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The structure and performance of American textile printing: Redefinition of an industry

Amidon, Jill Yousling, Ph.D.

The University of North Carolina at Greensboro, 1988

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THE STRUCTURE AND PERFORMANCE OF AMERICAN TEXTILE PRINTING: REDEFINITION OF AN INDUSTRY

by

Jill Yousling Amidon

A Dissertation Submitted to
the Faculty of the Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Greensboro
1988

Approved by

Billie G. Oakland

Dr. Billie G. Oakland

APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of the Graduate School at The University of North Carolina at Greensboro.

Dissertation Adviser _____

Committee Members _____
_____
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April 15, 1988
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Amidon, Jill Yousling, Ph.D. The Structure and Performance of American Textile Printing: Redefinition of an Industry. (1988) Directed by Dr. Billie G. Oakland. 185 pp.

The major purpose of this descriptive study was to gather data about the structure and performance of the American textile printing industry. Specifically, its objectives were: (1) to obtain data about the textile printing industry at the firm level; (2) to compare government statistics about the printing industry with data obtained from firms; (3) to investigate the performance of the printing industry with regard to profitability and productivity in 1986; and (4) to develop a profile of textile printing firms.

Data were collected using a self-administered survey questionnaire mailed to managers of 163 textile printing establishments in Fall 1987. Those firms censused were identified in Davison's Textile Blue Book. The response rate was 64.2%.

The independent structure variables were: geographic location; type of organizational structure; size of printing establishment; commission status; printing technology; product mix; and capital intensity. The two dependent variables which measured industry performance were defined as profitability and productivity. Data were analyzed using the Pearson product moment coefficient of correlation and two-way analysis of variance (ANOVA).

The responding firms differed with regard to productivity and size of firm. In the general analysis, productivity was related both to commission status and size of firm and type of ownership and size of firm. However, firm size was the more important factor in productivity than commission status particularly for multi-plant operations. The

other finding was that profitability was not related to any of the other structure variables including size of establishment.

The descriptive profile which emerged from the respondents was an industry comprised of small, independently owned establishments located predominantly in the eastern United States. The profile of the contemporary printing firm which emerged from this research differed from the profile of the textile mill products industry described in the literature.

ACKNOWLEDGEMENTS

This dissertation topic linked subject matter and research methodology across the academic disciplines of textiles, sociology, business, and history. That process was its challenge, its frustration and its strength. Research which spanned academic disciplines improved the overall scope of this dissertation.

I am indebted to the five outstanding members of my dissertation committee: Dr. David Pratto, Department of Sociology, for his fine expertise in research methodology; Dr. Patricia Warner, Department of Clothing and Textiles, for her editorial skills; Dr. Manfred Wentz, Department of Clothing and Textiles Chairman, for expertise in textile technology; Dr. Nicholas Williamson, Department of Management, for his invaluable suggestions in business research. I especially am indebted to Dr. Billie G. Oakland who, as committee chair, generously provided the time, encouragement and personal support which moved the dissertation process along at critical points.

Dr. Gordon Berkstresser, Department of Management, School of Textiles, North Carolina State University, generously agreed to allow the survey to be returned to him and lent his institution's name to this research. Dr. Joyce Storey, Philadelphia School of Textiles, graciously allowed me to use the Printing Technology Committee of AATCC as a resource.

During the final stages of the research process, I am indebted to Joan Koonce who as my manager at Cone Mills Corporation provided opportunities for me to ask key questions of key people. Her interest and encouragement provided me the flexibility of meet deadlines and keep appointments which ultimately allowed me to complete this research.

I am grateful to Marie Soyars whose excellent word processing skills, combined with schedule flexibility and patience, handled the form and details of the document.

Finally, I acknowledge the love and support of my husband Bill and my sons Peter and Gregory: Bill, for the professional and personal sacrifices he made so that I could pursue and complete my graduate degree; Peter and Gregory, who managed to thrive on benign neglect while developing responsibility and a wonderful sense of humor.

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CHAPTER I

INTRODUCTION

Purpose

The purpose of this research is to develop a profile and examine the performance of the American textile printing industry in 1986. One of the accepted measures of assessing industry performance in contemporary business and economic theory is by analyzing productivity and profitability (Stigler, 1963; Chandler, 1969; Scherer, 1980; Siegel, 1986). Industry performance is affected by a number of structural variables. Of theoretical importance to the printing industry are geographic location, type of ownership, size of establishment, commission status, production technology, product mix, and capital intensity (Barkin, 1949; Eisen, 1980; Pelzman, 1980, 1982; Toyne, Arpan, Barnett, Ricks, & Shimp, 1984; Berkstresser, Williamson, Michael, & Barner, 1985; Office of Technology Assessment, 1987).

Previous research has examined these relationships for the textile mill products major industrial groups as a whole. However, this study seeks to move beyond the general observations of past studies to investigate the behavior of a specific industry segment--the printing industry.

Objectives

The first objective of this study is to obtain data about the printing industry at the firm rather than the industry level. Most data

gathered about the printing industry are aggregated under the broader category of finished goods or textile mill products.

A second related objective is to compare data obtained from primary sources with data from government statistics on the printing industry. In meeting the first two objectives of this study a profile will be developed of contemporary printing firms with regard to industry structure, type of ownership, size of establishments, available technology, and geographic location.

The third objective is to investigate the nature of the relationships among these structure variables and the performance variables of productivity and profitability for the textile printing industry. Contemporary business and economic theory provide the framework for the analyses.

The fourth objective is to provide information for printing plant managers which might assist them in better understanding the industry position. The data generated by this study will provide additional insight into the printing industry sector as its managers try to analyze their current position for future planning purposes.

Justification

The importance of the printing and finishing processes to textile industry products cannot be overestimated. Finishing provides properties such as comfort and ease of care valued by the consumer. Most important of all, printing contributes aesthetic properties which can significantly affect the finished textile product's competitive market position. From a marketing standpoint, this results in a mature

product beginning a new product life cycle (Kotler, 1980; Toyne et al., 1984).

Although the contemporary textile industry has been described as capital intensive, vertically and horizontally integrated, a look at a representative list of printing firms suggests that the printing industry still may be composed of many small, private firms. Historically the finishing industry including printing has been characterized by many small converters and commission finishers. The many discrete processes involved in printing and finishing encourage such a structure. If the situation still exists for printworks, one might theorize that the performance of many printing firms may be marginal. The mergers and acquisitions which have characterized the textile industry since World War II raise questions as to the numbers of converters and commission finishers currently in operation. The relationship between the printing sector and the rest of the industry bears investigation.

Despite the existing literature about the textile industrial group as a whole, the extent to which similar factors have affected the performance of specific segments of the textile industry--for example, the printing sector--is unclear. The history and role of the printing segment of the textile mill might suggest that its performance differs from that of the textile mill products industry in general. The existing research on the textile industry lacks the examination of the various aspects of the textile printer. The structure and characteristics of the finishing and printing operations are examples of such aspects.

Textile printing is defined as a finishing operation which falls into the third of three basic stages of production (Census of Manufactures, 1982). This study is concerned with bleaching, dyeing, and finishing processes only as related to printing. The Standard Industrial Classifications Manual (1972) is used as a guideline for the distinctions made among the printing industry segments.

Although finished wool and knit products are classified differently by the government, those printers are included in this study because there was no way to exclude them systematically. The textile printing establishments of interest to the study are those firms which print apparel and home furnishing fabrics of cotton or man-made fibers using mechanical printing methods. Excluded are printers of rugs, carpets, and yarns. The government definitions are in Appendices A and B.

Background data which assisted in giving direction to the research hypotheses were derived from various volumes of the Census of Manufactures and the Annual Survey of Manufactures (ASM). The Commerce Department's Current Industrial Report, provides production data including goods printed by type of fabric and equipment by five digit product classifications.

Statement of Hypotheses

Separate hypotheses will be tested for profitability and productivity because the literature indicates that these two variables are not always correlated. It is necessary to take into consideration the size of the printing establishments. It is theorized that the size of printing establishment is related to performance because larger

plants can take advantage of economies of scale and long production runs. Therefore, the following sets of general hypotheses will be tested:

HYPOTHESIS 1A: HYPOTHESIS 1A: PROFITABILITY IS RELATED TO SIZE OF ESTABLISHMENT.

HYPOTHESIS 1B: HYPOTHESIS 1B: PRODUCTIVITY IS RELATED TO SIZE OF ESTABLISHMENT.

HYPOTHESIS 2A: HYPOTHESIS 2A: PROFITABILITY IS RELATED TO GEOGRAPHIC LOCATION AND SIZE OF ESTABLISHMENT.

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HYPOTHESIS 7A: PROFITABILITY IS RELATED TO CAPITAL INTENSITY AND SIZE OF ESTABLISHMETN.

HYPOTHESIS 7B: PRODUCTIVITY IS RELATED TO CAPITAL INTENSITY AND SIZE OF ESTABLISHMENT.

CHAPTER II

REVIEW OF THE LITERATURE

There are few aspects of the American textile mill products industry that have not been studied, and the research on the textile industry has spanned many academic disciplines. Its role in American industrial history has captured the imagination of social scientists, historians, industrial archeologists, political scientists, economists, management specialists, novelists, and filmmakers. Descriptive business histories about the textile mill products industry have been augmented by the application of econometric modeling and statistical analyses of textile industry data.

Much of the literature about American printed textiles has been written about design, aesthetics, and process. The focus is often on the origin and influence of textile patterns. While such research is invaluable for textile and art historians, the literature rarely mentions the relationship between product design and technology.

Many of the previous studies about the textile industry have concentrated on the timing of certain conditions, the forces affecting the development of the entire industry, the growth of individual companies, and the social effects of industrialization. A number of studies have investigated and analyzed the textile industry characteristics and structure. In addition to books by Olsen (1978) and Toyne et al. (1984; 1985), recent studies funded by research grants or government agencies provide additional data. Berkstresser et al.'s 1985

report on textile and apparel technologies for the U.S. Office of Technology Assessment examined the performance of the textile and apparel industry with regard to technological change. Pelzman's 1980 monograph on the competitiveness of the U.S. textile industry analyzed structural factors affecting the industry. A more recent general overview of the U.S. textile and apparel industry, recently published by the U.S. Office of Technology Assessment (1987), emphasizes the directions toward increased technology and capital investment, and increased horizontal and vertical industry integration. While the report is comprehensive and does not include printing and finishing specifically, its statistics and observations have aided in the formation of hypotheses about the printing industry.

In recent years, the textile industry has symbolized industrial decline, displaced workers, and an escalating international product life cycle which resulted in an unprecedented level of textile and apparel imports. It has been described as a classic example of a mature or "sun-set" industry. Notable among the studies of industrial decline has been the research by Bluestone and Harrison (1980; 1982) on the effects of disinvestment and capital mobility on American manufacturing and workers. Of special interest to textile industry observers was their research on the South and the "Sun Belt" (1982) where the authors, citing research by Birch (1979) based on Dun & Bradstreet investment data, noted that the Southeast was not immune to capital movement and plant closings. Their study cited the textile industry as one where resources had shifted from obsolete mills to new high-technology factories. Plants were closed not because they were unprofitable but

because they were not profitable enough to suit investors and management.

Background History

Some historical accounts of American textile printing firms are found in business histories of individual firms. These histories range from dissertations and books based on extant industry records (Phillips, 1985; Knowlton, 1948) to industry promotional literature (Yorke, 1945). Knowlton, for example, examined records donated by the Pepperell Company to the Harvard University Business School in which references to bleaching and dyeing appeared. Finishing provided a notable product differentiation which was important particularly into the early twentieth century as cheaper Southern goods began to compete with Northern goods. Although Knowlton mentioned the purchases of bleaching and finishing plants, there was neither documentation of printed products nor of equipment.

The evolution and documentation of the American textile printing industry is tied to the demand for one specific printed product—calico. Mechanized calico printing is cited as one of the earliest major technological innovations in mass production, and it was one of the most successful areas of the cotton textile industry by the first quarter of the nineteenth century (Barkin, 1981; Malone, 1985).

The history of calico printing in the United States and Great Britain is well documented (Bowker, 1974; Turnbull, 1951). Twentieth century books on printing technology cite earlier works and update the perspective on calico printing (Storey, 1974; Turnbull, 1951).

Turnbull's major work on the British calico printing industry through the 1940s quantitatively documents production, finances, and employment. Although Turnbull's research focused on the British industry, it included many references and comparisons to the American printing industry.

There is general agreement that the invention of the mechanical engraved roller printing machine, followed by the rotary screen printer, was critical to the development of the modern American printing industry. Much of the literature on printing, in fact, can be classified as literature on the history of mechanical printing technology.

With regard to industry history and development, the relationship of converters and commission finishers to one another and to the industry structure is important. However, documenting and identifying the extent to which this business relationship affects printing is difficult. Specialization by converters and commission finishers is an accepted historical pattern (Copeland, 1917; Murchison, 1930; Olsen, 1974; Toyne, 1985). However, there is little research to suggest that one path is more profitable than another.

Fairchild's Dictionary of Textiles (1979) defines converting as a general term applied to finishing of gray goods including printing, bleaching, and dyeing. A commission printer or finisher, on the other hand, prints fabric to order for an agreed-upon fee per yard and does not take title to the goods. The terms are used loosely in the literature and in modern day usage as well, and need to be incorporated into the research as structural variables.

The literature about the role of converters and commission houses in printing is sketchy. Copeland's 1917 text on cotton manufactures provides the most descriptive information about their roles in financing and distribution, but aside from this, there are few references in the literature to converting operations and commission finishers. His research noted the integration movement or the bringing together of several establishments under a single management, with its own finishing plant and but a single selling agency. The object, according to Copeland, was not so much the elimination of competition but to secure economies through the control of supplementary branches—particularly buying and selling. He noted printers were examples of independent firms who bought cloth to print and then sold it through a selling house. This, he suggested, had not always been the case.

Murchison (1930), more than Copeland, expanded on the role of the converter as both buyer and seller. He observed that the converter rarely owned or operated a plant. Instead, the converter purchased greige goods, determined the style characteristics, and had the actual processing done by another group of finishing specialists, including printers. The average mills did not have the quantity, variety of output, nor necessary capital to employ designers and operate the expensive machinery necessary for all the processes which were needed for finished products—including printing.

Historically, although it would be said that no single clear-cut organization structure represented the textile printing industry, two basic structures or organizations did emerge: the small, independent

printworks and the larger manufacturer for whom a printing establishment was a natural continuation of a greige goods converting operation.

Industry Statistics

The Census of Manufactures, published every five years by the U.S. Department of Commerce, Bureau of the Census, provides statistics on all aspects of the finishing industry, including the printing segment.* These data are of limited use to this study because none of these sources separate out printing production and industry information. In addition, the Census Bureau cautions users that ASM data are estimates based on a representative sample of establishments canvassed annually. The data may differ from results of a complete canvas of all establishments.

The most specific data on printing are available from the U.S. Department of Commerce's Current Industrial Reports, published yearly. The report for finished broadwoven fabrics contains production data summarized by (1) type of fiber; (2) decade; (3) geographic area; (4) type of mill operation (commission and not on commission); (5) inventories and back-log of finishing orders; (6) fabrics finished for crease resistance or wash-wear properties; and (7) monthly adjusted production figures. Production is given in printed linear yards. The two printed product categories for different fabrications are roller and

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* In the intervening years, selected statistics are published in the Annual Survey of Manufactures. The Census of Manufactures is published three to four years after the census is taken. Thus the 1982 edition was available in late 1986, and the 1987 volume will not be available until early 1990. Individual sections are published earlier as they become available, however.

intaglio engraved, and "other." The inclusion of rotary screen printing in the category "other" emphasizes the need to update data gathering techniques, tables, and terminology. It is most obvious when the printed yardage in the "other" category of the tables far exceeds the major category. Figures 1 and 2 summarize production data for 1986 from the report. It is this data on printing which is reprinted in ATMI's Textile Hi-Lights.

The Census of Manufactures reports economic statistics on the finishing industry, including printing for the following measures: historical statistics for the industry such as number of companies and employees, payroll, and hourly earnings; expenditures and assets; value added by manufacture; value of product shipments by class and industry; value of manufacturers' inventories; and statistics by geographic area. The major limitation of these statistics for the purpose of this study is that the printing industry statistics can not be isolated for the purpose of analysis.

A number of major industry studies of the textile mill products industry have relied on these statistics. Pelzman (1980) and Toyne et al. (1984) included the printing and finishing segment with the larger textile mill industry complex. Their primary interest was not in the performance of the printing segment of textile finishing, however. Despite the fact that the finishing segments are included with other industry segments in government publications, the data are aggregated and are useful only for a general understanding.

A dissertation by Nielsen (1973) included the finishing segments with the weaving industries. He acknowledged the complications of

classifications which included the finishing segment because many establishments also finish fabrics on a commission basis. Nielsen was interested primarily in the effects of imports on the industry as a whole.

Toyne et al. (1984) and Newby (1975) drew conclusions about the finishing industry in their studies of textile industry based on SIC-level data. In particular, Newby's descriptive paper summarized production information by printing category using the Annual Survey of Manufactures. Each of the studies included data on the textile finishing industry segment. It is difficult to determine from these studies about the textile mill products industry whether or not there are characteristics and behavior unique to the textile printing industry.

The most comprehensive available report specifically about the printing industry is a world-wide survey done by the Stork Brabant B.V. of Holland (1985), a major manufacturer of screen printing equipment. The data included are limited to percentages of printed yardage and of equipment. There is no indication of the response rate nor the number of firms included in the survey. Printed production percentages from 1968-1984 are given for the following areas of the world: Western Europe, North America, Latin America, Africa, the Near East, and the Far East. The study emphasized the world decline in printed yardage. For North America, it noted that the period from 1979-1982 marked a decline in printed yardage "never before seen" in textile printing. There is no way to distinguish data for the United States in the aggregate data.

Sufficient data about the textile printing industry are lacking. It may be assumed that machinery manufacturers and chemical suppliers to the industry have sophisticated marketing research information available to them but that the data are proprietary. Data bases compiled by private firms such as Kurt Salmon are unavailable. This research will gather data at the firm level which generally is unavailable in published research.

Industry Structure

The development, structure and characteristics of the American textile mill products (TMP) industry have been well defined. Many textbooks, articles, and reports describe the industry structure. Among the more recent summaries include those by Olsen (1978), Pelzman (1980), Berkstresser et al. (1985), and Toyne et al. (1984, 1985).

Barkin (1981) described the prototype textile firm, existing as early as the 1800s, as a large-scale, adequately financed, integrated, corporately organized enterprise which concentrated on mass production. Few studies of the textile industry omit the fact that there has been a marked trend toward mergers and integration of operations, an area of interest that has been actively researched (Barkin, 1949; Chakrabarti & Burton, 1983).

Badertscher (1984) linked the development of the printing industry structure to the four classic phases of industrialization: hand craft of mostly block printing prior to 1785; industrialization from 1785 to 1950 with mechanized engraved roller printing; industry expansion from 1950-1975 with (a) the introduction of rotary screen printing, (b)

growth in the textile industry due to manmade fibers, and (c) technological innovations in dyeing and finishing, and final phase of optimization or rationalization beginning in 1975 stressing reduced costs, improved reproducibility, assured quality standards, and reduced environmental pollution.

Geographic Location

It is common knowledge that the textile major industrial group has evolved from an historically labor intensive industry comprised of small, family-owned firms. The manufacturing center moved from New England to the southeastern United States in the twentieth century, and the size of the workforce has declined steadily over the past decades (Bluestone & Harrison, 1982; McCrea, 1982; Boyte, 1972; Hughes).

Authors cite various examples of the development of the printing industry in the United States, particularly in New England where early printing operations are cited (Pettit, 1970; Dunwell, 1978; Robinson, 1969; Little, 1928). It is likely that the first printing establishment grew out of a hand printing calico operation. McGouldrick's 1968 research in economic history mentioned early printworks as she looked at early textile wage rates, plant equipment, spending, output, fixed capital, and capacity based on extant records and government census information.

Galenson (1985) attributed the shift to the South to the fact that textiles were a "footloose" industry that doesn't need to be located near raw material sources. Based on Census of Manufactures statistics, Galenson attributed the shift to (1) timing and the removal of some

economic barriers in the South that coincided with an increased world demand for the product and (2) the competitive advantage of the labor force and the technology of the cotton industry.

Economic history accounts detail the emergence of the textile industry and its role in the industrialization of the United States. While most accounts have focused on the activity in New England textiles, Scranton (1983) noted the importance of the Philadelphia area to the history of textiles.

As noted in recent editions of Davison's, many printing firms remain in the Middle Atlantic and New England regions. While one might assume that printers located outside the South might be the older, less profitable mills that have not modernized, this has not been determined. Because of the discrete and almost independent nature of the production processes, printing firms still located outside the South may indeed be profitable and productive. The literature cited above indicates that the printing industry is located in the eastern United States, predominantly in New England, the Middle Atlantic states, and the South.

Ownership and Size of Firm

Printing firms or printworks historically have operated separately--financially and physically--from other textile production processes such as spinning and weaving. As the structure of the textile industry became more integrated, printworks became integrated into the production operations.

As recently as 1973, Nielsen questioned the assumption that most textile establishments were part of multi-unit companies. He noted that

in cotton finishing in 1967, only 62 finishing companies out of 216 establishments in existence belonged to multi-unit companies. Those 62, however, employed 78% of all employees in the industry and accounted for 85% of the industry's value of shipments. Most writers agree that the modern textile industry is a major, highly diversified industry that manufactures a variety of products.

Scherer (1980), in his textbook on the structure of U.S. industry, described the modern industrial U.S. economies as having four main facets: (1) An economy which as a whole is dominated by large enterprises; (2) particular markets dominated by one or a few sellers; (3) firms diversified across numerous product lines; and (4) vertically integrated firms.

Livesay and Porter (Chandler, 1969) indicated that the industry is dominated by large firms while Oldsman (1985) disagreed. He bemoaned the fact that opinions to the contrary, the textile industry is still defined as an industry with (1) many small, single mill companies; (2) a multiplicity of product classifications and business activity categories; and (3) extreme fragmentation.

Despite the diversity of products, most observers also agree that many sectors of the industry are clearly integrated (Pelzman, 1980; Zeisel, 1973; Vess & Johnson, 1985). The once small, family-owned operations have become large, integrated textile manufacturers who have increased their market share through the acquisition of smaller mills. Firms have become more integrated and have become part of large and diversified corporate entities (Office of Technology Assessment, 1987).

Newly integrated firms were generally loose consolidations of recently acquired mills, however. The local autonomy was probably a function of the history of independent, family-owned operations. Textile Outlook for the Sixties noted 25 years ago that the textile industry was unlike other industries in which vertical integration led to centralized control. In the textile industry the manager of each stage of the production process retained a great deal of autonomy even under corporate ownership. Despite this trend, many small and medium-size firms still exist which produce a range of products. Whether or not these firms are independently owned or "stand alones," or are part of a larger vertical structure is unclear. Whether or not this pattern exists for printers is equally unclear. The relationship between size of firm, type of ownership and performance is further complicated by the fact that a great deal of printing production is on a commission basis.

Commission Status

Historically the printing industry structure has included the commission printer, as noted in the background section. The finisher or printer does not take title to the goods, but warehouses the goods and ships as instructed by the client, who is usually a converter (Wingate, 1979). It is an arrangement that dates back to the early printworks.

Extensive references to the role of commission work are limited to Copeland (1917) and Murchison (1930). Copeland wrote that some of the older and larger firms operated integrated printworks, but most converting was done in independent establishments. Copeland cited two reasons: (1) skill and experience was needed which made it more

economical for a single large establishment to do the work; and (2) converting houses became more specialized with the rise of the merchant-converter as the demand for a greater variety of finishes and designs increased.

The commission finisher continues to play an important role in the exchange of finished textile products. Government statistics still are compiled separately for commission and noncommission finishers and printers. The extent to which commission printing continues as a factor for the textile printing industry is unclear and needs to be determined.

Printing Technology

There are numerous books and articles written about printing technology. Classic manuals on dyeing and printing (Knecht and Fothergill, 1936) have been supplemented over the years by texts which detail printing methods, cloth preparation, and formulas for dyes and print pastes (Diserens, 1948; Jacobs, 1952; Cockett, 1964) and the mechanical processes of printing (Blackwood, 1913; Miles, 1971; Clarke, 1971; Clark, 1985). Despite the number of books and articles on printing processes, few mention the characteristics and economics of the printing industry.

Storey (1974) wrote a manual on textile printing. Although written about the British printing industry, Americans used identical technology. Storey noted that all the major developments in printing technology during the twentieth century occurred in European countries--Germany, Holland, Austria, France, Switzerland, Italy, and even Portugal. Although there are historical references to early mechanized

block printing (Turnbull, 1951; Storey, 1974), it has essentially disappeared. Thus, only the literature on engraved roller printing technology and its successors--rotary screen printing and heat transfer printing--is reviewed.

Engraved Roller Printing. Classic engraving texts (Blackwood, 1913), and manuals by Knecht & Fothergill (1936), Turnbull (1951), and Storey (1974) all detail the mechanics and evolution of engraved roller printing. Improvements to engraved roller printing, as patented by Bell in 1783, focused on increased speed and efficiency. Twentieth century developments included helical pitching devices and hydraulic loading systems. Power sources changed, new machines were more streamlined in appearance, but many printworks continued to use the same machines into the 19th and 20th centuries. The development of photographic engraving provided the printing industry with another important twentieth century development.

Even improvements to engraving did not alter the basic machine principles. One notable attempt at redesign was the Sauressig machine which was introduced in 1971 at the Paris Textile Machinery Fair. The Sauressig was distinguished by more instrumental control. The machine was easier and faster to service, clean, and set up. From a design perspective, there was less pressure on the printcloth and less surface distortion. The Sauressig was one of the first machines intended to be so foolproof and easy to operate that it could be run by inexperienced operators. At the time it was suggested that the Sauressig could rejuvenate the engraved roller printing industry in the United States where the tradition of older technology and hand work did not exist.

The machine could also print on knitted fabrics which could not be printed by conventional methods (Storey, 1974) a factor that was increasingly important. Today, finishing experts recall that the Sauressig had a roller mechanism that warped; its demise was due to a failure to correct that flaw (W. Marshall, personal communication, September 24, 1987). The Sauressig is mentioned because a version still is used to print samples.

Engraved roller printing has a number of disadvantages. From a design point of view, the prints lack color brilliance because the cloth is crushed under the weight of the rollers during printing. The most suitable designs are those with finely drawn line detail which use colors in small areas and not in large printed grounds or "blotches." The roller printing industry thus is subject to fashion preferences for small printed designs. The other disadvantages are related to the total printing process. Shrinkage occurs during the wet processing--washing and finishing--which distorts printed shapes (Storey, 1974).

Despite the limitations and competition with the newer technology of rotary screen printing, engraved roller printing machines are still used. Machinery more than 60 years old is still in operation in some plants. However, despite the predictions of the decline of roller printing, there appears to be a place for the engraved roller print machine (Cunningham, 1973).

Mechanical Screen Printing. A major technological advance in printing was the mechanization of silk screen printing. As a mechanical operation, silk screen printing was a twentieth-century revolution, which, though it had a long history in the Far East, was not widely used

in Europe until the 1930s. It encouraged short production runs in a greater variety of designs.

The first documented use of silk screening in the United States was John Pilsworth's banners for the U.S. Army in 1915 (Robinson, 1969; Storey, 1974). These prints began as products for the upper and middle price ranges, but by 1950 were available in all price ranges. Robinson noted that silk screen printing was an example of a printing industry which had developed substantially in the U.S., though the technology was decidedly European, having achieved major advances in automatic processing in Germany and Switzerland.

During the 1920s and 1930s, hand screen printing was encouraged because manufacturers sought a method of printing designs into the new man-made fabrics made from acetate and rayon known as "art silks." With the introduction of man-made fibers, many fabrics could no longer be processed or printed using traditional cotton methods, since the new man-mades could not withstand the finishing and preparation processes used in conventional roller printing. Screen printing was the only method where experimentally drawn designs could be carried out quickly and inexpensively. The ease of changing colors and the low cost of screens made the method popular. Exclusive designs could be produced in small quantities. However, no one questioned the superiority of engraved roller printing for producing large quantities of one design, according to Storey (1974).

Robinson (1969) cited another point regarding the rapid acceptance of screen printing. The recessions of the 1930s decreased the market

for printed fabrics. Costs had increased and demand had decreased. Manufacturers were looking for a cheaper method of production.

The evolution of mechanized screen printing from a flat-bed operation to a rotary screen has been well-documented (Storey, 1974; Robinson, 1969) and well covered in trade publications. Flat-bed screen printing began to take form as an industry with the mechanization of screen printing about 1926 in Europe. Improvements focused on various mechanical means of lifting screens, types of squeegees, and moving cloth. By 1954 the first fully automatic flat-bed machine was in operation. Every process was mechanized from the feeding of the fabric to the gumming of the rollers. A number of flat screen machines were introduced by European manufacturers from Holland, Switzerland, Austria, and Italy. All contributed inventions and patents. While each differed in its solutions to common problems, the basic printing principles remained the same. The most widely used machines in the early 1970s were the Swiss Buser machine and the Austrian Johannes Zimmer (Storey, 1974). The firms remain major manufacturers today.

Rotary Screen Printing. Rotary screen printing machines were in commercial use as far back as 1954 when Peter Zimmer and Kufstein designed a machine to print wide width sheets and bedspreads. A major technological breakthrough was the 1964 introduction of the rotary screen printer by the Stork Company of Holland. It first revolutionized the home furnishings trade, and, as screens and dyes improved, the dress fabric market (Robinson, 1969). The Stork machine was unique because its seamless cylinder screen was made of a finely perforated sieve-like screen instead of wire mesh. Other firms introduced their own versions

almost simultaneously. The development of the seamless perforated cylinder gave a boost to the screenprinting industry. Larger yardages could be printed and the operations simplified (Storey, 1974).

