ABSTRACT

Dodd, Erin Linnea. U.S. Trends in Short Staple Spinning. (Under the direction of William Oxenham, PhD.)

The purpose of this research has been to examine possible factors which effect yarn production and prices in the U.S. The research approach first involved gathering the data from different sources about yarn production and prices. Second, data was gathered about the different factors which could have an effect on these. These factors included end use demand, cotton consumption, the effect of spinning systems, labor cost and demand, machinery hours and shipments, and the level of imports and exports. Third, the data was compared and conclusions were made based solely on the obvious trends in the data. Fourth, current situations in the textile market were examined in order to conclude if any have had an effect on yarn production and price. The main issues which are facing the textile industry and were included in this analysis were NAFTA, CBI, Asia and the WTO. The effect that these have had and will have on the spinning industry was examined in detail. Fifth, a statistical analysis was conducted. The analysis included the use of a correlation matrix for both yarn production levels and yarn prices in order to see which factors statistically had the strongest impact on these. Overall, this research offers a view into the inside of the U.S. spinning industry, including the dynamics which effect final yarn production levels and yarn prices, as well as situations which will have an impact on the future of the spinning industry.

U.S. TRENDS IN SHORT STAPLE SPINNING

by

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Chair of Advisory Committee

BIOGRAPHY

Erin Linnea Dodd was born on September 19, 1976 in Greeneville, Tennessee. At age five, she moved with her family to Hickory, North Carolina, where her parents still reside. Erin graduated from South Caldwell High School in 1994, and that fall she began college at North Carolina State University, double majoring in Textile Management and Latin American Studies. While there, she participated in many activities. These included being Vice President of the Panhellenic Association and Secretary of her sorority, Zeta Tau Alpha. Also, during the summer of 1995, Erin studied Spanish in Mexico. She had a summer internship with Milliken in 1998, and she graduated Magna Cum Laude from North Carolina State University in December 1998, with a Bachelor of Science degree in Textile Management and a Bachelor of Arts degree in Latin American Studies. Upon graduation, Erin entered the graduate program in Textile Technology Management, also at North Carolina State University. During this time, she was awarded membership in Phi Kappa Phi Honor Society and an Outstanding Teaching Assistant Award. After she receives her Masters of Science degree in this area in December 2000, Erin plans to continue her education by entering the Ph.D. program at North Carolina State University in Textile and Technology Management.

ACKNOWLEDGEMENTS

There have been many people who have played a role in the production of this thesis. First of all, I would like to thank Dr. William Oxenham for all of his guidance, support and patience throughout this process. I would also like to thank Dr. Tom Johnson and Dr. Cynthia Istook for their advice. In addition, I would like to thank Mark Messura of Cotton Incorporated for meeting with Dr. Oxenham and me in order to provide insight into the different aspects of this thesis.

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1 SPINNING TERMINOLOGY USED IN THIS THESIS

This thesis covers trends in yarn production and factors that may influence these trends. While is it not necessary to have a complete understanding of yarn production technology to follow the data that is presented, a comprehension of certain basic terms and concepts is essential since these are used to explain some of the major trends which are exhibited.

1. **Cotton Spinning System** refers to spun yarns that are made on machinery originally designed to process cotton (fibers with a length of up to 64 millimeters or 2.5 inches) (1).
2. **Spun Yarns** are yarns made from staple fiber.
3. **Short Staple Yarns** are a subdivision of spun yarns. They are called this due to the short length of the fibers, which are typically 25-38 millimeters.
4. **Ring Spinning** is the major spun yarn preparation system. Ring spun yarns can be made from either carded or combed fibers. The flow chart of the operations involved for converting fiber into yarn for this system is shown in Figure 1.1. A description of each of these processes is listed below.

   Opening, Cleaning and Blending is done in order to disentangle the fibers, remove impurities which may be present (cottenseed and leaf particles) and to blend different fibers together. The fibers enter these series of machines in tuft form and are usually fed to the next machine as a fiber mat

   Carding takes the fiber mat and "opens" the small fiber tufts into individual fibers and also continues the cleaning process. The fibers are fed through intermeshing wires which removes neps, or small tangles of fibers; trash; and straightens the fibers.

Once this is done, the fibers are passed through a funnel-shaped device which forms the sliver.

Drawing, or drafting, sends a multiple number of slivers through a series of rollers which attenuates the fibers in the strands. The purpose of this process is to reduce variation in linear density, straighten fibers, blend sliver and possibly reduce linear density. Depending on the end use, see Figure 1.1, the process can be done a various number of times.

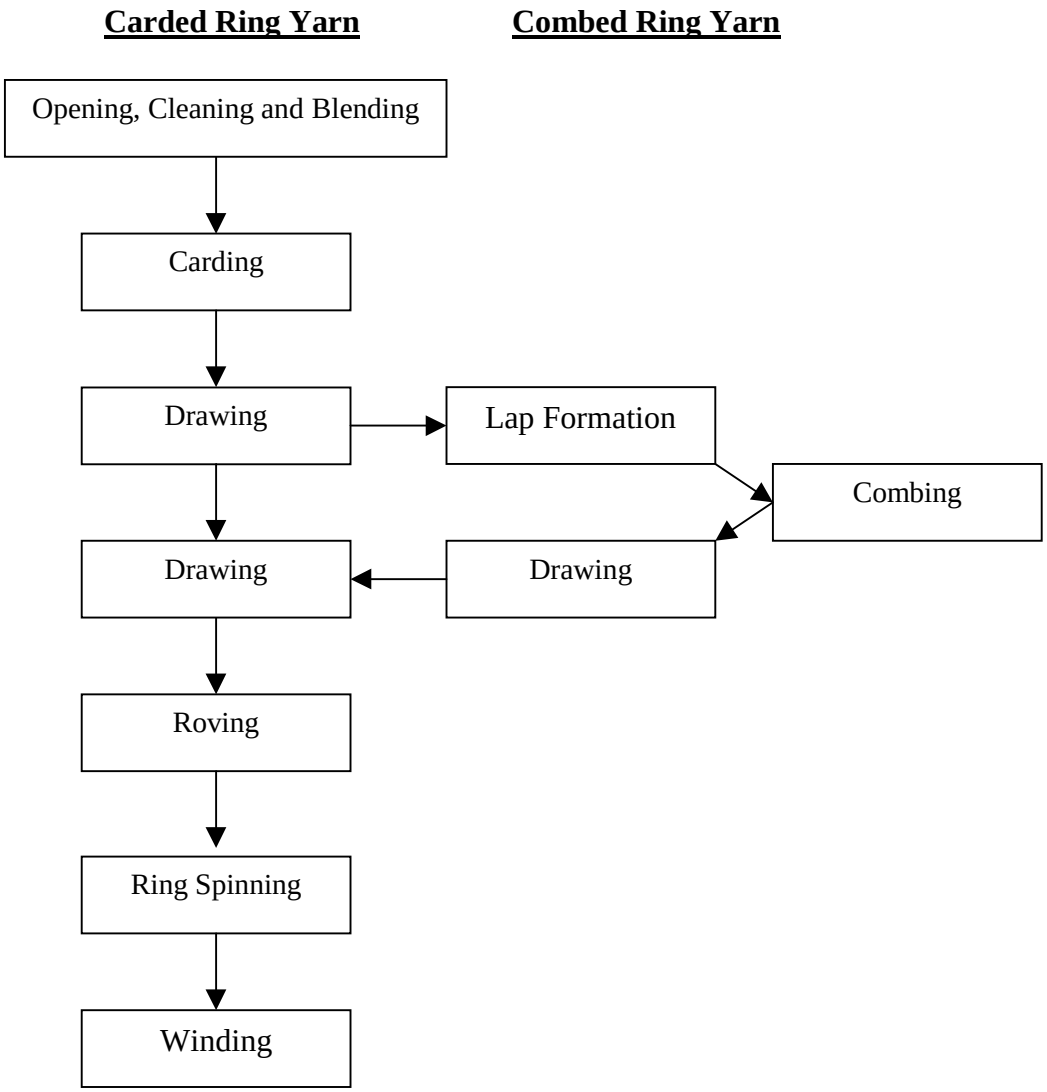

Figure 1.1: Flowchart for Carded and Combed Ring Spun Yarns

Lap Formation combines and drafts 16 to 48 slivers and forms a sheet ranging form 10.5 inches to 12 inches in width [1].

Combing removes short fibers and any remaining neps by arranging the fibers in a parallel form by passing them through a combing device. The output of this process is a combed sliver.

Roving also reduces linear density. The sliver is fed into the roving frame and passes through a series of rollers. The drafted strand is wound onto a bobbin and slight twist is added. The twisted strand on the bobbin is called a roving.

Ring Spinning is illustrated in Figure 1.2.

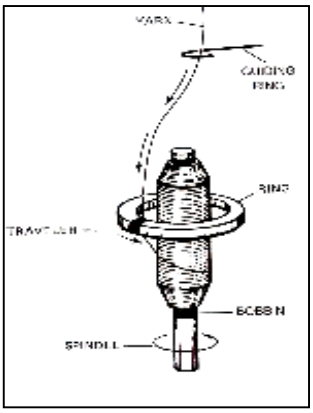

Figure 1.2: Ring Spinner [2]

The roving is fed through a drafting zone, which consists of rollers that reduce the linear density. At this point significant twist needs to be added in order to provide the yarn with an appropriate amount on strength. This is done by threading the newly formed yarn through a traveler and onto a tube. The traveler is positioned on the ring around the bobbin. In ring spinning, the yarn package rotates, which causes the yarn to wind onto the bobbin and to pull the traveler around the ring. One revolution of

the traveler inserts one rotation on twist into the yarn. The typical speed of a ring spinning machine is about 15,000 revolutions per minute (rpm). The speed depends of the count of the yarn and the diameter of the ring.

5. **Rotor Spinning**, or open end spinning, is another spun yarn preparation system. It is not quite as popular as ring spinning due to the yarns being weaker, but it produces yarn at a much faster speed, about 120,000 rpm. The flowchart of the rotor spinning process is shown in Figure 1.3.

