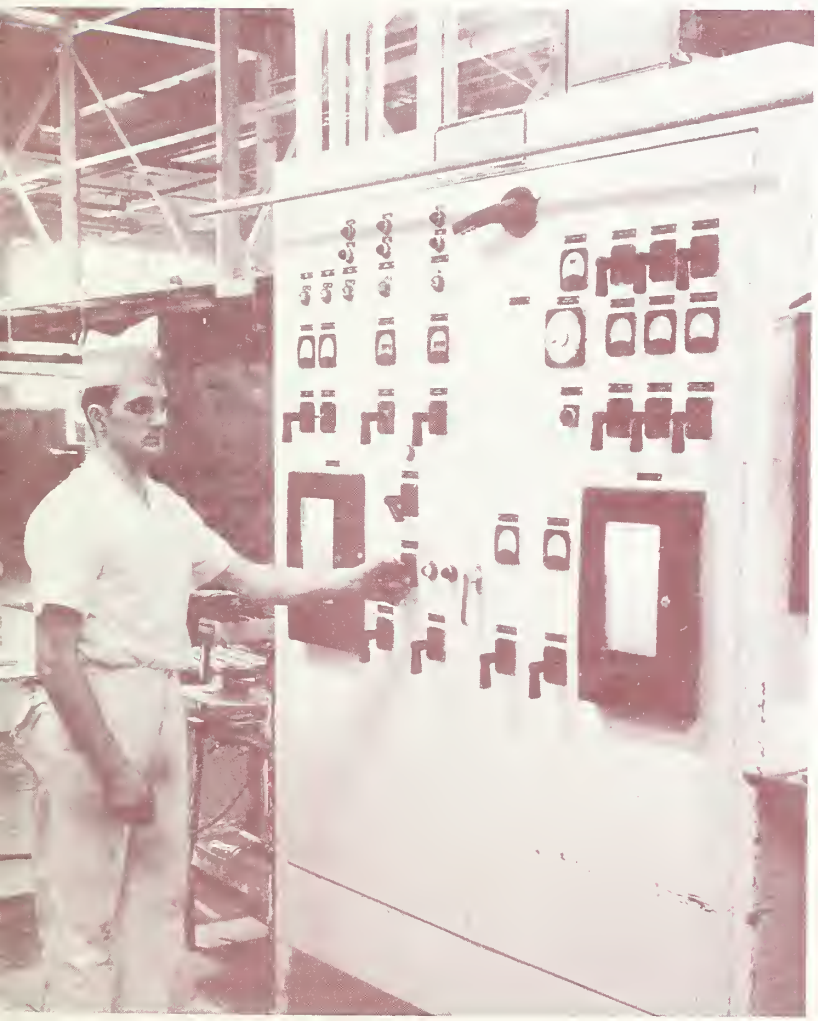
Adoption of the Continuous Mix Process in Bread Baking



Some Effects on Firms and the Industry

ERS-329
U.S. DEPARTMENT OF AGRICULTURE
ECONOMIC RESEARCH SERVICE

CONTENTS

January 1967

SUMMARY AND CONCLUSIONS

The impact of continuous mix on competition in the baking industry has been felt most by small plants, located primarily in and near areas where continuous mix operations have been introduced. In States where there were no continuous mix operations, there was a 3 percent drop in establishment numbers from 1958 to 1963, whereas in States with continuous mix the numbers declined 18 percent.

While total employment in the baking industry declined, it did not drop as much as that of production workers. New jobs arose, particularly those connected with sales and distribution.

In plants adopting continuous mix, average hourly wages for production workers rose more than those for the total baking industry during comparable time periods (11 percent for continuous mix, and 8 percent for the total baking industry.)

Average man-hours worked by continuous mix production workers increased 6 percent whereas the average for production workers in the total industry declined 7 percent.

Productivity in continuous mix plants rose 27 percent as shown in crude value added; for the total industry crude value added rose 8 percent.

