are in ranks 1 and 2 after 1977 until 1984. They decrease the gap significantly when these plants are compared to earlier years such as 1974, 1975 and 1976. Therefore, we detect various degrees of productivity between the meat products plants and separate the productive plants from the relatively less productive plants throughout the time period. The results suggest that growth occurs for each productivity scale group despite negative growth for the lowest productive ranked group.

The analysis investigating the number of times that plants change their productivity rankings shows that 9% of the meat products sub-industry plants do not change their productivity rankings throughout the time period. This percentage declines slightly as the plants age and 25% of meat sub-industry plants switch once, with 18% of the youngest plants, 29% of the middle-aged plants and 26% of the oldest plants switching once. Considering all age categories and the industry plants pooled together for this sub-industry, 37% of all plants switch twice, 38% of the youngest plants, 33% of the middle-aged plants, and 38 % of the oldest plants throughout the time periods, suggesting considerable movement in plants' productivity categories for this industry. Plant productivity transition tables in Celikkol (2003) show that meat products plants do not occupy a fixed rank with respect to their productivity levels. In fact, in no case do 50% of the plants stay in the same category, indicating considerable movement between productivity rank categories.

3.2 Dairy

3.2.1 Background

The U.S. dairy products sub-industry (along with the canned, frozen, preserved fruits, vegetables sub-industry) has the second largest percentage of plants (13%) which survived through 1972-95 period based on the total number of plants among all food manufacturing. It is the fourth largest sub-industry based on the material expenditure with 11.2% of total industry's material expenditures. Dairy products account for 7.3% of total food and kindred products industry's energy expenditure, 6.1% of industry's employment expenditure, 6.3% of industry's combined machinery and building investment expenditures as well as 6.1% of industry's machinery investment expenditure and 7.2% of industry's building investment expenditures. Dairy products sub-industry's total value of shipments is the fifth largest with 9.3% of total food and kindred products industry's total value of shipments.

Based on the recent reports by Harris (2002), the number of food processing plants rose 5% from 1992 to 1997. However, this increase is only in some industries where the small number of food processors has increased such as small salsa makers. But, over the last two decades across the food proceeding industry, the number of establishments have declined and the dairy products sub-industry lost the most establishments (approximately 190 establishments). Mergers and acquisitions are also seen in dairy and concentration continues to increase. For example, Harris (2002) reports that large dairy processing firms account for an increase share of dairy sales and companies with $800 million or more in sales accounted for 69% of U.S. dairy sales in 1998. Large U.S. dairy cooperatives gained market share from 17% in 1975 to 27% in 1998 relative to proprietary dairy companies (39% to 42%).

3.2.2 Productivity Patterns

In the TFP growth decomposition, on average, the scale effect is the most significant component of TFP growth for the plants in TFP ranks 0, 1 and 3. The average contributions of scale effects to TFP growth for these ranks are 93.2%, 82.9%, and 94.7%, respectively. Exogenous technical change has the most significant contribution throughout the time periods for the plants in rank 2, with an average of 389.4%. Plants in the lowest, middle and the highest ranks extract scale efficiencies over technological progress. For the lowest TFP ranked plants, this situation suggests that these plants cannot afford to realize higher productivity growth through technological adoption but they have the potential to reorganize input allocations to achieve productivity growth.

For dairy products, exogenous input bias results show that technical change is biased toward capital, averaging 10.4% throughout the time period, and toward labor after the 1976-80 period, averaging 9.5%. Technical change is biased against materials except in 1981-85, averaging –0.18% over all years. The direction of technical change is biased against energy during 1981-85 and 1991-95 and toward energy during the remaining periods, averaging –2.6% throughout the years.