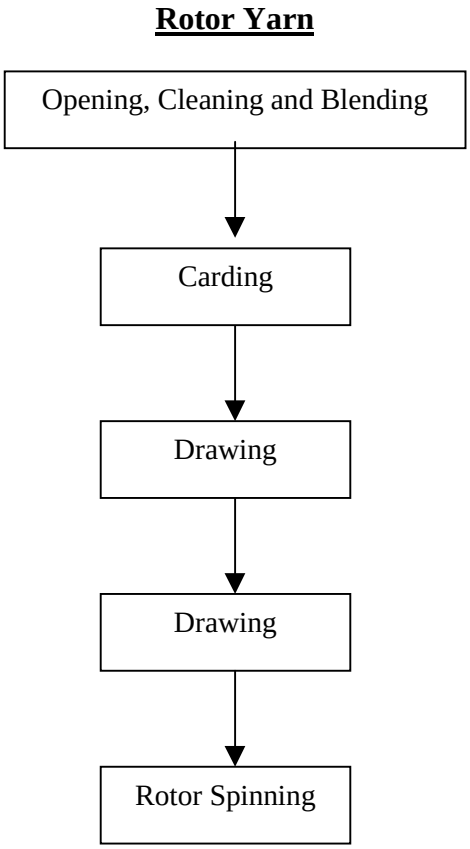

Figure 1.3: Flowchart for Rotor Spun Yarns

Most of the processes for rotor spinning are the same as for ring. The main difference is that rotor spinning does not require the roving process. Instead, the machine spins the yarn from the sliver. For this reason, rotor spinning normally produces coarser count yarns than does ring.

To produce rotor spun yarn, the sliver is fed by air into rollers which separate the fibers. These fibers are carried, also by air, to the rotor. Here, the centrifugal force of the turning rotor causes the fibers to collect around the end of the previously produced yarn. Twist is added by each rotation of the rotor, and the newly formed yarn is pulled out through the navel. Figure 1.4 shows a representation of the rotor spinning process.

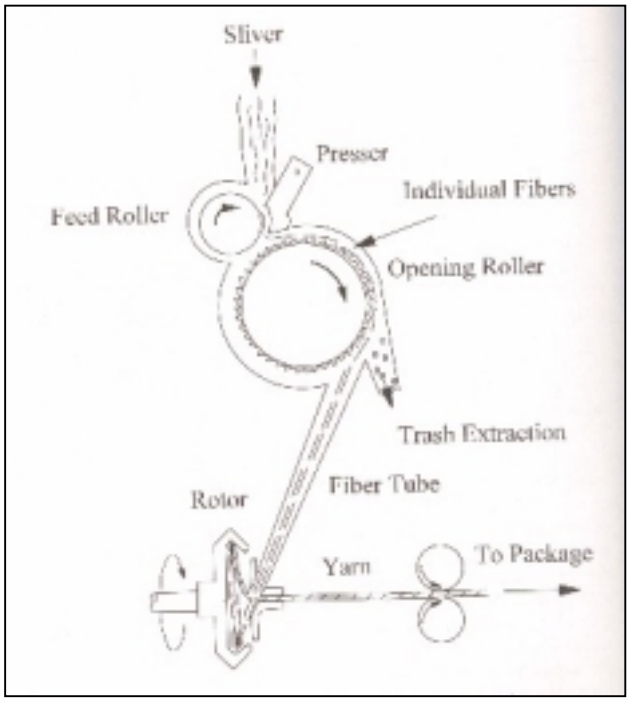

Figure 1.4: Rotor Spinning Process [1]

6. Air Jet Spinning also produces spun yarn. It produces yarn at approximately twice the speed of rotor spinning, and approximately fifteen times faster than ring spinning. The main limitation of air jet spinning is its inability to spin 100 percent cotton yarn. The flowchart for the air jet spinning process is shown in Figure 1.5.

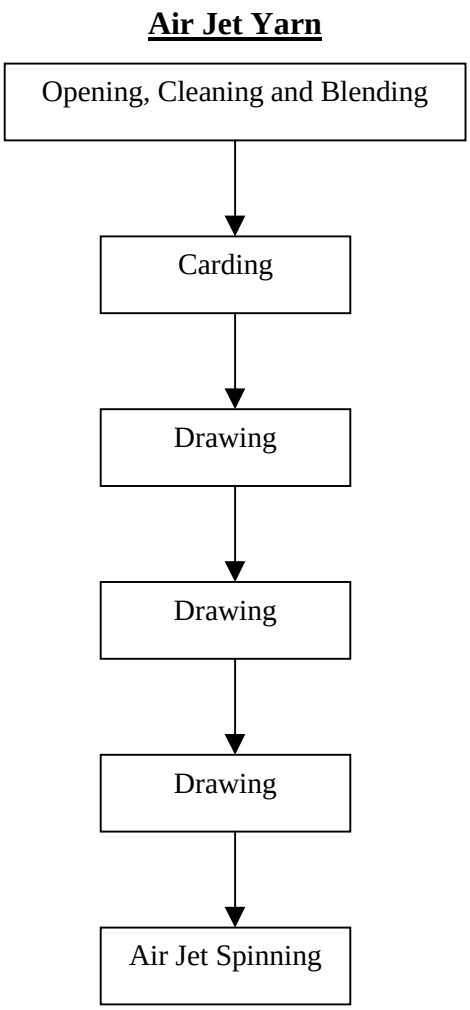

Figure 1.5: Flowchart for Air Jet Spun Yarns

Similar to rotor spinning, air jet spinning also does not require a roving process. Due to the sensitivity of the air jet machine, the sliver must be drawn three times in order to ensure uniformity.

To produce air jet spun yarns, the sliver is fed into the air jet chamber where they are twisted, first in one direction, then in the reverse direction in a second chamber. Figure 1.6 shows a representation of the air jet spinning process.

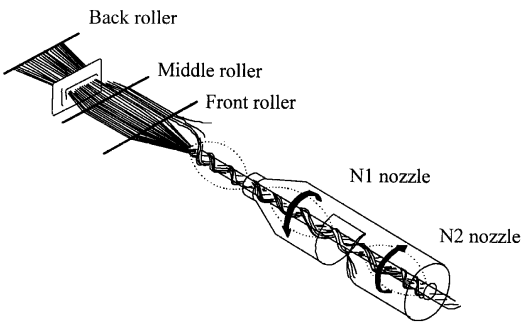

Figure 1.6: Air Jet Spinning Process [1]

2 OUTLINE OF TRADE AGREEMENTS

When analyzing the historical data and making prediction for the future, it is evident that past and future "trade agreements" are a significant factor. While there is extensive coverage of these "trade agreements" in the literature, it is thought worthwhile to overview these briefly to aid the present reader.

1. **GATT (General Agreement on Trade and Tariffs):** In 1947 GATT was formed in order to resolve international trade problems. The main goal of GATT was to liberalize trade, meaning that its objective was to free trade from the multitude of restraints which had evolved (3). Under this agreement, textile and apparel trade was governed by the same rules as other industries, until 1973 when the MFA was formed.

2. **MFA (Multifiber Arrangement):** Due to the sensitive nature of textile trade, the MFA was formed in 1973 as a framework that established quotas limiting imports into countries whose domestic industries were facing serious damage from rapidly increasing imports (4). MFA products consist of almost all the main textile and clothing product categories except those made from 100% silk and various other fibers used in small volumes (5). However, at the beginning of the Uruguay Round talks in 1986, it was decided that a method was needed which would integrate international textiles and clothing trade into the mainstream rules and disciplines of GATT, and the result was the ATC (6).

3. **WTO (World Trade Organization):** In September 1986, trade ministers met in Punta del Este, Uruguay in order to strengthen GATT and redo the trade policy areas in general. These talks which occurred as a result of the September 1986 meeting were called the Uruguay Round. When the Uruguay Round was signed in December 1993, the agreement included the establishment of the WTO. The WTO is the successor to GATT 1947 and provides the key rules for international trade. The WTO provides a permanent forum to address new issues facing the international trading system (3). It is the only global international organization dealing with the rules of trade between countries. It has a membership of 137 countries (as of June 14, 2000). These countries are shown in Table 2.1.

Angola	Cyprus	Hong Kong, China,	Mexico	Sierra Leone
Antigua and Barbuda	Czech Republic	Hungary	Mongolia	Singapore
Argentina	Democratic Republic of the Congo	Iceland	Morocco	Slovak Republic
Australia	Denmark	India	Mozambique	Slovenia
Austria	Djibouti	Indonesia	Myanmar	Solomon Islands
Bahrain	Dominica	Ireland	Namibia	South Africa
Bangladesh	Dominican Republic	Israel	Netherlands	Spain
Barbados	Ecuador	Italy	Netherlands Antilles	Sri Lanka
Belgium	Egypt	Jamaica	New Zealand	Suriname
Belize	El Salvador	Jordan	Nicaragua	Swaziland
Benin	Estonia	Japan	Niger	Sweden
Bolivia	European Communities	Kenya	Nigeria	Switzerland
Botswana	Fiji	Korea, Republic of	Norway	Tanzania
Brazil	Finland	Kuwait	Pakistan	Thailand
Brunei Darussalam	France	The Kyrgyz Republic	Panama	Togo
Bulgaria	Gabon	Latvia	Papua New Guinea	Trinidad and Tobago
Burkina Faso	The Gambia	Lesotho	Paraguay	Tunisia
Burundi	Georgia	Liechtenstein	Peru	Turkey
Cameroon	Germany	Luxembourg	Philippines	Uganda
Canada	Ghana	Macau, China	Poland	United Arab Emirates
Central African Republic	Greece	Madagascar	Portugal	United Kingdom
Chad	Grenada	Malawi	Qatar	United States
Chile	Guatemala	Malaysia	Romania	Uruguay
Colombia	Guinea Bissau	Maldives	Rwanda	Venezuela
Congo	Guinea	Mali	Saint Kitts and Nevis	Zambia
Costa Rica	Guyana	Malta	Saint Lucia	Zimbabwe
Côte d'Ivoire	Haiti	Mauritania	Saint Vincent & the Grenadines	
Cuba	Honduras	Mauritius	Senegal	

Table 2.1: WTO Members (as of June 14, 2000) (4)

4. **ATC (Agreement on Textiles and Clothing):** In 1995, the MFA was superseded by the ATC, which is overseen by the WTO. By this agreement, the textile quotas will end by 2005, and importing countries will no longer be able to discriminate between exporters (4). The phase-out of quotas is being implemented in three stages over the 10-year period. At the beginning of Stage I (January 1, 1995), the U.S. had to integrate a range of products whose imports amounted to 16 percent of total U.S. textile and clothing import volume in 1990. Once these products were integrated, they were freed from any quota restrictions, and from the possibility of quotas being introduced on those products in the future. At the beginning of Stage II (January 1, 1998), 17% of U.S. textile and clothing imports were required to be integrated. However, in the case of categories selected for integration at Stage II—and those scheduled for integration in Stage III (January 1, 2002)—products were either not subject to quotas at all, or had quotas which were underutilized. The integration of the most "sensitive" goods has been deferred until the end of the 10-year phase-out (January 1, 2005) (5).