Continuous mix equipment, like many other innovations and technological improvements, has resulted in greater total output as well as greater output per man-hour.

The adoption of continuous mix by part of the industry will place increased pressures upon nonadopting plants, and especially upon plants too small to adopt this process. Such plants may adjust by changing their product mix or their market clientele, or both.

Lowered production costs should enable adopting plants to expand their market area. Such expansion would lead to distributive efficiencies not as readily available in a more limited geographic context, for instance, drop shipments to more distant markets. Also, the adoption of continuous mix appears to encourage increased specialization of plant product mix. There will be more plants making bread products only, and more specializing in sweet goods.

Like the introduction of other new and improved technologies, continuous mix probably will expand sales, service, and other nonproduction jobs, as well as increasing the skill required of persons retained in the production process.

ADOPTION OF THE CONTINUOUS MIX PROCESS IN BREAD BAKING: SOME EFFECTS ON FIRMS AND THE INDUSTRY

By Toledo W. Chumley
Agricultural Economist
Marketing Economics Division

INTRODUCTION OF CONTINUOUS MIX

A continuous mix machine that allows a more nearly automatic and continuous process of bread baking was introduced in 1953. In 1955 preparations of various bread mixes were developed. Together these two technological developments incorporated the previously existing techniques of mixing, developing, dividing, shaping, and panning the bread dough continuously. In many plants this process has replaced the previous batch process which required 6 to 12 stages in the conventional production line, namely, flour scaling units, batch mixers, fermentation room, dough troughs and hoists, dividers, rounders, intermediate proofer, and molder-panners. Comparisons of standard and continuous mix plants (for first-generation continuous mix equipment) showed short-run average total costs for continuous mix plants to be lower, and to have steeper slopes. 1/

PURPOSE OF THIS STUDY

This study was conducted to provide information about the impact of the continuous mix process upon the operations of bread bakeries, and upon the structure of both individual firms and markets composing the baking industry. As Walsh and Evans stated in their study of the baking industry,

> "...the farming, milling, baking, retailing, and consuming functions are integrally related. Changes in the organization and practices in one may induce changes in others... As a result, consumers, farmers, millers, and retailers, as well as bakers themselves, have a vital interest in the way the baking industry performs." 2/

This report presents data on baking establishments which show (1) the impact of technological change (particularly continuous mix) upon the structure of both individual firms and markets composing the baking industry; (2) such measures as plant activity, industry structure, wages, capital expenditures, crude value added, and changes in the number of establishments; (3) input-output data before and after installation of continuous mix equipment; and (4) comparisons of establishments having continuous mix equipment with the total baking industry.

1/ Walsh, R. G. and Evans, Bert G. Economics of Change in Market Structure, Conduct and Performance, The Baking Industry, 1947-1958, Univ. Nebr. Press, New Series, No. 28, 1963, p. 53.

2/ Walsh and Evans, pp. 1-2.

Not all of the changes shown by the "before" and "after" comparisons in this report can be attributed completely to the adoption of the continuous mix process. Continuous mix is only one of a long series of new processes, and the impacts of technological progress continue to accumulate. For this reason, a brief description of technological progress in baking will be helpful.

THE DEVELOPMENT OF FULLY AUTOMATED BREAD BAKING

Automation in bread baking was the product of a series of improvements in baking equipment. Automation began with the development of mixing machines around 1880, followed by special machines for dividing, slicing, and wrapping of bread. Innovations adopted around the turn of the century enabled the largest bread plants to produce about 1,000 pounds of bread per hour, or about 15,000 loaves per day.