In dairy products, the time profile of productivity growth for all quartile groups indicates that plants in the TFP ranks 1 and 2 follow one another closely with a small persistent gap throughout the period. Plants in the lowest and the highest TFP growth categories present a significant gap. The lowest ranked plants close the gap between the other categories until 1977 and gaps between other categories remain constant after 1977 until the end of the period. Plants in the lowest TFP rank have the most fluctuating productivity growth patterns over the course of this study. Overall, there is a gap among all the TFP growth ranks; in particular between the highest and the lowest TFP ranked plants. For example, while the lowest ranked plants' productivity growth averaged –1.9%, the highest ranked plants' productivity growth averages 1.1% over the study period. Plant productivity transition tables in Celikkol (2003) generally show that no more than 50% of the plants stay in the same category in the dairy products sub-industry suggesting considerable movements between productivity rank categories.

3.3 Sugar and Confectionery Products

3.3.1 Background

The U.S. sugar and confectionery products sub-industry is relatively small, with the percentage of plants based on total industry's plants accounting for 7.3% of total food and kindred products industry's material expenditure, 11.8% of industry's energy expenditure, and 8.2% of industry's employment expenditure. During the time frame considered, the sub-industry has the sixth largest capital investment expenditures with a 9.7% of total industry's machinery investment expenditure, 7.7% of total industry's building expenditure as well as 9.3% of total industry's combined machinery and building investment expenditures. Total value of shipments from the plants that survived during the course of the study constitutes about 8% of total food and kindred products industry's total value of shipments. Although this sub-industry is one of the most understudied among the food sub-industries, U.S imports by sugar and confectionery products industry reached $3.5 billion during 2000 and new plants entered during the 1992-97 period.

3.3.2 Productivity Patterns

In the TFP growth decomposition, the scale effect is the most significant component of the TFP growth for the plants in TFP ranks 0, 1 and 3 throughout the time periods. The average contributions of the scale effect to TFP growth for these ranks are 109.5%, 560.9% and 93.2%, respectively. The exogenous technical change effect is the most significant contribution for the TFP rank 2 plants throughout the time period with an average of 82.9%. Plants in the lower TFP ranks (rank 0 and 1), and the highest TFP rank exhibit scale efficiencies over technological progress. For the lowest TFP ranking plants, this situation suggests that these plants cannot afford to realize higher productivity growth through technological adoption but they have the potential to reorganize input allocations to achieve productivity growth.

In sugar and confectionery products, the exogenous input bias results imply that technical change is biased toward capital and materials except in the 1973-75 period, toward labor except in the 1973-75 and 1981-85 periods, and toward energy except in the 1973-75 and 1976-80 periods. The capital-and labor-using nature of technical change can be attributed to the increased machinery sophistication and new equipment developments. These changes in turn require a better-trained labor force.

In sugar and confectionery products, the time profile of productivity growth for all quartile groups indicates that plants in all quartile groups follow a similar TFP growth pattern with almost no gap between TFP ranks 1 and 2, and a constant and small gap between the lowest ranked plants (rank 0) and the highest ranked plants (rank 3). Even though the different ranked plants in this sub-industry exhibit similar patterns and the gap between them is small, and we are able to separate the productive plants from the lowest productivity plants.

Plant's productivity transition tables in Celikkol (2003) show that sugar and confectionery products plants generally do not occupy a fixed rank with respect to their productivity levels with rarely more than 50% of the plants staying in the same category except for the plants that are in the two younger age categories in rank 3 during the first two periods, indicating considerable movement between productivity rank categories. Less than half of the plants stay in the same category, and most of the plants switch categories throughout the time periods.

4 Role of Agricultural Production and Trade Policies

The historical orientation of agricultural policies is directed at commodity production with some trade policies intending to address commodity producers' welfare. Domestic price support and income policies are directed at farmers and trade policies have focused on managing domestic surpluses by stimulating export demand (e.g., the Export Enhancement Program) commercially, lending or gifting excess supply for development purposes (e.g., PL 480 program), and preventing foreign supply from entering the domestic market. With commodity production being one node in the food system, the impact of policies intended to address commodity producers' concerns radiate forward and backwards along the food system. Hence, the impact of the commodity-based programs is evident at the food manufacturing level.