5. **NAFTA (North American Free Trade Agreement):** NAFTA was implemented on January 1, 1994, and began liberalizing trade and investment rules among the United States, Canada, and Mexico. NAFTA encompasses the Canada-U.S. Free Trade Agreement (CFTA), which began in 1989. For textile products, the U.S. reduced tariffs and expanded quota-free access for items constructed from yarn and fiber produced by a NAFTA country. Starting in 1998, all duties on textile goods between the U.S. and Canada that qualify under NAFTA are eliminated. By 1999, over 95 percent of the U.S. duties on Mexico's textile goods that qualify under NAFTA rules

of origin will be eliminated, and at the same time, over 90 percent of Mexico's duties on U.S. textile exports that qualify will be eliminated (7).

6. **CBI (Caribbean Basin Initiative):** CBI is officially known as the Caribbean Basin Economic Recovery Act. The CBI was implemented in 1983 and now provides special trade privileges for 28 Caribbean countries in order to help their economies. Table 2.2 gives the CBI members. Although the CBI was given tariff-free access for most of their products exported into the U.S., tariffs continued on textile and apparel products (3).

Antiqua	Costa Rica	Haiti	St. Kitts
Barbuda	Dominica	Honduras	Nevis
Aruba	Dominican Republic	Jamaica	St. Lucia
Bahamas	El Salvador	Montserrat	St. Vincent
Barbados	Grenada	Netherland Antillies	Grenadines
Belize	Guatemala	Nicaragua	Trinidad
British Virgin Islands	Guyana	Panama	Tobago

Table 2.2: CBI Members (8)

7. **CBI Access Program (807A or Super 807):** Under this 1986 agreement, Caribbean apparel products are given a more liberal quota system for access to the U.S. market if fabrics are both made and cut in the U.S (3).

8. **Trade and Development Act of 2000:** This act becomes effective on October 1, 2000 and extends duty-free and quota-free benefits for apparel products assembled in the Caribbean and Sub-Saharan Africa that use fabrics manufactured in the U.S. from U.S. yarn (9).

3 INTRODUCTION

3.1 Introduction

It is impossible to exactly predict the path that the spinning industry will take in the future. It is possible, however, from historical data, to examine the different factors which can determine yarn demand, and thus, yarn production and price. The major factors examined are as follows:

- end use demand,
- cotton consumption and price,
- influence of spinning system (i.e. ring vs. rotor)
- labor—amount employed and cost,
- machinery—hours operated and shipments, and
- imports and exports of yarn.

These factors are examined from a historical viewpoint. Each one intuitively should have a relationship to production and price, whether direct or indirect, which, in turn, affects the total quantity produced. For example, cotton consumption can be used to predict yarn production. If cotton consumption increases, then most likely the amount of yarn produced would also increase. Also, if cotton price increases, the price of yarn would be expected to be affected as well. All of the factors that are considered in this section can, in turn, be affected by many other factors, all of which indirectly affect the amount of yarn produced.

3.2 Yarn Production

While exhibiting a general upward trend, yarn production varied considerably from year to year until 1990, when it began to increase steadily. But in 1994, NAFTA was implemented, and yarn production began to decrease. This trend is clearly evident in Figure 3.1. Figure 3.2 shows the yarn production over the same time scale for Mexico and Canada.

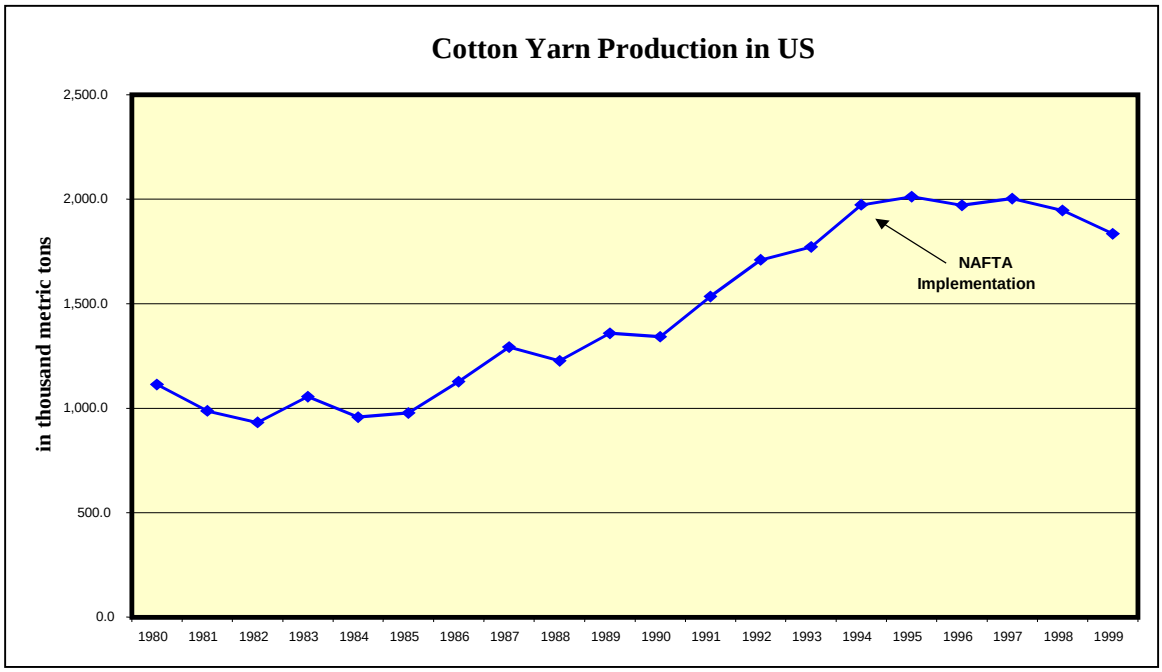

Figure 3.1: Cotton Yarn Production Since 1970 (10)

Yarn production decreased in the U.S. after the implementation of NAFTA due to the industry moving mainly to Mexico, and to a much lesser degree to Canada. Figure 3.2 shows that the yarn production of each of these countries has increased since the implementation of NAFTA. Mexico's yarn production has increased 162.42% since 1994, and Canada's has increased 48.70%. Yarn production in the U.S. has decreased 7.02%. Looking at the 162.42% increase in Mexico, it appears to be much more dramatic than the US's 7.02% decrease. But, Mexico was only producing 158.0 metric tons of

yarn in 1993, the year before NAFTA was implemented. Since 1994, Mexico's yarn production has increased by 263.6 metric tons, and the U.S. has decreased by only 138.6

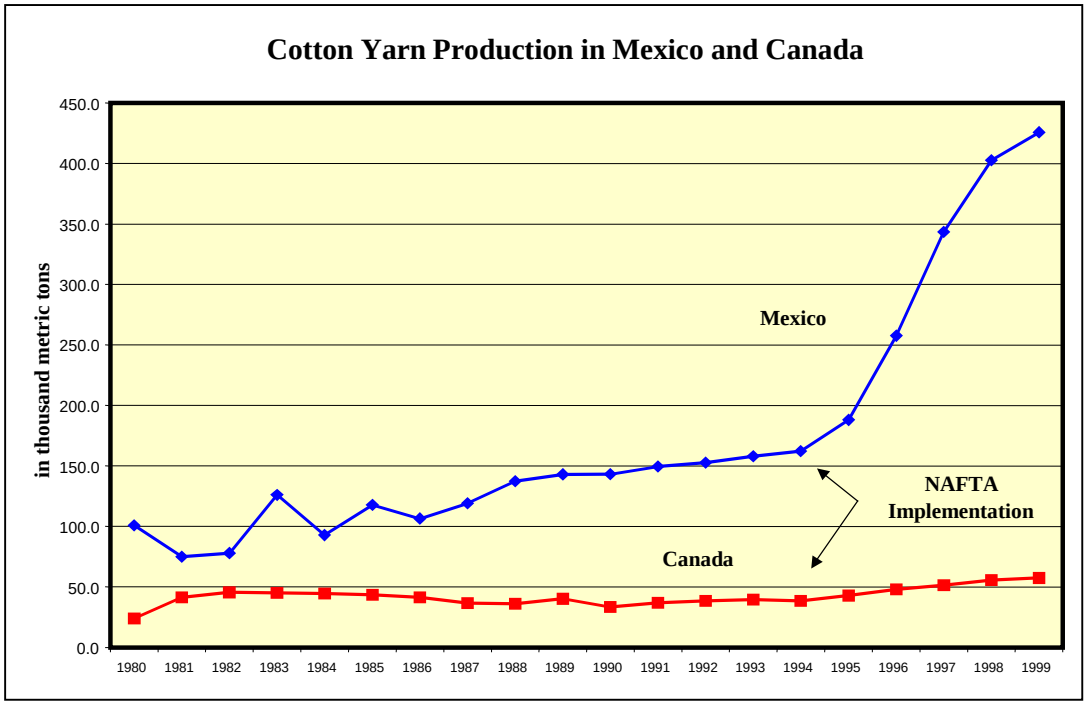

Figure 3.2: Cotton Yarn Production in Mexico and Canada [10]

metric tons. This shows that the yarn no longer produced in the U.S. is most likely being produced in Mexico. Figure 3.3 shows the total yarn produced in North America compared to that produced in the U.S., Mexico and Canada.