During the past 20 years the expanded use of pneumatic conveyors has made possible bulk handling of ingredients all the way from the rail siding or truck dock to the mixing machines. These conveyors were best suited for medium and large plants, and resulted in significant labor savings. It was estimated that 75 to 90 percent of the larger baking plants had adopted pneumatic conveyor systems by 1958, while only 15 percent of the small plants had done so. As a result of this innovation, an increase of as much as 40 times in the output per man-hour in unloading flour into the plant was achieved. 3/

An additional increase in productivity was associated with a change of formula. During World War II the ratios of sugar, shortening, and other ingredients to flour were reduced because of shortages of these ingredients. (They have not yet returned to prewar levels.) This formula change accompanied by consumer acceptance of a thinner crust, improved oven performance, and stepped-up heat, was responsible for reducing average baking time per pound loaf from 35 to 18 minutes. These changes encouraged development and installation of continuous automatic ovens which permitted bread to be loaded, baked, and unloaded without constant supervision. Such ovens have been adopted by 90 percent of the medium and large plants and 75 percent of the small. 4/

The continuous mix process is the latest significant innovation to be adopted by bread bakeries. All of these innovations made it possible by 1966 for the largest plant to operate at 14,000 pounds per hour per production line. Output per line of most plants approximated 5,000 pounds per hour. Typically, commercial bread plants do not operate 24 hours a day nor do they operate 7 days a week. On the busiest day, a plant may produce 30 percent of a week's production.

EXPECTED IMPACTS OF ADOPTION OF THE CONTINUOUS MIX PROCESS

What kind of impact may we expect for a plant adding a continuous mix process? A priori, one would expect: (1) Greater output per plant, (2) a rise in total expenditures for ingredients, materials, and supplies as well as for fuels and electric energy, (3) an increase in continuous mix establishment sales and delivery staff, (4) a shift in the ratio of production to nonproduction workers.

3/ Walsh and Evans, p. 48.
4/ Walsh and Evans, p. 53.

In contrast, the baking industry would experience a decrease in the number of establishments, a drop in total industrial employment, and an increase in nonproduction workers.

SELECTION AND ANALYSIS OF DATA FOR PLANTS STUDIED

A sample of about 300 establishments having continuous mix units installed between January 1, 1956, and January 1, 1964, was chosen for study to evaluate, in part, the effects of the adoption of continuous mix upon selected measures of output and expenditures. Data were to be obtained for each plant in the sample for the 2 years prior to and the 2 years following the year of installation of continuous mix. At the time data compilation was terminated, complete data were available for only 78 of the 300 plants. These plants had installed the equipment prior to January 1, 1962.

The 78 plants were divided into two groups according to the number of production workers employed by each establishment at the time of installation of the continuous mix equipment. Group A consisted of those plants having 20-74 production workers; and Group B, 75 to 350 workers. The average number of workers per plant was 50 for Group A and 145 for Group B.

An index method of analysis was used. For example, for plant 1 in Group A, the sum of production workers' wages for the 2 years prior to installation was divided into the sum of production workers' wages for the 2 years after installation, and the resulting ratio was multiplied by 100. This process was repeated for each of the other plants in Group A. The sum of the indexes for all plants divided by the number of plants gave an average index. Subtraction of 100 from this average gave the 18.2 percent increase shown in the first column--first row location of table 1. Analogous procedures were followed in computing the remainder of the data shown in table 1.

The total time span for each of the 78 plants was 5 years, although not the same 5 years in all cases. Some of the plants installed the continuous mix process in each of the years 1956-61. Although the total time spanned by the data for each plant was 5 years, the percentage changes shown in table 1, and elsewhere, reflect a time span of only 3 years. The procedure, in effect, compared the midpoints of the two, 2-year sets of data, with an intervening year for which no data entered the analysis.

CHANGES IN GROUP A COMPARED WITH GROUP B

Generally speaking, the smaller-sized firms reported a greater percentage of change in the measures used to picture the impact of continuous mix (table 1). In part, this occurs because the same absolute amount of change is reflected as a greater magnitude when expressed as a percentage because of the difference in the size of the base in each group. Furthermore, the larger companies maintained a different ratio of management and sales staff to nonproduction workers than did the smaller plants. Thus, for wage measures, Group A experienced a higher percentage increase than Group B, except for total payroll. However, total payroll includes all forms of compensation; salaries, wages, commissions, dismissal pay, bonuses, vacation and sick leave pay. Hence, the larger companies which historically have had both more extensive and more intensive unionization, report a higher total payroll increase, even though their percentage increase in wages was lower. In terms of numbers of employees, Group A experienced the greatest increase in all measures.