The advantages of rotary screens were numerous: short set-up times, easy operations by quickly trained workers, and economic short as well as long runs. The rotary screens were promoted as combining the advantages of flat screen printing with engraved roller printing. The machine combined the speed, continuity, quick and continuous registration of engraved rollers with the lack of pressure, clean, bright, and uncrushed colors of flat screens. Storey predicted that the 80- or 90-year-old engraving machines still in operation would be replaced eventually with rotary machines.

By the 1970s, authorities were still divided on the merits of engraved versus screen printing technologies. While most agreed that the newest flat and rotary machines were well-designed, and capable of doing extremely satisfactory work, the arguments for roller printing continued. As late as 1974 Storey supported the continued used of engraved roller printing where the printworks were established firms with the necessary skills for engraved roller printing machines and where large lots of 500-1000 yards were needed. In the United States where roller printing machines developed high operating speeds, yardage had to be large to be economical. Franken (1958) cited features which increased running speeds: roller bearings in the mandrels; independent doctor drives; automatic registration control gears; more safety features; and improved methods of cleaning blankets.

Fulmer (1987) noted that with the extended wear life provided by the polyester in cotton/polyester blends, a new means to spur sales was needed. The design possibilities and rotary screen printing machine were golden opportunities for marketing experts. By the 1960s the industry had begun to use rotary screens combined with man-made fibers. The industry's organization began to change from small units to a largely vertically organized large units (Miles, 1971). Arguments to the contrary, the world production of roller engraved prints rapidly lost its position to screen printing.

Heat Transfer Printing. In the 1960s, the applications of the decalcomania process (in which a design previously printed on paper can be transferred to textiles) introduced new competition and products into the traditional printed goods market. The process became known as heat transfer printing or sublistatic printing. The key process was sublimation—the application of heat and pressure to transfer inks or dyes printed on paper from a solid to a vapor back into a solid again upon cooling on the textile surface. It worked best on synthetic fibers and hence its introduction corresponded with the popularity of polyester knits and the introduction a few years earlier of disperse dyes. Printing companies quickly moved into this area. The structure was complicated by the entrance of firms from outside the traditional textile mill products industry (Reichman, 1976).

While transfer printing initially was not viewed as direct competition with roller or screen printing, its use cut into the traditional market share of prints. This was because it could be used

to print knits and other synthetic fabric which could not pass through conventional printing machines (Storey, 1974).

The disadvantages of heat transfer printing equally were stressed by Reichman (1976). One drawback was the limitation of the fiber because it was not successful with natural fibers--cotton, silk, and wool. The paper was expensive, and there was often a six to eight week wait to obtain paper printed with an exclusive design.

The process was expensive for short runs and became more economical with yardages above 10,000. However, rotary screen manufacturers were quick to turn a threat into an opportunity. They promoted their equipment's ability to print the paper--claiming that 80% of the desired designs could be printed by rotary screens.

From an industry standpoint, there were many advantages to heat transfer printing: (1) cloth structure was less important to the quality of the print; (2) unstable fabric structures could be used; (3) all colors could be printed in one operation; (4) no auxiliary printing equipment such as steamers and washers were necessary; (5) the process was extremely clean with no dye stocks and other chemicals needed; (6) the results were immediate and did not require expensive personnel training; (7) little space was needed; and (8) machinery was relatively simple and inexpensive consisting of flat-bed presses and continuous calenders (Storey, 1974; Reichman, 1976).

In economic terms, the movement was successful; a broader spectrum of the textile industry purchased equipment. It was also an ecologist's dream: it required less energy and caused less pollution into the streams and atmosphere by chemicals. Publicly, industry members

declared that they did not feel threatened because the growth would not be at the expense of conventional printing. Rather, it would expand the total yardage being printed.

By the late 1970s and early 1980s, printed synthetic knits had cycled out of fashion. Recent developments in heat transfer printing technology include improvements for its use on natural fibers and better dye penetration (Kasten, 1988). It is likely that a market niche continues to exist for heat transfer printing.

Related Technology. Any review of the evolution of textile printing technology must include references to related technological changes which have affected the printing industry. Paramount are the developments in dye chemistry and print paste technology. As an historical example, the 1829 development in Lowell, Massachusetts of the Turkey Red dye--a fast, brilliant color which could successfully compete with French prints--contributed to the growing competitiveness of American prints (Little, 1928). Although this research is not concerned directly with the vast literature on print pastes and dye technology, no advances in printing technology were possible without the advances in dye chemistry.

Miles (1971) divided printing into two fundamental operations: (1) impression--the essentially mechanical and physical stage of applying colors; and (2) coloration--the selection of suitable dyes or pigments and the chemical conditions of application, fixation, and processing. Miles credited all industrial developments in printing impression and coloration to Europeans.

The study by the U.S. Department of Labor (1968) divided technological change in the textile industry into three general types: (1) improvements to conventional machines and adding equipment to increase productivity and improve product quality; (2) more radical change such as integration of two or more processes, advanced instrumentation, use of computers and new production methods; and (3) increasing use of man-made fibers.

In the late fifties articles stressed the importance of applying more scientific and technological ideas to textile wet-processing practices. The emphasis was on increased production, improved quality, and lower overhead. To increase production, a continuous process of textile finishing was emphasized (Franken, 1958).

The introduction of man-made fibers earlier in the century had an incalculable effect on printing technology. With the introduction of the first synthetic resins to fix pigments onto rayon, one after another new dyestuffs and printpastes were introduced for fabrics woven or knitted with the new generic classes of fibers.

The development of thickeners--necessary to facilitate printing--was also a critical related technology. According to Storey (1974) one of the biggest difficulties in early printing was the lack of suitable thickenings. Thickeners need to be completely removable during washing, be compatible with other print past components, and not be too expensive (Clarke, 1971).

One new development to affect printing was the use of foam in print pastes. Although introduced in the 1950s, it has become an important factor. Foam has the advantages of being energy efficient, with faster

printing speeds. It saves on thickeners, limits need for afterwash, and reduces environmental effluent controls (Lyons & Namboodri, 1981; Lyons, 1986). Foam technology was considered the "Technology of the '80s" (Zimmer, 1986).

The printing process requires that gums and other materials in the printing paste be removed after printing. Hence, large amounts of water and mechanical energy are necessary. Much of the new technology is directed toward post-printing washing operations. Interest is in machines which can replace rope ranges with open-width capabilities, and also can handle a wide range of fabrics at fast speeds--especially delicate, light-weight fabrics (Mansfield, February 1987).

Badertscher (1984), at a printing industry symposium, cited the following technology trends in printing: (1) use of color measurement, streamlined dye ranges and dye combinations; (2)automatic metering equipment making print paste preparation more accurate in the color shop; (3) synthetic thickeners and foam technology improving fixation and reproducibility in print paste compositions; and (4) process control in printing machines, dryers, steamers, and washing machines.

In a survey cited by Mansfield (1986) involving Quick Response programs, both commission and vertical mills listed important factors as computerized color matching, computerized dyehouses, and new computerized process equipment. Currently, there is a renewed interest in flat-bed printing. New automatic features make it faster and more economical to operate. The new automatic flat-beds have shorter set-up times and new magnetically controlled features to reduce squeegee pressure and make pressure changes automatic during production. Flat-

beds still are perceived as important for specialty fibers such as silk and wool and where smaller runs are important (Zimmer, 1986; DiMaria, 1987).

Other related technological developments include laser engraving systems for rotary screens and computerized color separation capabilities (Lennox-Kerr, 1986; Simon, 1986; DiMaria, 1987). The emphasis in the literature continues to be on process quality control and automation (Ettekoven, 1986; Clune, 1988; P. Danahey, personal communication, November 6, 1987; D. Poulin, personal communication, January 4, 1988).

Product Mix

A firm's printed product mix and type of technology are closely related structure variables. Historically for American printed products, product standardization rather than specialization was characteristic. Copeland wrote that in 1917 no mill would take an order for less than 2,000 yards of a single pattern. For many mills the minimum order was 6,000-10,000 yards.

Textile mill products are considered by some market analysts to be substitutes for one another. Nielsen (1973) used this as a justification to group SIC code data together for his study on the effects of tariffs on textile mill products. He pointed out that unless there is some form of "snob appeal" attached to the use of imported goods or a patriotic attitude to "Buy American," the barrier to entry associated with product differentiation in textile products in terms of country of manufacture is negligible.

In fact, it is the printing of different patterns on greige goods that provides the distinguishing characteristics of one product from another. The printing technology is such that the same machine can print both apparel and home furnishing fabrics.

The Product Life Cycle Theory made famous by Kotler (1981) has been applied often to the textile industry. Olsen (1978), for example, wrote that the larger, more successful, integrated firms concentrated on the start-up and rapid growth phases of the cycle. New products resulting from research and development are introduced and produced until the product reached maturity. Some firms continued to compete well into the maturity phase because of the good production cost control. Smaller firms usually entered the product life cycle during the later stages of rapid sales growth. Their operations were often less efficient and often at a cost disadvantage (Olsen, 1978).

The textile industry traditionally has been vulnerable to spurts and cycles. Hughes described textile production and marketing as unpredictable and profitability uncertain. Once a firm hit upon a hot-selling consumer item, other firms would jump quickly into the market producing a similar product. The market would become saturated and the industry would go into a slump. Stanback (1958) observed that an emphasis on product differentiation and promotion could significantly alter the market structure. The integration movement after World War II tended to direct firms into additional fabric markets rather than increasing their control in any one market.

Toyne et al. (1984) concluded that the United States had the only textile mill products industry of any industrial country to emerge from

the 1980s with a successful undifferentiated marketing strategy. The U.S. had always adopted a proliferated strategy which assumed market homogeneity. This strategy by its very nature was dependent upon productivity, productive flexibility, and advanced technology. However it lacked a marketing orientation, a reason for linkage with other textile complex sectors, and an export orientation. As a result, emphasis was on advanced technology which might increase productivity, fabric quality, and replace costly labor. Economy of scale was important. Therefore, mills tended to be large, relatively inflexible, dependent on large volume orders, and relatively unresponsive to market changes

Their University of South Carolina study recommended the need to invest more heavily not only in modern and advanced technology, but also in manufacturing techniques related to productive flexibility and product diversity. The approach should include a differentiated market strategy manufacturers specialized fabrics in short production runs.

Capital Investment

There is general agreement that the economic and structural factors underlying the textile industry's lack of innovation had changed by the 1960s. This was reflected by an increased level of expenditures for new plants, equipment, research and development. The interest in modernization was often attributed to improved financial strength, competitive pressures to reduce costs, and the desire for integration. Revised depreciation rates along with investment tax credits contributed to the trend (Eisen, 1980; Olsen, 1978; Zeisel, 1973). However these

same authors pointed out that even with new machines the smaller companies still used large amounts of obsolete equipment and that the industry facilities were still the oldest in all of manufacturing.

The printing industry had unusual problems because it required a greater expenditure of capital not only initially but to maintain the stock of raw, finished, and semi-worked materials. Consequently, there were more early commercial failures than successes. Turnbull joked that such activity resulted in a rapid succession of bankruptcies, elopements, convictions, and sudden deaths.

As more capital became available, there was a change from a vertical structure--printing operations connected with weaving and spinning--to a wider horizontal structure (Turnbull, 1951). With the introduction of steam power, spinning and weaving were no longer dependent on water power for driving the machinery. It became possible to erect spinning and weaving mills in localities removed from printworks. The possibility of being able to conduct businesses as specialized processes encouraged the arrangement.

For the textile industry in general from 1970 to 1980, capital investment doubled from $800 million to $1.6 billion (Pelzman, 1980). The United States Department of Commerce estimated that by the 1970s new capital expenditures per textile employee were $680, while the estimated expenditure per employee in all manufacturing was $1,900 (Olsen, 1978). Olsen cited two reasons for the textile industry's reluctance to invest in new capital equipment: (1) the overcapacity already existing in much of the industry which idled equipment already owned; and (2) the instability of the market for textile raw materials and end products.

Capital investment implies different things for the large integrated textile firms than for the small firms. The larger integrated firms have on-going capital improvement programs resulting in newer facilities based on more modern technology. In addition, the integrated mills are assumed to have research and development staffs to generate internal capital improvements and to evaluate proposed new techniques. At the opposite extreme, the smaller, non-integrated firms often have no continuing capital improvement programs and major capital expenditures are unusual occurrences. The smaller mills tend to have older, fully depreciated plants with equipment based on relatively obsolete technologies. In the 1960s, about half of all capital investment made in the textile industry were made by the five largest firms. In addition, textile machinery is increasingly being imported from overseas with the research and development being done outside the United States (Olsen, 1978).

Eisen (1980) used government SIC categories to examine capital expenditures and productivity changes in broad woven fabric production since 1947. His research cited the industry's traditional conservatism and the reluctance to invest in new technology. The following reasons were mentioned: the conservative attitude toward investment; the high degree of vertical fragmentation of the industry structure; the relatively low level of profits for most mills in postwar years; the lack of sufficient internal funds such as retained earnings and depreciation allowances which permitted expenditures over and above the amount needed for maintenance of machinery and plants; and the limited

amount of market research and advertising to develop and promote new products and markets.

Olsen's 1978 book cited two reasons for the textile industry's reluctance to invest in new capital equipment: the overcapacity already existing which idled owned equipment, and the instability of the market for textile raw materials and end products. It noted that capital investment implies different things for large integrated textile firms than for smaller firms. The larger firms are expected to have on-going capital improvement programs resulting in newer facilities based on more modern technology. In addition, the integrated mills are assumed to have research and development staffs to generate internal capital improvements and to evaluate proposed new techniques. At the opposite extreme, the smaller, non-integrated firm is not expected to have continuing capital improvement programs or major capital expenditures. Smaller mills tend to have older, fully depreciated plants with equipment based on relatively obsolete technologies. In the 1960s, for example, about half of all capital investment made in the textile industry was made by the five largest firms. In addition, textile machinery is increasingly being imported from overseas with research and development being done outside the United States (Olsen, 1978).

A more recent study examined the relationship between capital intensity and performance for the textile major industrial group. Berkstresser et al. (1985) investigated selected structure variables including labor intensity, capital intensity, industry concentration, economies of scale in production, and technological volatility and the relationships to productivity and profitability. The analyses combined

textile and apparel groups and concluded that capital intensity is believed to have a positive effect on industries' performances. The report stated that high capital intensity could only be reached with high investment and that the institution of new technologies is most likely related to capital intensity.

The degree to which printing plants have invested in capital equipment and modern technology is another dimension of this research. Since printing plants may be represented by smaller, independent establishments, the relationship between capital investments and other variables bears investigating. Since capital intensity is a critical variable with regard to performance of the printing industry, its role in the printing industry needs to be identified. Its relationship to the other variables must be examined.

Industry Performance

Business and economic analysts have studied many aspects of the textile industry in order to better understand its present condition and future place in the economy. Chang (1979) looked at mill location as a function of wage rate and level of industrialization as defined by number of persons employed in manufacturing industries. Technological change has been measured by comparing production costs (Clark & Olsen, 1959) as well as by aggregate production functions (Batavia, 1979; Eisen, 1980). The effects of tax changes on textile industry investment patterns have also been studied (Stanback, 1969).

Scranton (1983) argued that more attention should be paid to the closely-held corporation and incorporated proprietorship as compared to

the "textile paradigm" of the Lowell-Lawrence models as a direct line development to the modern corporation. His study maintained that there was more than one pattern for a successful path to profit and accumulation of wealth.

Articles appearing from time to time in industry trade publications express concerns about the performance of the printing industry. One plant manager of a medium-size printing plant noted that from 1973 to 1983, yardage printed in the U.S. declined by almost 30%. The printing industry is not immune to the problems faced by the rest of the textile industry (Cunningham, 1973).

In recent years, speakers at symposiums have called for better industry cooperation (Mintz, 1983; Suchecki, 1984; Turner, 1981). The recent industry emphasis to respond faster to customer orders and work more closely with suppliers has been formalized in programs called Quick Response or Just-In-Time. This movement has recognized the importance of improved communications within the industry as well (Mansfield, 1986). While these strategies will affect the printing industry, the effect cannot be quantified at this time.

Performance Measures

Winn (1975) defined performance as the end result of business activity or conduct which serves the economic interest of the public. Performance usually is measured quantitatively by prices, profits, outputs, costs, etc. He suggested that organization and industry structure exert the strongest influence on business performance. Among

the physical properties which can be measured for firms are number and size distribution, product differentiation, and vertical integration.

Productivity. The measure of performance most often used is productivity. The review of the productivity literature for this research focuses on recent studies involving productivity in the textile industry.

Scherer (1980) measured performance by value added in manufacture. He defined this as sales less outside purchases of materials including energy and certain specialized services. He maintained that it is probably the best overall indicator of productivity taking into account the contribution of both labor and capital. Sales data can be used to serve as a substitute, especially intercompany comparisons, as long as the degree of vertical integration does not vary too widely. He emphasized, however, that debating criteria is pragmatic; one must use the variable on which one can obtain the highest quality data relevant to one's hypothesis (1980). He cautioned about using SIC level data because the emphasis is often on the similarity of production processes which may not reflect competitive interrelationships. Consequently, four and five digit census industries and product classes are sometimes too broad to be relevant.

Productivity is classically defined as a family of ratios of output quantity to input quantity (Kendrick, 1983; Bitran & Li, 1984; Levitan & Werneke, 1984; Siegel, 1986). Most productivity indexes have a denominator which refers to labor input such as number of employees or hours. The numerator refers to physical or constant-dollar volume of final products, sales or production. Whatever is defined as an input

and output differs depending on the specialized definitions. Different productivity measures found in the literature include the concept of total factor productivity (TFP) as the ratio of real gross product to total real gross factor input including energy usage. Kendrick (1983) favored this definition to compare productivity changes and growth across industries using SIC codes and government data. Synnott (1968) compared pre- versus post-Civil War periods of industry productivity using hypothetical cotton manufacturing firms and simulation measuring productivity as machine and labor hours. One econometric analysis focused on production technology in the textile industry (Williams, 1984). Williams used data from the Annual Survey of Manufactures for textile mill products to compare models which estimated the elasticity of substitution between the capital and labor inputs.

One case study of six textile mills measured the amount of technological change which had occurred after World War II (Clark & Olsen, 1959) by examining increases in labor productivity from 1949-1955. Like other studies, the stated objective was to look more closely at the specific subsection of the textile industry. However all the studies reviewed used four-digit SIC level data for textile mill products.

Other studies such as a U.S. Department of Labor study (1968) on technology and manpower in the textile industry limited the indicator of productivity as output per man hour. A study which compared productivity across countries used output per employee for the textile industry (Prais, 1981).

Levitan & Werneke (1984) noted the difficulty of defining the concept of productivity because it means different things to different people. For a textile weaver it may be associated with work effort. For the plant manager, it may be a measurement of output.

Larger companies often have measures of output based on value added rather than or in addition to gross product. Siegel quoted a doctoral candidate's survey of major U.S. corporations which recorded that firms use more than one measure for measuring productivity (Grossman, 1984, as cited in Siegel). One broad productivity measure, for example, is one that related gross output to all associated inputs including land, other natural resources, and energy (Kendrick & Grossman, 1980).

Greenberg (1973) supported the inclusion of all employees in productivity ratios. He felt that it would help minimize interfirm productivity differences. Because textile printing does not have a wide range of end products interfirm differences might be minimized because one product would not require significantly more man-hours that another. Siegel (1986) expressed concern that two vexing issues in productivity measures are the quantification of the output of white-collar workers and the input of capital.

Gale (1980) preferred value added per employee as the best measure of overall industry productivity. It takes the value increased of the purchased raw material when converted into products as well as measure the efficiency of the marketing and financial operations. Gale also acknowledged that different productivity measures are needed for different purposes. Dividing value added by the number of employees gives a measure of labor output that is comparable across businesses.

The concept of value added per employee is not designed to measure every aspect of productivity, according to Gale. But Gale supported it use as enabling multibusiness general managers to compare both the level and the rate of change in output per employee across portfolios. The value-added concept thus takes capital inputs as well as labor into account. It also links productivity improvement to profitability. Gale's definition of productivity was the one use by the recent comprehensive textile industry study on productivity and performance (Berkstresser, et al., 1985) as summarized by the Office of Technology Assessment (1987).

Profitability. While productivity denotes the efficiency with which resources are used, it is distinct from the concept of profitability. Profitability is reflected by financial factors. While a productive company may be profitable, not all profitable companies may be productive. A firm's major concern is its ability to be profitable. Entrepreneurs leave relatively unprofitable industries and enter relatively profitable ones. The rate of return as a guide to investment among industries is one of the oldest and most basic elements in the theory of a competitive, private enterprise economy according to Stigler (1963). Consequently, a measure of a firm's profitability must be included as a determinant of performance.

Avery & Sullivan (1983) noted that the textile industry in general does not generate large profits. Its financial returns are consistently among the lowest of all U.S. industries. However, some firms do well, particularly in the area of specialty textiles.

Scherer (1980) cautioned about analyzing profitability solely as a function of size at the firm level. According to his point of view,

large firms may realize higher profits not only because they are more efficient, but because of monopoly power. In addition, profit figures may be sensitive to accounting variations. Another accounting problem is the greater likelihood that smaller corporations with owner-managers will pay themselves salaries with a generous dose of what would otherwise be called profit. As a result, small firms' reported profits can be biased downwards. In addition, the comparative profitability of small versus large corporations may vary with the business cycle, with smaller firms doing relatively well in good times and poorly in recessions. On the other hand, small firms, through successful product differentiation, can carve out small but profitable niches. He recommended the use of average after-tax rates of return on stockholders' equity for a profitability measure.

Winn (1975) investigated the correlation between a firm's concentration and profitability. Although concerned about anti-trust legislation, he noted the importance of other structural factors such as firm size and capital intensity. He also advocated using the average rates of return on investment to measure profitability but before taxes. According to Winn, profitability is the criterion of performance. Winn argued that the long-run rates of return were a simple index but most meaningful.

Stigler (1963) argued that rates of return are the most important decision variable for most firms. He noted that under competition, the rate of return on investments tends toward equality in all industries. It is an index of marketplace competition.

Gale (1980) researched the relationship between investment intensity and profitability. He found that although investment in equipment automated production (thus allowing each worker to add greater amounts of value) mechanization was not an all-purpose panacea. For most businesses, increased investment intensity reduced profitability. It also led to increased competition, especially when economic conditions worsened and plant and equipment were only partially used. While increased investment affected the competitive climate, in the short run, it almost invariably reduced return on investment. Gale also noted that heavy fixed investment acts as a barrier to exit. He noted examples of investment-intensive, low-profit businesses.

To summarize the performance measures selected for use in this research, the conceptual framework for productivity as the first criterion for performance has been laid by productivity researchers Kendrick (1983), Scherer (1980), Siegel (1986), and Greenberg (1973). The conceptual framework for profitability as a second criterion for performance is supported by the work of Stigler (1963), Gale (1980), and Winn (1975).

CHAPTER III

METHODOLOGY

A census of textile printing establishments was made using a mail survey questionnaire. The population was canvassed because of the relatively small number of printing establishments. A census was an appropriate choice given the relatively small number of firms and lack of knowledge of the population.

The population of textile printers consisted of those printing firms listed in the 1987 edition of Davison's Textile Blue Book. One hundred sixty-three firms were coded as printers in Davidson's. Names and addresses which were obviously marketing headquarters and duplicates were excluded. The questionnaire was mailed to the person listed as either the plant manager or the company president.

The Davison's list was selected because the book contains the only comprehensive listing of textile firms over a relatively long period of time. Previous studies by Knowlton (1948) and Gilman (1956) used Davison's for information regarding product lines, management structure and executives. Two chemical company sales representatives reviewed the Davison's list, and while unable to suggest additional names, they did note firms that had closed.

Two professional organizations were contacted about membership lists: the American Association of Textile Chemists and Colorists (AATCC) and the American Printed Fabrics Council. Neither membership list was appropriate for this research.

Definitions and Measurements of Variables

Seven independent and two dependent variables were chosen for the study. The seven independent variables were: (1) geographic location; (2) type of organizational structure; (3) size of printing establishment; (4) commission status; (5) printing technology; (6) printed product mix; and (7) capital intensity. The dependent variable, industry performance, is defined as two classic measures--productivity and profitability.

Independent Variables

Geographic location refers to the section of the United States in which the establishment is located. Standard regional areas are used: New England; Middle Atlantic; South; Midwest; and West.

The type of organizational structure refers to whether or not a firm is part of a larger vertically organized firm or is a "stand-alone" firm. Vertical integration is the extent to which firms cover the entire spectrum of production and distribution (Scherer, 1980).

Printing establishment size is determined using Census of Manufactures definitions. A printing establishment is one having a payroll. A firm is defined as one or more establishments. An establishment is measured by the number of employees.

Commission status refers to whether or not a printing firm prints fabric on a commission basis. A commission printer seldom if ever takes title to the greige goods on which the establishment prints.

Printing technology is defined and classified by production processes. The textile printing and related finishing processes

typically used four types of equipment: engraved roller machines; flat-bed screens; rotary screens; and heat transfer equipment. Related machinery usually includes washers and drying equipment, and mechanical or computerized dye dispersion systems. A measure of printing technology may be made by equipment categories.

Product mix is defined as the percentage of a firm's printed production given to apparel fabric or home furnishing fabrics (upholstery, drapery, and bedding).

Capital intensity is defined as a ratio of the gross value of fixed assets divided by number of employees.

Dependent Variables

Productivity is defined and measured as value added per employee. This definition is considered a measurement of the efficiency of the marketing and financial parts of an operation (Greenberg, 1973; Scherer, 1980; Kendrick, 1983; Siegel, 1986). While many authors find definitions for productivity and profitability incomplete (Gale, 1980; Winn, 1975), the definitions are widely accepted and can be used for comparison purposes with government statistics.

Profitability is defined as return on investment as measured by before tax profits on stockholders' equity (Stigler, 1963; Winn, 1975; Gale, 1980). Obtaining a reliable performance measurement depends on gathering data that may be both proprietary and unreliable. For example, it is expected that printing firms differ with regard to accounting methods. In a large vertically integrated firm, the profits and production data may be aggregated. One difficulty of measuring

performance is that production and profitability data are guarded as proprietary by most companies.

Instrument

The instrument was a self-administered twelve-page questionnaire developed by the researcher. It was pretested by eight textile printing industry experts and plant managers including five industry managers from two large vertically integrated firms and a small specialized printing plant. Joyce Storey, professor and author of the definitive text on textile printing, William Nichols, an industry color and wet-processing consultant, and, Joan Koonce, corporate quality control manager critiqued the survey. Their suggestions regarding the printing technology questions, categories of responses, handling of proprietary questions, and cover letter disclosures were incorporated.

The questionnaire format was developed following the Dillman (1969) model of a 8 1/4" by 12 3/4" booklet with a vertical flow of close-ended questions (Appendix C).

Procedures

A cover letter endorsement was obtained from the Printing Technology Committee of the American Association of Textile Chemists and Colorists (AATCC). The questionnaire was mailed under the names of two major universities. The instrument and protocol were developed to adhere strictly to the format recommended in Mail and Telephone Surveys: The Total Design Method (Dillman, 1978).

The mail census was administered as single-blind. This method was selected only because the researcher is a textile industry employee of a corporation owning a printing establishment. While the name of the researcher, identifying institution, and employment status were given in the initial cover letter, the mailing institution did not know who was to receive the survey. The firm returning the questionnaire could not be identified.

Due to the importance of assuring confidentiality as well as minimizing nonresponse, a cooperating institution was asked to mail out the questionnaires and serve as a return address for responses. Dr. Gordon Berkstresser, School of Textiles at North Carolina State University agreed to cooperate in the research. The choice of NCSU was optimized because many textile industry managers are graduates of the School of Textiles.

The mail census was conducted over a period of nine weeks. A week before the first mailing of the questionnaire, a pre-notification letter was sent to the 163 firms coded as printers in the 1987 edition of Davison's Textile Blue Book.

The initial mailing consisted of a cover letter, questionnaire, stamped return envelope, and a postcard enabling the addressee to (1) request a copy of the results and (2) ask to be removed from any follow-up activity. The cover letter requested that an enclosed postcard be returned separately from the questionnaire. This was done to assure respondents that the requests for copies (which would necessarily require a return address) would be separated from the completed questionnaire. Although the possibility that the postcard would be

returned without the questionnaire exists, no alternative solution could be found.

Two weeks after the initial mailing, each firm was mailed a postcard of thanks for participation in the research and as a further reminder to return the questionnaire. The following subsequent activities were completed: (1) second mailing to non-respondents with new cover letter; and (2) follow-up telephone calls to non-respondents.

Nonresponse

A number of procedures were incorporated into the data collection process to minimize nonresponse. Three weeks after the first mailing, a second complete mailing was sent to non-respondents. Non-respondents were identified as firms which had not returned a postcard requesting that their names be removed from the mailing list. A follow-up telephone call was made 3 weeks after the second mailing to all firms who had not returned the postcards. As a result of the phone calls, additional questionnaires with a new cover letter were mailed to firms who either requested a replacement or had had personnel changes.

Despite the relatively high response rate, there remains the fact that 35.8% of the firms did not respond. Little is known about the non-respondents except their geographic location. Non-respondents among populations tend to differ because of less involvement, less interest, and sometimes less-education (Clover & Balsley, 1979). Whether or not this holds for printing firms is not known.

Because the follow-up telephone calls uncovered a number of management changes, a suggestion by a firm to mark the envelope

"confidential" was incorporated into the final correspondence. Since nothing was known about the non-respondents except their geographic location, not enough was known to permit a statistical analysis to compare the group of respondents with non-respondents.