The total yarn produced in North America has decreased slightly in the past few years, as shown in Figure 3.3. Also, Mexico's increased production in very closely proportionate to the U.S.'s decrease in production. Figure 3.4 shows the percentages of each of these countries of total North American yarn production.

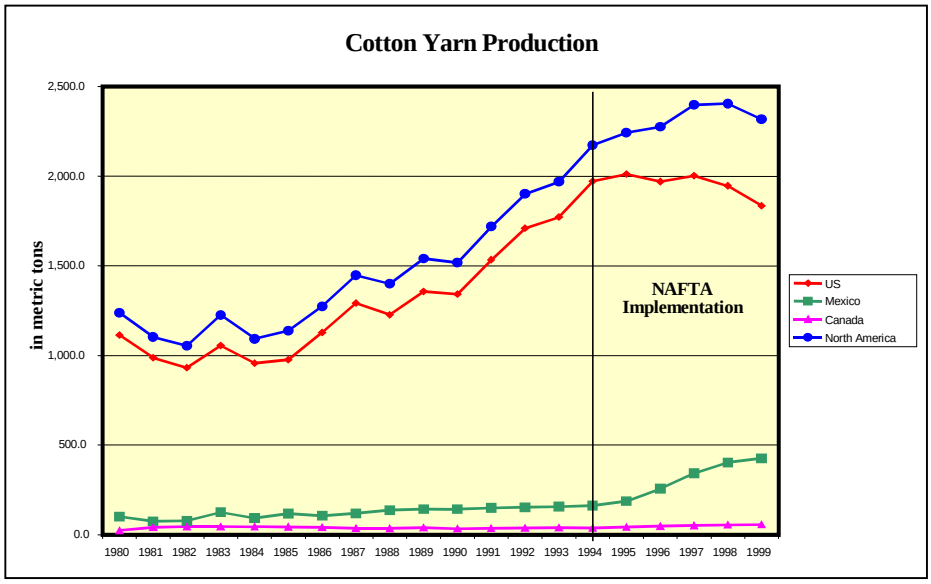

Figure 3.3: Cotton Yarn Production for North America (10)

This figure simply reinforces the points of Figure 3.3. In 1994, the U.S. produced approximately 90% of yarn in North America. In 1999, the U.S. produced a little less than 80%, but Mexico has produced the remaining 10%, with Canada's change being almost negligible.

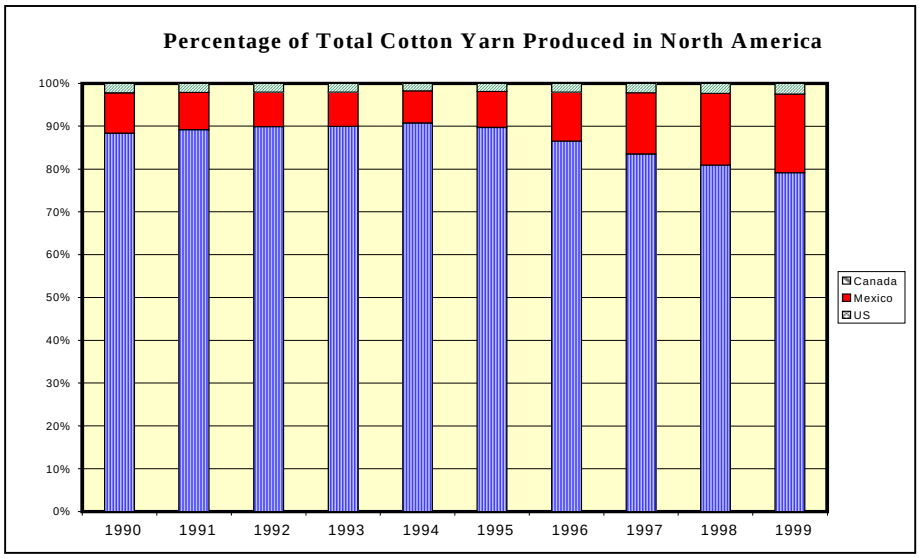

Figure 3.4: Percentage Cotton Yarn Produced in North America (10)

Also, when looking at yarn production, it is important to determine if there is any seasonality. While the data used above was annual and did not show monthly yarn production, alternative data was found useful for this analysis. Data for the cotton system spindle hours was examined, and some of this is presented in Figure 3.5.

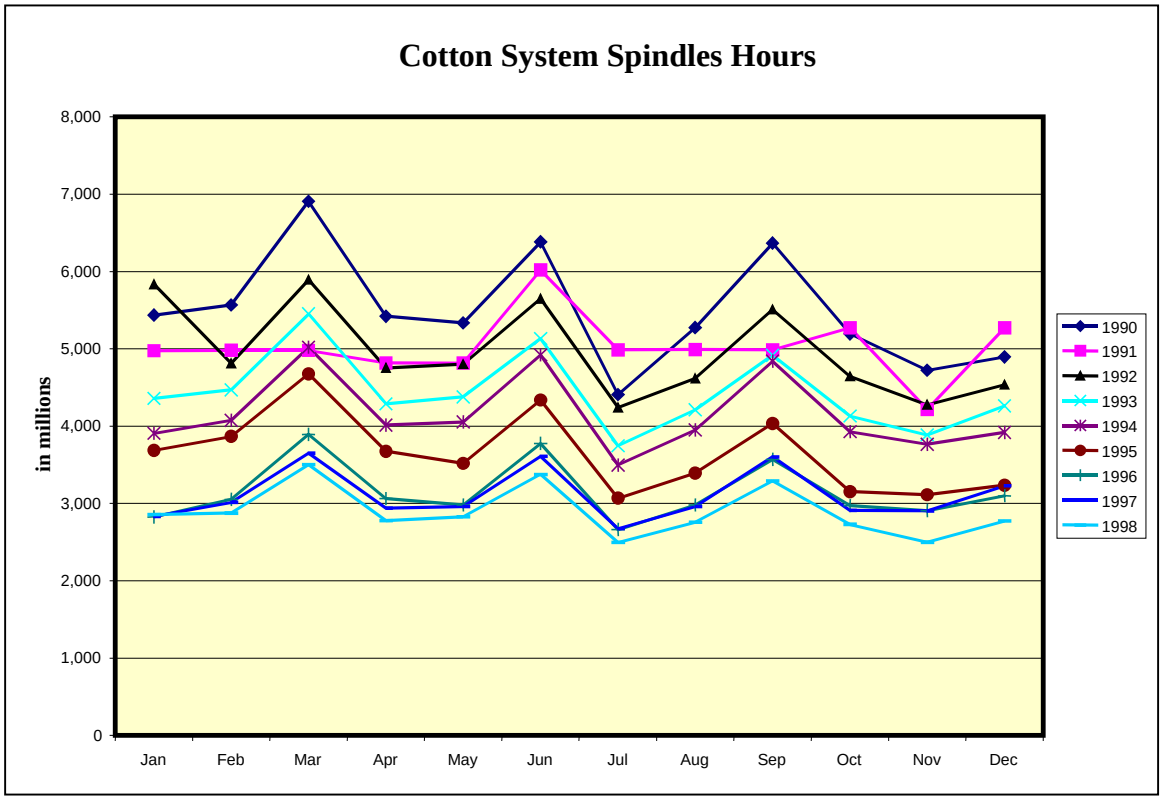

Figure 3.5: Cotton System Spindle Hours [11]

There is a definite seasonal trend exhibited in Figure 3.5, based on data obtained from the Census database. This is consistent for the most recent nine years of data. Spindle hours, and therefore yarn production, decreased in the months of July and December. The reason for this is most likely due to plant closings for July 4th and Christmas. Also, production increased in the months of March, June and September, most likely because of increased demand for summer, fall and spring fashions. These

figures show the basic trends in yarn production. The reasons causing these trends will be further examined in later sections.

Note that Figure 3.5 shows a decrease in the overall number of spindle hours from 1990 to 1998, but this graph shows hours and not yarn production. Over that time period ring spinning machines have been replaced by more productive machinery, such as rotor spinning machines. Therefore, overall production may have increased or remained stable due to higher production rates.

3.3 Yarn Price

When trying to determine the future of the spinning industry, it is important not only to look at historical yarn production, but also yarn prices. By looking at where prices have been, it is possible to recognize trends that will continue into the future. The monthly price of ring spun yarn from 1984 to present is shown in Figure 3.6.

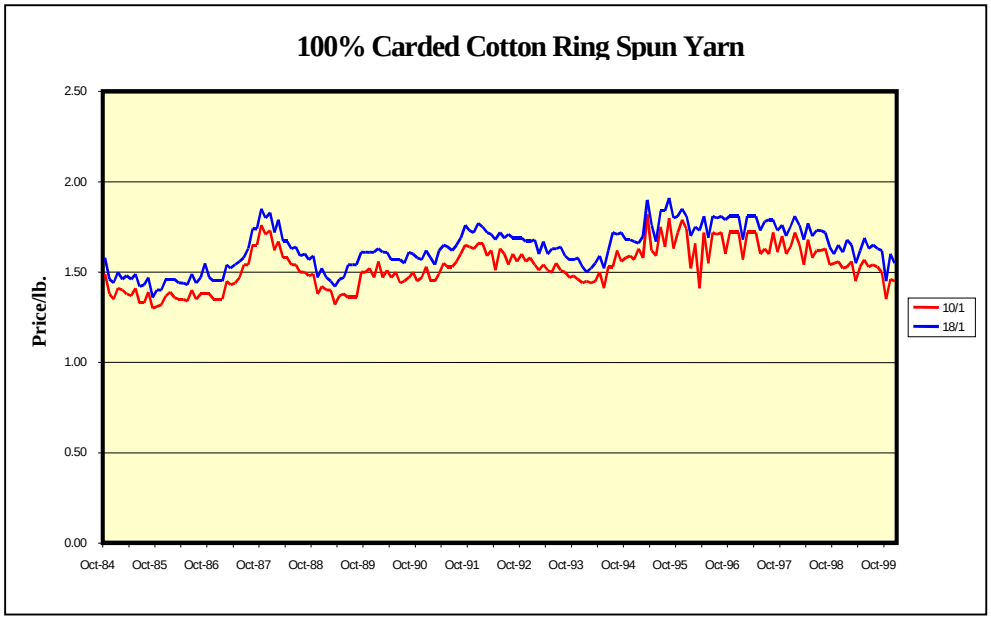

Figure 3.6: 100% Carded Cotton Ring Spun Yarn Prices [12]

Despite the variation from year to year, both fine and coarse counts have generally increased until around 1997. After that, ring spun prices have gradually decreased. In order to understand why, substitute prices need to be considered. The main substitute for ring spun yarns is rotor spun, or open end yarns. This is due to their increased productivity speeds. Figure 3.7 similarly shows the prices for rotor yarns of the same time period.