Table 1.--Percentage change for selected measures of output and expenditures in 78 baking plants after installation of continuous mix equipment, by establishment size 1/

Item of comparison	Number of production workers per establishment: 20-74 (group A)	Number of production workers per establishment: 75-350 (group B)	All establishments
	Percent	Percent	Percent
Production workers' wages	18.2	14.9	16.5
All other employees' wages	26.9	14.4	20.6
Total payroll	20.0	28.5	24.2
Total number of production workers	5.1	3.0	4.0
Total number all other employees	14.6	9.1	11.8
Total number all employees	7.5	4.1	5.8
Plant man-hours production workers (January-March)	4.6	3.5	4.0
Plant man-hours production workers (April-June)	5.2	4.2	4.7
Plant man-hours production workers (July-September)	7.1	5.3	6.2
Plant man-hours production workers (October-December)	7.6	.7	4.1
Total man-hours production workers (January-December)	5.9	5.3	5.6
Cost of materials: materials, containers, etc.	25.3	18.2	21.7
Cost of products bought and resold without further manufacture	45.9	158.6	102.2
Cost of fuels consumed	5.2	2.1	3.6
Cost of purchased electric energy	29.5	19.8	24.6
Cost of contract work done for establishment by others	---	---	---
Total cost of materials, supplies, etc.	31.2	22.2	26.7
Expenditures for new structures and addition to plant	251.5	7.9	129.7
Expenditures for new machinery and new equipment	86.2	166.2	126.2
Expenditures for used plant and used equipment	---	-9.6	-4.8
Total capital expenditures	69.1	222.9	146.0
Total value of shipments	30.8	21.0	25.9
Total cost of goods sold	31.0	23.1	27.0
Crude value added 2/	33.9	19.9	26.9
Average hourly wages per production worker	11.8	9.9	10.8
Hours worked per year per production worker	3.3	.7	2.0
Salaries and wages per dollar of shipments	-6.0	-9.6	-8.1
Materials cost per dollar of shipments	2.4	1.3	1.8

1/ Based on special tabulations prepared from the Annual Survey of Manufactures, Bur. Census, U.S. Dept. Commerce. See p. 3 of text for method used in computing percentage change.

2/ Total value of shipments less cost of materials. Resales are included in both cost of materials and value of shipments.

Data on cost of materials are most interesting with respect to two measures. Prior to adopting continuous mix the larger plants apparently produced a higher proportion of their supply of sweet goods on the same premises than did the smaller plants. Although both groups experienced a large percentage increase in the amount of goods bought and resold, following their introduction of continuous mix the larger plants experienced a much greater increase.

The increase of expenditures for new buildings was a higher proportion of total new investment for the smaller plants. To house continuous mix and related equipment they needed new buildings more than did larger plants. Group A plants reported an increase in building expenditures of 252 percent. This compares with 8 percent reported by the larger plants. For equipment, the larger plants experienced an increase of 166 percent, whereas the smaller plants had 86 percent.

Both groups expanded total value of shipments and crude value added. This would be expected as both would have economic incentives to expand sales following introduction of continuous mix. The downward slope of their in-plant average total unit cost functions would encourage such actions. The increase in value added appears to be associated with a change from their standard equipment to their new average total unit cost functions for continuous mix. The cost functions reported by Walsh 5/ seem to depict the general experience of our plants. The shift of the small plants to their new curve would result in a greater percentage change (decrease in cost), because of the steeper slope of their plants' average total unit cost curves. The percentage change in value added for Group A plants would be greater than for the larger plants.