Data Analyses

For the categorical variables of geographic location, type of organizational structure, commission status, product end-use, and equipment, the number and percentages of responding firms were compared separately before levels of each variable were combined. For the two continuous variables, firm size and capital intensity, the Pearson product moment coefficient of correlation was used to investigate any relationship between the variables. The relationship between the two dependent variables, profitability and productivity, also was tested using the Pearson product moment coefficient of correlation.

The relationships of the categorical independent variables to each dependent variable were investigated using a two-way analysis of variance (ANOVA) taking into consideration size of firm. The relationships of the independent variables measured on a continuous scale, size of firm as measured by number of employees and capital intensity, to the dependent variables were examined using a regression analysis.

CHAPTER IV

FINDINGS AND DISCUSSION

Survey Response

The respondents to the census questionnaire mailed to plant managers represented more than 64% of the known population of textile printing plants. Of the 163 questionnaires mailed, 40 firms were deleted for reasons ranging from closed operations to absence of printing. Of the 123 remaining firms, 79 responded to the survey. The response pattern is summarized in Table 1. A summary of the responses by state is included in the appendix (Table A-1).

Table 1

Summary of Textile Printing Firms' Response Rate by Activity

ACTIVITY	RESPONSES RECEIVED No.	FIRMS MISIDENTIFIED No.	CUMULATIVE RESPONSE RATE %
FIRST MAILING	24	7	23.18%
POSTCARD REMINDER	11	5	
SECOND MAILING	22	7	39.58
TELEPHONE CALL	22	21	64.2
TOTAL	**79/163**	**40**	**79/123 = 64.2 % RESPONSE**

The geographic areas with the highest percentages of response were the South (69%) and New England (65%). The response percentage from the Middle Atlantic states including New York and New Jersey was 42%. Responses were the lowest from the Midwest (34%). The higher percentage from the South was expected because the two universities identified in the cover letter are regionally well-known. However, the response rate from New England was only four percentage points lower.

The response rate to the census was considered excellent for a self-administered instrument mailed to a population of plant managers whose time is at a premium and for which there was no real incentive to response. The higher than normal response was attributed to strict adherence to recommended follow-up procedures, cover letter endorsements, credibility of academic institutions connected to the research, interest in the subject, and timing.

The timing of the mailing turned out to be important. Immediately following the stock market crash of October 19, 1987, the initial questionnaire was mailed. This eliminated any complications due to bias over time. November and December are slower months for the textile industry. Therefore, despite warnings by Dillman (1978) and others to avoid holiday mail, the timing appeared to have been a positive factor in increasing the response rate.

Another unexpected benefit of the timing was that it may have alerted plant managers to the business environment. It may have momentarily slowed business to the point where managers had more time to handle mail.

A response rate of 64.2% is considered acceptable for survey research (Selltiz et al., 1962; Clover & Balsley, 1979). Although the relatively long length of the questionnaire no doubt hindered response, the advantages of obtaining more comprehensive information to include a number of important variables had to be considered.

The overall quality of the responses was excellent. None of the returned surveys had to be eliminated due to poor or partial completion. While not all firms answered all questions, almost all the firms answered the majority of the questions. The questions asking for proprietary information were often skipped by the respondents, several of whom noted in the margins that they would not answer the question. However, enough responses were obtained on proprietary questions to formulate a general analysis of the data. Some caution was necessary in interpretation, however, because it was possible that some levels of the variables were underrepresented in the second stage of the analysis.

Relationships Among the Independent Variables

The findings with regard to the relationships among the independent variables are discussed first. The associations of each independent variable to each dependent variable follow in a later section. The first step was to examine the questionnaire responses in order to more systematically classify the firms by the variables of interest and reduce the levels of the independent variables when appropriate. In order to do that, a series of tables was used to analyze the relationships among the independent variables.

Geographic Location

The printing firms responding to the survey were located geographically across 17 states. Of the 72 firms that indicated their geographic location, 58% were located in the southern United States. Twenty-one percent were located in New England and 15% in the Middle Atlantic states. The remaining 6% were divided between the Midwest and the West. The number of responses from each state is shown in Table I-1 in the appendix. The number of firms in each geographic area is in Table 2.

Fifty-eight of the 72 plants (80%) whose geographic location was known had been at their present location since 1960. Of those 58 plants, 36 or half of all the firms have been at the present location since 1975. Eight firms have been at their present location since 1945 and two since before 1915.

As expected, the oldest printing plants of those responding were located in New England. However firms that had been at their present location since 1915 were in the South. All the responses from the Middle Atlantic, Midwest, and West reported plants that had been established since 1960.

Sixty-three percent of the respondents' plants had been established at the present location by the present owner; another 28% had been established at their present location by a previous owner. Of the 78 firms, only 13 (17%) had been acquired through a buyout.

Sixty-eight percent of the plants had originally been printing plants. Of those that were not, plants had originally been weaving, knitting, dyeing or finishing operations. Other plants once had had

operations as diverse as quilting, woven labels, and industrial processes.

Type of Ownership. In all geographic locations except the South, more than half of the responding establishments were stand-alone firms. In the South, the opposite was true: more than half of the responding firms (57%) were part of a multi-plant structure. Of those firms, more than twice as many belonged to a corporation owning no other printing plants as belonged to one with multiple printing establishments. Firms in the Middle Atlantic states and Elsewhere had the highest percentage of respondents belonging to stand-alone structures. About half of the responding New England firms were independently owned. Table 3 indicates the number of firms and the type of ownership for each area of the country.

Size of Firm. The smallest responding firms or those establishments employing the fewest number of people were located in the Middle Atlantic states. The median firm size was 51-100 employees. In New England, over half (53%) of the responding firms employed more than 100 people. Firms in the South were larger, with half the responding firms employing more than 200 people. Both New England and the South had the largest firms, employing over 500 people. On the other hand, the South had the smallest firms as well, tying with the Middle Atlantic states, employing fewer than 20 employees. Of the responding nine firms who were located outside the eastern United States and not identified geographically, the median firm size was between 201 and 500 employees (Table 4).

Commission Status. Regardless of geographic location, firms tended to fall into two distinct categories with regard to commission status or the percentage of production printed on commission. Firms either printed a high percentage of their yardage on commission or a relatively small amount. However, regardless of geographic location, relatively few firms (21%) reported that they printed no yardage on commission. Forty-six percent of the New England firms reported printing entirely on commission, compared with 26% of southern plants reporting the same. Overall more than half of the firms in New England and the Middle Atlantic states printed at least 60% of their production on commission, in contrast with the South and Elsewhere where more than half of the firms printed less than 20% of their production on commission. The levels of commission status and geographic location are shown in Table 5. The lower percentage of southern firms who print on commission is expected, given the high proportion of southern firms that are part of larger firms or production units.

Product End-Use. Fifty-four percent of the responding establishments reported that their product line was at least 50% apparel. Another 34% specialized in more than 51% home furnishings fabric with the remaining 12% specializing in miscellaneous printed products. Under the category of miscellaneous printed products were carpets, labels, heat transfer paper, flocking, cut piece goods, craft and home sewing products, and nonwoven surfaces. Firms in New England were evenly divided between those printing mostly apparel and those firms printing home furnishings and other miscellaneous products. In the Middle Atlantic states, only 1 of the 11 responding firms reported

printing a majority of its production as home furnishings fabric; most of the responding firms (72%) reported printing predominantly apparel. Fifty-four percent of the southern plants reported that they printed predominantly apparel fabrics. Another 33% of the southern plants reported a specialization in home furnishings fabric as compared to 42% with that specialty in New England and 55% in the Other category (Table 6).

Technology. The South had the highest percentage of printed production using predominantly engraved roller printing equipment. New England, on the other hand, printed a higher percentage of its production using rotary screens. Except for firms in the Middle Atlantic states, 50% or more of the printed production was done predominantly with rotary screens. The Middle Atlantic states have a proportionately higher percentage of their printing done by heat transfer equipment. No New England firms reported printing more than half their production using predominantly heat transfer equipment. The percentage of firms printing most of their production with flat-bed equipment (12%) was almost as high as for those printing with heat transfer equipment (17%) (Table 7).

Capital Expenditures. Of the 71 responding firms, 57% reported investing less than $500,000 in capital equipment and machinery in 1986. This was the case for all geographic regions except the South where fewer than half the respondents invested that little. However, only 4 firms reported making more than $2 million of capital expenditures in 1986. In New England, 4 firms reported making more than $1 million worth of capital expenditures in 1986 (Table 8).

Table 2

Number of Textile Printing Firms by Geographic Region

REGION	No.	%
NEW ENGLAND	15	21
MIDDLE ATLANTIC	11	15
SOUTH	43	58
MIDWEST	2	3
WEST	2	3
TOTAL	73	100

(FREQUENCY MISSING = 6)

Table 3

Number of Textile Printing Firms by Geographic Region and Type of Ownership

	NEW ENGLAND	MIDDLE ATLANTIC	SOUTH	OTHER*	TOTAL
OWNERSHIP TYPE	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
MULTI-PLANT w/ other printing	3 (20)	1 (9)	8 (17)	--	12 (15)
MULTI-PLANT w/ no other printing	4 (27)	1 (9)	17 (40)	1 (11)	23 (29)
STAND ALONE	8 (53)	9 (82)	18 (42)	8 (89)	43 (55)
TOTAL	15	11	43	9	78
(%)	(19%)	(14%)	(55%)	(12%)	

(FREQUENCY MISSING = 1)

* Includes unknown (5), and plants outside East (4).

Table 4

Number of Textile Printing Firms by Geographic Region and Size of Establishment

NUMBER OF EMPLOYEES	NEW ENGLAND No. (%)	MIDDLE ATLANTIC No. (%)	SOUTH No. (%)	OTHER* No. (%)	TOTAL No. (%)
≤ 20	—	3 (27)	3 (7)	—	6 (8)
21 - 50	3 (20)	1 (9)	4 (10)	1 (11)	9 (12)
51 - 100	4 (27)	5 (45)	6 (14)	2 (22)	17 (22)
101 - 200	4 (27)	2 (18)	8 (19)	1 (11)	15 (19)
201 - 500	2 (13)	—	19 (45)	5 (56)	26 (34)
> 500	2 (13)	—	2 (5)	—	4 (5)
TOTAL	**15**	**11**	**42**	**9**	**77**
(%)	**(19%)**	**(14%)**	**(54%)**	**(12%)**	

(FREQUENCY MISSING = 2)

* Includes unknown, and plants outside East.

Table 5

Number of Textile Printing Firms by Geographic Region and Commission Status

% COMMISSION PRINTING	NEW ENGLAND No. (%)	MIDDLE ATLANTIC No. (%)	SOUTH No. (%)	OTHER* No. (%)	TOTAL No. (%)
NONE	3 (20)	1 (9)	9 (21)	3 (33)	16 (21)
< 20%	1 (7)	2 (18)	13 (31)	2 (22)	18 (23)
20 - 39%	1 (7)	—	4 (10)	1 (11)	6 (8)
40 - 59%	—	2 (18)	2 (5)	—	4 (5)
60 - 79%	1 (7)	1 (9)	—	—	2 (2)
80 - 99%	2 (13)	1 (9)	3 (7)	1 (11)	7 (9)
100%	7 (47)	4 (36)	11 (26)	2 (22)	24 (31)
Total	**15**	**11**	**42**	**9**	**77**
(%))	**(19%)**	**(14%)**	**(54%)**	**(12%)**	

(FREQUENCY MISSING = 2)

* Includes unknown, and plants outside East.

Table 6

Number of Textile Printing Firms by Geographic Region and Product End-Use

	NEW ENGLAND	MIDDLE ATLANTIC	SOUTH	OTHER*	TOTAL
PRODUCT END-USE	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
100% Apparel	4 (28)	3 (27)	6 (14)	2 (22)	15 (20)
50 - 99% Apparel	3 (21)	5 (45)	17 (40)	1 (11)	26 (34)
100% Home Furn.	4 (28)	1 (9)	8 (19)	3 (33)	16 (21)
51 - 99% Home Furn.	2 (14)	—	6 (14)	2 (22)	10 (13)
< 60% Other	1 (7)	2 (18)	5 (12)	1 (11)	9 (12)
TOTAL	14	11	42	9	76
(%)	(18%)	(14%)	(55%)	(12%)	

(FREQUENCY MISSING = 3)

* Includes unknown, and plants outside East.

Table 7

Number of Textile Printing Firms by Geographic Region and Production by Printing Equipment Type

% PRODUCTION BY EQUIPMENT	NEW ENGLAND No. (%)	MIDDLE ATLANTIC No. (%)	SOUTH No. (%)	OTHER* No. (%)	TOTAL No. (%)
≥ 50% ROLLER	1 (10)	1 (12)	9 (24)	1 (10)	12 (18)
> 50% FLAT-BED	2 (20)	1 (12)	2 (5)	3 (30)	8 (12)
> 50% ROTARY SCR.	7 (70)	3 (38)	19 (51)	5 (50)	34 (52)
≥ 50% HEAT TRANS.	--	3 (38)	7 (19)	1 (10)	11 (17)
TOTAL	10	8	37	10	65
(%)	(15%)	(12%)	(57%)	(15%)	

(FREQUENCY MISSING = 14)

* Includes unknown, and plants outside Eastern and Southern regions.

Table 8

Number of Textile Printing Firms by Geographic Region and Capital Expenditures

CAPITAL EXPENDITURES	NEW ENGLAND No. (%)	MIDDLE ATLANTIC No. (%)	SOUTH No. (%)	OTHER* No. (%)	TOTAL No. (%)
< $500,000	9 (64)	7 (78)	19 (49)	6 (60)	41 (57)
$500,000 - 999,999	1 (7)	1 (11)	6 (15)	2 (20)	10 (14)
$1 - 1.9 MILLION	2 (14)	--	9 (23)	2 (20)	13 (18)
$2 - 2.9 MILLION	1 (7)	--	2 (5)	--	3 (4)
$3 - 4 MILLION	--	1 (11)	1 (3)	--	2 (3)
> $4 MILLION	1 (7)	--	1 (3)	--	2 (3)
TOTAL	14	9	38	10	71
(%)	(19%)	(13%)	(54%)	(14%)	

(FREQUENCY MISSING = 8)

* Includes unknown, and plants outside East.

When capital intensity is considered, a more comprehensive picture emerges. Capital intensity is a ratio which is calculated by dividing a firm's gross value of fixed assets by the number of employees. It is a measure that takes a firm's size into account. In Table I-2 the calculated means for capital intensity are compared for each independent variable. For the four geographic regions, all regions were similar except for those regions classified as Elsewhere. The differences with regard to capital intensity were within $2,000 of one another for firms in New England, the Middle Atlantic, and the South. Only those firms classified as Elsewhere had a capital intensity ratio as low as $16,000 (Table I-2 in appendix).

Ownership Structure

Of the responding printing establishments, 55% were stand-alone firms. The remaining 45% were multi-plant operations. Of the multi-plant corporations, 12 firms (15%) were part of a corporation with other printing plants. Twenty-three plants (29%) were part of a corporation with other plants but not other printing operations (Table 9).

As noted in the section on geographic location, the respondents in New England and the South were similar with regard to type of ownership. Nine of the 11 responding firms in the Middle Atlantic region were independent or stand-alone firms.

Table 9

Number of Textile Printing Firms by Type of Ownership

	No.	%
MULTI-PLANT CORPORATION WITH OTHER PRINTING PLANTS	12	15%
MULTI-PLANT CORPORATION WITH NO OTHER PRINTING PLANTS	23	29
INDIVIDUALLY OWNED CORPORATION (STAND-ALONE) (Includes partnerships)	43	55
TOTAL	**78**	**100%**

(FREQUENCY MISSING = 1)

Size of Firm. The median firm size for the responding firms was between 101 and 200 employees. Forty-eight percent of the responding stand-alone firms employed fewer than 100 people. The distribution of responding firms belonging to multi-plant structures was skewed toward larger firms. Sixty-one percent of firms belonging to a multi-plant structure with no other printing establishments employed more than 100 people with 48% of the firms employing more than 200. For those 12 firms belonging to a multi-plant organization which owned other printing firms, 50% of the firms employed more than 200. Table 10 summarizes the type of ownership structure by size of firm.

When ownership structure and size of firm were considered, the expected pattern that emerged was that for the smaller firms employing fewer than 100 people, most were independently owned. However, a large percentage (40%) of multi-plant firms with no other printing plants also employed fewer than 100 people. Twenty-five percent of the multi-plant firms belonging to corporations owning other printing establishments also employed fewer than 100 people. Therefore, while smaller firms tended to be independently owned, this was not always the case. There were 13 large plants employing more than 200 which were independently owned. This compared with 17 large firms belonging to multi-plant organizations.

Commission Status. More than 58% of the responding firms reported that they printed at least 60% of their production on commission. For stand-alone firms, the percentage was the same as for all firms--more than half of the stand-alone firms printed at least 60% of their production on commission. For those firms belonging to a multi-plant or vertical corporation, the percentage printed on commission was slightly higher than for stand-alone firms. Sixty-one percent of the vertical plants with no other printing plants printed at least 60% on commission. A higher percentage of the respondents which belonged to a stand-alone firm printed smaller percentages of their production on commission. However, regardless of ownership structure, responding firms represented all levels of commission status from less than 20% to 100% printed on commission as emphasized in Table 11.

Product End-Use. When the percentage of firms that printed at least 50% apparel fabrics was compared across types of ownership

structure, the percentage of plants varied by no more than six percentage points (Table 12). For all three ownership types, at least 50% of the responding firms reported printing at least 50% apparel. A higher percentage of vertically structured firms with other printing plants specialized either in home furnishing fabrics or in apparel with fewer firms printing a mix of products. However, for the three structures, the percentage of firms with product lines based primarily on apparel ranged from 33% to 35%, so was almost identical for the three types of ownership.

Equipment. No clear-cut picture emerged with regard to type of ownership and the type of printing equipment in use. While it appears that the multi-plant firms owning other printing plants operated with and printed more fabric using engraved roller equipment, no other clear patterns can be distinguished. Regardless of the ownership structure, the highest percentage of plants printed at least 51% of their yardage using rotary screens. One finding was that for stand-alone firms, the second highest percentage of yardage printed was with flat-bed equipment. For vertically structured firms, 21% printed predominantly with heat transfer equipment and with rollers only slightly higher than for stand-alone firms (14%). Conversely, 17% of stand-alone firms printed at least half their line with flat-beds as compared with only 10% of vertically structured plants (Table 13).

Capital Expenditures. In 1986, most firms (56%) made less than $500,000 worth of investments in capital equipment and machinery. The largest number and highest percentage of responding firms falling into this category were stand-alone firms. Ninety-seven percent of stand-

alone firms invested less than $2 million. On the other hand, 3 of the 11 plants which were part of a multi-plant structure with other printing plants reported investing over $3 million. The median for this group was $1-1.9 million as compared to a median of under $500,000 for the other two levels of ownership structure (Table 14). Regardless of ownership structure, the amount of capital expenditures was relatively small in 1986 and was lowest for stand-alone firms. Capital intensity was higher for multi-plant firms than for the independent firms by $13,000 (Table I-2).

Size of Firm

As described in the sections on respondents' geographic location and ownership organizational structure, printing plants were relatively small as measured by total number of employees. Smaller firms tended to be stand-alone structures, and the Middle Atlantic region has the highest percentage of small firms.

For the responding firms, the median number of firms employed between 101 and 200 people. Sixty-one percent of the firms employed fewer than 200 employees. Eight percent of the respondents reported a firm size of fewer than 20 employees. This compared to only 5% reporting a firm size of over 500 employees. Of the responding plants, 87% reported that a least 70% of their employees were production workers. Table I-3 in the appendix compares the means for number of employees for each independent variable.

Table 10

Number of Textile Printing Firms by Type of Ownership and Size of Establishment

NUMBER OF EMPLOYEES	MULTI-PLANT w/ OTHER PRINTING No. (%)	MULTI-PLANT w/ NO OTHER PRINTING No. (%)	STAND-ALONE No. (%)	TOTAL No. (%)
≤ 20	1 (8)	2 (9)	3 (7)	6 (8)
21 - 50	--	2 (9)	7 (17)	9 (12)
51 - 100	2 (17)	5 (22)	10 (24)	17 (22)
101 - 200	3 (25)	3 (13)	9 (21)	15 (19)
201 - 500	4 (33)	10 (44)	12 (27)	26 (34)
> 500	2 (17)	1 (4)	1 (2)	4 (5)
TOTAL	12	23	42	77
(%)	(16%)	(30%)	(55%)	

(FREQUENCY MISSING = 2)

Table 11

Number of Textile Printing Firms by Type of Ownership and Commission Status

% COMMISSION PRINTING	MULTI-PLANT w/ OTHER PRINTING No. (%)	MULTI-PLANT w/ NO OTHER PRINTING No. (%)	STAND-ALONE No. (%)	TOTAL No. (%)
NONE	3 (25)	7 (30)	3 (7)	13 (17)
< 20%	4 (33)	6 (26)	7 (17)	17 (22)
20 - 39%	1 (8)	--	10 (24)	11 (14)
40 - 59%	1 (8)	2 (9)	9 (21)	12 (16)
60 - 79%	--	--	12 (29)	12 (16)
80 - 99%	--	1 (4)	1 (2)	2 (3)
100%	3 (25)	7 (30)	--	10 (13)
TOTAL	12	23	42	77
(%)	(16%)	(30%)	(55%)	

(FREQUENCY MISSING = 2)

Table 12

Number of Textile Printing Firms by Type of Ownership and Product End-Use

	MULTI-PLANT w/ OTHER PRINTING	MULTI-PLANT w/ NO OTHER PRINTING	STAND-ALONE	TOTAL
PRODUCT END-USE	No. (%)	No. (%)	No. (%)	No. (%)
100% APPAREL	4 (33)	5 (22)	6 (14)	15 (19)
50 - 99% APPAREL	2 (17)	8 (35)	16 (37)	26 (33)
100% HOME FURN.	4 (33)	5 (22)	7 (16)	16 (21)
51 - 99% HOME FURN.	—	3 (13)	7 (16)	10 (13)
< 60 OTHER	2 (17)	2 (9)	5 (12)	9 (12)
TOTAL	12	23	43	76
(%)	(15%)	(29%)	(55%)	

(FREQUENCY MISSING = 3)

Table 13

Number of Textile Printing Firms by Type of Ownership and Production by Equipment Type

% PRODUCTION BY EQUIPMENT	MULTI-PLANT w/ OTHER PRINTING No. (%)	MULTI-PLANT w/ NO OTHER PRINTING No. (%)	STAND-ALONE No. (%)	TOTAL No. (%)
≥ 50% ROLLER	3 (30)	3 (16)	5 (14)	11 (17)
> 50% FLAT-BED	1 (10)	1 (5)	6 (17)	8 (12)
> 50% ROTARY SCR.	4 (40)	11 (58)	19 (54)	34 (53)
≥ 50% HEAT TRANS.	2 (20)	4 (21)	5 (14)	11 (17)
TOTAL	10	19	35	64
(%)	(16%)	(30%)	(55%)	

(FREQUENCY MISSING = 15)

Table 14

Number of Textile Printing Firms by Type of Ownership and Capital Expenditures

CAPITAL EXPENDITURES	MULTI-PLANT w/ OTHER PRINTING No. (%)	MULTI-PLANT w/ NO OTHER PRINTING No. (%)	STAND-ALONE No. (%)	TOTAL No. (%)
< $500,000	3 (27)	13 (59)	24 (63)	40 (56)
$500,000 - 999,999	2 (18)	1 (5)	7 (18)	10 (14)
$1 - 1.9 MILLION	2 (18)	5 (23)	6 (16)	13 (18)
$2 - 2.9 MILLION	1 (9)	2 (9)	—	3 (4)
$3 - 4 MILLION	--	1 (5)	1 (1)	2 (3)
> $4 MILLION	3 (27)	—	—	3 (4)
TOTAL	**11**	**22**	**38**	**71**
(%)	**(15%)**	**(31%)**	**(53%)**	

(FREQUENCY MISSING = 8)

Commission Status. The median number of firms with regard to commission status printed between 40-59% of their production on commission. However, the distribution was bimodal in that many firms either printed most of their production on commission or very little. For all firms, 44% printed less than 20% on commission. Another 40% printed over 80% of their production on commission.

The relationship between commission status to size of firm was difficult to determine. Firms doing more commission printing averaged only 10 employees more per plant. What is clear was that regardless of firm size, the percentage of firms in each size category at either extreme was approximately the same as for all firms. The only group where the percentage printed on commission was lower than for all firms was for those firms employing between 201-500. Table 15 shows the distribution across the size levels.

Product End-Use. More than half of the responding firms (54%) reported that 50% or more of their product line was printed apparel. Another 34% specialized in printed home furnishing fabric. Twelve percent specialized in miscellaneous printed products.

Forty-two percent of the firms employing between 201 and 500 reported specializing in printed apparel. Forty-six percent of that size group reported specializing in home furnishing fabrics (Table 16). That group also reported the highest percentage of firms specializing in home furnishing fabric.

The responding firms employing fewer than 20 employees specialized in miscellaneous printed products or apparel. Firms printing

miscellaneous products appeared to be smaller when the average number of employees was compared to that for apparel and home furnishings.

Printing Equipment. The small firms employing fewer than 50 people reported that the majority of their production was printed using either heat transfer equipment or rotary screens. The large firms employing over 500 reported printing a high percentage of their production using roller machines. For those firms with between 101 and 500 employees, most of the production was done using rotary screens. For those small firms employing between 51 and 100 people, a higher percentage of the production was printed using flat-bed screens than for the other size groups. In general, there were more firms of larger sizes using rotary screens and rollers; firms of smaller sizes used more heat transfer equipment and flat-beds. What is unclear was that 15 of the 77 responding firms reported that more than half of their production came from a combination of equipment; they did not specialize in any one type of equipment. Those firms were excluded from Table 17.

Capital Expenditures. More of the large responding firms invested the most in capital expenditures in 1986. For all firms regardless of size, the median number of firms invested less than $500,000, however. The median was the same for firms employing fewer than 200. For responding firms employing over 200 people, the median number of firms invested between $1 million and $2 million. For those firms employing over 500, the median number of firms invested between $2 million and $3 million (Table 18).

Table 15

Number of Textile Printing Firms by Size of Establishment and Commission Status

	NUMBER OF EMPLOYEES						
	≤ 20	21 - 50	51 - 100	101 - 200	201 - 500	> 500	TOTAL
% COMMISSION PRINTING	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
NONE	1 (17)	2 (22)	3 (17)	--	8 (31)	2 (50)	16 (21)
< 20%	1 (17)	2 (22)	4 (24)	6 (40)	5 (19)	--	8 (23)
20 - 39%	1 (17)	1 (11)	1 (6)	--	3 (12)	--	6 (8)
40 - 59%	--	--	2 (12)	--	2 (8)	--	4 (5)
60 - 79%	--	--	1 (6)	1 (7)	--	--	2 (3)
80 - 99%	1 (17)	1 (11)	1 (6)	3 (20)	1 (4)	--	7 (9)
100%	2 (33)	3 (33)	5 (29)	5 (33)	7 (27)	2 (50)	24 (31)
TOTAL	6	9	17	15	26	4	77
(%)	(8%)	(12%)	(22%)	(19%)	(34%)	(5%)	(100%)

(FREQUENCY MISSING = 2)

Table 16

Number of Textile Printing Firms by Size of Establishment and Product End-Use

	NUMBER OF EMPLOYEES						
	≤ 20	21 - 50	51 - 100	101 - 200	201 - 500	> 500	TOTAL
PRODUCT END-USE	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
100% APPAREL	3 (50)	1 (11)	3 (18)	6 (40)	1 (4)	1 (33)	15 (20)
50-99% APPAREL	1 (17)	4 (44)	5 (29)	4 (27)	10 (38)	2 (67)	26 (34)
100% HOME FURN.	--	1 (11)	6 (35)	1 (7)	8 (31)	--	16 (21)
51-100% HOME FURN.	1 (17)	1 (11)	1 (6)	3 (20)	4 (15)	--	10 (13)
< 60% OTHER	1 (17)	2 (22)	2 (12)	1 (7)	3 (12)	--	9 (12)
TOTAL	6	9	17	15	26	3	76
(%)	(8%)	(12%)	(22%)	(20%)	(34%)	(4%)	(100%)

(FREQUENCY MISSING = 3)

Table 17

Number of Textile Printing Firms by Size of Establishment and Production by Printing Equipment

	NUMBER OF EMPLOYEES						
	≤ 20	21 - 50	51 - 100	101 - 200	201 - 500	> 500	TOTAL
% PRODUCTION BY EQUIPMENT	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
≥ 50% ROLLER	--	1 (14)	2 (15)	2 (13)	4 (16)	2 (67)	11 (17)
> 50% FLAT-BED	--	--	3 (23)	3 (20)	2 (8)	--	8 (12)
> 50% ROTARY SCR.	--	3 (43)	3 (23)	8 (53)	19 (76)	1 (33)	34 (53)
≥ 50% HEAT TRANS.	1 (100)	3 (43)	5 (38)	2 (13)	--	--	11 (17)
TOTAL	1	7	13	15	25	3	64
(%)	(2%)	(11%)	(20%)	(23%)	(39%)	(5%)	(100%)

(FREQUENCY MISSING = 15)

Table 18

Number of Textile Printing Firms by Size of Establishment and Capital Expenditures

	NUMBER OF EMPLOYEES						
	≤ 20	21 - 50	51 - 100	101 - 200	201 - 500	> 500	TOTAL
CAPITAL EXPENDITURES	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
< $500,000	5 (100)	8 (89)	13 (76)	7 (54)	7 (30)	--	40 (56)
$500,000-999,999	--	--	3 (18)	2 (15)	5 (22)	--	10 (14)
$1-1.9 MILLION	--	1 (11)	1 (6)	2 (15)	8 (35)	1 (25)	13 (18)
$2-2.9 MILLION	--	--	--	1 (8)	1 (4)	1 (25)	3 (4)
$3-4 MILLION	--	--	--	1 (8)	1 (4)	--	2 (3)
> $4 MILLION	--	--	--	--	1 (4)	2 (50)	3 (4)
TOTAL	5	9	17	13	23	4	71
(%)	(7%)	(13%)	(24%)	(18%)	(32%)	(6%)	(100%)

(FREQUENCY MISSING = 8)

Commission Status

As noted in the sections discussing geographic location, ownership and size, the responding firms either printed most of their production on commission or very little. Forty percent of the responding firms reported that they printed more than 80% of their production on commission; 44% of the firms reported printing less than 20% of their production on commission. Although the number of firms was concentrated in those two categories, only 21% of the firms reported doing no commission finishing. Most firms did some printing on a commission basis.