4.1 Meat Products

The meat industry has seen major changes over the past several decades, although the changes have been driven more by technology than policy. The development of boxed beef plus the commodity nature of the beef market allowed Iowa Beef Packers (now part of Tyson) to change the location of the beef packing industry from cities to the feeding area, and to replace skilled meat cutters with less skilled assembly-line workers. In the process all of the former industry leaders were driven from business and replaced by companies with fewer outmoded and poorly located plants. The broiler industry had used on-farm technological advances to reshape and relocate the processing industry in the 1950s and 60s and the pork industry did the same in the 1990s. The recent purchase of IBP by Tyson is the first large-scale joint ownership of red meat and poultry processors. Lawsuits about food safety and additional regulations may have sped the consolidation of the industry and ended small-scale slaughter facilities, but these changes would have occurred because of the economics in any case. Branded processed meat still has many small firms, but the commodity portion of the meat industry is increasingly the purview of larger firms. Poultry and beef have gone to greater further processing in the factory, using large size economies to move these steps from the supermarket, restaurant, and home.

4.2 Dairy Products

The dairy processing industry is affected by policy in two ways. The most obvious is the classified pricing system, which when combined with regional price pooling, induces production of cheese and other storable products in regions where it would not otherwise occur. For example, cheese producers all pay the same price for milk, the class III price. However, farmers delivering their milk to the cheese plant do not receive the class III price, but a higher price that is a weighted average of the four class prices, with the weights determined by the usage of milk for the different products in that region. Without pooling no farmer in a higher priced region, such the northeastern United States, would want to deliver to the cheese plant because it would be a lower price than he would receive at a fluid plant. This would mean a northeastern cheese plant would have to pay more for its milk and would soon be driven from business by a Wisconsin cheese plant that paid less for its milk. Without classified pricing and pooling, one would expect more geographic concentration of cheese plants in the low priced regions and probably more concentration of milk production in these regions. The classified pricing system also administers spatial price differentials in Class I (fluid) milk. These differentials create artificial spatial price differentials that are sometimes greater than would occur in a free market. This also encourages milk production in deficit regions since the price is artificially high in those regions, especially the southeastern United States.

A second distortion is created by the price support program. The willingness of the government to buy cheese, butter, and powdered milk at the support price, often keeps these prices higher than they would be otherwise and encourages production of supported commodities at a level greater than is justified by market conditions. A lot of skim milk powder in particular has been purchased in recent years, making butter-powder plants more profitable and, with the classified pricing system, allowing them to continue to exist in deficit regions.

Beyond agricultural policy effects the dairy industry has seen major changes recently. Driven by WalMart, the supermarket industry has had many mergers in the past decade as they modified their inventory and ordering practices. They have tried to get fluid milk suppliers who can serve the chains across the country. In response, the fluid milk bottling industry has gone from almost entirely regional firms, to being dominated by two rapidly growing national firms, Suiza and Dean Foods. These firms were allowed to merge in 2001, creating a single national fluid bottler with 40% of the market. In response to these changes, two national dairy cooperatives were created through the merger of regional milk marketing cooperatives, Dairy Farmers of America and Land O'Lakes.

4.3 Sugar and Confectionery Products

American sugar policy has clearly affected the shape of the sugar processing industry. The policy restricted imports, thereby holding the price of sugar well above world prices and further used to quotas to keep domestic beet sugar and cane sugar production at approximately the same size. By keeping the price of sugar so high, the policy encouraged the development of high-fructose corn syrup (HFCS) and other sugar substitutes. At this point, any food product that can use a liquid caloric sweetener has switched from sugar to HFCS, especially soft drinks. As a result the share of imported sugar in the market dropped steadily, finally reaching a point where the sugar program went from just a consumer-financed price support to having considerable budget impact. Accordingly, most sugar plants in port cities like Philadelphia that processed imported cane sugar lost their business and closed. Sugar-beet processors and domestic cane processors owe their existence to the protective policy and domestic quotas, which have defined their locations and ability to grow. There have been many mergers over the years and other consolidation in the domestic industry, vaguely like the rest of the food industry. However, widespread relocation of the industry and other changes that might have occurred did not. Neither beet nor cane sugar could compete well with imported sugar without protection.