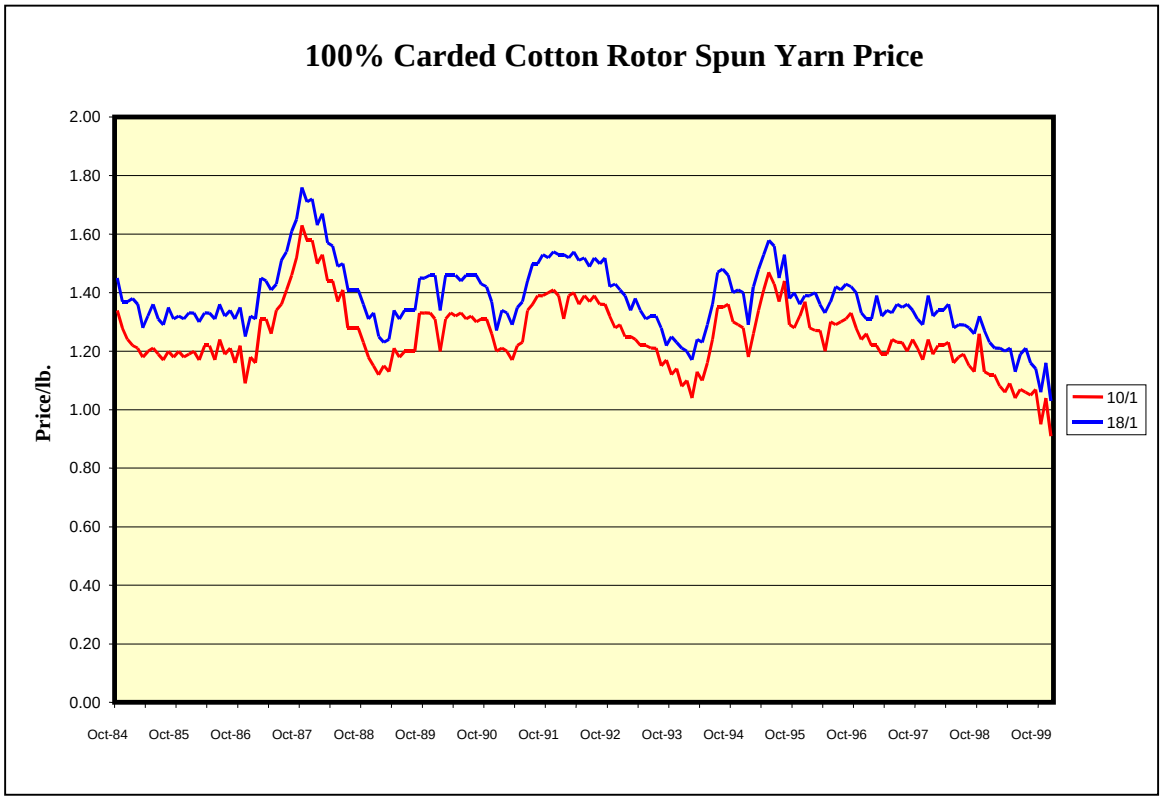

Figure 3.7: 100% Carded Cotton Rotor Spun Yarn Prices [12]

Where ring spun yarn prices have generally increased over time, open end prices have appeared to decrease. There was a large amount of variation in the price up until 1996, when prices continued to decrease, similar to ring spun yarns, but at a more rapid pace.

One of the most interesting trends is the difference between ring and rotor yarn prices. A comparison of the prices of ring and rotor yarns is shown in Figure 3.8, based on data obtained from *ATI*.

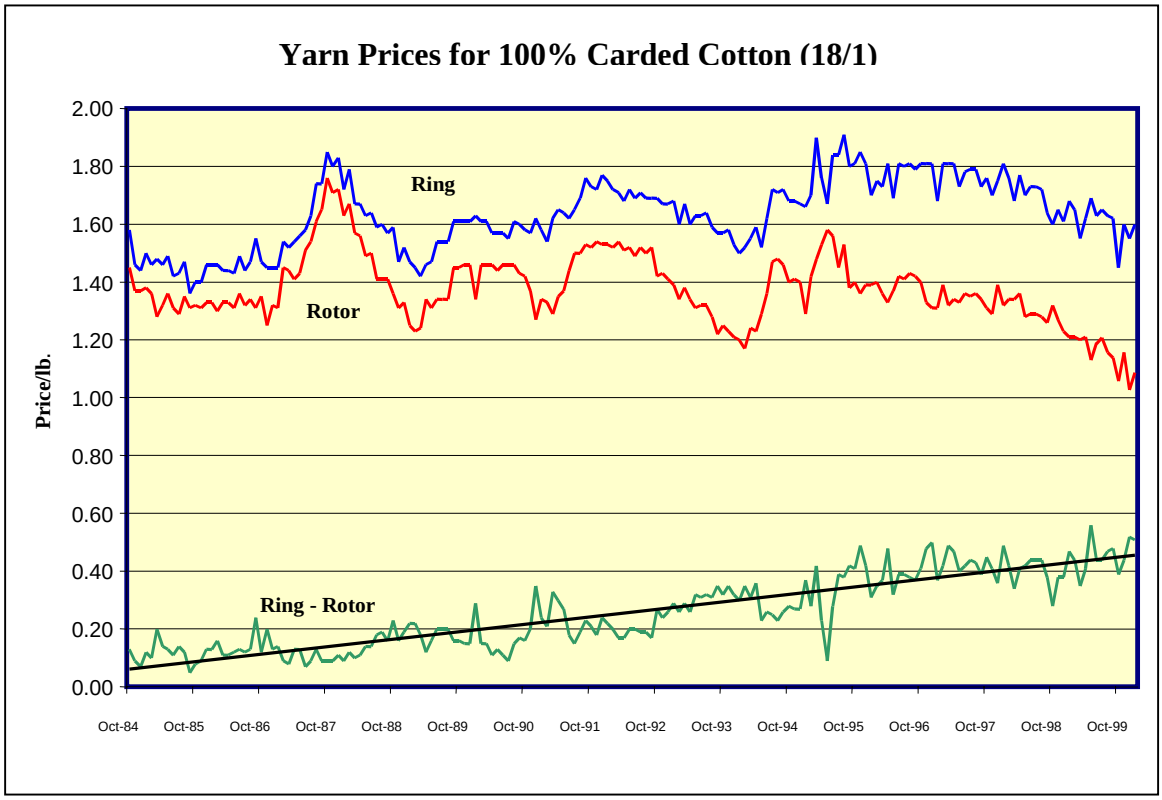

Figure 3.8: Ring vs. Rotor Spun Yarn Prices for 100% Carded Cotton [12]

The prices shown above are for 1984 to present for ring and rotor yarns of the same count (18/1 Ne). In addition, the difference between ring and rotor yarn is shown. Figure 3.9 proves that the difference in prices has increased almost linearly with time. The difference in price in October 1984 was $0.13, and the difference in January 2000 was $0.51. From this figure, it is easy to see that the price difference between ring and rotor yarns is increasing. The reason for the increasing difference in prices is that while

ring spun prices have generally increased, until 1997, rotor prices have either remained stable or fell more rapidly than those of ring spun.

Another interesting comparison is that of the prices of different counts of both ring and rotor yarns. In Figures 3.6 and 3.7, fine and coarse counts seemed to follow the same path for ring and rotor spun yarns. Figure 3.9 shows the difference between 18/1 Ne and 10/1 Ne for both ring and rotor yarn prices (18/1 – 10/1).

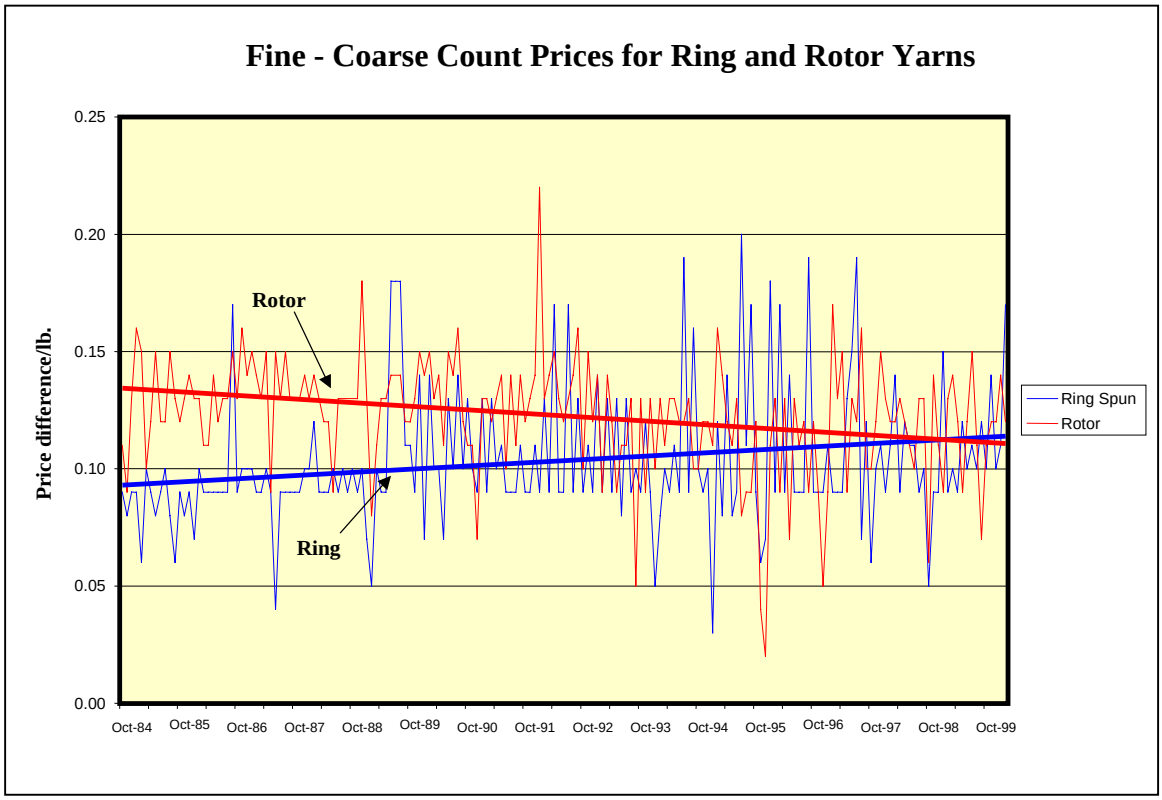

Figure 3.9: Fine (18 Ne) – Coarse (10 Ne) Count Prices for Ring and Rotor Yarns [12]