A number of firms which were part of a multi-firm structure printed a large percentage of their production on commission. Stand-alone firms printed proportionately less yardage on commission. However, it does not appear to be the case that commission printing is restricted to independently owned firms.

Product End Use. The responding firms which printed the smallest percentage of their production on commission were predominantly apparel fabric printers. More than half of those specializing in apparel printed nothing on commission, for example. At the other extreme, 67% of those firms printing 100% on commission specialized in apparel fabrics. With regard to those firms specializing in home furnishings fabrics or miscellaneous specialized printed products, no distinctions could be made. At least one firm at each level responded that they did some of their production on a commission basis (Table 19).

Printing Equipment. A clearer pattern emerged with regard to commission status and type of equipment specialty. Those responding

firms printing at least 60% of their production on commission specialized either in rotary screen printing or heat transfer equipment. For firms specializing in flat-bed equipment, less than 40% of their production was on commission. Those firms specializing in engraved roller printed goods reported that between 1% and 59% of their production was printed predominantly with roller equipment. Of those firms printing 100% on commission, 11 out of 13 firms reported specializing in rotary screen printing (Table 20).

Capital Expenditures. With regard to commission status, only two categories had respondents which had invested more than $500,000 in capital equipment and machinery in 1986. Two out of the four firms which printed between 40% and 59% of their production on commission reported investing between $1 million and $2 million. Four out of 22 firms which printed 100% of their production on commission reported that they invested between $500,000 and $1 million on capital equipment and machinery. Aside from those two categories, the relationship for every level of capital expenditures and commission status is unclear (Table 21).

Table 19

Number of Textile Printing Firms by Commission Status and Product End-Use

	COMMISSION PRINTING (AS % OF PRODUCTION)							
	NONE	< 20%	20 - 39%	40 - 59%	60 - 79%	80 - 99%	100%	TOTAL
PRODUCT END-USE	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
100% APPAREL	2 (13)	5 (28)	1 (17)	--	1 (50)	1 (14)	5 (21)	15 (20)
50-99% APPAREL	6 (40)	1 (6)	2 (33)	3 (75)	--	3 (43)	11 (46)	26 (34)
100% HOME FURN.	6 (40)	3 (17)	1 (17)	1 (25)	1 (50)	--	4 (17)	16 (21)
51-100% HOME FURN.	--	3 (17)	2 (33)	--	--	3 (43)	2 (8)	10 (13)
< 60% OTHER	1 (7)	6 (33)	--	--	--	--	2 (8)	9 (12)
TOTAL	15	18	6	4	2	7	24	76
(%)	(20%)	(24%)	(8%)	(5%)	(3%)	(9%)	(32%)	(100%)

(FREQUENCY MISSING = 3)

Table 20

Number of Textile Printing Firms by Commission Status and Production by Printing Equipment Type

	COMMISSION PRINTING (AS % OF PRODUCTION)							
	NONE	< 20%	20 - 39%	40 - 59%	60 - 79%	80 - 99%	100%	TOTAL
% PRODUCTION BY EQUIPMENT	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
≥ 50% ROLLER	--	1 (13)	1 (25)	1 (50)	--	--	--	3 (7)
> 50% FLAT-BED	3 (27)	1 (13)	1 (25)	--	--	--	--	5 (12)
> 50% ROTARY SCR.	7 (64)	3 (38)	2 (50)	--	1 (100)	1 (50)	11 (85)	25 (61)
≥ 50% HEAT TRANS.	1 (9)	3 (38)	--	1 (50)	--	1 (50)	2 (15)	8 (20)
TOTAL	11	8	4	2	1	2	13	41
(%)	(27%)	(20%)	(10%)	(5%)	(2%)	(5%)	(32%)	(100%)

(FREQUENCY MISSING = 3)

Table 21

Number of Textile Printing Firms by Commission Status and Capital Expenditures

	COMMISSION PRINTING (AS % OF PRODUCTION)							
	NONE	< 20%	20 - 39%	40 - 59%	60 - 79%	80 - 99%	100%	TOTAL
CAPITAL EXPENDITURES	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
< $500,000	8 (57)	12 (75)	3 (60)	1 (25)	2 (100)	5 (71)	9 (41)	40 (57)
$500,000-999,999	2 (14)	1 (6)	--	1 (25)	--	2 (29)	4 (18)	10 (14)
$1-1.9 MILLION	1 (7)	3 (19)	2 (40)	2 (50)	--	--	5 (23)	13 (19)
$2-2.9 MILLION	1 (7)	--	--	--	--	--	2 (9)	3 (4)
$3-4 MILLION	1 (7)	--	--	--	--	--	1 (5)	2 (3)
> $4 MILLION	1 (7)	--	--	--	--	--	1 (5)	2 (3)
TOTAL	14	16	5	4	2	7	22	70
(%)	(20%)	(23%)	(7%)	(6%)	(3%)	(10%)	(31%)	(100%)

(FREQUENCY MISSING = 38)

Product End-Use

Twenty percent of the responding firms reported that 100% of their printed product line was apparel. Twenty-one percent of the firms reported that 100% of their line was home furnishings. If those firms whose lines were at least 50% either apparel or home furnishing fabrics are included, 54% specialized in apparel printing in 1986; 34% specialized in home furnishing prints. The remaining 12% specialized in miscellaneous printed products. Products included ticking, crafts and home sewing products such as needlepoint canvas, hosiery, labels, printed logos, circuit boards, nonwoven mattress ticking, and fiberglass. Also printed were flocked designs, heat transfer paper, cut piece goods (shirts, sportswear), stuffed rag toys, baby products, and government camouflage.

As discussed in other sections, the relationship between the other independent variables was undetermined.

Printing Equipment. As should be expected, the relationship between product end-use and type of printing equipment was clearer than for the other variables. However, of the four groups classified by equipment specialty, only flat-bed equipment was used for a single end-use product. It predominantly was used to print home furnishing fabric and miscellaneous printed products. Heat transfer equipment was used mainly for apparel printing and miscellaneous products. Other equipment was used for all product end-uses.

For those firms printing at least half their product line using engraved roller machines, more apparel was printed than home furnishing fabrics. However, two predominantly roller printing firms reported that

over 60% of their printed production was a product line other than apparel or home furnishing fabric.

Both apparel and home furnishings reportedly more widely used rotary screen equipment. This reflects the fact that more of the responding firms were rotary screen printers and that rotary screen printing was the dominant technology in 1986. Twenty firms out of 42 reported that their product line was at least 50% apparel while 14 out of 26 firms reported that their product line was at least 51% home furnishings (Table 22).

A related variable which needs to be considered is the fabric ground construction for the printed fabrics. It had been assumed that firms listed in Davison's were printers of broadwoven products. This was because Davison's has a separate volume for knit manufacturers. To check this association with fabric construction (wovens, knits, or nonwovens and other printed products such as labels), Table 23 classifies the product lines by fabric construction. This helps clarify that a number of the responding firms printed on knits as well as wovens. Knit goods can include apparel products such as sportswear for which the printing is done on the cut goods. This emphasizes the complexity of classifying firms by printed end-products with regard to type equipment.

It becomes clearer that predominantly apparel printing firms were divided between those printing on knits and those on wovens. For those printing mostly home furnishing fabrics, all the responding firms reported that they printed on woven constructions or on miscellaneous nonwoven or narrow fabric constructions.

Table 22

Number of Textile Printing Firms by Product End-Use and Production by Printing Equipment Type

% PRODUCTION BY EQUIPMENT	100% APPAREL No. (%)	50 - 99% APPAREL No. (%)	100% H. FURN. No. (%)	51 - 99% H. FURN. No. (%)	< 60% OTHER No. (%)	TOTAL No. (%)
≥ 50% ROLLER	2 (15)	7 (29)	--	1 (11)	2 (33)	12 (16)
> 50% FLAT-BED	--	--	3 (23)	2 (22)	3 (50)	8 (10)
> 50% ROTARY SCR.	6 (46)	14 (58)	8 (62)	6 (67)	--	34 (44)
≥ 50% HEAT TRANS.	5 (38)	3 (13)	2 (15)	--	1 (17)	11 (14)
TOTAL	13	24	13	9	6	65
(%))	(20%)	(37%)	(20%)	(14%)	(9%)	(100%)

(FREQUENCY MISSING = 14)

These observations were made: (1) flat-bed screens printed predominantly for home furnishings and miscellaneous products; (2) rotary screens printed both apparel and home furnishings although weighted toward apparel because more of the respondents reported specializing in apparel; (3) heat transfer equipment printed mostly apparel and knits; (4) engraved rollers printed more apparel than other categories.

Table 23

Fabric Construction as Related to Product End-Use

	WOVENS	KNITS	OTHER	TOTAL
PRODUCT	No. (%)	No. (%)	No. (%)	No. (%)
MOSTLY APPAREL	17 (49)	18 (90)	7 (32)	42 (55)
MOSTLY HOME FURN.	17 (49)	--	9 (41)	26 (33)
MISCELLANEOUS	1 (3)	2 (10)	6 (27)	9 (12)
TOTAL	35	20	22	77
(%)	(45%)	(26%)	(29%)	

(FREQUENCY MISSING = 2)

Capital Expenditures. For only one group did capital expenditures exceed $500,000 in 1986. As a group, firms reporting that they specialize in apparel invested more than firms in other specialties. However, a few firms specializing in printed home furnishings fabric also invested between $1 million to $4 million in capital expenditures in 1986. The highest percentage of firms investing under $500,000 was those firms who specialized in miscellaneous printed products (Table 24). With regard to capital intensity, those firms printing predominantly miscellaneous products in 1986 also led other printers by as much as $23,000. Capital intensity for apparel specialists was almost $41,000 as compared to $37,000 for home furnishing printers (Table I-2).

Printing Equipment

Four types of printing technology were identified from the literature as being the most commonly used machinery in American textile printing. The four types of printing equipment were (1) engraved roller machines; (2) flat-bed screens; (3) rotary screens; and (4) heat transfer equipment. Almost half the responding firms reported using only one type of equipment.

The remaining 42 firms used a combination of printing equipment. In attempting to better understand the combinations of printing machines and their relationship to product line, firms were classified as to whether or not at least half of their production was printed with one type of equipment. The firms were classified by equipment type in Table 25.

Table 24

Number of Textile Printing Firms by Product End-Use and Capital Expenditures

CAPITAL EXPENDITURES	100% APPAREL No. (%)	50 - 99% APPAREL No. (%)	100% H. FURN. No. (%)	51 - 99% H. FURN. No. (%)	< 60% OTHER No. (%)	TOTAL No. (%)
< $500,000	7 (58)	10 (42)	10 (62)	7 (70)	7 (88)	41 (59)
$500,000 - 999,999	1 (8)	6 (25)	2 (12)	1 (10)	--	10 (14)
$1 - 1.9 MILLION	2 (17)	4 (17)	3 (19)	2 (20)	1 (11)	12 (17)
$2 - 2.9 MILLION	1 (8)	2 (8)	--	--	--	3 (4)
$3 - 4 MILLION	--	1 (4)	1 (6)	--	--	2 (3)
>$4 MILLION	1 (8)	1 (4)	--	--	--	2 (3)
TOTAL	12	24	16	10	8	70
(%)	(17%)	(34%)	(23%)	(14%)	(11%)	(100%)

(FREQUENCY MISSING = 9)

Table 25

Percentage of Printed Production by Equipment Type

% PRINTED PRODUCTION	No.	%
≥ 50% ENGRAVED ROLLERS	12	18%
> 50% FLAT-BED	8	12
> 50% ROTARY SCREEN	34	52
≥ 50% HEAT TRANSFER	11	17
TOTAL	**65**	
(FREQUENCY MISSING = 14)		

As noted in the section of product end-use, for those firms using engraved roller machines, more apparel was printed than home furnishing fabrics in 1986. Although one associates roller printing with woven fabrics, a few firms reported using roller printing with knits. Heat transfer printing appears to be used more for apparel and little for home furnishings. Rotary screen equipment, which dominates the market, was used both for home furnishing and apparel products.

Capital Expenditures. The two groups of responding firms that invested more than $500,000 in capital equipment and machinery in 1986

were those specializing in rotary screen printing and those specializing in roller printing. For those using roller equipment, the median number of firms reported investing between $500,000 and $1 million. For firms specializing in rotary screen printing, the median number invested between $500,000 and $2 million. No firms specializing in heat transfer equipment reported investing more than $1 million. However, one firm specializing in flat-bed printing reported investing as much as $2 million (Table 26). The comparison of capital intensity figures emphasizes this relationship. Capital intensity is lowest for firms with predominantly flat-bed and heat transfer equipment. For firms with roller machines, rotary screens, and a diverse mixture of equipment, capital intensity only ranged between almost $48,000 and $51,500 (Table I-2).

Table 26

Number of Textile Printing Firms by Production by Printing Equipment Type and Capital Expenditures

CAPITAL EXPENDITURES	≥ 50% ROLLER No. (%)	> 50% FLAT-BED No. (%)	> 50% ROT. SCR. No. (%)	≥ 50% HEAT TRNS. No. (%)	TOTAL No. (%)
< $500,000	4 (40)	6 (75)	11 (37)	9 (82)	30 (51)
$500,000 - 999,999	3 (30)	1 (12)	4 (13)	2 (18)	10 (17)
$1 - 1.9 MILLION	1 (10)	1 (12)	10 (33)	--	12 (20)
$2 - 2.9 MILLION	1 (10)	--	2 (7)	--	3 (5)
$3 - 4 MILLION	--	--	2 (7)	--	2 (3)
>$4 MILLION	1 (10)	--	1 (3)	--	2 (3)
TOTAL	10	8	30	11	59
(%)	(17%)	(14%)	(51%)	(19%)	(100%)

(FREQUENCY MISSING = 8)

Capital Intensity

The calculated means for capital intensity for each independent variable are compared in Table I-2 in the appendix. Although comparisons have been made regarding to capital expenditures, capital intensity is a more appropriate measure because it is a ratio of gross value of fixed assets divided by number of employees. Consequently it is easier to compare firms across sizes.

Firms in New England, the Middle Atlantic, and the South only differed by a few thousand dollars with regard to capital intensity. Estimated capital intensity ranged from $45-47.4 thousand. Only those firms outside those geographic regions or who were unidentified were considerably less capital intensive. Firms belonging to a multi-plant organization were more capital intensive than stand-alone firms,+ reporting $51.4 thousand as compared to $37.5 thousand. Firms printing less on commission were more capital intensive than those printing more.

Those firms specializing in miscellaneous printed products were more capital intensive than either apparel or home furnishing printers. Firms using predominantly roller, rotary screen, or a mixture of equipment were almost twice as capital intensive as those firms using either flat-bed or heat transfer equipment. Firms using roller equipment and rotary screens reported capital intensity as $50-51 thousand.

The Pearson product moment correlation coefficient was used to investigate a possible relationship between size of establishment and capital intensity. For the responding 44 firms for which there were data, there was little explained variability (r^2 = .04) (Table J-1).

Summary of Relationships Among Independent Variables

Responding firms differed geographically with regard to type of organizational structure, commission status, size of establishment, equipment, and capital intensity. Firms in the Middle Atlantic states consistently differed from other regions. There, firms were smaller, almost all independently owned, printed less on commission, and printed more apparel with heat transfer equipment. New England and the southern plants were similar in product mix, size and equipment. However, southern firms were larger, belonged more to multi-plant corporations, and invested more in capital equipment in 1986.

There were regional differences with regard to commission status. More New England plants printed a larger percentage of their production on commission. However, several large southern plants also printed a large percentage of their production on commission. While the firms employing the most people were in the South and New England, the South also tied the Middle Atlantic region for the greatest number of smallest establishments.

The relationships among organizational structure and product end-use and printing equipment was unclear. Only in the Middle Atlantic region, where more firms were independently owned, was it clear that more apparel was printed. No pattern was identified for other regions.

Table I-4 in the appendix compares the independent variables with regard to size of printing establishments. The average size of the responding establishments was similar for all geographic regions except the Middle Atlantic states where firms were the smallest. Logically, the independent or stand-alone firms generally were smaller than those

firms belonging to a multi-plant corporation. However, this was not always the case, as several large firms were independently owned. Likewise, several firms owned by multi-plant corporations employed fewer than 100 people. The relationship between firm size and commission status was less clear. When the means for number of employees were compared, those firms printing less on commission were larger by only 10 employees.

Most firms printed some of their production on commission. Commission printing was not restricted to independently owned firms; more firms belonging to a multi-plant structure printed on commission. Nor was commission printing restricted to a particular product line, although the situation with regard to apparel was contradictory. A number of apparel firms printed 100% on commission. However, several apparel printers reported that they did no commission work. Commission printers tended to own either heat transfer or rotary screen equipment. Fewer flat-bed printers and roller printers reported printing a high percentage of their production on commission.

Firms in all geographic areas reported printing a high percentage of apparel fabrics in 1986, but the percentage was highest in the Middle Atlantic states. Plants in New England and the South were evenly divided between printed apparel and home furnishings fabric although the percentage of home furnishing fabrics printed in the South was comparatively smaller. Firms outside the three major geographic regions specialized in printing home furnishing fabrics.

The responding firms were identified as having: (1) flat-bed screens printing predominantly for home furnishing and miscellaneous

products; (2) rotary screens printing both apparel and home furnishing, although more respondents reported specializing in apparel in 1986; (3) heat transfer printing on apparel; (4) engraved roller printing more on apparel than other categories.

As expected, most firms printed the largest percentage of their yardage using rotary screen equipment. However, several reported that they printed a high percentage of their production using engraved roller equipment. Another finding was that flat-bed screen printing was used by as many respondents as heat transfer equipment. In addition, 15 out of 77 firms had such a diverse mix of equipment that no one type of equipment was identified. Flat-bed equipment was most popular for those firms employing 51-100 people. Roller equipment was used both by very large and very small firms. Heat transfer equipment was the most popular for smaller firms. Rotary screen equipment was used by plants of all sizes.

Table I-4 in the appendix is a matrix containing the independent variables. Possible relationships among the variables are noted. The levels of the categorical independent variables were reduced according to the distributions around the medians and logical breaks in the data.

Discussion

In the initial analysis for type of ownership or organization structure, multi-plant corporations were divided into two groups--those firms belonging to corporations owning other printing plants and those which did not. While it was suspected that there might be differences between those two groups, those differences were not apparent as noted

previously in the tables and discussion. Additionally, few firms were classified as multi-plant structures with other printing plants. The survey was not designed to match those firms together, and the questionnaire stressed responses for individual establishments. Consequently, only two types of organizational structures were compared: multi-plant firms and stand-alone firms.

Commission status was classified as either those firms printing 60% or more of their production on commission, or those firms printing less than 60%. The division at 60% represented the median and a convenient division with regard to the questionnaire wording.

The original five categories for product end-use were reduced to three: those firms printing at least 50% apparel; firms printing at least 50% home furnishings fabric; and 50% miscellaneous. A separate category for those firms printing miscellaneous end-products was retained because of the larger than expected number of firms falling into that category.

While it may be common knowledge that printing equipment and product end-use are related, determining the exact relationship for the purpose of this research was difficult. Some relationships were obvious because the equipment was more specialized with regard to end-product. However, most equipment such as rotary screens had multiple end-use products. Product end-use was retained as a variable because it was assumed that firms would clearly specialize in a particular product line having its own unique equipment and technology. That relationship may be more obvious than true.

With regard to the independent variables, it should be noted that one of the objectives of this study was to compare findings from individual firms with data available from government statistics on the printing industry. One of the findings was that printing industry data available in government publications was lacking except for very general information. As an example, government statistics as published in Current Industrial Reports gave only two classifications: printing firms were either commission printers or they were not. Survey results clearly indicate that almost all firms printed some yardage on commission, suggesting that commission status is not a discrete classification. How government publications define commission status is unclear.

In addition to the data limitations, the classifications of printed goods in government publications are lacking. Printers are classified as those printing either cotton broadwoven fabrics, man-made broadwoven fabrics, knits, or N.E.C. (not elsewhere classified). In this survey, the responding plants indicated that these categories were often combined within a plant making such a distinction by product line meaningless. The survey results indicated that firms print a mix of yardage with regard to fiber cotton (cotton and man-mades such as polyester and rayon), and sometimes print knits as well as wovens. Therefore, the classifications with regard to product end-use were unclear and could not be compared.

Another limitation of the government statistics was the classification of equipment as either roller and intaglio engraved or "other." According to the footnote in Current Industrial Reports,

"other" includes screen prints (hand or automatic). Since screen prints dominate production, this category contained production numbers two to three times larger than the roller category. Category terminology is outdated. Figures 1 and 2 in the appendix graphed general production information as given in Current Industrial Reports. However, the categories were insufficient in providing a clearer picture of industry production. Figure 2, for example, emphasizes the large amount of printed production which is classified as "other."

Dependent Variables

Previous literature discussed the relationship between profitability and productivity and generally confirmed that the two variables were not related. To check for the relationship, the Pearson product moment correlation was used. There was a small positive correlation between the two variables which was significant ($p < .0454$). However the amount of variability which could be explained was comparatively small ($r^2 = .11$) (Table J-1).

Profitability

Of the responding firms, those in New England reported the highest before tax return on stockholders' equity (ROI) of 11.45% per share. Firms located elsewhere were second with 9.30% per share followed by southern firms with 8.35%. Firms in the Middle Atlantic region reported the lowest ROI of 7.81%.

Multi-plant firms reported slightly higher profits than stand-alone firms: 9.02% per share as compared to 8.76%.

Firms printing 60% or more of their production on commission reported profits of almost 5% per share more than firms printing less than 60% of their production on commission. Commission firms averaged 11.26% per share as compared to 6.73%.

Apparel printers reported higher profits than those printing home furnishing fabrics--9.79% over 7.50%--but those firms printing miscellaneous products reported the highest ROI, 10.57% per share.

Printers specializing in roller equipment had the highest ROI of all, 11.95% per share. Rotary screen specialists were second with 9.20%. Printers using predominantly flat-bed equipment were third with 8.25% followed by firms with a diverse mixture of equipment (7.36%) and heat transfer printers (6.64%).

The means for profitability as measured by before tax profit on stockholders' equity for each independent variable are listed in the appendix (Table I-5). The mean, median, and the quartiles are compared in the box charts in Appendix K (Figures 3-8).

Productivity

Productivity was defined as value added per employee. Southern printers reported the highest value added of $9.38. Closely following were firms in New England and elsewhere which tied at $9.17. Firms in the Middle Atlantic states were lowest with $7.50.

Printers who belonged to multi-plant organizations reported the highest value added of $10.50. Stand-alone firms reported $8.36.

Firms printing less of their production on commission reported a value added of almost $3 more than those firms printing more on

commission. Value added for the predominantly commission-oriented firms was $7.98 as compared to $10.11 for those firms printing less on commission.

The highest figure for value added--$15.50--was reported by the few firms that specialized in miscellaneous printed products. This compared to $7.75 for apparel specialists and $8.89 for home furnishings.

The firms using flat-bed printers or a diverse mixture of equipment reported the highest productivity figures: $11.25 and $11.50. Rotary screen specialists reported a value added of $8.89 as compared to $7.50 for engraved roller printers. Printers whose production was dominated by heat transfer equipment averaged $5.83.

The productivity means as measured by value added per employee for each independent variable are in Table I-6 in the appendix. The distributions of the means for each independent variable are graphically show in Figures 9-14 in Appendix K.

Testing of the Hypotheses

Because size of firm had been identified in the literature as an important variable associated with the performance of the textile industry, the relationships between size and the two dependent variables were examined first using Pearson's product moment correlation (Table J-1). Size was included as one of the two independent variables as each of the subsequent hypotheses as tested using a two-way analysis of variance (ANOVA). The hypotheses are tested at the .05 level of significance.

The following hypotheses were tested:

HYPOTHESIS 1A: PROFITABILITY IS RELATED TO SIZE OF ESTABLISHMENT.

The hypothesis was rejected. For the responding firms, the correlation between firm size and profitability was not significant ($p > .2356$) (Table J-1).

HYPOTHESIS 1B: PRODUCTIVITY IS RELATED TO SIZE OF ESTABLISHMENT.

The hypothesis was accepted. There was a positive correlation between firm size and productivity that was significant ($p < .0446$) (Table J-1).

HYPOTHESIS 2A: PROFITABILITY IS RELATED TO GEOGRAPHIC LOCATION AND SIZE OF ESTABLISHMENT.

The hypothesis was rejected. There were no overall association between geographic location and profitability for the responding printing firms ($p > .653$) (Table J-2).

HYPOTHESIS 2B: PRODUCTIVITY IS RELATED TO GEOGRAPHIC LOCATION AND SIZE OF ESTABLISHMENT.

The hypothesis was rejected. There were no overall association between geographic location and productivity for the responding printing firms ($p > .7565$) (Table J-3).

HYPOTHESIS 3A: PROFITABILITY IS RELATED TO OWNERSHIP STRUCTURE AND SIZE OF ESTABLISHMENT.

The hypothesis was rejected. There were no overall association between type of ownership and profitability for the responding firms ($p > .4943$) (Table J-4).

HYPOTHESIS 3B: PRODUCTIVITY IS RELATED TO OWNERSHIP STRUCTURE AND SIZE OF ESTABLISHMENT.

The hypothesis was accepted. There was an overall association between type of ownership and productivity for the responding firms ($p < .0105$). While the differences in productivity attributed to type of ownership were not significant ($p > .0977$), differences attributed to size of firm were significant ($p < .0132$). There was a significant interaction affect for ownership type and size of firm ($p < .0087$) (Table J-5).

HYPOTHESIS 4A: PROFITABILITY IS RELATED TO COMMISSION STATUS AND SIZE OF ESTABLISHMENT.

The hypothesis was rejected. While there was an overall association between commission status and profitability ($p < .0406$), when the variability explained by size of firm was considered, the association was not significant ($p > .3210$) (Table J-6).

HYPOTHESIS 4B: PRODUCTIVITY IS RELATED TO COMMISSION STATUS AND SIZE OF ESTABLISHMENT.

The hypothesis was accepted. Overall, the productivity of the groups differed with regard to commission status ($p < .0176$). There were significant differences attributed to commission status ($p < .0285$)

and to size of firms ($p < .0479$). There was significant interaction between commission status and firm size ($p < .0179$) (Table J-7).

HYPOTHESIS 5A: PROFITABILITY IS RELATED TO PRODUCT LINE AND SIZE OF ESTABLISHMENT.

The hypothesis was rejected. There was no overall association between product line and profitability ($p > .1013$) (Table J-8).

HYPOTHESIS 5B: PRODUCTIVITY IS RELATED TO PRODUCT LINE AND SIZE OF ESTABLISHMENT.

The hypothesis was rejected. Initially, there was an overall difference in productivity for the firms with regard to printed product line ($p < .04$). However, when the differences due to firm size were considered, the differences were insignificant ($p > .3743$) (Table J-9).

HYPOTHESIS 6A: PROFITABILITY IS RELATED TO TYPE OF PRINTING TECHNOLOGY AND SIZE OF ESTABLISHMENT.

The hypothesis was rejected. There was no overall association between printing equipment used and profitability ($p > .7009$) (Table J-10).

HYPOTHESIS 6B: PRODUCTIVITY IS RELATED TO TYPE OF PRINTING TECHNOLOGY AND SIZE OF ESTABLISHMENT.

The hypothesis was rejected. There was no overall association between printing equipment used and productivity ($p > .3120$) (Table J-11).

HYPOTHESIS 7A: PROFITABILITY IS RELATED TO CAPITAL INTENSITY AND SIZE OF ESTABLISHMENT.

The hypothesis was rejected. There was no overall association between how capital intensive a printing firm was and its profitability ($p > .3972$) (Table J-12).

HYPOTHESIS 7B: PRODUCTIVITY IS RELATED TO CAPITAL INTENSITY AND SIZE OF ESTABLISHMENT.

The hypothesis was rejected. There was no overall association between how capital intensive a printing firm was and its productivity ($p > .1996$) (Table J-13).

Discussion of the Analyses

There was a positive correlation between the two dependent variables profitability and productivity. However, since the shared variance was .1095, the variables were considered separately as suggested by the literature.

The positive correlation between size of establishment and productivity is attributed to scale economies; the respondents who had larger printing plants reported higher productivity as measured by value added per employee.

Significant relationships between the structure variables and the dependent variables were determined for productivity and ownership structure, and productivity and commission status. Because productivity appeared to be jointly driven by commission status and organization structure with size as a linking factor, an additional analysis was run. A three-way ANOVA was performed to examine the relationships among the

three variables with regard to productivity. As a result of the analysis, commission status dropped out as a significant factor. For the respondents, whether or not to do commission printing was not as significant a factor in productivity as the type of ownership. While there were economies of scale in general, they are more important with regard to type of ownership than for commission status (Table J-14).