The production of chocolate and other confectionary products is affected by the sugar, peanut, and, to a lesser extent, dairy policies. With artificially inflated input prices, costs are increased, unfavourably affecting final product demand and encouraging imports and movement of the industry offshore.

5 Consolidation in the Food Sector

5.1 Background

Increasing concentration has been a characteristic of the U.S. food processing industry in recent decades. Food processing, distribution and retailing activities account for the majority of retail food and beverage costs for all major US commodity groups. These costs amount to 80% of consumer's expenditures on food, about 75% of the cost of food at home and 84% for food away from home. The share of costs attributable to these marketing activities is rising over time, from 62% in 1953, which reflects the additional services included in food costs. The trend of the farm share of the market declined rapidly since 1980 from 40% to 22.2% in 1998 and is attributable to forces arising in both food manufacturing and food retailing.

Behavior in the marketing sector has an increasingly independent effect on the welfare of both consumers and farmers. As the marketing sector moved to improve its profitability, it reached the point where most internal efficiencies were achieved. Further efficiencies were mainly available through increased coordination with suppliers and customers.

The top 20 food manufacturers accounted for 50% of food-processing value added in 1995 (this is more than double the corresponding share in 1954) (Sexton, 2000). Part of this increase arises from more value added products and part because of the numerous mergers between food processors during this period which created larger and more multi-product firms. As time goes on we observe cycles of larger food manufacturing firms seeking scope economies in acquisitions across product categories only to observe the pendulum swinging back as these firms divest of less profitable units and focus on core competencies.

Concentration at the food retailing sector is a more recent trend to emerge. The Top 4 supermarket retailers controlled 16-17% of supermarket sales in 1930 and 1990, but doubled to 34% by 1999 (Kinsey, 2000). The creation of national supermarket chains in response to WalMart is a major part of this. The concentration in local markets has always been much higher, with a few dominant firms in most markets.

5.2 Concerns

The first concern is that a handful of food manufacturers will supply the bulk of our foodstuffs. The drivers of consolidation and concentration include i) technological advances in inventory control and management and manufacturing processes, and ii) economic forces related to scale economies and the value of money. The consolidation of the food-marketing sector can have important positive implications. Enhanced efficiency can lead to higher welfare. The cost of market power leads to efficiency gains and thus lower costs to the consumers. The deleterious impacts of concentration and consolidation relate to the distorting impact market power has on the incentives to undertake market-expanding activities. Since processors or related market power transfers surplus from farmers, incentives at the farm level to undertake investments in demand expansion (such as advertising) or cost reduction (such as adopting new technologies) are adversely affected. Similarly, the transfer of surplus to the marketing sector gives marketing firms an incentive to undertake some new investment to reduce their costs with new technologies and to engage in advertising.

The second major concern of consolidation and concentration is that a few powerful supermarket chains provide high quality products at low prices. Ellickson (1999) focused on how many supermarket firms control the market and finds two or three firms dominate smaller markets while most larger markets are controlled by between 2-5 firms. In the largest markets, only 3-4 firms dominate 60% of the MSAs. If only 3-4 firms fit into the majority of large markets, we should expects to find monopolies (i.e., a sole firm) in the smaller markets. In fact, there is no tendency toward a single dominant firm in any markets except small towns. If concentration were being driven by exogenous economies of scale, we would expect to consistently observe one firm, especially in the smaller markets. The fact that so few single dominant firms are observed even in the smallest markets, suggests that natural oligopoly is a stable outcome and that some additional force is driving industry structure. The oligopolistic structure does not fragment as market size expands. These natural oligarchs compete head-to-head for the same consumers. The presence of rival high quality firms' forces competing stores to increase their own level of quality (as measured by the store size).