It is difficult to see the trends in the figure due to the variation. The linear trend lines have been added in order to make the trends more visible. While there is considerable variation in price with time, it appears that the difference in price between the finer and coarser counts of ring spun yarn is increasing slightly. This conclusion is

different from that for rotor yarns. The difference in price for fine and coarse counts of rotor yarns is decreasing over time.

The previous figures, generated from data from various sources, have shown the basic trends in yarn prices and production. Simply looking at the trends by themselves is not enough. It is also important to look at the factors mentioned in the first section (end use demand, cotton consumption and price, effect of spinning system, labor—amount employed and cost, machinery—hours operated and shipments, and imports and exports of yarn) to see how each of these relate to yarn production and price. By doing this and determining how each affects the other, it may be possible to gain some insight into the future of the spinning industry.

The following sections attempt to determine the impact of various factors on the trends shown in this chapter. This includes a literature survey, which was carried out primarily to discover whether any similar research had been completed in this area, and to ascertain whether trends in other areas (e.g. use of yarns in apparel, fiber stock, labor costs, etc.) could be used to explain trends in yarn production and price.

4 LITERATURE REVIEW

4.1 Introduction

In light of the fact that there has been very little research published on the specific topic of yarn production trends, this literature review will mainly focus on important issues facing the overall textile industry today. Throughout this thesis, raw data was researched and then analyzed in order to determine specific relationships to yarn production and prices. Very little of the conclusions drawn, are influenced by the opinions of other authors. Although some of the conclusions are similar to the intuitive predictions, those in the present work are based on the analysis of actual raw data.

Most of the previous "research" found in the literature dealt with the outlook for cotton together with international issues, such as NAFTA, CBI, the Asian financial crisis, the entrance of China to the World Trade Organization and the Trade and Development Act. Information was also found dealing with the outlook for the textile industry as a whole, but even these mainly referred to apparel and fabric. Very few articles even mentioned yarn, much less focused on it.

Another issue with this literature review was that for research to be relevant, it needed to be current—less than three years old. The reason for this is that with the implementation of NAFTA in 1994, many of the issues facing the textile industry have changed.

4.2 Relevant Research

One article in particular dealt with the same issues as this thesis: "Spinning's Predicted Growth" by Oxenham [13]. The article, similar to this thesis, looks at the industry from a historical perspective. But, whereas this thesis deals with only short staple yarn, Oxenham's article also refers to long staple yarn.

The main observation of the article was that an inspection of the current trend in spun yarn production, as shown in Figure 4.1, would result in a prediction of "continued growth in yarn production in the United States." This figure differs from Figure 3.1 in the introduction in the fact that this chart deals with all spun yarn and Figure 3.1 shows only the production of 100% cotton yarn. Oxenham states that this would be

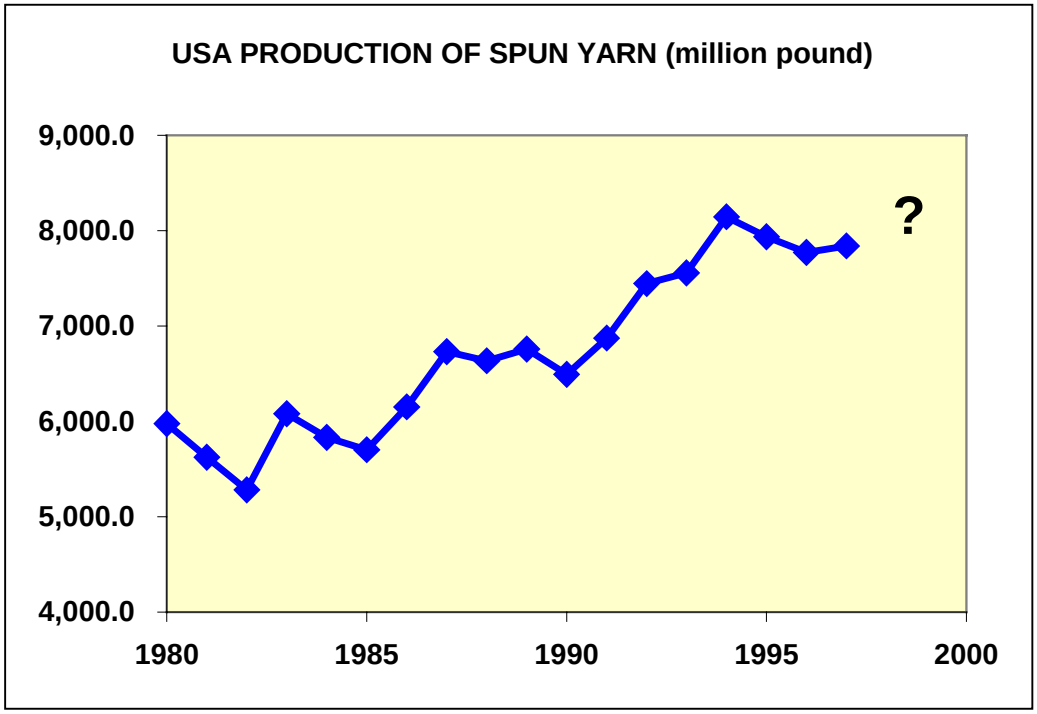

Figure 4.1: USA Production of Spun Yarn [13]

accomplished through rotor, air jet and Murata's Vortex, which are more productive systems than ring spinning. Another major point raised in this article was that even though labor costs do affect yarn costs, other factors, such as raw material and capital costs, can have a more significant impact. This statement is in accord with the results presented later in this thesis. Oxenham also shows that when North America's installation of spindles is taken as a percentage of the world total, it is obvious that a large amount of investments has been made in rotor spindles, at the expense of ring spindles. This thesis will elaborate on the issues raised in Dr. Oxenham's article.

In addition to Oxenham's article, a paper presented at the National Cotton Council 1999 Annual Meeting, also briefly addressed the issue of yarn. In this paper, Mark Lang, Director of Economic Services, discussed the reasons behind declining yarn prices. Due to the Asian financial crisis, yarn imports into the U.S. and Europe have increased substantially over the past few years. This has created a buildup of yarn stocks in these regions, which, in turn, has decreased yarn prices (14).

4.3 Outlook for Textile Industry

It can be unequivocally agreed upon that the textile industry is in a downward cycle. Production and demand have decreased, as well as employment. Stock values and profits have reached lows not seen in years. Certain causes have without a doubt played a major role in this downturn. An article in *ATI*, "Textiles on the Edge of 2000", addresses these issues (15). In this article a group of four industry analysts discussed the major problems facing the textile industry today. The analysts were as follows: Greg Keramis, senior vice president for Heller Financial, Inc.; Greg Powell, managing director

of Bank of America's Apparel/Home Furnishings/Textiles Group; Kay Norwood, textile analyst for Wachovia Securities; and Kent Phillips, managing director of Furnishings and Textiles Investments Banking for First Union Capital Markets.

All the panelists mentioned above agree that there is currently an over-capacity of textile products on the domestic and global market. As Phillips pointed out, this global over-capacity has been further aggravated by the Asian financial crisis. The U.S. textile market has experienced an influx of cheap Asian imports, which, in turn, takes the business away from U.S. manufacturers. This, combined with the decreased consumer spending in Asia, has seriously hurt domestic manufacturers. Also, the textile products which are consumed in Asia, are paid for with devalued currency, further hurting the U.S. economy.

Another problem for U.S. textile companies is that apparel prices have remained flat for the past 5 years. The prices of the raw material, yarn and fabric have continuously changed, while the price of the final product has remained the same. This means that the "middle men" have to absorb the costs. As Keramis stated, this is due to the pricing pressures and demands from the retailers. Also, an article in *Textile World*, pointed out that there has been a change in "power placement" (16). What this means is that the pricing power has changed from being with the fiber and textile manufacturers to now lying with the retailers.

Some of the problems the textile industry is facing today are temporary, such as the effects of the Asian financial crisis. Others are permanent, such as the retailer having more control over price. Every analyst agreed that in order for a textile manufacturing

company to survive in today's global economy, they must learn to react to the challenges at a faster pace.

4.3.1 Predictions for the 2000 and beyond

Many predictions have been made as to what changes the new millennium has in store for the textile industry. Some forecasters are not very optimistic, while others are. Dr. Constantine G. Soras, the economics editor for *ATI*, believes that the prospects for U.S. textile producers are not very promising for 2000 (17). On the other hand, Robert Reichard, consulting editor for *Textile World*, has a slightly more positive opinion. He has a "cautiously optimistic forecast", but he also believes that it is unrealistic for the textile industry to expect significant gains during the year 2000 (18). Whole both of these articles deal with predictions for this year, another article looks at the next 10 years. In this article, Doug Ellis, former president of the American Textile Manufacturers Institute (ATMI), has an optimistic outlook, stating that U.S. markets for textile products will grow at a 2 to 3 percent rate (19). Reichard thinks that U.S. demand for textile products this year will be only a fraction under 1999 levels, but both he and Soras stated in their articles that textile production is expected in increase by the end of this year.