For profitability and the structure variables, no relationships were statistically established. Although a perusal of the descriptive means indicated differences in profitability for geographic locations and commission status, those differences were not significant. Those factors which were related to productivity, commission status and type of ownership, could not be linked to profitability. Since no relationships were established, it follows that geographic location, commission status, type of ownership, product line and printing technology were not factors in the profitability of the responding firms.

The large amount of commission work occurring in the industry suggests more interchange of goods among manufacturers than one might have anticipated. The traditional definition of a commission printer is one who does not take title to the goods printed. When asked how often a firm takes title to goods, there was no correlation to a firm's response to that question and the degree of commission printing done. It may be that the definition of commission work has different meaning or that financial arrangements among customers and suppliers are determined individually. The fact remains that larger multi-plant firms

which reported doing more commission printing may be attempting to utilize their excess capacity.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This study examined the structure and performance of the American textile printing industry in 1986. A self-administered questionnaire was mailed to the population of textile printers identified in Davison's Textile Blue Book. The response rate was 64.2%.

The independent variables were: geographic location; type of ownership structure; size of printing establishment; commission status; product line; printing technology; and capital intensity. Profitability and productivity were chosen as the dependent variables to measure industry performance. Data were analyzed using the Pearson product moment coefficient of correlation and two-way analysis of variance (ANOVA). The descriptive profile which emerged from the census data for the responding textile printing firms suggested an industry with small, independently owned plants. Structurally, those printing establishments either remained relatively small, independently owned firms or were part of a large, vertical corporation. Printing establishments in different geographic regions differed in unexpected ways. The responding New England firms, for example, were not using as much of the older printing technology, and they were as profitable as other areas. Nor were southern plants all vertically structured, newer, and highly capital intensive. In fact the New England respondents were more similar to southern firms than different. Firms in both regions were identical

with regard to capital intensity and size. However, even when the size of the firms was taken into consideration, there was no statistical relationship between capital intensity and either profitability or productivity for the respondents. Value added per employee for both regions was almost identical. An unexpected difference was profitability. When the percentage of before tax profit on stockholders' equity (ROI) was compared, New England firms reported higher profits than firms in the South of almost 3%. Although these relationships were not tested empirically, they are worth reporting.

Older technology was still important as evidenced by the fact that printing firms continued to use engraved roller technology. Technology appeared not to be a predictor of performance in all cases. For example, of the respondents, those few firms printing predominantly with rollers reported a higher return on investment than printers with other equipment. Those printing with rotary screens--by far the largest group--reported slightly lower profits. However, despite these descriptive observations, there was no statistical relationship between the type of printing equipment used and either profitability or productivity.

Descriptively, the responding plants were comparatively small; 42% of the responding firms reported that they employed fewer than 100 people. However empirical evidence points to economies of scale. There was a positive correlation between the size of the firm and productivity for the respondents. Value added per employee for large firms was $10.50 as compared to $7.24 for firms employing 100 or fewer people.

Two variables—commission status and type of ownership--were significant factors in firm productivity in the general analysis. The hypothesis that productivity was related to commission status was one of the hypotheses confirmed. Firms which reported printing less of their production on commission reported a higher value added per employee (Figure K-12). Productivity was related to type of ownership structure as well. Firms which were part of a multi-plant structure were more productive.

CONCLUSIONS

Along the tested dimensions, there were more similarities than differences among the responding textile printing firms. With regard to profitability, there were no significant differences which were attributed to geographic location, size of establishment, type of ownership, commission status, product line, printing technology, or capital intensity. Although individual differences were identified when percentage return on investment figures were compared for firms in different regions or under different types of ownership, the differences in profitability overall were not significant. The size of the firm was not a determinant of profitability for the respondents.

There was, however, a positive correlation between size of firm and productivity. Larger firms reported a higher value added per employee than smaller firms. The size of the firm and commission status were related jointly to firm productivity. Additionally, type of ownership and size were significant factors in productivity. When those factors were considered simultaneously, type of ownership was more important to

productivity than commission status. Specifically, printing firms which were owned by multi-plant corporations reported that they were more productive than stand-alone firms.

RECOMMENDATIONS

The description of the responding establishments is one of relatively small, independently-owned firms. However, the empirical evidence points to economies of scale. Consequently, it would be useful to consider the descriptive characteristics of the industry as it is likely to change in the future, given the results of this study. One characteristic of the industry is the lack of industry concentration. Future research should focus on how the structure of the industry will be rationalized by consolidation of firms.

The results of this study indicated that type of ownership was positively related to productivity for printing plants. Research to investigate further the type of organization structure which would best encourage economies of scale and productivity is warranted.

The amount of production done on a commission basis was another determinant of performance. Although in this study the effects of commission status were negated by the type of ownership structure, commission status is another related structural characteristic that should be more closely examined.

With regard to technological innovation, no relationship between equipment and performance could be determined. However, in the general analysis, type of printing technology was associated generally to

productivity (Table J-9). Individual differences did exist and would suggest further investigation.

A final observation related to the overall scope of the research emphasizes the scarcity of available firm level data about the textile industry. Therefore, the final recommendation encourages additional research efforts into specific industry segments.

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APPENDIX A

STANDARD INDUSTRIAL CLASSIFICATION (SIC) DEFINITIONS

Major Group 22.—TEXTILE MILL PRODUCTS

This major group includes establishments engaged in performing any of the following operations: (1) preparation of fiber and subsequent manufacturing of yarn, thread, braids, twine, and cordage; (2) manufacturing broad woven fabric, narrow woven fabric, knit fabric, and carpets and rugs from yarn; (3) dyeing and finishing fiber, yarn, fabric, and knit apparel; (4) coating, waterproofing, or otherwise treating fabric; (5) the integrated manufacture of knit apparel and other finished articles from yarn; and (6) the manufacture of felt goods, lace goods, nonwoven fabrics, and miscellaneous textiles.

This classification makes no distinction between the two types of organizations which operate in the textile industry: (1) the "integrated" mill which purchases materials, produces textiles and related articles within the establishment, and sells the finished products; and (2) the "contact" or "commission" mill which processes materials owned by others. Converters or other nonmanufacturing establishments which assign materials to contract mills for processing (other than knitting) are classified in nonmanufacturing industries; establishments which assign yarns to outside contractors or commission knitters for the production of knit products are classified in Group 225.

Group No. 226 DYEING AND FINISHING TEXTILES, EXCEPT WOOL FABRICS AND KNIT GOODS

Industry No.

2261 Finishers of Broad Woven Fabrics of Cotton

Establishments primarily engaged in finishing purchased cotton broad woven fabrics, or finishing such fabrics on a commission basis. These finishing operations include bleaching, dyeing, printing (roller, screen, flock, plisse), and other mechanical finishing such as preshrinking, calendering and napping. This industry also includes the shrinking and sponging of cloth for the trade, and chemical finishing for water repellency, fire resistance, and mildew proofing. Establishments primarily engaged in finishing wool broad woven fabrics are classified in Industry 2231; knit goods in Group 225; and those coating or impregnating fabrics in Industry 2295.

Bleaching cotton broad woven fabrics

Bleaching, kier: continuous machine

Calendering of cotton fabrics

Dyeing cotton broad woven fabrics

Embossing cotton broad woven fabrics

Finishing of cotton broad woven fabrics

Fire-resistance finishing of cotton broad woven fabrics

Mercerizing cotton broad woven fabrics

Mildew proofing cotton broad woven fabrics

Napping of cotton broad woven fabrics

Preshrinking cotton fabrics, for the trade

Printing and finishing of cotton broad woven fabrics

Refinishing and sponging cotton broad woven fabrics, for the trade

Shrinking cotton cloth, for the trade

Sponging and refinishing cotton cloth, for the trade

Sueding cotton broad woven goods

Teaseling cotton broad woven goods

Water repellency finishing of cotton broad woven fabrics

2262 Finishers of Broad Woven Fabrics of Man-Made Fiber and Silk

Establishments primarily engaged in finishing purchased man-made fiber and silk broad woven fabrics or finishing such fabrics on a commission basis. These finishing operations include bleaching, dyeing, printing (roller, screen, flock, plisse), and other mechanical finishing such as preshrinking, calendering, and napping. Establishments primarily engaged in finishing wool broad woven fabrics are classified in Industry 2231; knit goods in Group 225; and those coating or impregnating fabrics in Industry 2295.

Bleaching man-made fiber and silk broad woven fabrics

Calendering of man-made fiber and silk broad woven fabrics

Dyeing man-made fiber and silk broad woven fabrics

Embossing man-made fiber and silk broad woven fabrics

Finishing of man-made fiber and silk broad woven fabrics

Fire resistance finishing of man-made fiber and silk broad woven fabrics

Napping of man-made fiber and silk broad woven fabrics

Preshrinking man-made fiber and silk broad woven fabrics, for the trade

Printing man-made fiber and silk broad woven fabrics

Shrinking man-made fiber and silk cloth, the the trade

Silk broad woven fabric finishing

Sueding man-made fiber and silk broad woven fabrics

Teaseling man-made fiber and silk broad woven fabrics

2269 Finishers of Textiles, Not Elsewhere Classified

Establishments primarily engaged in dyeing and finishing textiles, not elsewhere classified, such as bleaching, dyeing, printing and finishing of raw stock, yarn, braided goods, and narrow fabrics, except wool and knit fabrics. These establishments perform finishing operations on purchased textiles or on a commission basis.

Bleaching raw stock, yarn, and narrow fabrics: except knit and wool

Braided goods except wool: bleaching, dyeing, printing and other finishing

Cloth mending, except wool: for the trade

Dyeing raw stock, yarn, and narrow fabrics: except knit and wool

Embossing linen broad woven fabrics

Finishing raw stock, yarn, and narrow fabrics: except knit and wool

Gassing yarn

Labels, cotton: printed

Linen fabrics: dyeing, finishing, and printing

Mercerizing yarn, braided goods, and narrow fabrics: except knit and wool

Mill enders, contract: cotton, silk, and man-made fiber

Printing narrow fabrics: except knit and wool

(Source: 1972 Standard Industrial Classification Manual)

APPENDIX B

LIST OF INDIVIDUAL TEXTILE PRODUCTS BY PRODUCT CLASSES

22611 FINISHING COTTON WOVEN FABRICS
- Bleached and white finished
- Plain dyed and finished
- Printed and finished

22612 FINISHING SYNTHETIC AND SILK WOVEN FABRICS
- Bleached and white finished
- Plain dyed and finished
- Printed and finished

22613 FINISHING YARNS AND RAW STOCK, EXC. WOOL
- Bleached yarn and raw stock
- Dyed yarns and raw stock
- Mercerized yarns

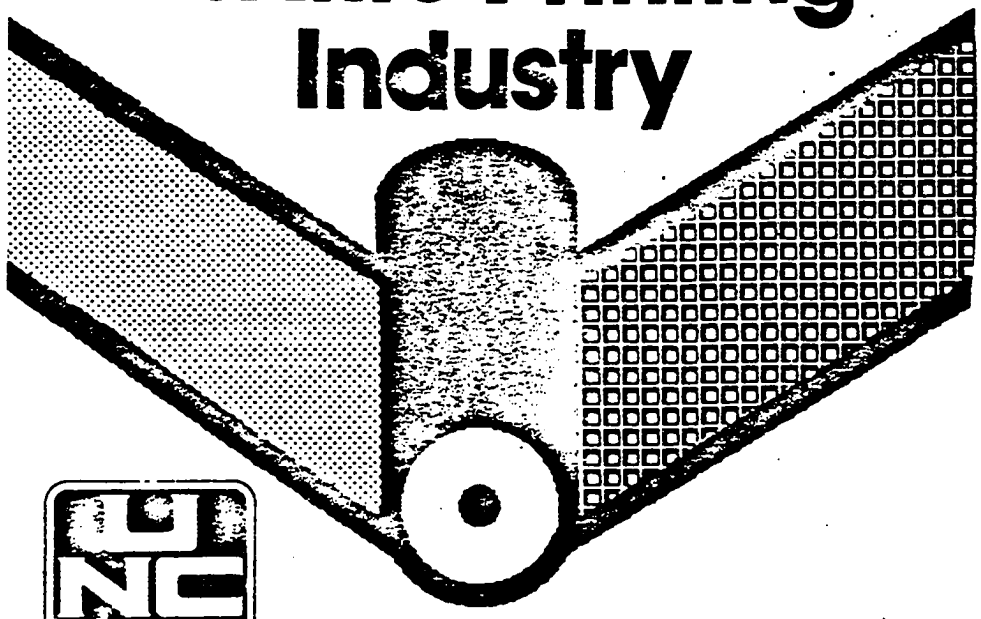
22614 OTHER FINISHED FABRICS
- Embossed
- Flameproofed
- Mercerized
- Mildewproofed
- Sueded

(Source: Annual Survey of Manufacturers, 1956.)

APPENDIX C

INSTRUMENT

The American Textile Printing Industry



Department of Clothing and Textiles
THE UNIVERSITY OF NORTH CAROLINA
AT GREENSBORO

Department of Textile Management and Technology
School of Textiles
North Carolina State University

Instructions: Most questions can be answered quickly by checking off the category which best describes your plant. The first section is about your plant and will be used to develop a more accurate profile of printing plants today. Please answer all questions. If you wish to comment on any question or qualify your answer, please feel free to use margins. Thank you for your help.

1. On the map please put an "X" on the state where your plant is located.

2. How long has your plant been at its present location?
   ___ SINCE 1975
   ___ SINCE 1960
   ___ SINCE 1945
   ___ SINCE 1930
   ___ SINCE 1915
   ___ PRIOR TO 1915

3. Which best describes your plant's location?
   ___ METROPOLITAN AREA POPULATION OVER 250,000
   ___ LARGE CITY POPULATION 100,000 - 249,999
   ___ CITY POPULATION 50,000 - 99,999
   ___ CITY POPULATION 10,000 - 49,999
   ___ SMALL TOWN POPULATION UNDER 9,999

4. Which methods of transportation are used to ship in and out? (Check <u>all</u> that apply.)
   ___ COASTLINE
   ___ RIVER
   ___ RAILROAD
   ___ AIRPORT
   ___ HIGHWAY

5. How would your plant's history best be described? (Check all that apply.)
   ___ RELOCATED FROM NEW ENGLAND BY PRESENT OWNER
   ___ RELOCATED FROM NEW ENGLAND BY PREVIOUS OWNER
   ___ ESTABLISHED AT PRESENT LOCATION BY PRESENT OWNER
   ___ ESTABLISHED AT PRESENT LOCATION BY PREVIOUS OWNER
   ___ ACQUIRED THROUGH A BUY-OUT

6. Has your plant always done printing?
   ___ YES
   ___ NO If NO, what was plant originally? _____

7. How would you best describe your plant's type of ownership?
   ___ INDIVIDUAL PROPRIETORSHIP
   ___ INDIVIDUAL CORPORATION WITH SEVERAL PLANTS INCLUDING OTHER PRINTING FACILITIES
   ___ INDIVIDUAL CORPORATION WITH SEVERAL PLANTS WITH NO OTHER PRINTING FACILITIES
   ___ FAMILY OWNED BUSINESS
   ___ OTHER (Please specify.) _____

8. To the best of your knowledge, has your company owned other printing plants in the past?
   ___ YES If YES, how long ago? _____
   ___ NO

9. What percentage of your printed goods are purchased by a company owned by your corporation? _____%

10. On the last government census, how was your plant classified? (Check all that apply.)
    ___ INDUSTRY 2261 FINISHING PLANTS, COTTON
    ___ INDUSTRY 2262 FINISHING PLANTS, SYNTHETICS
    ___ INDUSTRY 2269 FINISHING PLANTS, NOT ELSEWHERE CLASSIFIED
    ___ OTHER (Please specify.) _____

11. What percentage of your total corporate production (by value) was printed goods in 1986?
    ___ LESS THAN 20%
    ___ 20 - 39%
    ___ 40 - 59%
    ___ 60 - 79%
    ___ 80 - 99%
    ___ 100%

12. Of your total corporate printed production alluded to in question 11 above, what percent did your plant contribute?
    ___ LESS THAN 20%
    ___ 20 - 39%
    ___ 40 - 59%
    ___ 60 - 79%
    ___ 80 - 99%
    ___ 100%

13. What percent of your total plant output in 1986 was commission printing?
    ___ NONE
    ___ LESS THAN 20%
    ___ 20 - 39%
    ___ 40 - 59%
    ___ 60 - 79%
    ___ 80 - 99%
    ___ 100%

14. Ten years ago, what percent of your total plant output was commission printing?
    ___ NONE
    ___ LESS THAN 20%
    ___ 20 - 39%
    ___ 40 - 59%
    ___ 60 - 79%
    ___ 80 - 99%
    ___ 100%

15. Approximately what was the total number of employees at your plant in 1986?
    ___ FEWER THAN 20 EMPLOYEES
    ___ 21 - 50 EMPLOYEES
    ___ 51 - 100 EMPLOYEES
    ___ 101 - 200 EMPLOYEES
    ___ 201 - 500 EMPLOYEES
    ___ OVER 500 EMPLOYEES

16. Of this number, approximately what percentage were production workers?
    ___ FEWER THAN 50%
    ___ 50 - 69%
    ___ 70 - 79%
    ___ 80 - 89%
    ___ MORE THAN 90%

17. Which unions are represented in your plant? (Check all that apply.)
    ___ MACHINE PRINTERS ASSOCIATION
    ___ ACTWU
    ___ OTHER (Please list.) _____

18. Check all the organizations you and your firm belong to.
    ___ AATCC
    ___ ASQC
    ___ ASTM
    ___ ATMA
    ___ ATMI
    ___ OTHER (Please list.) _____

Next, we would like to ask you about your firm's printing equipment in 1986. Check all that apply and estimate number of machines.

19. What types of printing equipment did you have in place.

___ ENGRAVED ROLLER PRINTERS HOW MANY? _____
___ ROTARY SCREEN PRINTERS HOW MANY? _____
___ HEAT TRANSFER PRINTERS HOW MANY? _____
___ FLATBED SCREEN PRINTERS HOW MANY? _____
___ OTHER (Please list.) _____ HOW MANY? _____
_____

20. Of this equipment, what did you operate in 1986?

___ ENGRAVED ROLLER PRINTERS HOW MANY? _____
___ ROTARY SCREEN PRINTERS HOW MANY? _____
___ HEAT TRANSFER PRINTERS HOW MANY? _____
___ FLATBED SCREEN PRINTERS HOW MANY? _____
___ OTHER (Please list.) _____ HOW MANY? _____
_____

21. What types of preparation and finishing equipment did you have in place?

___ WASHERS HOW MANY? _____
___ DRYER-CANS HOW MANY? _____
___ CALENDERS HOW MANY? _____
___ SANFORIZERS HOW MANY? _____
___ COMPUTERIZED COLOR MIXING SYSTEM HOW MANY? _____
___ ROTARY SCREEN ENGRAVING SYSTEM HOW MANY? _____
___ SAURESSIG MACHINES HOW MANY? _____
___ CONTINUOUS DYE RANGE HOW MANY? _____
___ PAD DYEING HOW MANY? _____
___ OTHERS (Please list.) _____ HOW MANY? _____
_____

22. Of this equipment, what did you operate in 1986?

___ WASHERS HOW MANY? _____
___ DRYER-CANS HOW MANY? _____
___ CALENDERS HOW MANY? _____
___ SANFORIZERS HOW MANY? _____
___ COMPUTERIZED COLOR MIXING SYSTEM HOW MANY? _____
___ ROTARY SCREEN ENGRAVING SYSTEM HOW MANY? _____
___ SAURESSIG MACHINES HOW MANY? _____
___ CONTINUOUS DYE RANGE HOW MANY? _____
___ PAD DYEING HOW MANY? _____
___ OTHERS (Please list.) _____ HOW MANY? _____
_____

23. Do you do any hand printing?

___ NO
___ YES If YES, with what equipment? _____

24. What percentage of your 1986 printed goods was printed with each type of equipment? (Write in percent.)

_____% ENGRAVED ROLLER PRINTING
_____% FLATBED SCREEN PRINTING
_____% ROTARY SCREEN PRINTING
_____% HEAT TRANSFER PRINTING
_____% OTHER (Please list.) _____
(TOTAL = 100%)

25. What printing methods did you use in 1986?

_____% PIGMENT PRINTING
_____% DISCHARGE OR RESIST PRINTING
_____% OTHER (Please list.) _____
(TOTAL = 100%)

26. What percent of your printing is done with foam technology? _____%

27. Which category most likely applies to the typical number of colors you run in a design?

___ 1 - 2
___ 3 - 4
___ 5 - 7
___ 8 - 12
___ 13 - 15
___ MORE THAN 16

28. Which of the production run sizes below is most popular in your plant?

___ LESS THAN 500 LINEAR YARDS
___ 500 - 999 LINEAR YARDS
___ 1,000 - 1,999 LINEAR YARDS
___ 2,000 - 2,999 LINEAR YARDS
___ 3,000 - 4,000 LINEAR YARDS
___ OVER 4,000 LINEAR YARDS

The following questions ask you about your product lines.

29. Which different fabric constructions did you print in 1986?

_____% WOVEN FABRICS
_____% NONWOVENS
_____% KNITS
_____% CARPETS
_____% OTHER (Please specify.) _____
(TOTAL = 100%)

30. What was the product mix of your prints in 1986?

_____% APPAREL FABRIC
_____% HOME FURNISHING FABRIC
_____% CARPET
_____% OTHER (Please specify.) _____
(TOTAL = 100%)

31. Which type of customer buys your prints?
_____% MASS MERCHANDISER
_____% SPECIALTY HOUSE
_____% FOREIGN MANUFACTURER
_____% MERCHANT CONVERTER
_____% OTHER (Please describe.) _____
(TOTAL = 100%)

32. How would you best characterize the fiber content of your greige goods in 1986? (Check one.)
___ 100% COTTON
___ 100% MAN-MADE
___ MORE COTTON THAN MAN-MADE
___ MORE MAN-MADE THAN COTTON
___ OTHER (Please specify.) _____

33. What is the source of your greige goods? (Estimate the percentage.)
_____% COMPANY OWNED MILLS
_____% OUTSIDE DOMESTIC MILLS
_____% OUTSIDE FOREIGN MILLS
(TOTAL = 100%)

34. Where do your printed designs originate?
_____% PLANT ARCHIVES
_____% IN-HOUSE DESIGNER/STYLIST
_____% DESIGNER/STYLIST EMPLOYED BY ANOTHER DIVISION
_____% FREELANCE DESIGNER/STYLIST
_____% CONVERTER OR AGENT
_____% OTHER (Please explain.) _____
(TOTAL = 100%) _____

35. Does your plant hold title to the greige goods which you print?
___ ALWAYS
___ USUALLY
___ SELDOM
___ NEVER

36. With how many domestic firms do you estimate your firm competes directly?
___ NO ONE
___ 1 - 2
___ 3 - 5
___ 6 - 10
___ MORE THAN 10

We are interested in your personal observations about the condition of the printing industry.

1. Please rate the financial health of the printing industry as compared to all other segments of the textile industry in general with regard to profitability and before-tax profit on stockholders' equity.

   ___ WAY ABOVE AVERAGE
   ___ ABOVE AVERAGE
   ___ AVERAGE
   ___ BELOW AVERAGE
   ___ WAY BELOW AVERAGE

Below are some factors which have influenced the textile industry in general. Circle the appropriate number which indicates how critical you feel the factor has been for the printing industry. The higher the number, the more important the factor.

1 = Not Important **3 = Moderately Important**
2 = Somewhat Important **4 = Very Important**
5 = Critically Important

		Not Important		Moderately Important		Critically Important
2.	COMPETITION FROM PRINTED IMPORTS	1	2	3	4	5
3.	RAPIDLY CHANGING TECHNOLOGY	1	2	3	4	5
4.	CONSUMER BUYING HABITS	1	2	3	4	5
5.	INCREASED COMPETITION FROM OTHER DOMESTIC PRINTING PLANTS	1	2	3	4	5
6.	GOVERNMENT REGULATIONS (EPA, OSHA)	1	2	3	4	5
7.	INFLATION	1	2	3	4	5
8.	GOVERNMENT TAX STRUCTURE	1	2	3	4	5
9.	LACK OF GOVERNMENT SUBSIDIES	1	2	3	4	5
10.	LACK OF ORGANIZATION WITHIN THE PRINTING INDUSTRY	1	2	3	4	5
11.	INABILITY OF SMALL PLANTS TO COMPETE WITH LARGER ONES	1	2	3	4	5
12.	TAX STRUCTURE WHICH FAVORS SMALLER FIRMS	1	2	3	4	5
13.	TAX STRUCTURE WHICH FAVORS LARGER FIRMS	1	2	3	4	5
14.	LACK OF MARKETING ORIENTATION IN PRINTING FIRMS	1	2	3	4	5
15.	INDUSTRY STRUCTURE	1	2	3	4	5
16.	LACK OF DESIGN INNOVATION IN AMERICA	1	2	3	4	5
17.	TECHNOLOGICAL NATURE OF BUSINESS	1	2	3	4	5
18.	FOREIGN MACHINERY MANUFACTURERS	1	2	3	4	5
19.	CUT THROAT COMPETITION	1	2	3	4	5
20.	RESEARCH AND DEVELOPMENT	1	2	3	4	5
21.	QUALITY IMPROVEMENT PROGRAMS	1	2	3	4	5
22.	DOMESTIC OVERCAPACITY	1	2	3	4	5
23.	INSTABILITY OF RAW MATERIAL SOURCES	1	2	3	4	5

For each area listed, circle the symbol which you feel best predicts what your plant realistically will be emphasizing in the 1990s.

—	Large Decrease/De-emphasis	+	Moderate Increase/Emphasis
-	Moderate Decrease/De-emphasis	++	Large Increase/Emphasis
0	No Change from Present/Status Quo		

		Decrease/De-emphasis		No Change		Increase/Emphasis
1.	ENGRAVED ROLLER PRINTING	--	-	0	+	++
2.	ROTARY SCREEN PRINTING	--	-	0	+	++
3.	HEAT TRANSFER PRINTING	--	-	0	+	++
4.	COMPUTERIZED COLOR MIXING	--	-	0	+	++
5.	FOAM PRINTING	--	-	0	+	++
6.	CREATING A GREATER VARIETY OF PRINTED APPAREL FABRIC	--	-	0	+	++
7.	CREATING A GREATER VARIETY OF PRINTED HOME FURNISHINGS FABRIC	--	-	0	+	++
8.	UNCOVERING NEW PRODUCTS	--	-	0	+	++
9.	TOTAL PRINTED YARDAGE	--	-	0	+	++
10.	OPTIMIZING YARDAGE PRINTED PER RUN	--	-	0	+	++
11.	OPTIMIZING NUMBER OF COLORS PER RUN	--	-	0	+	++
12.	AMOUNT OF IMPORTED GREIGE GOODS	--	-	0	+	++
13.	EXPORT INVOLVEMENT	--	-	0	+	++
14.	REDUCING NUMBER OF EMPLOYEES	--	-	0	+	++
15.	COMMISSION PRINTING	--	-	0	+	++
16.	PERCENTAGE OF SECONDS	--	-	0	+	++
17.	NUMBER OF PRODUCT LINES	--	-	0	+	++
18.	AMOUNT OF YEARLY CAPITAL INVESTMENTS	--	-	0	+	++
19.	MARKETING ORIENTATION	--	-	0	+	++
20.	EMPHASIS ON QUALITY	--	-	0	+	++
21.	PROFITABILITY	--	-	0	+	++
22.	PLANT SALES	--	-	0	+	++
23.	OPTIMIZING DESIGN QUALITY	--	-	0	+	++
24.	RESTRUCTURING SALES FORCE	--	-	0	+	++
25.	RESTRUCTURING DISTRIBUTION SYSTEM	--	-	0	+	++
26.	INVOLVEMENT WITH GROUPS SUCH AS TALC/FASLINC	--	-	0	+	++
27.	INVENTORY REDUCTION	--	-	0	+	++
28.	POLITICAL LOBBYING	--	-	0	+	++
29.	IMPLEMENTING TOXIC SUBSTANCE CONTROL ACT	--	-	0	+	++
30.	IMPLEMENTING EPA REGULATIONS	--	-	0	+	++

Circle the appropriate number indicating your agreement with each of the following statements. The higher the number, the more you agree.

1 strongly disagree with the statement.
2 I generally disagree with the statement.
3 I moderately agree with the statement.
4 I generally agree with the statement.
5 I strongly agree with the statement.

		strongly disagree		moderately agree		strongly agree
1.	THE COMPETITIVE PROBLEMS FACING THE **PRINTING INDUSTRY** ARE MORE DIFFICULT TO SOLVE THAN FOR THE TEXTILE INDUSTRY IN GENERAL.	1	2	3	4	5
2.	THE COMPETITIVE POSITION OF THE AMERICAN TEXTILE PRINTING INDUSTRY IS ERODING VERSUS FOREIGN COMPETITION.	1	2	3	4	5
3.	THE DOMESTIC TEXTILE PRINTING INDUSTRY WILL NOT SURVIVE FOR MORE THAN 20 YEARS WITHOUT GOVERNMENT SUPPORT.	1	2	3	4	5
4.	THE PRINTING INDUSTRY SUFFERS FROM THE STIGMA THAT AMERICAN PRINTS AREN'T FASHIONABLE AND CREATIVE.	1	2	3	4	5
5.	THE LARGE VOLUME OF PRODUCTION REQUIRED FOR PRINTING FIRMS TO BE PROFITABLE CURRENTLY CREATES A COMPETITIVE DISADVANTAGE FOR MY FIRM IN THE MARKETPLACE.	1	2	3	4	5
6.	MY PRINTING FIRM IS INTERESTED IN THE MASS MARKETS.	1	2	3	4	5
7.	THE MOST BEAUTIFUL PRINTS COME FROM OVERSEAS.	1	2	3	4	5
8.	THE PURCHASE PRICE OF NEW PRINTING TECHNOLOGY IS TOO HIGH FOR MY PLANT.	1	2	3	4	5
9.	THE AMERICAN PRINTING INDUSTRY HAS MADE PROGRESS IN GLOBAL COMPETITIVENESS OVER THE PAST 10 YEARS.	1	2	3	4	5
10.	U.S. CONSUMERS ARE MORE SENSITIVE TO THE PRICE OF QUALITY PRINTED GOODS THAN THEY WERE 10 YEARS AGO.	1	2	3	4	5
11.	PRINTED PATTERNS ARE SO SUBJECT TO FASHION THAT MY FIRM FINDS DIFFICULTY IN PLANNING.	1	2	3	4	5
12.	50% OF ALL PRINTING PLANTS WILL BE FORCED TO CLOSE BY A.D. 2000.	1	2	3	4	5
13.	VERTICAL INTEGRATION HAS PRODUCED POSITIVE FINANCIAL EFFECTS FOR THE PRINTING INDUSTRY.	1	2	3	4	5
14.	THE QUALITY OF MY FIRM'S PRINTS MUST IMPROVE TO BE COMPETITIVE.	1	2	3	4	5
15.	ONLY SMALL SPECIALIZED PRINTING FIRMS CAN BE PROFITABLE.	1	2	3	4	5

There has been a lot of talk about quality improvement programs over the past few years. The next questions ask about your plant's activities in the area of quality improvement.