A third major concern is that a handful of food manufacturers will supply the bulk of our foodstuffs. The consolidation of the food-marketing sector can have important positive implications. Enhanced efficiency can lead to higher welfare.

Britain and Australia have had a much more concentrated food retail sector than the U.S. for many years and inferences from these markets can be made about future actions in the U.S. market. Certainly, Australian supermarket chains dramatically affected the structure of the dairy industry once deregulation of milk markets occurred.

6 Intercountry Impacts

Although many anticipated considerable affects from the North American Free Trade Agreement (NAFTA) on the structure of the Mexican and Canadian food industries, to date the most interesting parts of NAFTA have not been implemented. Certainly dairy has the greatest exposure for change, but meat and grain markets may see substantial impacts as well. Although considerable trade occurs in these latter products, to date grain movements have been in raw form and meat in processed form. Given the geography or both Canada and Mexico, many markets would be more easily served by U.S. sources in a free trade environment, with some U.S. markets being logical Canadian or Mexican outlets. The Northeastern United States is a latter example, especially for dairy.

The expansion of the EU should cause similar effects, as new members have easier access to Germany and Italy than some of their current suppliers, changing trade patterns, with corresponding impacts on affected plants. An interesting anomaly may occur with expansion, as greater WTO access undermines the Common Agricultural Policy since some new members held access quotas before and greater access will have to be granted to outsiders, such as Serbia, Russia, and Ukraine.

Clearly freer trade makes restrictive agricultural policies unsustainable and protected plants and industries (such as sugar) may find their future at risk. At the same time, freer movement of capital may lead to investment in processors in developing countries, especially given their greater market access. Manufacturing jobs, already under pressure in high wage countries, will be further at risk with open markets. Whether this creates enough economic activity to slow migration is an open question (Dunn and Bailey, 2003).

7 Potential Trends and Patterns

Consolidation in the food manufacturing sector is not necessarily coincident with increases in market power at consumers' expense. Oftentimes, consolidation is focused regionally. In the advent of growing, more integrated marketing channels, food industry giants tend to find themselves going head-to head for market share. Regional brands still hold significant appeal to consumers and examples abound of the inability of emerging national brands to gain a leading position in all regional markets. The future patterns and trends arising from consolidation will likely depend on specific product categories or the marketing channels embedded in a region.

Growth arises from both scale effects (doing more of the same thing) and innovation (doing it a new way). The technological progress is evident in all linkages in the food system. Inventory management advances have influenced the function between commodity production and commodity transformation (or food manufacturing) and between commodity transformation and commodity distribution. The entrepreneurial capital associated with innovation leads to growth by serving as a mechanism for knowledge spillovers, increasing competition by the increased number of enterprises, and providing diversity among firms. There is both a supply and demand side for innovations. Innovations evolve along the four phases of functionality, reliability, convenience and then price. What forces the transition from one phase to the next to occur is performance oversupply; i.e., when firms oversupply the ability to satisfy customers' needs, then the competition shifts to the next phase.

In the longer run, the role of public policies is manifested by growth in the food manufacturing system and the larger food system. The impact of commodity policies directed at primary commodity producers and the agents in the food system closest to them eventually radiate through the chain in the form of innovations that may not be undertaken. The impact of policies directed at value-added products such as those related to food safety and quality assurance radiate forward to consumers and are predicated on traceability standards that by definition radiate backward through the food system.

Market- and policy-driven forces have a myriad of opportunities to influence growth and reorientation of patterns at the nexus where food manufacturing links the food system. The productivity and international competitiveness of the food manufacturing sector must be evaluated in the context of governmental incentives, international standards and the emerging supply- and value-chains.

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