Soras went even further in stating that textile production in expected to increase by 0.7 percent this year. Both Soras and Reichard believe that the price of clothing will continue to decline, but the amount of money that consumers spend on clothing will increase. Though in his article, Soras points out that many of the items bought will be imports, and because of this, the U.S. production of apparel is expected to decrease in the upcoming years. Ellis, in contrast, stated that he thinks there will be moderate overall

growth of the apparel market. In contrast to apparel, all forecasters believe that the demand for home furnishings is expected to increase, due to the high level and turnover of homes and re-urbanization. This will also have a positive effect on carpet sales.

Soras and Reichard both believe that the amount of textiles imported into the U.S. will continue to rise. One of the only differences in their articles was that Soras believed that this would increase the trade deficit. Reichard, on the other hand, believes that the imports will increase at a slower rate than previous years, and exports will also increase, reducing the trade deficit. Ellis believes that the U.S. textile market will experience only moderate growth, but world textile markets will expand rapidly as world economies grow.

Soras, Reichard and Ellis stated that the overall amount of people employed in the U.S. textile industry will decrease, but Ellis said that the demand for skilled workers will increase. Both Soras and Reichard stated that they believe wages will increase, but Reichard also believes that even though the number of people employed will decrease, the output per worker will increase by 2 to 3 percent.

Both Ellis and Soras believe that demand for industrial textile and fiber markets will increase. Ellis also stated that many of the commodity yarn and fabric manufacturers will move into more specialized, higher value added products. As far as overall textile profits are concerned, Ellis believes that profits will reach record levels and stock value will soar. Reichard was more specific in his prediction; he believes that profits and stockholder equity will increase up to 1.8 percent and 6.5 percent, respectively. If Ellis'

predictions are correct, the decade "will end up being a very good one for the U.S. textile industry" [20].

4.3.2 How to deal with changes in the textile industry

At the annual meeting of the International Textile Manufacturers Federation, Herwig Strolz, director general of ITMF, said, "We seem to have reached yet another turning point in our history, one of a structural and therefore fundamental nature. We would all be well advised to take the signs seriously and not wait for better times" [16]. In keeping with this prophecy, there have been many suggestions made on how to deal with the challenges that are currently facing the textile industry. Some of these include ideas such as product development, while others focus on global expansion.

Almost all of the analysts/forecasters mentioned above believe that the most important thing that U.S. textile manufacturers can do is focus on product development. With Asia producing low-cost staple fabrics, the U.S. needs to concentrate on developing products which cannot be produced in other markets. This includes products with better quality and design, quick turnaround and specialty, or niche, products, emphasizing "innovation, creativity and increased productivity" in order to compete with cheaper imports [16]. Barry F. Shea, CFO of Dan River Mills, gave his opinions on how to survive. They are as follow: 1) zero in on products where style, service and short lead times are essential, 2) step up research and product development to gain competitive advantage, 3) emphasize products where labor accounts for only a relatively small portion of overall costs and 4) move manufacturing facilities abroad to lower-cost countries [21]. Another point made by Keramis is that recently technical fibers have

experienced tremendous growth. This same type of growth is also available in other markets such as automotive, medical, fire safety, cosmetic and telecommunications (15). These are products that customers cannot buy anywhere else.

In addition to the suggestions of product development, analysts also agree with Shea that the manufacturing of labor intensive products should move to lower cost labor areas, such as Mexico. Norwood explains that there will still be textile manufacturing left in the U.S., but these products will be value-added products that can justify the labor costs (15). She also stated that commodity fabrics and other products that are labor intensive will have to move to Mexico or off-shore. Akio Mera, president of the Itochu Textile Institute, believes that the advanced countries will be responsible for the development of new materials, improvement of quality and overall efficiency, things developing countries are not capable of at this time. In return, the developing countries will provide the human resources that will contribute to vastly increasing world trade (16). One issue to point out is that companies that want to set up manufacturing facilities in Mexico should do so quickly. Asian companies have realized the potential benefits of producing apparel in Mexico in order to take advantage of low labor costs and no-tariff access into the U.S.

Another major issue for textile companies in the U.S. is the Agreement on Textiles and Clothing. At the end of 2005, the World Trade Organization will unify this agreement, which means that bilateral and voluntary agreements and quotas will disappear. The ITMF president, Min-Sok Suh stated at the annual meeting of ITMF last

year that “we must use this short time span to prepare ourselves for that new and much tougher competitive environment that will most likely be ours from beyond 2005” (16).

4.4 Outlook for Cotton

Just as the overall textile industry has been suffering, so has the cotton industry. Some of the reasons are related, such as increasing imports, but cotton has its own unique problems with which to deal. Whatever the reasons for the faltering cotton industry, it has had a significant impact on textile production. Due to the fact that a large amount of textiles are produced from cotton, problems facing cotton production also influence textile production.

4.4.1 Problems facing the cotton industry

Most articles researched agree that the cotton industry has been facing a difficult time the last few years. For the fifth consecutive year in a row, average cotton prices have fallen and are now around $0.54/lb. (22). Also, the Asian financial crisis has been detrimental to the cotton industry, resulting in an influx of cheap textile imports to the U.S, which has decreased the demand for domestically produced products. Another problem facing the cotton industry is that mills have had a substantial inventory of cotton and are therefore buying less (23). In addition to this, there has also been lower production in the U.S. due to lower planted and harvested area and yield as well as adverse weather conditions. Because of this, some cotton farmers are switching to more lucrative crops (24). Furthermore, low substitute prices, such as polyester, have contributed to the problems in the cotton industry.

Many of the reasons given in the researched literature for the depression in the cotton market were consistent. Mark Lang, Director of Economic Services for the National Cotton Council (NCC), stated that most of the decline in mill use was due to a decrease in apparel production, although not in the retail use of cotton products (14). With cotton consumption per capita in the U.S. rising each year, (it reached 35 lbs. in 1999), it is surprising that there would be a decrease in apparel production. But as Lang pointed out, "the answer is simple: textile imports" (14). A speaker at the 2000 NCC Annual Meeting agreed that the problems facing the cotton industry can be attributed to the continuing decline in U.S. apparel production due to pressure from imported textile and apparel products (25).

Lang also pointed out that the decline for the demand of cotton can be attributed to 1) market share loss to cheaper fibers and 2) loss of consumer purchases because of rising unemployment and lower incomes across much of Asia (23). Focusing on the market share lost to cheaper fibers first, it seems that Terry Townsend, Executive Director of the International Cotton Advisory Committee, also agrees. He pointed out that through July 1999, U.S. polyester prices were an average of 10 cents lower than cotton prices (22). Because of this, cotton's share of world fiber market fell from about 50 percent in the 1980s to 42 percent in 1998 and 1999 (22). Lang explained that due to the Asian crisis, many of the cotton producing countries there are now producing textile products with a high man-made fiber content because of the lower cost (23). This, by itself, has hurt the cotton market. Secondly, focusing on the effects of the Asian financial crisis on the cotton market, Lang commented that demand for cotton and cotton products

in that region has been "battered" (23). When China moved from a net importer of cotton to a net exporter, it took away a large market for U.S. cotton. China imports for the 1999/00 season were essentially zero (22). Historically, China has been the number one export market for U.S. cotton, but recently, China has imported significantly less U.S. cotton and has been offering its own cotton on the world market (26). This increase in exported cotton is the result of China's efforts in reducing their own significant inventories.

Due to the Asian crisis, the U.S. dollar strengthened against most currencies and resulted in a flood of less expensive textile imports. U.S. consumers purchased more Asian and non-NAFTA/CBI products than domestically or NAFTA/CBI produced goods. As Lang pointed out, this is not a permanent reversal, but only a temporary set back (14). He continued to say that because of the huge currency devaluation in this region, these countries needed a market for their products, which had previously been distributed to the now recessionary markets. Therefore, Asia began exporting their products to the strong economies of the U.S. and the European Union. Because the Asian countries were desperate to sell their products, they sold them at a much cheaper cost than competing products. This, in turn, has slowed mill use and driven down the prices of U.S. textile mill products and resulted in lower profits as well as lower cotton consumption. Obviously, the financial crisis in Asia has had a tremendous negative impact on the U.S. cotton industry. Fortunately, this is not a permanent situation.

4.4.2 Reasons for optimism

Literature published since the beginning of 2000 shows signs of increasing optimism. One paper, presented at the 2000 NCC Annual Meeting, cited the factors which have led to this positive outlook (25). These factors are as follows:

- the rebound of world mill use of cotton is faster than anticipated and driven by a more vigorous than expected recovery of the Asian economies,
- strengthening polyester prices have reduced the competitive disadvantage faced by cotton in many markets and
- Chinese cotton policies appear to be having the desired effect of reducing that country's cotton surplus.

Townsend also agrees with these reasons and stated that because of them, demand for cotton is expanding to a record for the 2000/01 crop season (22). Also leading to an increase in the demand for cotton is the recent surge of cotton use in U.S. home furnishings. In 1998, cotton use in this market increased by 10.5 percent from the previous year to 14.5 million bales. This resulted in cotton's share of the domestic home furnishings market increasing to 40 percent (25). Pete Burr, an agricultural economist with the USDA, co-wrote an article which explained how during the last 25 years, cotton consumption has failed to grow when the world GDP growth was less than 2.3 percent. Fortunately for the cotton industry, GDP data for the 4th quarter of 1998 saw the highest quarterly growth in over two years. Burr states that "if growth continues near this level,

retail demand for cotton may rise further, which in turn could push mill use higher than currently projected" (24).