37. Check **all** the programs that your plant has been **actively** involved with in 1986.
    ___ QUALITY CIRCLES
    ___ QUALITY IMPROVEMENT PROGRAMS (SUCH AS PHILIP CROSBY)
    ___ STATISTICAL PROCESS QUALITY CONTROL
    ___ QUALITY ASSURANCE OR JIT PROGRAMS WITH CUSTOMERS
    ___ OTHER (Please specify.) _____

38. By 1990, which of these programs do you predict your plant will become **significantly more involved** with? (Check all that apply.)
    ___ NONE
    ___ QUALITY CIRCLES
    ___ QUALITY IMPROVEMENT PROGRAMS (SUCH AS PHILIP CROSBY)
    ___ STATISTICAL PROCESS QUALITY CONTROL
    ___ QUALITY ASSURANCE OR JIT PROGRAMS WITH CUSTOMERS
    ___ OTHER (Please specify.) _____

39. With regard to printing seconds, check the approximate percentage of seconds you printed in 1986.
    ___ FEWER THAN 5% SECONDS
    ___ 5 - 7% SECONDS
    ___ 8 - 10% SECONDS
    ___ 11 - 15% SECONDS
    ___ MORE THAN 15% SECONDS

The following questions ask about your plant's performance in 1986. Please check the categories which are closest to your plant's situation. Remember that individual firms cannot be identified. This general information about your firm is critical for our analyses.

1. Approximately how many linear yards of greige goods did your plant print in total in 1986?
    ___ LESS THAN 100,000 THOUSAND
    ___ 100,000 - 499,999 THOUSAND
    ___ 500,000 - 999,999 THOUSAND
    ___ 1 - 9 MILLION
    ___ 10 - 24 MILLION
    ___ 25 - 49 MILLION
    ___ 50 - 74 MILLION
    ___ 75 - 100 MILLION
    ___ MORE THAN 100 MILLION

2. For 1986 what was the approximate total value of product shipments exclusive of transportation costs?
    ___ LESS THAN $250,000
    ___ $ 250,000 - $ 499,999
    ___ $ 500,000 - $ 999,999
    ___ $ 1 - $ 4.9 MILLION
    ___ $ 5 - $ 9.9 MILLION
    ___ $ 10 - $ 20 MILLION
    ___ OVER $ 20 MILLION

3. For 1986 what was the approximate figure for capital expenditures for new machinery and equipment?

___ LESS THAN $ 500,000
___ $ 500,000 - $ 999,999
___ $ 1 - 1.9 MILLION
___ $ 2 - 2.9 MILLION
___ $ 3 - 3.9 MILLION
___ $ 4 - 4.9 MILLION
___ OVER $ 5 MILLION

4. What does your firm estimate to be the average value added per production worker hour?

___ LESS THAN $ 5.00
___ $ 5.00 - $ 9.99
___ $ 10.00 - $ 14.99
___ $ 15.00 - $ 20.00
___ MORE THAN $20.00

5. What does your firm estimate to be the average value added by manufacture per employee?

___ LESS THAN $ 5.00
___ $ 5.00 - $ 9.99
___ $ 10.00 - $ 14.99
___ $ 15.00 - $ 19.99
___ $ 20.00 - $ 25.00
___ MORE THAN $25.00

6. What is the average wage per hour for your production workers?

___ $ 4.50 - $ 4.99
___ $ 5.00 - $ 5.49
___ $ 5.50 - $ 5.99
___ $ 6.00 - $ 6.49
___ $ 6.50 - $ 6.99
___ $ 7.00 - $ 7.49
___ $ 7.50 - $ 8.00
___ OVER $ 8.00

7. What is the average wage per hour for **all** your employees?

___ LESS THAN $ 6.00
___ $ 6.00 - $ 6.49
___ $ 6.50 - $ 6.99
___ $ 7.00 - $ 7.49
___ $ 7.50 - $ 7.99
___ $ 8.00 - $ 8.49
___ $ 8.50 - $ 8.99
___ $ 9.00 - $ 9.49
___ $ 9.50 - $10.00
___ OVER $ 10.00

8. Appoximately what did you estimate to be your plant's gross value of fixed assets to be in 1986? _____

9. What is the average number of hours per week your plant is in printing production?

___ LESS THAN 20
___ 20 - 39
___ 40 - 59
___ 60 - 79
___ 80 - 100
___ OVER 100

10. What is the average selling price per yard of your typical printing run?

___ LESS THAN 50¢
___ $ .50 - $ .99
___ $ 1.00 - $ 1.99
___ $ 2.00 - $ 2.99
___ $ 3.00 - $ 3.99
___ $ 4.00 - $ 5.00
___ OVER $ 5.00

11. How would you describe your plant's financial health at the present time?

___ TOP 10% OF ALL DOMESTIC PRINTING PLANTS
___ TOP 25% OF ALL DOMESTIC PRINTING PLANTS
___ TOP 50% OF ALL DOMESTIC PRINTING PLANTS
___ BOTTOM HALF OF ALL DOMESTIC PRINTING PLANTS

12. Approximately what was your plant's before tax profit on stockholders' equity in 1986?

___ LESS THAN 1.0 %
___ 1.0 - 1.9 %
___ 2.0 - 2.9 %
___ 3.0 - 4.9 %
___ 5.0 - 9.9 %
___ 10.0 - 14.9 %
___ 15.0 - 20.0 %
___ MORE THAN 20.0 %

Thank you for completing this study.

Mail the postcard requesting a copy of the results separately. Your name immediately will be removed from our mailing list and only nonrespondents will be contacted again. In case the stamped return envelope for returning the booklet has become separated, the booklet should be returned to:

Department of Textile Management & Technology
Box 8301
NCSU School of Textiles
Raleigh, NC 27695-8301

ATTN: Dr. Gordon Berkstresser

Thank you again for your time and cooperation.

Additional comments and suggestions:

APPENDIX D

PRENOTIFICATION LETTER

North Carolina State University
School of Textiles

Department of Textile Management and Technology
Box 8301, Raleigh, NC 27695-8301
Tel (919) 737-3442

October 21, 1987

NAME, TITLE
COMPANY
STREET ADDRESS
PO BOX
CITY, STATE, ZIP CODE

SALUTATION:

As you know, American textile printing has changed dramatically over the past ten years. While the American textile industry in general has been the subject of many articles and studies, there has been no published comprehensive research about the printing industry. Printers face unique problems. We would like to document those concerns and investigate implications for future competition.

As a key decision-maker in your printing operation, you will be receiving a survey from the North Carolina State University School of Textiles and the University of North Carolina at Greensboro within the next seven to ten days. Industry leaders who have previewed the survey feel that the results will generate significant insight into the present and future competitive issues specific to the printing industry.

If you decide to participate, you and your firm will share in the results by receiving a copy of the findings. We can assure you that the study is carefully designed so that individual firms cannot be identified. The survey can be completed in approximately 15 minutes. We feel that the president of your company should receive a copy of the results.

Dr. Gordon Berkstresser from NCSU and Dr. Nicholas Williamson from UNCG--both consultants for the recently published textile industry study from the U.S. Office of Technology Assessment--are working with me on this study. Ms. Joyce Storey and the AATCC Printing Technology Committee also have expressed interest in this project. If you have questions or concerns in advance of receiving the survey, please feel free to contact Dr. Williamson at (919)334-5691, Dr. Berkstresser at (919)737-3442 or me at (919)379-6187.

Sincerely,

Jill Y. Amidon
Graduate Researcher
University of North Carolina
at Greensboro

APPENDIX E

FIRST MAILING COVER LETTER AND POSTCARD

North Carolina State University
School of Textiles

Department of Textile Management and Technology
Box 8301, Raleigh, NC 27695-8301
Tel (919) 737-3442

October 27, 1987

NAME, TITLE
COMPANY
STREET ADDRESS
PO BOX
CITY, STATE ZIP CODE

SALUTATION:

Recently the American textile industry has been the subject of many articles and studies. Most of these analyze the industry in general but do not accurately reflect what is happening to the specialized but important industry segment of printing. We suspect that textile printers face unique problems. We want to document those problems and concerns and investigate the implications for the future. Unlike surveys you may have filled out for your suppliers in the past, this is strictly academic research. You and your plant will share in the results by receiving a copy of the study. Dr. Gordon Berkstresser from NCSU and Dr. Nicholas Williamson from UNCG--both consultants for the recently published textile industry study done by the U.S. Office of Technology Assessment--are working with me. Ms. Joyce Storey and the AATCC Printing Technology Committee also have expressed interest in this project.

The enclosed survey asks about your plant and your opinions. It can be completed in less than 15 minutes. A few of the questions ask about your plant's general financial situation. (No useful analysis can be made without some indication of your plant's performance.) We know that this information must remain confidential so we are not asking for exact figures.

The study is carefully designed so that individual firms cannot be identified. There are no identification numbers or invisible ink. Although I have become employed by Cone Mills since the research began, I will not know who has returned the booklet or the postcard because they are to be returned directly to Dr. Berkstresser at NCSU. The return postcard ensures that your name will be removed from a follow-up list. Return only the booklet to Dr. Berkstresser in the postage free envelope.

I realize your time is at a premium, but the success of this important study will depend on your response. Please return the completed survey by November 6. If you wish to receive a copy of the study, please indicate this on the postcard. The results will be mailed to you within the next few months. If you have any questions, please contact Dr. Berkstresser at (919) 737-3442. Thank you very much.

Sincerely,

Jill Y. Amidon
UNCG Graduate Researcher

PLEASE SEND A COPY OF THE PRINTING INDUSTRY STUDY
RESULTS TO:

(MAKE ANY NECESSARY CORRECTIONS IN THE ABOVE ADDRESS)

REMOVE MY NAME FROM THE FOLLOW-UP LIST.

APPENDIX F

POSTCARD REMINDER

November 13, 1987

Over a week ago you received a questionnaire from NCSU and UNCG asking about your printing operation and your opinions about future directions of the American textile printing industry. The responses will be used to profile the current printing industry and examine the implications for its future competitive position.

If you have already completed and returned the questionnaire, please accept our sincere thanks. If not, please take about 15 minutes and complete it today. Because the number of printing plants is relatively small, it is extremely important that your firm be included to make this a comprehensive study. If you have not received it, please call me immediately to have one sent to you.

Jill Y. Amidon
919-379-6187

APPPENDIX G

SECOND MAILING COVER LETTER

North Carolina State University
School of Textiles

Department of Textile Management and Technology
Box 8301, Raleigh, NC 27695-8301
Tel (919) 737-3442

November 25, 1987

NAME, TITLE
COMPANY
STREET ADDRESS
PO BOX
CITY, STATE ZIP CODE

SALUTATION:

About three weeks ago, I wrote to you seeking information about your textile printing operations. As of today we have not yet received your completed questionnaire. We feel that failure to participate in this important study will deprive your firm of important information about the printing industry.

I am writing to you again because a response from each plant is critical to developing a comprehensive and accurate profile of the printing industry. With fewer and fewer printing plants, a response from each one is imperative. Indications are that the textile printing industry has characteristics which make it different from other segments of the textile industry. As such, there are implications for the industry's competitive position in the future.

The responses to the questionnaire will be tabulated to protect the identity of individual firms. All responses are to be returned to Dr. Gordon Berkstresser at NCSU. The questionnaires contain no identification numbers. You are assured of complete confidentiality.

In case your questionnaire has been misplaced, I have enclosed a replacement for your convenience. Please take approximately 15 minutes and complete it immediately.

Thank you very much for your time and consideration.

Sincerely,

Jill Y. Amidon
UNCG Researcher

P.S. A number of people have asked when the results will be available. We hope to have them out the first of the year.

APPENDIX H

THIRD MAILING COVER LETTER

North Carolina State University
School of Textiles

Department of Textile Management and Technology
Box 8301, Raleigh, NC 27695-8301
Tel (919) 737-3442

December 18, 1987

(inside address)

Dear :

As per your telephone conversation yesterday with Claudia Apple, enclosed is a copy of our textile industry survey. Thank you very much for agreeing to complete it. It must be returned immediately so that your firm will be included in this important and comprehensive printing industry study.

Let me reemphasize that the study is carefully designed so that individual firms cannot be identified. The completed booklet and postcard are to be returned directly to Dr. Berkstresser at NCSU. The return postcard ensures that we will not have to call you again! (It also assures you a copy of the study.) The summary will be available within a few months.

Again, please complete the survey immediately. It will take approximately 15 minutes. Please feel free to contact me directly at 919-379-6187 if you have any questions. Thank you very much.

Sincerely,

Jill Y. Amidon
UNCG Graduate Researcher

APPENDIX I

TABLES

Table I-1

Response by State (n = 79)

STATE	% RESP.	# RESP.	# MAILED	# MISIDEN.	ADJUSTED POP.
CONNECTICUT	100%	3	3	0	3
DELAWARE	100%	1	1	0	1
MAINE	100%	1	1	0	1
VIRGINIA	100%	2	2	0	2
NORTH CAROLINA	76%	22	38	9	29
ALABAMA	67%	2	5	2	3
PENNSYLVANIA	67%	2	5	2	3
MASSACHUSETTS	64%	7	11	0	11
SOUTH CAROLINA	61%	11	21	3	18
RHODE ISLAND	57%	4	9	2	7
GEORGIA	56%	5	10	1	9
CALIFORNIA	50%	2	5	1	4
TENNESSEE	50%	1	3	1	2
NEW JERSEY	43%	3	16	9	7
NEW YORK	38%	5	22	9	13
ILLINOIS	33%	1	3	0	3
OHIO	25%	1	4	0	4
FLORIDA	0%	0	1	0	1
NEW HAMPSHIRE	0%	0	1	0	1
MINNESOTA	0%	0	1	0	1
WISCONSIN	0%	0	1	1	0
(UNKNOWN)	--	6	--	--	--
TOTAL	**64.2%**	**79**	**163**	**40**	**123**

Table I-2

Capital Intensity Means Compared by Categorical Independent Variables

	MEAN CAPITAL INTENSITY ($000)	No.
GEOGRAPHIC LOCATION:		
New England	45.44	5
Middle Atlantic	47.39	6
South	45.68	29
Elsewhere	16.34	4
ORGANIZATIONAL STRUCTURE:		
Multi-plant	51.40	18
Stand-alone	37.53	26
COMMISSION STATUS:		
Less than 60% Commission	49.19	23
60% or more Commission	36.65	21
PRODUCT END-USE:		
Apparel	40.86	23
Home Furnishings	36.74	16
Miscellaneous	63.33	4
EQUIPMENT:		
Roller	51.50	7
Flat-bed	22.00	4
Rotary Screen	50.03	19
Heat Transfer	19.76	6
Diverse Mixture	47.99	8

Table I-3

Mean Size of Printing Establishments (as measured by number of employees)

	MEAN	No.
GEOGRAPHIC LOCATION:		
New England	198	15
Middle Atlantic	66	11
South	191	42
Elsewhere	175	9
ORGANIZATIONAL STRUCTURE:		
Multi-plant	207	35
Stand-alone	144	42
COMMISSION STATUS:		
Less than 60% Commission	177	44
60% or more Commission	167	33
PRODUCT END-USE:		
Apparel	177	41
Home Furnishings	161	26
Miscellaneous	123	9
EQUIPMENT:		
Roller	270	11
Flat-bed	147	8
Rotary Screen	206	34
Heat Transfer	69	11
Diverse Mixture	108	13

Table I-4

Matrix of Independent Variables (Number in parentheses refers to table number in text.)

	GEO LOC.	ORGAN.	SIZE	COMMISS.	PROD.	EQUIP.	CAPEXP.
GEO LOC.	--	--	--	--	--	--	--
ORGAN.	Yes (3)	--	--	--	--	--	--
SIZE	Yes (4)	Yes (10)	--	--	--	--	--
COMMSS.	Yes (5)	Yes (11)	No (15)	--	--	--	--
PROD.	No (6)	No (12)	No (16)	Yes (19)	--	--	--
EQUIP.	Yes (7)	No (13)	Yes (17)	Yes (20)	Yes (22)	--	--
CAPEXP.	Yes (8)	Yes (14)	Yes (18)	No (21)	Yes (23)	Yes (24)	--

Table I-5

Comparison of the Means of the Dependent Variable Profitability for Each Categorical Independent Variable (as measured by before tax profit on stockholders' equity)

	MEAN %	No.
GEOGRAPHIC LOCATION:		
New England	11.45	10
Middle Atlantic	7.81	8
South	8.35	31
Elsewhere	9.30	5
ORGANIZATIONAL STRUCTURE:		
Multi-plant	9.02	22
Stand-alone	8.76	31
COMMISSION STATUS:		
Less than 60% Commission	6.73	28
60% or more Commission	11.26	25
PRODUCT END-USE:		
Apparel	9.79	26
Home Furnishings	7.5	20
Miscellaneous	10.57	7
EQUIPMENT:		
Roller	11.95	10
Flat-bed	8.25	4
Rotary Screen	9.20	22
Heat Transfer	6.64	7
Diverse Mixture	7.36	11

Table I-6

Comparison of the Means of the Dependent Variable Productivity for Each Categorical Independent Variable (as measured by value added per employee)

	MEAN $	No.
GEOGRAPHIC LOCATION:		
New England	9.17	9
Middle Atlantic	7.50	5
South	9.38	24
Elsewhere	9.17	6
ORGANIZATIONAL STRUCTURE:		
Multi-plant	10.50	15
Stand-alone	8.36	29
COMMISSION STATUS:		
Less than 60% Commission	10.11	23
60% or more Commission	7.98	25
PRODUCT END-USE:		
Apparel	7.75	20
Home Furnishings	8.89	18
Miscellaneous	15.50	5
EQUIPMENT:		
Roller	7.50	6
Flat-bed	11.25	4
Rotary Screen	8.89	18
Heat Transfer	5.83	6
Diverse Mixture	11.50	10

APPENDIX J

STATISTICAL TABLES

Table J-1

Pearson's Correlation Coefficients for Capital Intensity, Size of Firm, Productivity, and Profitability

PEARSON CORRELATION COEFFICIENTS
/ PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	CAPINV	EMPLO	AVVAPE	AVROI
CAPINV	1.00000 0.0000 44	0.19827 0.1970 44	0.13209 0.4637 33	0.13707 0.4054 39
EMPLO	0.19827 0.1970 44	1.00000 0.0000 77	0.30430 0.0446 44	0.16572 0.2356 53
AVVAPE	0.13209 0.4637 33	0.30430 0.0446 44	1.00000 0.0000 44	0.33097 0.0454 37
AVROI	0.13707 0.4054 39	0.16572 0.2356 53	0.33097 0.0454 37	1.00000 0.0000 54

Table J-2

Two-way Analysis of Variance for Geographic Location and Size of Firm by Profitability

DEPENDENT VARIABLE: AVROI

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	7	274.00452584	39.14350369	0.72
ERROR	45	2435.57094586	54.12379880	PR > F
CORRECTED TOTAL	52	2709.57547170		0.6530

R-SQUARE	C.V.	ROOT MSE	AVROI MEAN
0.101125	82.9607	7.35688785	8.86792453

SOURCE	DF	TYPE I SS	F VALUE	PR > F
GEOLOC	3	84.28494750	0.52	0.6713
EMPLO	1	42.21988208	0.78	0.3818
EMPLO*GEOLOC	3	147.49969626	0.91	0.4445

SOURCE	DF	TYPE III SS	F VALUE	PR > F
GEOLOC	3	168.61438621	1.04	0.3847
EMPLO	1	185.70152195	3.43	0.0705
EMPLO*GEOLOC	3	147.49969626	0.91	0.4445

Table J-3

Two-way Analysis of Variance for Geographic Location and Size of Firm by Productivity

DEPENDENT VARIABLE: AVVAPE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	7	267.98570023	38.28367146	0.59
ERROR	36	2320.65066341	64.46251843	PR > F
CORRECTED TOTAL	43	2588.63636364		0.7565

R-SQUARE	C.V.	ROOT MSE	AVVAPE MEAN
0.103524	88.3174	8.02885536	9.09090909

SOURCE	DF	TYPE I SS	F VALUE	PR > F
GEOLOC	3	14.67803030	0.08	0.9726
EMPLO	1	234.54499430	3.64	0.0645
EMPLO*GEOLOC	3	18.76267563	0.10	0.9612

SOURCE	DF	TYPE III SS	F VALUE	PR > F
GEOLOC	3	14.37943341	0.07	0.9734
EMPLO	1	88.93448494	1.38	0.2479
EMPLO*GEOLOC	3	18.76267563	0.10	0.9612

Table J-4

Two-way Analysis of Variance for Type of Ownership and Size of Firm by Profitability

DEPENDENT VARIABLE: AVROI

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	3	128.06658204	42.68886068	0.81
ERROR	49	2581.50888966	52.68385489	PR > F
CORRECTED TOTAL	52	2709.57547170		0.4943

R-SQUARE	C.V.	ROOT MSE	AVROI MEAN
0.047264	81.8496	7.25836448	8.86792453

SOURCE	DF	TYPE I SS	F VALUE	PR > F
ORGTYPE	1	0.90135146	0.02	0.8965
EMPLO	1	74.00801754	1.40	0.2416
EMPLO*ORGTYPE	1	53.15721304	1.01	0.3201

SOURCE	DF	TYPE III SS	F VALUE	PR > F
ORGTYPE	1	35.23268392	0.67	0.4174
EMPLO	1	87.93230238	1.67	0.2024
EMPLO*ORGTYPE	1	53.15721304	1.01	0.3201

Table J-5

Two-way Analysis of Variance for Type of Ownership and Size of Firm by Productivity

DEPENDENT VARIABLE: AVVAPE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	3	627.88768198	209.29589399	4.27
ERROR	40	1960.74868165	49.01871704	PR > F
CORRECTED TOTAL	43	2588.63636364		0.0105

R-SQUARE	C.V.	ROOT MSE	AVVAPE MEAN
0.242555	77.0147	7.00133680	9.09090909

SOURCE	DF	TYPE I SS	F VALUE	PR > F
ORGTYPE	1	45.18808777	0.92	0.3428
EMPLO	1	209.13286215	4.27	0.0454
EMPLO*ORGTYPE	1	373.56673206	7.62	0.0087

SOURCE	DF	TYPE III SS	F VALUE	PR > F
ORGTYPE	1	140.96575455	2.88	0.0977
EMPLO	1	329.65745942	6.73	0.0132
EMPLO*ORGTYPE	1	373.56673206	7.62	0.0087

Table J-6

Two-way Analysis of Variance for Commission Status and Size of Firm by Profitability

DEPENDENT VARIABLE: AVROI

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	3	417.40967494	139.13655831	2.97
ERROR	49	2292.16579675	46.77889381	PR > F
CORRECTED TOTAL	52	2709.57547170		0.0406

R-SQUARE	C.V.	ROOT MSE	AVROI MEAN
0.154050	77.1264	6.83950976	8.86792453

SOURCE	DF	TYPE I SS	F VALUE	PR > F
COMMGRP	1	270.77440027	5.79	0.0200
EMPLO	1	102.40156869	2.19	0.1454
EMPLO*COMMGRP	1	44.23370598	0.95	0.3356

SOURCE	DF	TYPE III SS	F VALUE	PR > F
COMMGRP	1	47.01876115	1.01	0.3210
EMPLO	1	108.53678230	2.32	0.1341
EMPLO*COMMGRP	1	44.23370598	0.95	0.3356

Table J-7

Two-way Analysis of Variance for Commission Status and Size of Firm by Productivity

DEPENDENT VARIABLE: AVVAPE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	3	572.43684762	190.81228254	3.79
ERROR	40	2016.19951602	50.40498790	PR > F
CORRECTED TOTAL	43	2588.63636364		0.0176

R-SQUARE	C.V.	ROOT MSE	AVVAPE MEAN
0.221135	78.0961	7.09964703	9.09090909

SOURCE	DF	TYPE I SS	F VALUE	PR > F
COMMGRP	1	49.92000753	0.99	0.3256
EMPLO	1	215.00643612	4.27	0.0454
EMPLO*COMMGRP	1	307.51040398	6.10	0.0179

SOURCE	DF	TYPE III SS	F VALUE	PR > F
COMMGRP	1	260.36027757	5.17	0.0285
EMPLO	1	210.02142287	4.17	0.0479
EMPLO*COMMGRP	1	307.51040398	6.10	0.0179

Table J-8

Two-way Analysis of Variance for Product Line and Size of Firm by Profitability

DEPENDENT VARIABLE: AVVAPE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	5	675.70492915	135.14098583	2.62
ERROR	37	1910.34158248	51.63085358	PR > F
CORRECTED TOTAL	42	2586.04651163		0.0400

R-SQUARE	C.V.	ROOT MSE	AVVAPE MEAN
0.261289	78.7197	7.18546126	9.12790698

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PRODUCT	2	242.01873385	2.34	0.1101
EMPLO	1	429.79025259	8.32	0.0065
EMPLO*PRODUCT	2	3.89594271	0.04	0.9630

SOURCE	DF	TYPE III SS	F VALUE	PR > F
PRODUCT	2	104.21873133	1.01	0.3743
EMPLO	1	193.84093122	3.75	0.0603
EMPLO*PRODUCT	2	3.89594271	0.04	0.9630

Table J-9

Two-way Analysis of Variance for Product Line and Size of Firm by Productivity

DEPENDENT VARIABLE: AVROI

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	5	473.34642992	94.66928598	1.97
ERROR	46	2212.07664701	48.08862276	PR > F
CORRECTED TOTAL	51	2685.42307692		0.1013

R-SQUARE	C.V.	ROOT MSE	AVROI MEAN
0.176265	77.3818	6.93459608	8.96153846

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PRODUCT	2	73.76879121	0.77	0.4702
EMPLO	1	194.75282465	4.05	0.0501
EMPLO*PRODUCT	2	204.82481406	2.13	0.1305

SOURCE	DF	TYPE III SS	F VALUE	PR > F
PRODUCT	2	165.70995967	1.72	0.1899
EMPLO	1	0.10804820	0.00	0.9624
EMPLO*PRODUCT	2	204.82481406	2.13	0.1305

Table J-10

Two-way Analysis of Variance for Printing Technology and Size of Firm by Profitability

DEPENDENT VARIABLE: AVROI

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	9	348.36171666	38.70685741	0.70
ERROR	43	2361.21375504	54.91194779	PR > F
CORRECTED TOTAL	52	2709.57547170		0.7009

R-SQUARE	C.V.	ROOT MSE	AVROI MEAN
0.128567	83.5625	7.41025963	8.86792453

SOURCE	DF	TYPE I SS	F VALUE	PR > F
EQUIP	4	145.70443995	0.66	0.6209
EMPLO	1	28.53563728	0.52	0.4749
EMPLO*EQUIP	4	174.12163943	0.79	0.5364

SOURCE	DF	TYPE III SS	F VALUE	PR > F
EQUIP	4	98.92086685	0.45	0.7715
EMPLO	1	56.43105933	1.03	0.3164
EMPLO*EQUIP	4	174.12163943	0.79	0.5364

Table J-11

Two-way Analysis of Variance for Printing Technology and Size of Firm by Productivity

DEPENDENT VARIABLE: AVVAPE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	9	634.33354502	70.48150500	1.23
ERROR	34	1954.30281862	57.47949467	PR > F
CORRECTED TOTAL	43	2588.63636364		0.3120

R-SQUARE	C.V.	ROOT MSE	AVVAPE MEAN
0.245045	83.3968	7.58152324	9.09090909

SOURCE	DF	TYPE I SS	F VALUE	PR > F
EQUIP	4	156.27525253	0.68	0.6108
EMPLO	1	262.21703537	4.56	0.0400
EMPLO*EQUIP	4	215.84125712	0.94	0.4534

SOURCE	DF	TYPE III SS	F VALUE	PR > F
EQUIP	4	339.14352831	1.48	0.2314
EMPLO	1	136.15278644	2.37	0.1330
EMPLO*EQUIP	4	215.84125712	0.94	0.4534

Table J-12

Two-way Analysis of Variance for Capital Intensity and Size of Firm by Profitability

DEPENDENT VARIABLE: AVROI

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	2	104.38100206	52.19050103	0.95
ERROR	36	1983.04207486	55.08450208	PR > F
CORRECTED TOTAL	38	2087.42307692		0.3972