CONTINUOUS MIX PLANTS COMPARED WITH TOTAL INDUSTRY

These changes in the sample of continuous mix plants become more evident when compared to changes experienced by the industry as a whole. It would be quite possible for the plants which did not install continuous mix to have experienced similar changes.

Hence, since industry data include all continuous mix plants along with non-continuous mix plants, differences of performance between continuous mix plants and the industry average would have been greater had it been possible to exclude the continuous mix plants from the total industry data.

We find that with respect to numbers of employees, continuous mix plants increased while the industry decreased. For instance, production workers for continuous mix establishments rose nearly 12 percent while for the industry they dropped about 2 percent.

In respect to wages, while both industry and continuous mix plants increased, total wages for both nonproduction and production workers of continuous mix plants more than doubled the increase for the industry average. Thus, we find total production workers' wages for the sample rose 17 percent and for the industry only 7 percent.

The other measures of activity showed analogous relationships. For instance, cost of materials rose 22 percent for continuous mix, and only 3 percent for the

5/ Walsh and Evans, p. 55.

industry. More important, total crude value added for continuous mix plants was more than three times that of the industry mean (27 percent versus 8 percent, table 2). 6/

Table 2.--Percentage change in specified items, continuous mix baking plants and all baking plants

Item	Continuous mix plants in sample 1/	Total industry (including continuous mix establishments) 2/
	Percent	Percent
Number of production workers	4.0	-6.6
Number of nonproduction workers	11.8	-2.4
Total number of employees	5.8	-4.8
Plant man-hours production workers	5.6	-6.6
Total production worker wages	16.5	7.2
Total nonproduction worker wages	20.6	7.2
Total payroll	24.2	7.2
Average hourly production worker wages	10.8	7.8
Cost of materials	21.7	3.0
Cost of fuel	3.6	-18.0
Cost of electricity	24.6	---
Expenditures for new plant	129.7	-21.6
Expenditures for new equipment	126.2	-2.4
Cost of products bought and resold without further manufacture	102.2	17.4
Total value of shipments	25.9	6.0
Total crude value added	26.9	8.4

1/ Based on table 1.
2/ Annual rate of change 1958-63 multiplied by 3 to place on comparable time span with continuous mix plant comparison. Data derived from Censuses of Manufacturers, 1958 and 1963.

The notion that automation means fewer jobs and lower total labor cost for all establishments is not supported by this analysis for bread bakeries. We must make a distinction between direct and indirect labor. Although it is immediately apparent that direct labor costs indeed did decline per unit of output with increasing automation, simultaneous increases in indirect labor costs equaled or partially offset this decline. What happened was that unskilled labor was replaced by machinery, 7/ but simultaneously greater labor demands were imposed for such fields as program scheduling, production control, sales and delivery, and maintenance.

6/ The time period is not identical to the period covered by the 78 sample plants adopting the continuous mix process. Most plants adopted the process in 1958 or later, but the time span covered between the "before" and "after" comparisons was 3 years for each plant. Thus, by taking three-fifths of the total industry differences between 1958 and 1963, equivalent time-span comparisons are made for the entire industry and the 78 plants entering the analyses in table 1. See p. 3 for the explanation of time span.
7/ In some instances (not in this case) plants can be forced to automate by absence of labor skilled in the particular art.

Consequently, emphasis was shifted from unskilled labor to skilled technicians, and sales personnel. But in terms of labor cost, each adopting establishment's payroll increased.

CHANGES IN NUMBER OF ESTABLISHMENTS AND TOTAL EMPLOYMENT

Data from County Business Patterns 8/ for the years 1956 and 1964 enable comparisons of changes at the 3 digit (SIC 205) level 9/ in numbers of establishments and employees between these two periods when continuous mix equipment was being installed in many bakeries. The comparison between States which had continuous mix plants introduced sometime during this period and States which had no known installations are crude because the introduction of plants in the various States was neither simultaneous nor at a constant rate. However, the differences noted give some indication of the kind and magnitude of changes associated with such an introduction.