R-SQUARE	C.V.	ROOT MSE	AVROI MEAN
0.050005	84.6356	7.42189343	8.76923077

SOURCE	DF	TYPE I SS	F VALUE	PR > F
CAPINV	1	39.21776902	0.71	0.4044
EMPLO	1	65.16323305	1.18	0.2840

SOURCE	DF	TYPE III SS	F VALUE	PR > F
CAPINV	1	19.68985532	0.36	0.5537
EMPLO	1	65.16323305	1.18	0.2840

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	6.50872442	3.11	0.0036	2.09103066
CAPINV	0.01964756	0.60	0.5537	0.03286261
EMPLO	0.00816359	1.09	0.2840	0.00750576

Table J-13

Two-way Analysis of Variance for Capital Intensity and Size of Firm by Productivity

DEPENDENT VARIABLE: AVVAPE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	2	201.07779906	100.53889953	1.70
ERROR	30	1773.16462518	59.10548751	PR > F
CORRECTED TOTAL	32	1974.24242424		0.1996

R-SQUARE	C.V.	ROOT MSE	AVVAPE MEAN
0.101851	85.2788	7.68800933	9.01515152

SOURCE	DF	TYPE I SS	F VALUE	PR > F
CAPINV	1	34.44603286	0.58	0.4512
EMPLO	1	166.63176620	2.82	0.1035

SOURCE	DF	TYPE III SS	F VALUE	PR > F
CAPINV	1	15.06136348	0.25	0.6174
EMPLO	1	166.63176620	2.82	0.1035

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	5.88820087	2.53	0.0170	2.32935131
CAPINV	0.01596577	0.50	0.6174	0.03162800
EMPLO	0.01329811	1.68	0.1035	0.00792000

Table J-14

Three-way Analysis of Variance for Commission Status, Type of Ownership, and Size of Firm by Productivity

DEPENDENT VARIABLE: AVVAPE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	5	805.51013192	161.10202638	3.43
ERROR	38	1783.12623172	46.92437452	PR > F
CORRECTED TOTAL	43	2588.63636364		0.0117

R-SQUARE	C.V.	ROOT MSE	AVVAPE MEAN
0.311172	75.3515	6.85013682	9.09090909

SOURCE	DF	TYPE I SS	F VALUE	PR > F
COMMGRP	1	49.92000753	1.06	0.3089
ORGTYPE	1	35.67882430	0.76	0.3867
COMMGRP*ORGTYPE	1	149.34705562	3.16	0.0824
EMPLO*ORGTYPE	2	570.56424447	6.08	0.0051

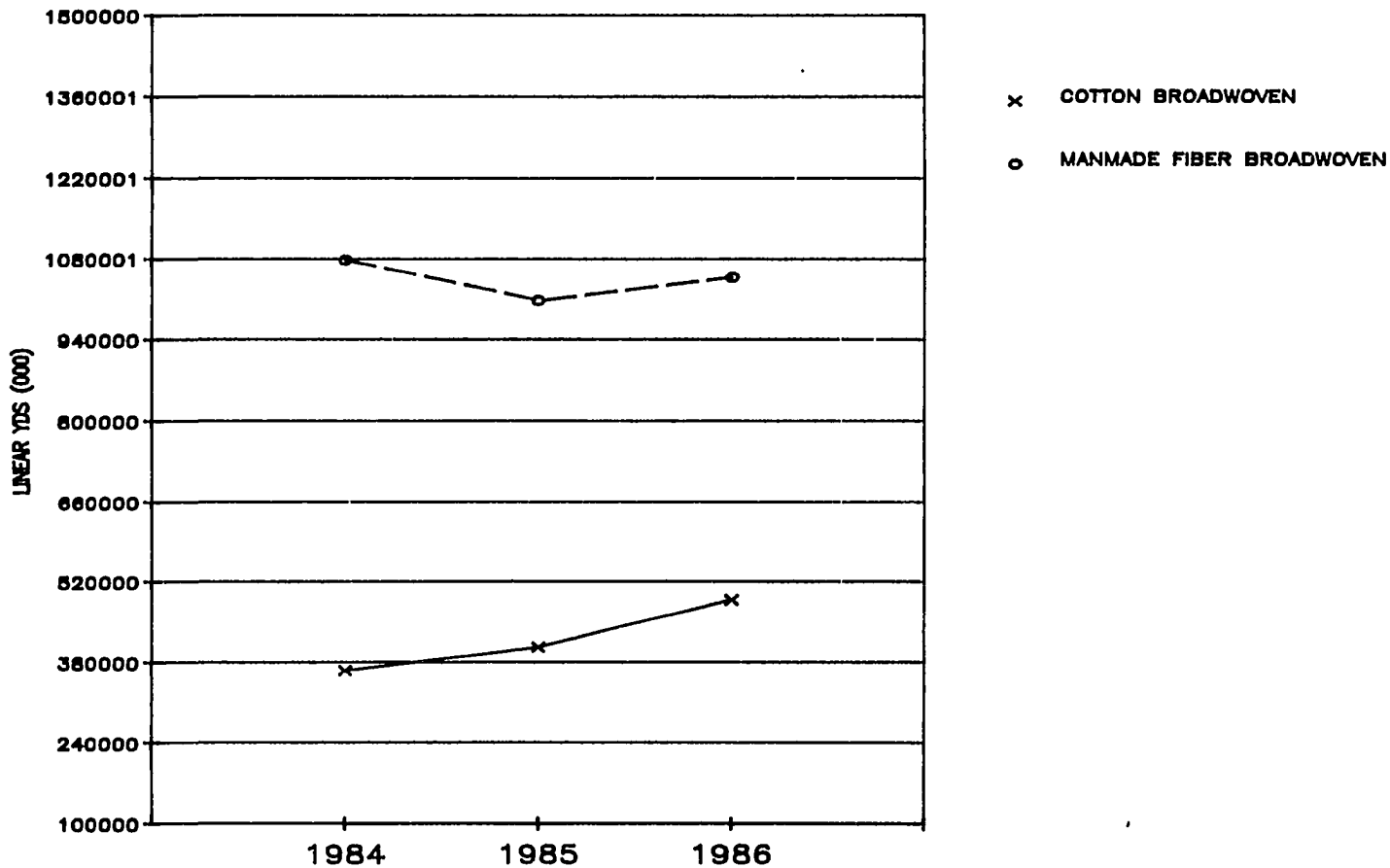
SOURCE	DF	TYPE III SS	F VALUE	PR > F
COMMGRP	1	23.46692796	0.50	0.4838
ORGTYPE	1	152.82364698	3.26	0.0791
COMMGRP*ORGTYPE	1	105.61213050	2.25	0.1418
EMPLO*ORGTYPE	2	570.56424447	6.08	0.0051

PARAMETER			ESTIMATE	T FOR H0: PARAMETER=0	PR > | T |	STD ERROR OF ESTIMATE
INTERCEPT			6.74850488 B	3.36	0.0018	2.00910609
COMMGRP	1		4.95657340 B	1.88	0.0674	2.63224430
	2		0.00000000 B	.	.	.
ORGTYPE	1		-2.79291626 B	-0.66	0.5149	4.24868963
	2		0.00000000 B	.	.	.
COMMGRP*ORGTYPE	1	1	-6.73731213 B	-1.50	0.1418	4.49085479
	1	2	0.00000000 B	.	.	.
	2	1	0.00000000 B	.	.	.
	2	2	0.00000000 B	.	.	.
EMPLO*ORGTYPE	1		0.03701550	3.43	0.0015	0.01078181
	2		-0.00547183	-0.61	0.5451	0.00896242

APPENDIX K

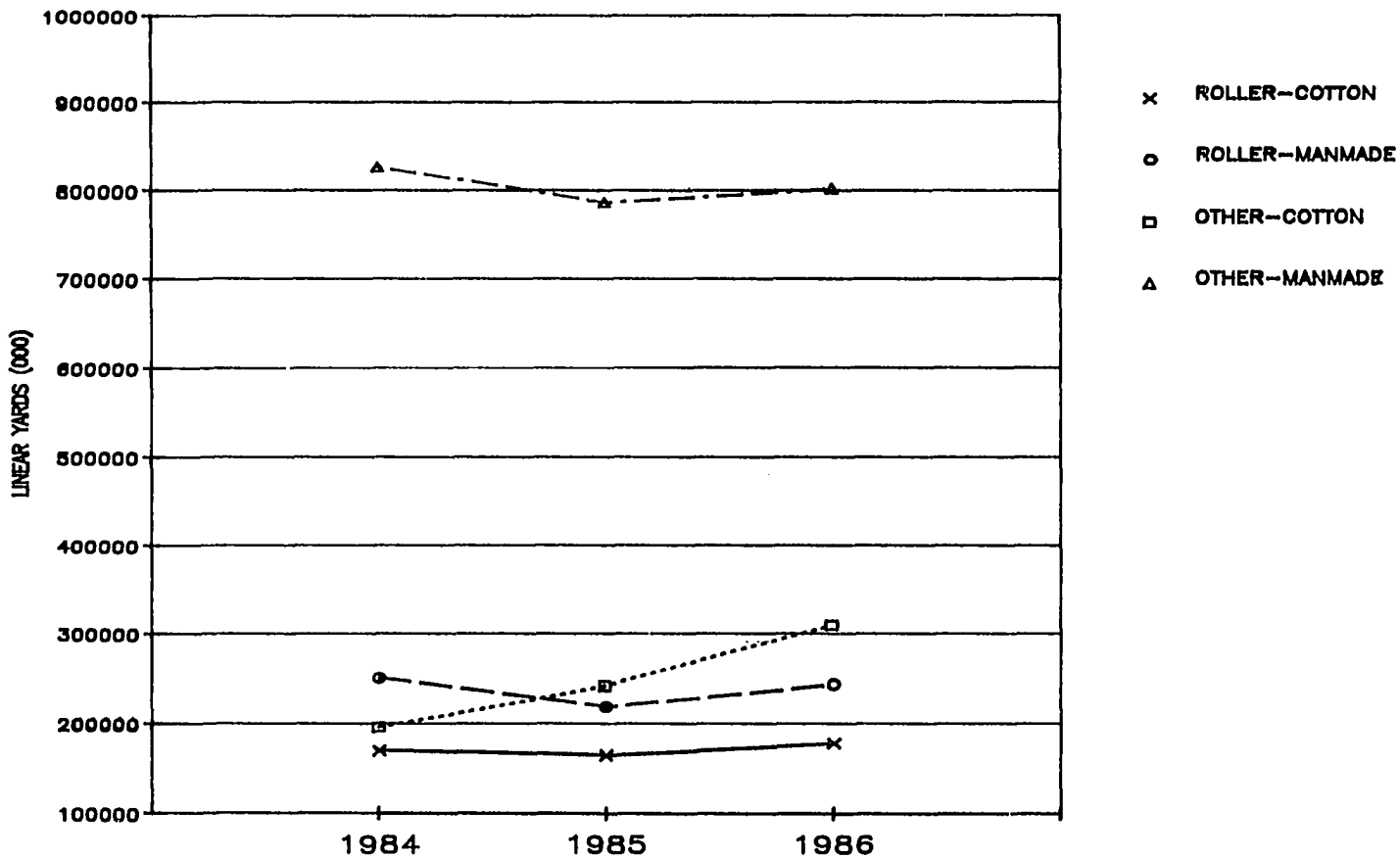
FIGURES

Figure K-1. PRINTED FABRIC PRODUCTION 1984—1986
(in thousands of linear yards)



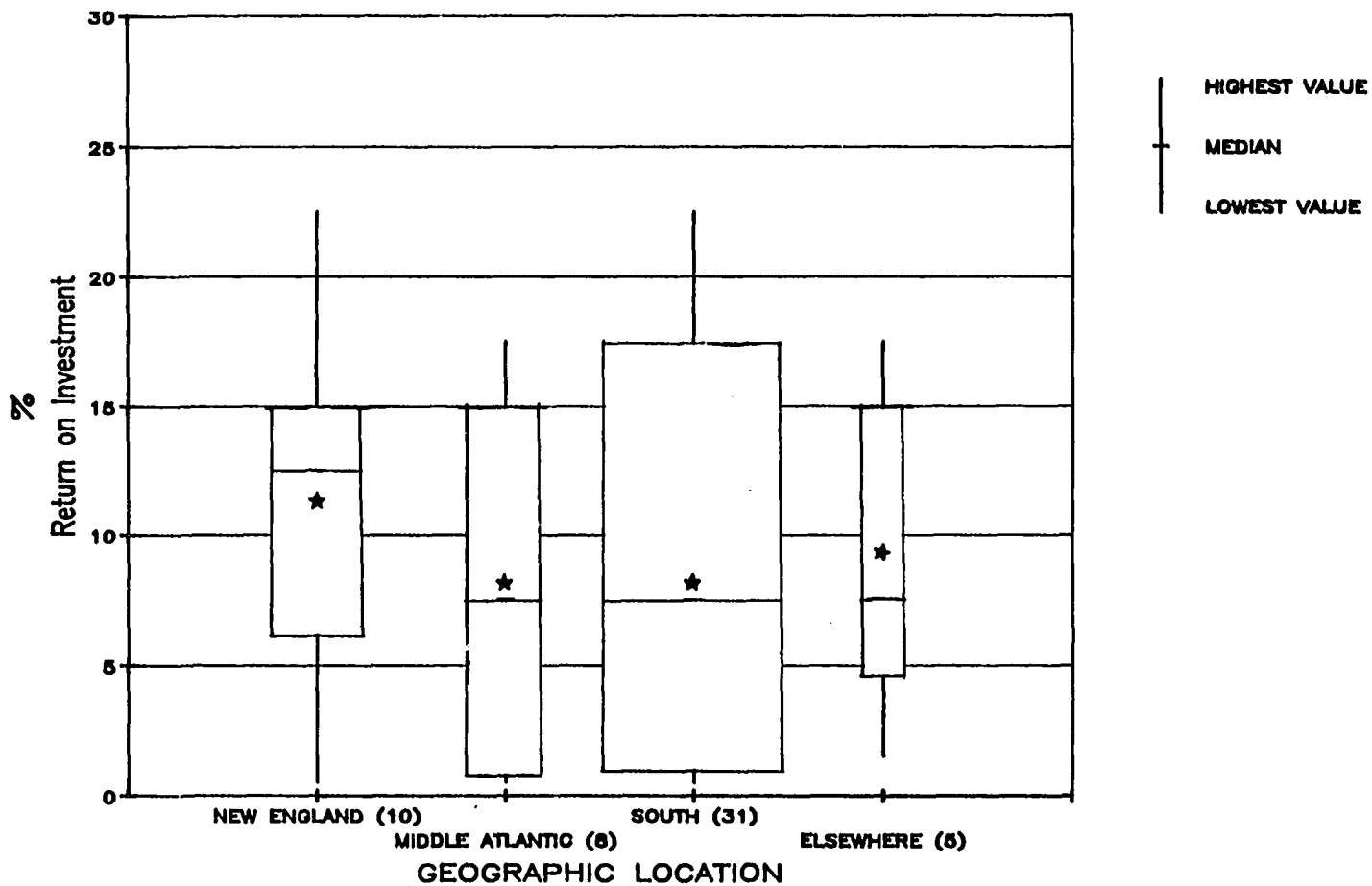
Source: Current Industrial Reports

Figure K-2. PRINTED FABRIC PRODUCTION 1984–1986
EQUIPMENT TYPE BY FIBER CONTENT
(in thousands of linear yards)



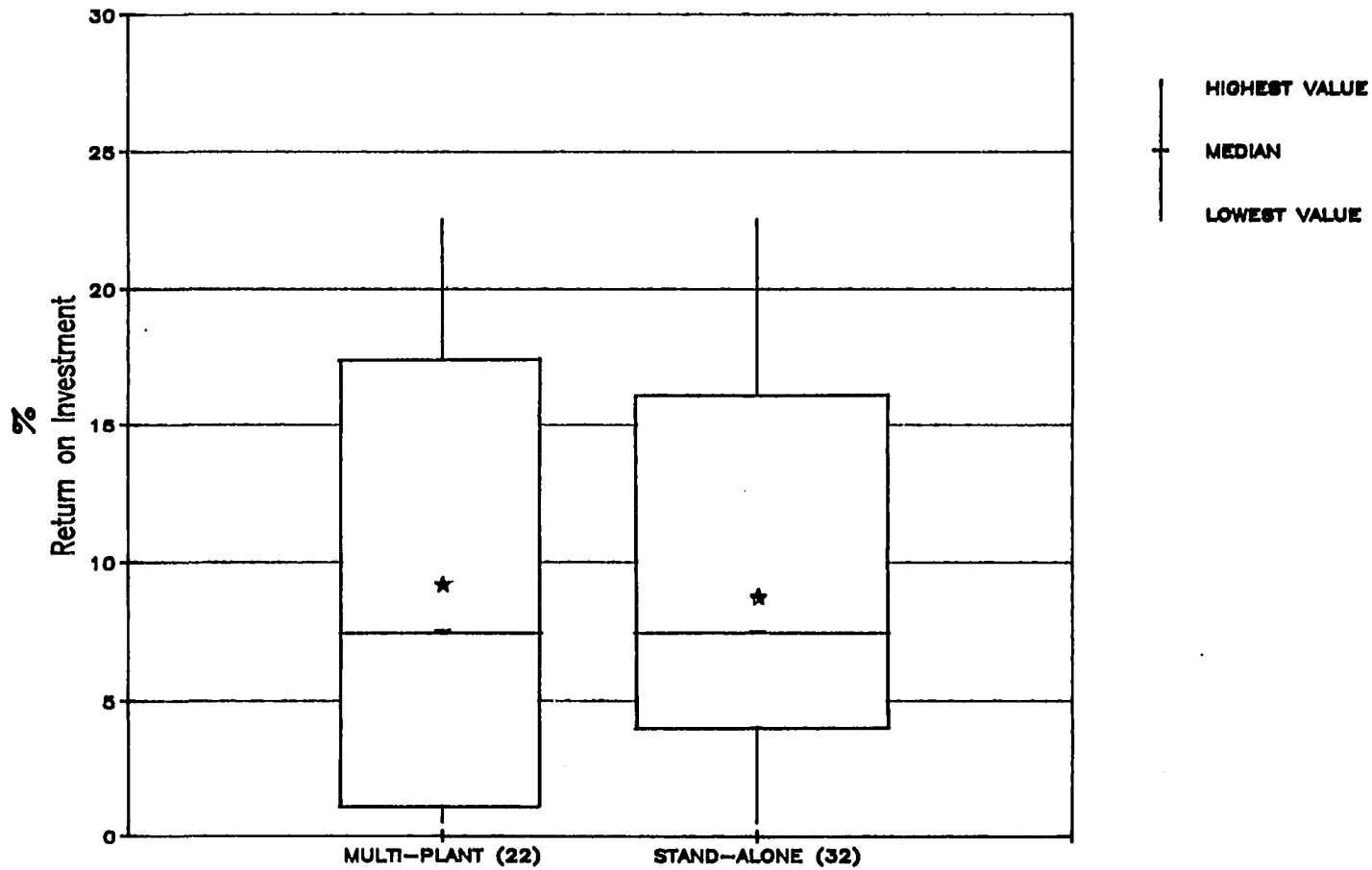
Source: Current Industrial Reports

Figure K-3. PROFITABILITY OF PRINTING ESTABLISHMENTS WITH REGARD TO GEOGRAPHIC LOCATION



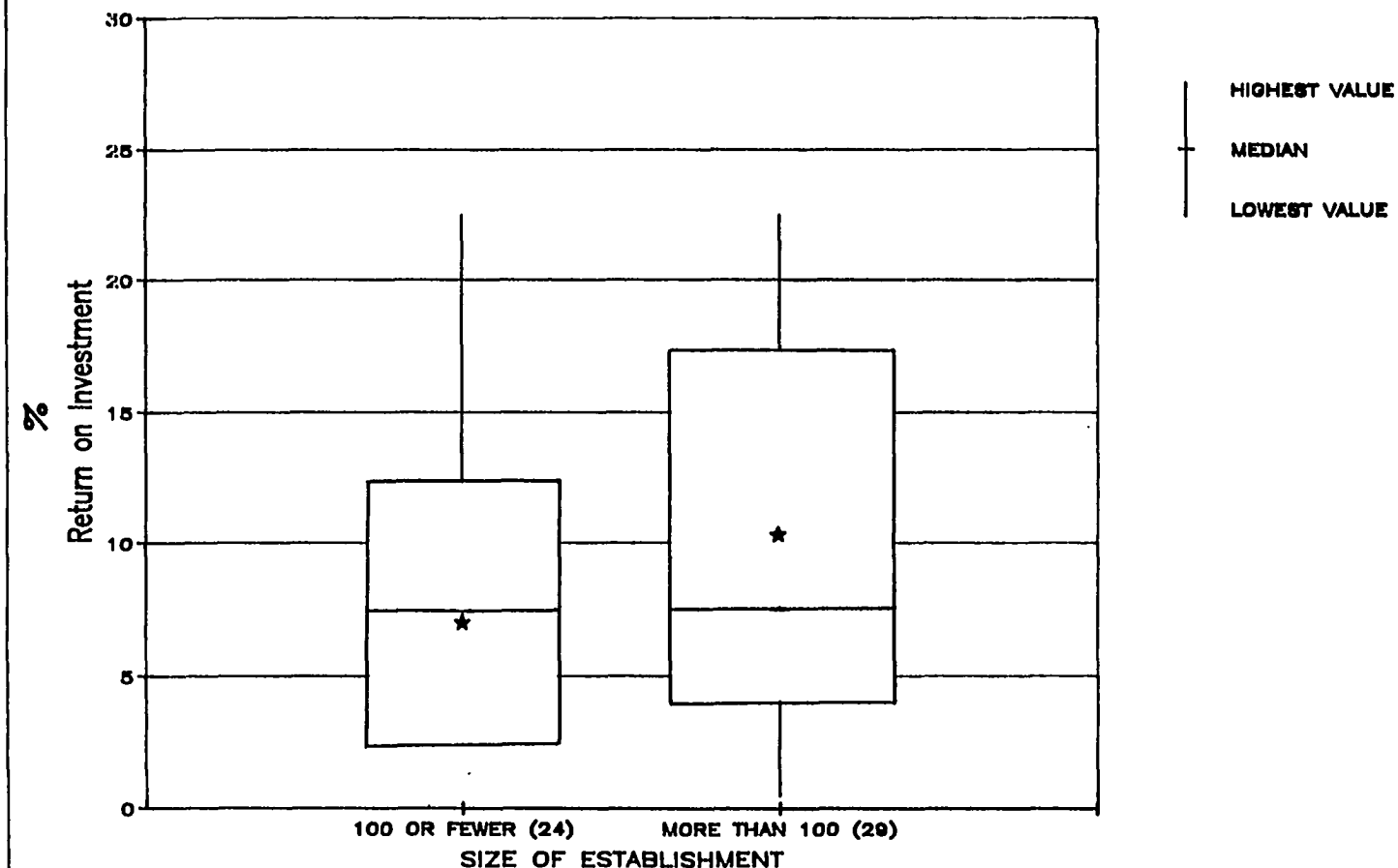
(Top of box=Q3; Bottom=Q1; ★=mean)

Figure K-4. PROFITABILITY OF PRINTING ESTABLISHMENTS WITH REGARD TO ORGANIZATIONAL STRUCTURE



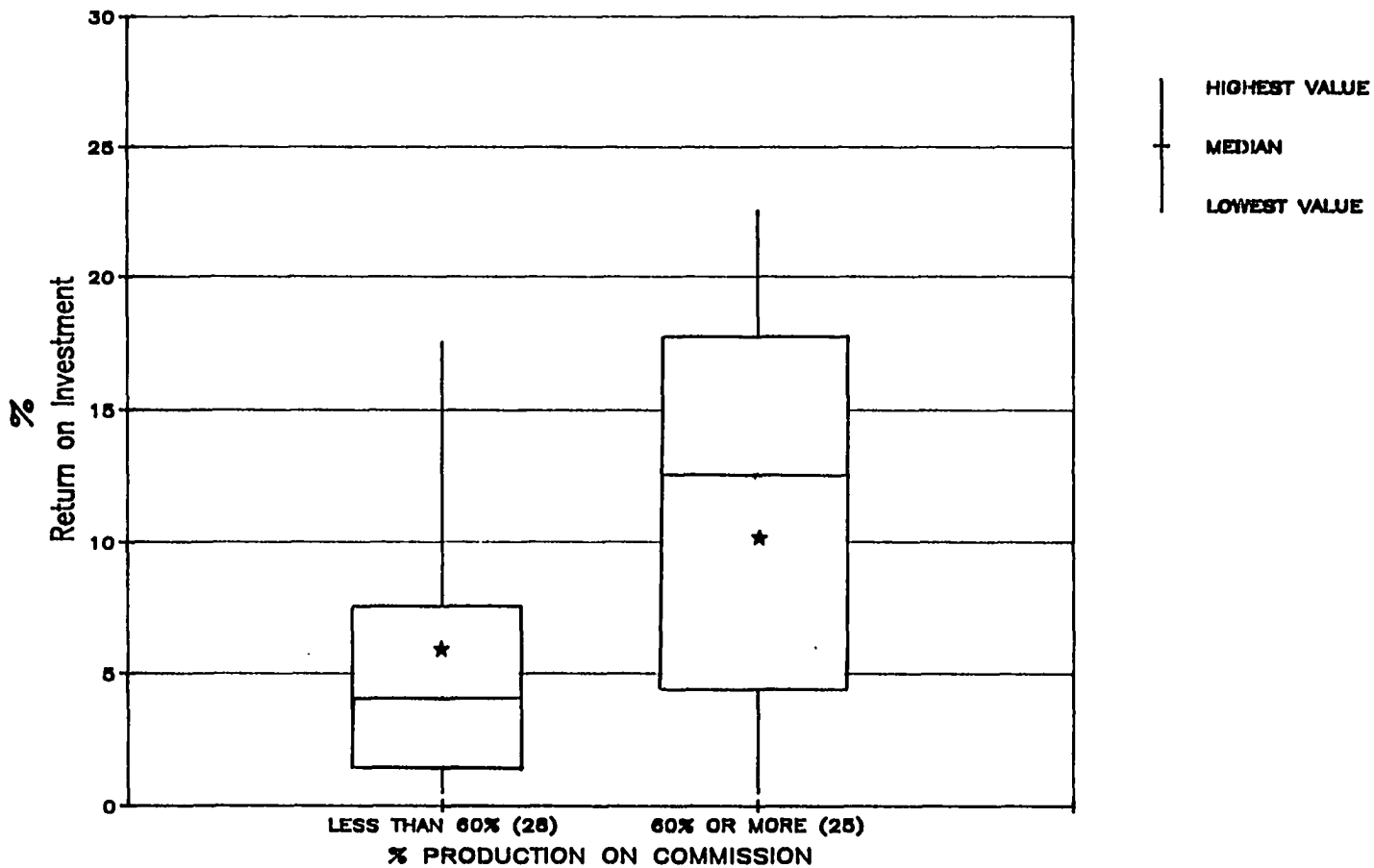
(Top of box=Q3; Bottom=Q1; ★=mean)

Figure K-5. PROFITABILITY OF PRINTING ESTABLISHMENTS WITH REGARD TO SIZE OF ESTABLISHMENT
(AS MEASURED BY NUMBER OF EMPLOYEES)



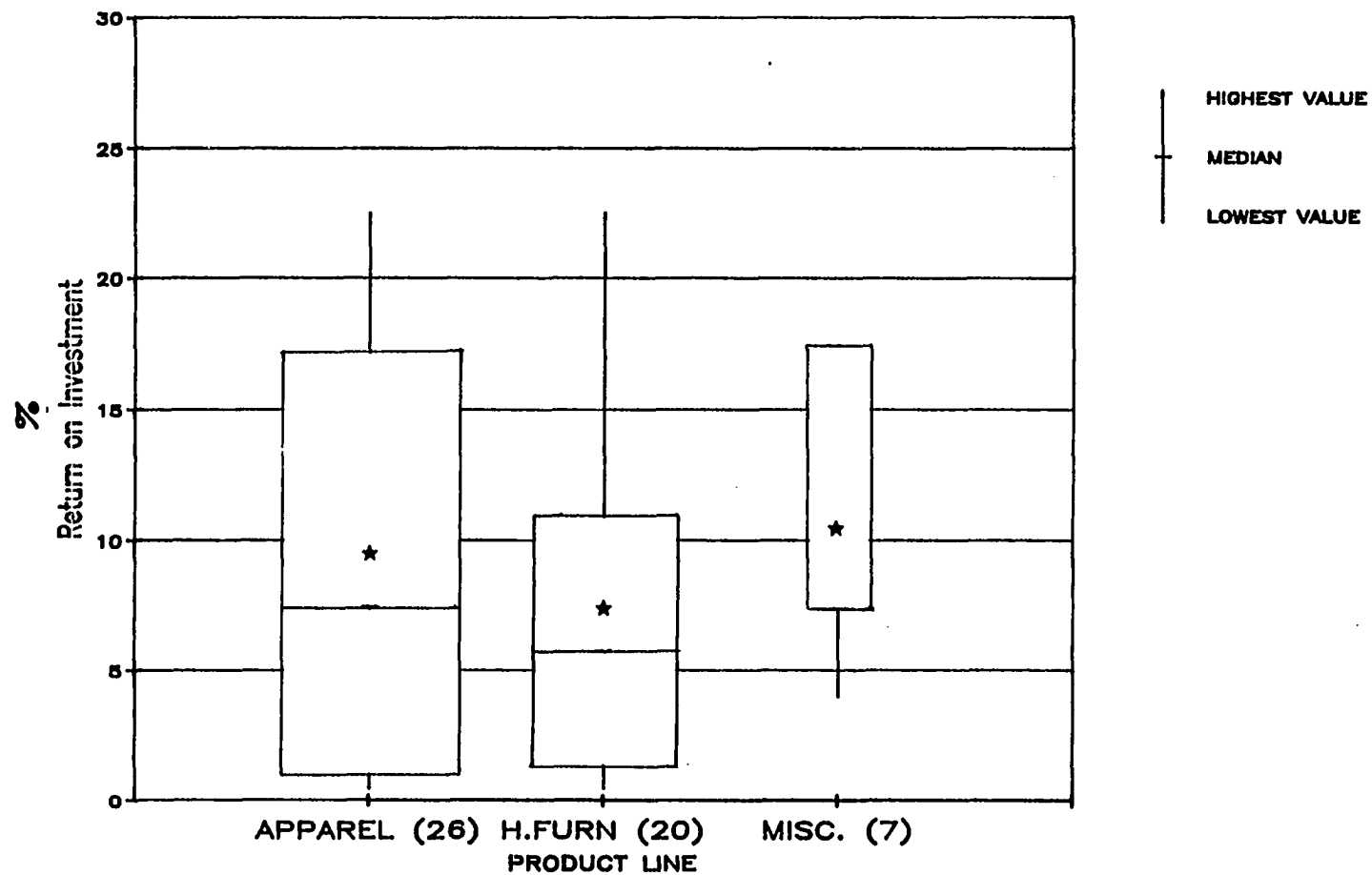
(Top of box=Q3; Bottom=Q1; ★=mean)

Figure K-6. PROFITABILITY OF PRINTING ESTABLISHMENTS WITH REGARD TO COMMISSION STATUS
(AS MEASURED BY % OF PRODUCTION ON COMMISSION)



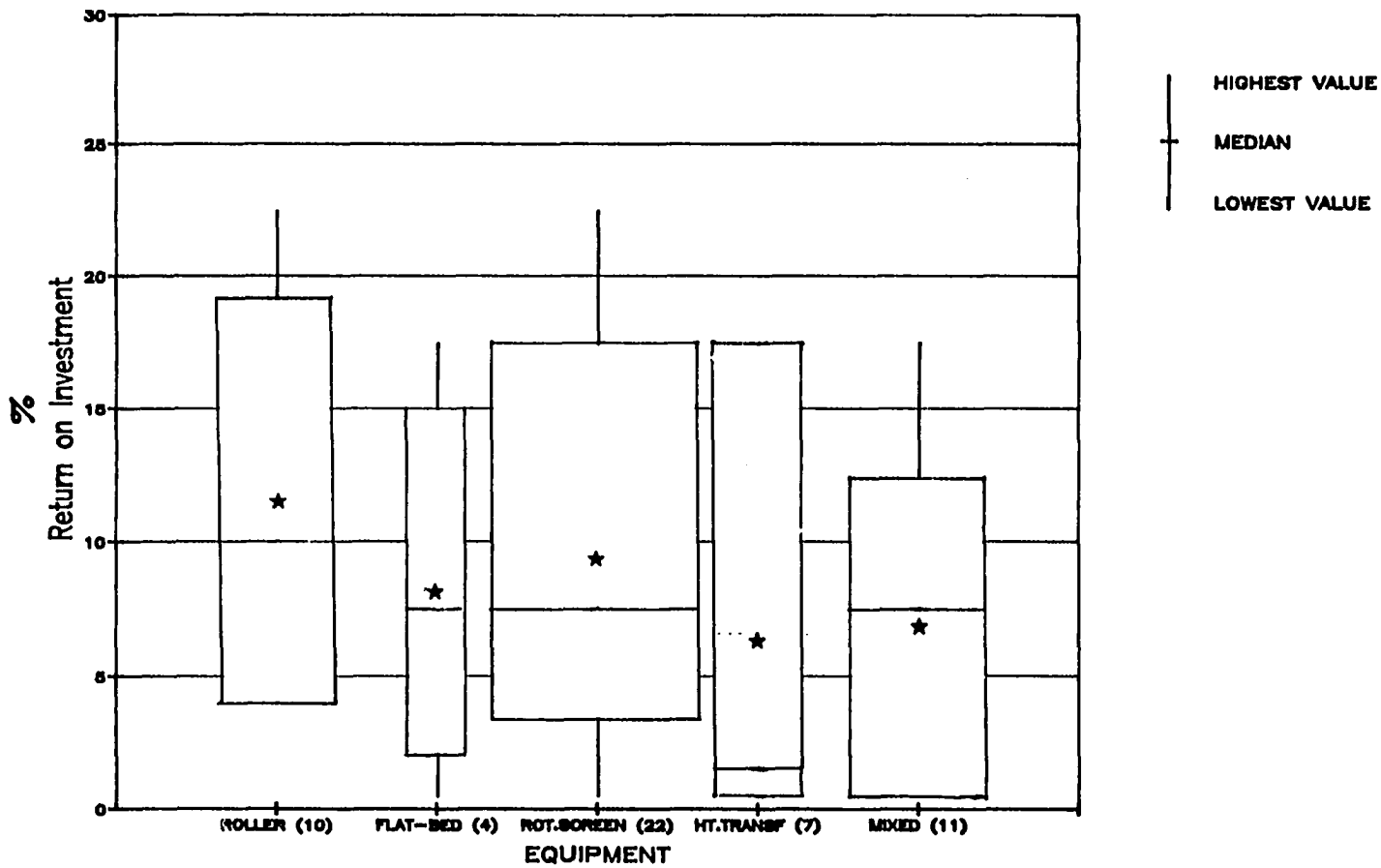
(Top of box=Q3; Bottom=Q1; ★=mean)

Figure K-7. PROFITABILITY OF PRINTING ESTABLISHMENTS WITH REGARD TO PRODUCT LINE



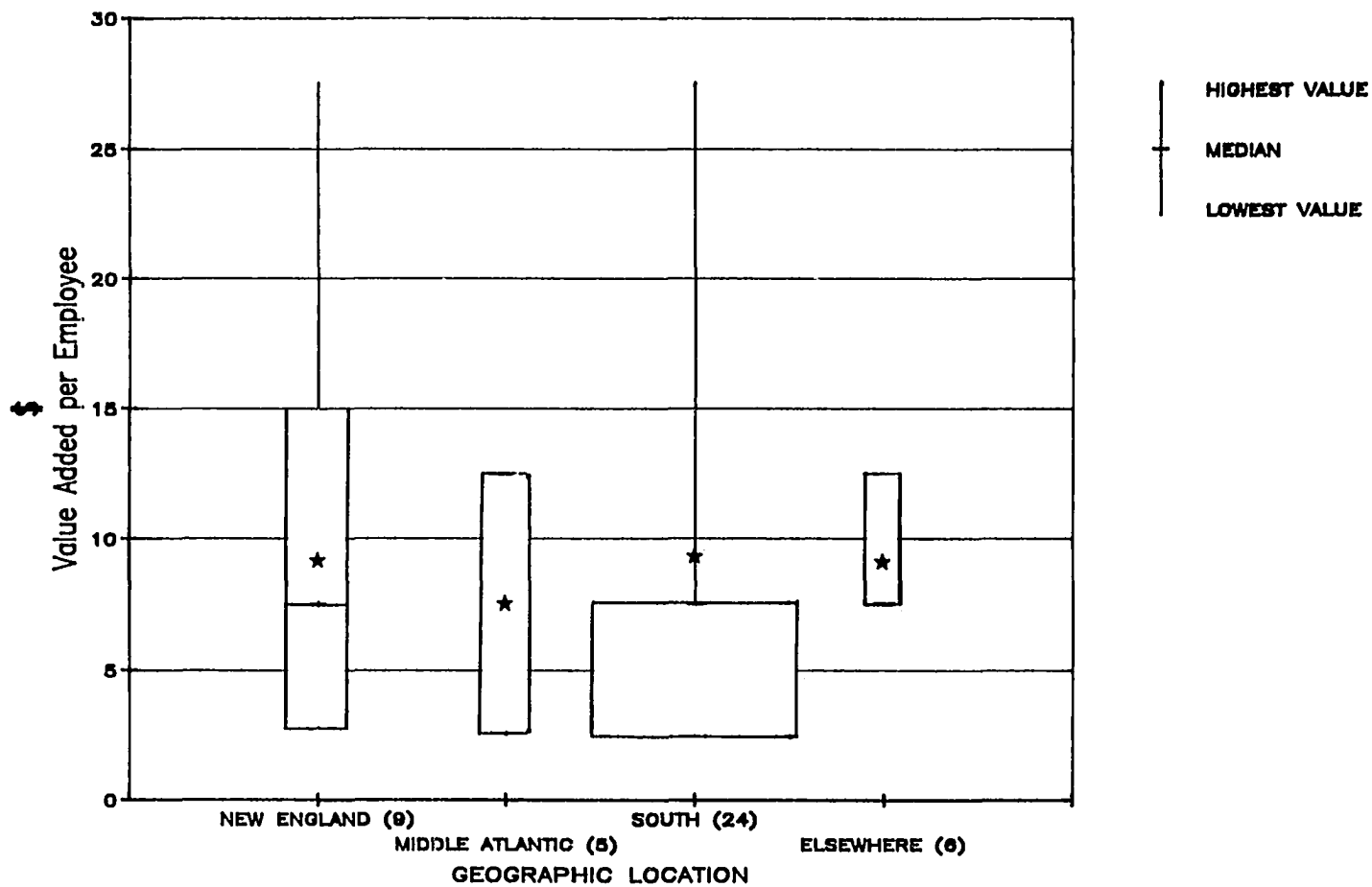
(Top of box=Q3; Bottom=Q1; ★=mean)

Figure K-8. PROFITABILITY OF PRINTING ESTABLISHMENTS WITH REGARD TO PRINTING EQUIPMENT
(by equipment used for 50% or more production)



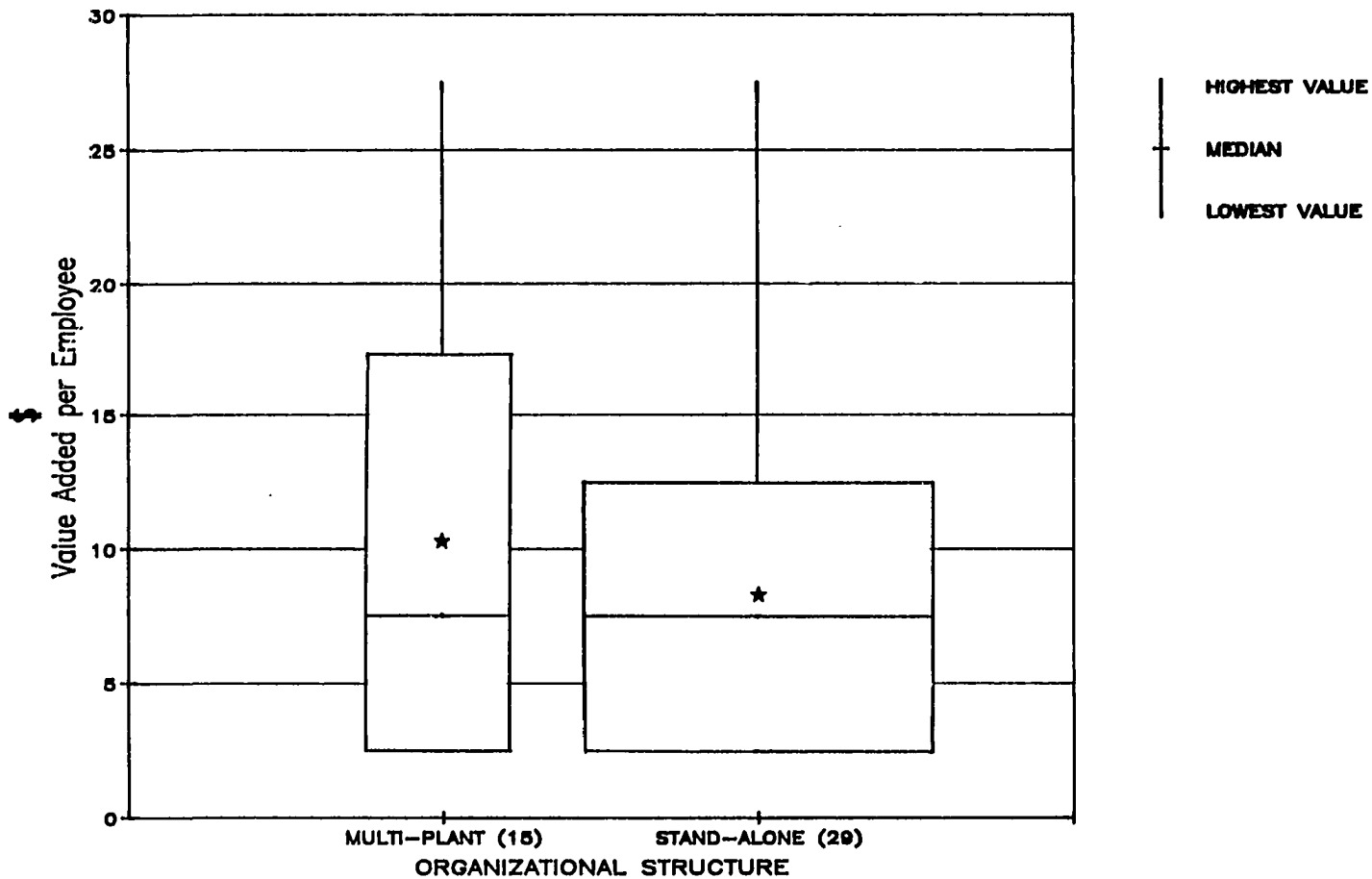
(Top of box=Q3; Bottom=Q1; ★=mean)

Figure K-9. PRODUCTIVITY OF PRINTING ESTABLISHMENTS WITH REGARD TO GEOGRAPHIC LOCATION



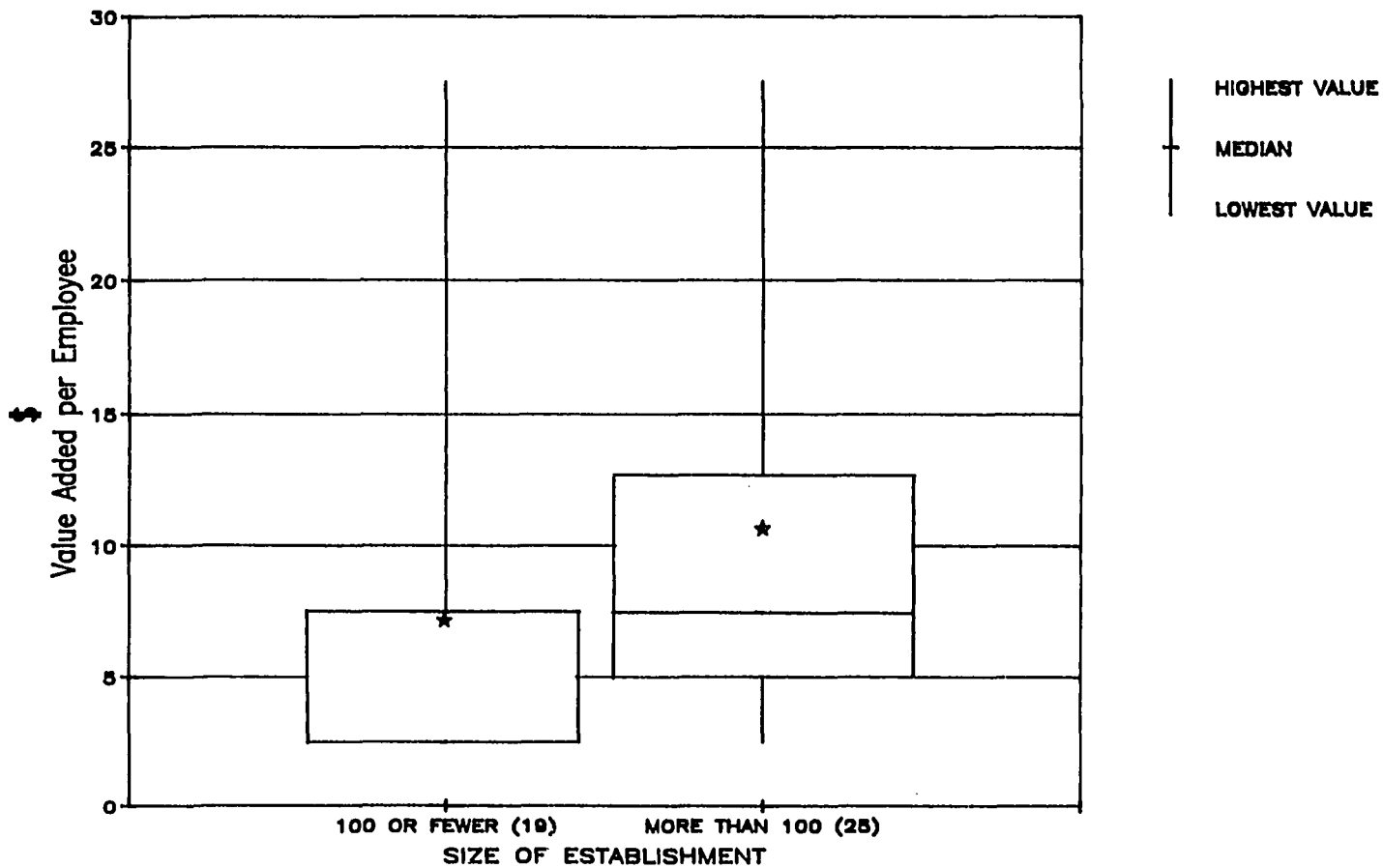
(Top of box=Q3; Bottom=Q1; ★=mean)

Figure K-10. PRODUCTIVITY OF PRINTING ESTABLISHMENTS WITH REGARD TO ORGANIZATIONAL STRUCTURE



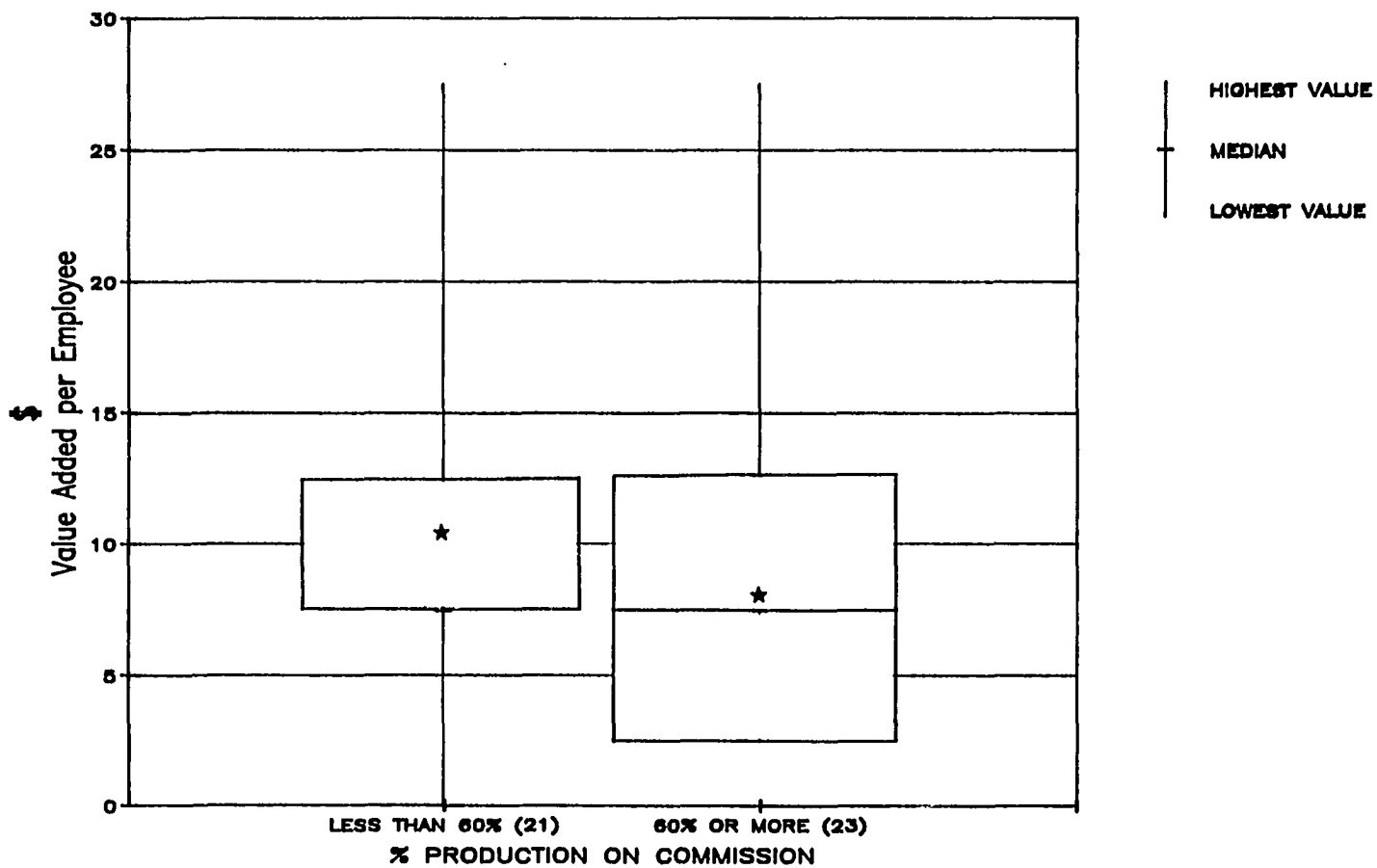
(Top of box=Q3; Bottom=Q1; ★=mean)

Figure K-11. PRODUCTIVITY OF PRINTING ESTABLISHMENTS WITH REGARD TO SIZE OF ESTABLISHMENT
(AS MEASURED BY NUMBER OF EMPLOYEES)



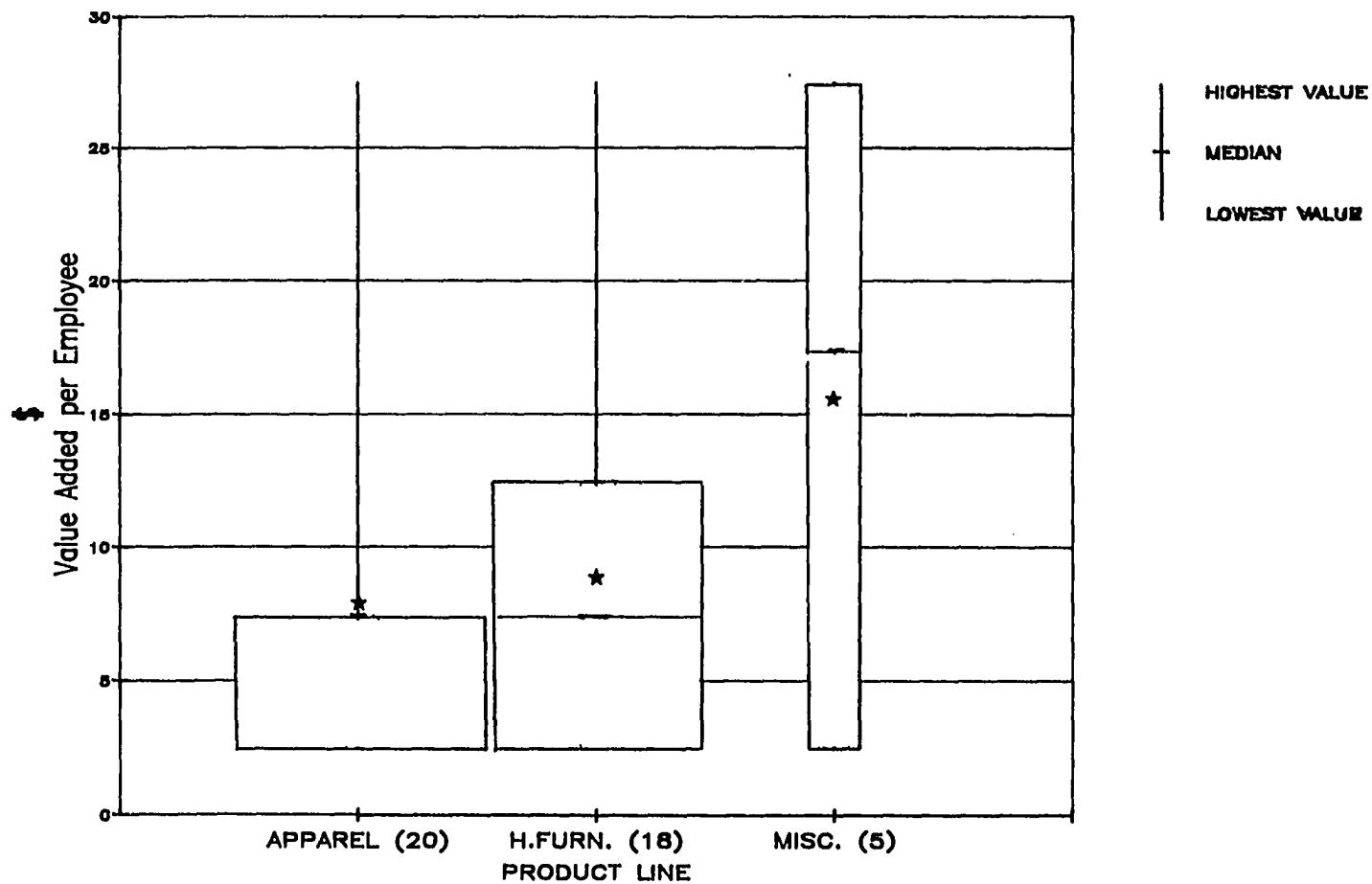
(Top of box=Q3; Bottom=Q1; ★=mean)

Figure K-12. PRODUCTIVITY OF PRINTING ESTABLISHMENTS WITH REGARD TO COMMISSION STATUS
(AS MEASURED BY % OF PRODUCTION ON COMMISSION)



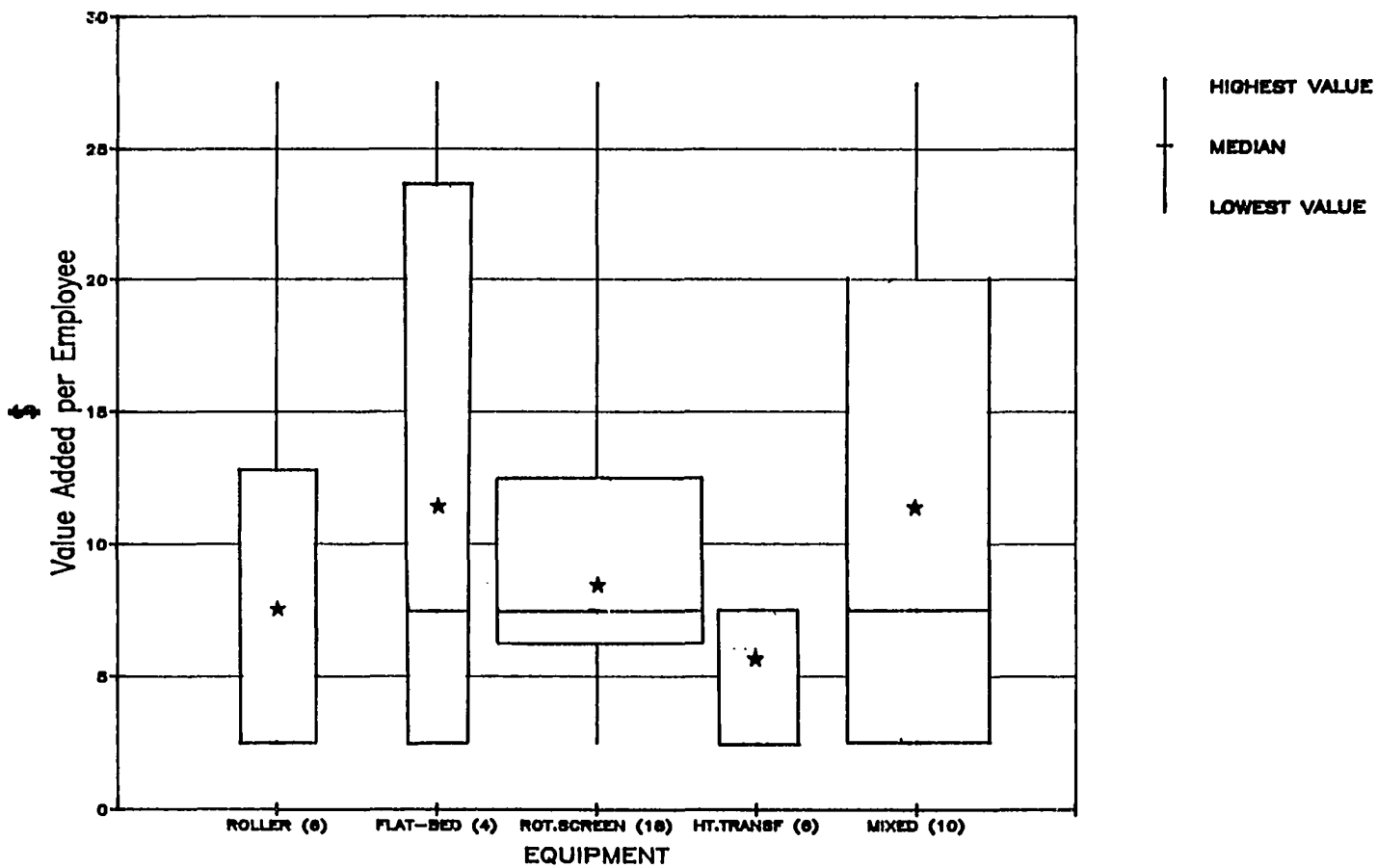
(Top of box=Q3; Bottom=Q1; ★=mean)

Figure K-13. PRODUCTIVITY OF PRINTING ESTABLISHMENTS WITH REGARD TO PRODUCT LINE



(Top of box=Q3; Bottom=Q1; ★=mean)

Figure K-14. PRODUCTIVITY OF PRINTING ESTABLISHMENTS WITH REGARD TO PRINTING EQUIPMENT
(by equipment used for 50% or more production)



(Top of box=Q3; Bottom=Q1; ★=mean)