Between 1956 and 1964, States where continuous mix equipment had been introduced had a drop of 18 percent in the total number of bakery establishments and a decline of 13 percent in the number of employees. States without any known continuous mix plants during this period experienced a drop of 3 percent in the number of establishments and 6 percent in the number of employees (County Business Patterns).

Before attributing the total difference to the introduction of continuous mix, we must compare the changes within States having continuous mix. Within such States, counties having continuous mix plants experienced a drop of 18 percent in the number of establishments, and 10 percent in the number of employees. In counties without continuous mix, there was a drop of 19 percent in the number of establishments and a decline of 13 percent in the number employed.

These data suggest that the economic pressure exerted by continuous mix plants may be felt as much in contiguous counties without continuous mix installations as within counties having them. This belief is realistic in view of the economies of continuous mix which encourage expansion of routes; the expansion can lower average total unit in-plant production costs of those plants which have a high proportion of fixed to total costs. Other changes besides continuous mix, of course, also help to reduce unit costs.

The disappearance of establishments included both those associated with multi-establishment companies, and their single-unit competitors. Data available do not permit a precise breakout by these ownership types. However, census data show that between 1958 and 1963, there was a 19 percent drop in the number of establishments with less than 20 employees and an 11 percent drop for those with 20 or more. 10/ Between 1958-63 and earlier periods there was a relatively greater disappearance of smaller establishments.

Thus, while the introduction of continuous mix installations apparently did not decrease the numbers of employees in the plants where it was introduced, it did

8/ County Business Patterns, Bureau of the Census, U.S. Dept. Commerce.
9/ Standard Industrial Classification Manual, Executive Office of The President, Bureau of the Budget.
10/ Establishments with fewer than 20 employees are predominately single-unit establishment firms. Establishments with 20 or more employees have an increasing probability of association with multiestablishment firms.

contribute to the decline both in establishment numbers, and in the number of production workers for the industry as a whole. It also expanded sales, service, and other nonproduction jobs in plants installing continuous mix.

These comparisons do not necessarily carry over with identical magnitudes, either to food and kindred products industries as an aggregate, or to manufacturing as a whole, although the general direction of change should be the same. Technical innovations differ and their impacts likewise differ. Some of the changes shown in table 3 may be the result of changes in social structure as well as the effects of technological innovations.

The Census of Manufactures reports a decrease from 1958 to 1963 of 4 percent in total number of production workers for food and kindred products, and a decrease of 11 percent for baking. In contrast, all manufacturing increased 5 percent. The Census of Manufactures also reports a 30 percent increase in new capital expenditures for food and kindred products, but an 8 percent decrease for baking, and a 26 percent increase for all manufacturing. The number of establishments increased 5 percent for all manufacturing, but decreased 10 percent for food and kindred products establishments and 17 percent for bread and related products (SIC 2051) (table 3).

Table 3.--Comparison of total manufacturing, food and kindred products, and the baking industry, 1958-63

Item	1958	1963	Change
Production workers in manufacturing:	Workers	Workers	Percent
All manufacturing establishments	11,644,213	12,232,360	5.1
Food and kindred products	1,137,621	1,098,116	-3.5
Bread and related products	145,933	129,909	-11.0
Capital expenditures: 1/	$1,000	$1,000	Percent
All manufacturers	9,075,759	11,397,296	25.6
Food and kindred products	964,624	1,249,245	29.5
Bread and related products	104,085	95,280	-8.5
Number of establishments:	Number	Number	Percent
All manufacturers	298,182	311,784	4.6
Food and kindred products	41,619	37,521	-9.8
Bread and related products	6,026	5,010	-16.9

1/ 1958 data on capital expenditures exclude value of plants under construction, and 1963 data include value of plants under construction.

Based on data from Census of Manufactures.