As stated earlier, however, cotton consumption and demand on the consumer level was never a problem. The problem was that much of the cotton products purchased by U.S. consumers were imports. With the economic situation in Asia stabilizing, this should result in a more even playing field, with Asian products being priced closer to other products. Lang points out that the highest percentage of U.S. imports come from Mexico, and upward of 80 percent of these textile imports contain U.S. cotton (23). Since the price of Asian imports is increasing, this should allow the NAFTA and CBI countries to gain the market share lost to Asia during their financial crisis.

4.4.3 Impact of Trade Policies

As mentioned earlier, NAFTA's impact on the cotton market has been positive. Ignoring the effect of the Asian financial crisis, which is only temporary, Mexican imports have gained market share at the expense of competing Asian imports. More than two-thirds of the apparel exported by Mexico into the U.S. contains U.S. cotton, yarn and fabric (15).

Similar to NAFTA, a Caribbean trade bill is before Congress which would give preferences to the use of U.S. cotton and cotton textile components in the CBI (27). This CBI bill would hopefully give duty and quota free access to:

1) apparel assembled in the Caribbean region from fabric that was cut in the U.S. and formed in the U.S. from U.S. yarn,

2) apparel assembled and cut in the Caribbean region from fabric that was formed in the U.S. from U.S. yarn and assembled with U.S. sewing thread, and

3) apparel made from knit and woven fabric formed in the CBI region from U.S. yarn (27).

Ron Rayer, President of NCC, testified before a House of Representatives Subcommittee that this CBI parity bill could increase the demand for U.S. raw cotton and U.S. cotton yarn by at least one million bales annually within three years. He also stated that this increase in demand would not be at the expense of the U.S. trading relationship with Mexico (27). He pointed out that this bill should only be a trade preference bill and not a free trade agreement, arguing that allowing Caribbean apparel and fabric to qualify would enable U.S. competitors to benefit from this trade preference. Doug Ellis also agrees with the idea of expanding trade policies to the CBI stating that "if it is working in Mexico—why not the Caribbean" (20).

It is impossible to look at the future of the cotton industry without addressing the impact that China's entry into the WTO will have. China would have to cut import barriers, which would create a significant opportunity to increase U.S. cotton exports. Under this agreement, China would permit imports of 743 thousand metric tons of cotton at a duty of one percent. This volume would grow to 894 thousand metric tones by 2004. Imports above these levels would face a higher duty of 76 percent, which would be reduced to 40 percent by the year 2004 (28). A representative of the USDA stressed that unless Congress grants China permanent normal trading relations status, U.S. competitors would benefit from the agreement while U.S. agriculture loses out (29).

4.5 Outlook for Trade

There has been a considerable amount of heated dispute about the benefits of the different trade policies. The most current discussions surround the possible accession of China into the WTO and the Trade and Development Act, which includes Africa and the Caribbean. Also of controversy is NAFTA. But, due to the recent surge of Asian imports, textile manufacturers are beginning to realize the potential of this arrangement, as well as the CBI Parity.

4.5.1 NAFTA

While there has been a lot of disagreement about the positive and negative effects of NAFTA, most textile industry analysts concur that this agreement is necessary for U.S. textile companies to compete in a global market. Kay Norwood explained that despite the effects of the Asian financial crisis, Mexican imports were 2.6 times those from China. She stated that without NAFTA, this garment production would have undoubtedly gone to Asia. Because of NAFTA, U.S. fabric producers were at least provided with an opportunity to sell their products (30). Another analyst, Lucinda Vargas who is Dallas Fed's senior economist, testified that NAFTA led to U.S. textile and apparel exports increasing by close to 40 percent in 1994, with an average increase of 27 percent a year between 1996 and 1999 (31). Despite the over 3 billion dollar trade deficit that the U.S. currently has with Mexico for textile and apparel products, two-thirds of the apparel imported from Mexico contain U.S. cotton, yarn and fabric (32). Bill Walsh, Head of the Department of Textile Engineering at Auburn University, explains how data such as this has given NAFTA a "bad name". He points out that even though apparel production and both apparel and textile employment are all decreasing, textile

production is actually increasing. Walsh states that "these figures are at the root of the general misunderstanding of what is going on in the industry today" (33). He goes on to explain that apparel manufacturing makes up only one-third of all textile production in the U.S.; the other two-thirds being home furnishings and industrial/technical fabrics. The last two have been relatively unaffected by the changes brought by NAFTA. As for apparel, despite technical advancements, the labor in sewing is still very high. Because of this, apparel manufacturers have realized the benefits of making fabric in the U.S. and sewing it in Mexico and the Caribbean. He writes that manufacturers have realized this is the most effective way to compete with Asian producers, and statistics prove this to be true, since Mexico has surpassed China as the major exporter of apparel to the U.S (33).

Even with all the optimism surrounding NAFTA, some still believe it has only damaged the textile industry. When Milliken & Company closed their Gaffney plant on June 25, 2000, Richard Dillard, Milliken's Director of Public Affairs, blamed it on the growth of imported textile and apparel products from China, the Far East, Mexico and the Caribbean. He cited figures from the Bureau of Labor Statistics, which stated that since NAFTA passed in 1993, the U.S. textile industry has lost 134,000 jobs and the U.S. apparel industry has lost 319,000 jobs. This results in a combined total of 453,000 jobs lost in the textile and apparel industries since NAFTA's inception (34). Another representative from Milliken, John F. Nash Jr., says that NAFTA countries are not "real markets" but "manufacturing platforms" for products being re-exported to the U.S. He continues in warning that when textile quotas are phased out and China becomes a member of the WTO, that nation will "submerge everyone else" (35).

An article, which appeared in the July 1999 issue of *American Sportswear & Knitting Times*, addressed the effect of international trade on the U.S. garment production industry. The author, Seth M. Bodner, wrote that despite the pre-NAFTA promises that textile production would remain in the U.S., Burlington, Cone and Guiford all moved a majority of their production to Mexico. Bodner also stated that as more and more companies shift their production south, the trade imbalance will continue to grow. One organization, Public Citizen, agrees that pre-NAFTA assurances have failed to materialize. On their web page, they explain that despite the fact that the central focus of pro-NAFTA campaigning was the promise of hundreds of thousands of new, high-paying U.S. jobs, NAFTA has led to widespread job loss. They claim that the fact that job growth totally unrelated to NAFTA has produced a net gain in U.S. employment, this in no way changes the reality that NAFTA has cost large numbers of individual workers their jobs. Most of these are now unemployed or working at jobs that pay less than the ones they lost (36). The Public Citizen organization also focuses on the trade deficit issue. They state, on the same web page, that NAFTA has transformed the U.S.' $1.7 billion trade surplus with Mexico in 1993 into a projected $14.7 billion deficit for 1998 (36). Upon confirming this data using the same census web page cited in the report, the actual year-to-date trade deficit with Mexico is $10.04 billion (37). In light of all the various statistics shown as to whether NAFTA is beneficial or detrimental to the U.S. textile industry, it all comes down to what the individuals and organizations quoted above believe is the ultimate goal of this trade agreement.

4.5.2 Trade and Development Act of 2000

With NAFTA, it is easy to see the positive and negative sides of this agreement. On the other hand, the Trade and Development Act was only recently passed and will not go into effect until October 1, 2000. Because of this, none of the outcomes resulting from this act can be quantified, and therefore, it is harder to make specific conclusions.

CBI

There are many proponents of the Caribbean Basin Initiative (CBI) legislation of the Trade and Development Act. Many see this as expanding a NAFTA-type agreement to the Caribbean and further allowing the U.S. to displace imports from Asia. Roger W. Chastain, president of the American Textile Manufacturers Institute stated that this legislation will provide many U.S. textile companies with real export advantages and opportunities in the Caribbean, specifically U.S. apparel and yarn manufacturers (38). He said that studies estimate the gains are valued at an estimated $8 billion in added sales for U.S. textile mills (39). Another major textile organization also endorsed this trade agreement. The American Apparel Manufacturers Association (AAMA) believes that this bill represents a "win-win for U.S. consumers, as well as apparel manufacturers and related businesses (40). Jim Jacobsen, chairman of the AAMA, believes that the CBI legislation will spur economic growth and reinforce democratization efforts in many of the world's poorest countries. He also stated that this would enhance the competitiveness of apparel producers throughout the Western Hemisphere.

One web site referred to specific statistics which have contributed to this optimism towards this bill. On-line Textile News posted an article entitled "White House Fact Sheet: Details of the Trade and Development Act of 2000. This article cited that

since the enactment of the Caribbean Basin Economic Recovery Act (CBERA) in 1984, U.S. exports to that region have more than tripled to $19 billion in 1999. This site also described how expanding the CBI program, to extend preferential tariff treatment to certain textile and apparel products assembled from U.S. fabric, would encourage additional U.S. exports of cotton and yarn. As a result, U.S. investment in that region would strengthen as well as the international competitive position of the domestic textile industry (9).

Sub-Saharan Africa

Some advocates of the CBI legislation believe that the Sub-Saharan Africa trade section of the Trade and Development Act would only hurt the U.S. textile industry. In particular, Chastain stated that the provisions of this section of the trade agreement would have a "damaging impact on the segments of the U.S. textile industry that produce apparel fabric and yarn (38). His reasons for concern arise from the portion of the legislation that allows for increased apparel imports from Africa that do not contain U.S. yarn or fabric. Chastain suspects that Africa might target individual apparel product categories, which would greatly increase the potential damage this bill might have on U.S. textile jobs and production. Kay Norwood explains how she views the Sub-Saharan Africa portion of the Trade and Development Act as not particularly positive or negative for the U.S. textile industry. She continued in pointing out that the group of 48 African countries only accounted for one-half percent of apparel imports into the U.S. in 1999 and because of this it is hard to see much harm or benefit in this legislation (30). She did point out that the potential problem with the Sub-Saharan Africa trade bill comes from "China's stated intention to use this free trade with Sub-Saharan Africa as a means of

illegally transshipping its goods to the U.S." (30). In her opinion, this would be a disaster, since China could flood domestic markets with no controls whatsoever. Some speakers, who went before Congress, also addressed the issue that reduced quotas and tariffs on African imports would allow Asian textiles to flood the U.S. market. Opponents claim that by Asia shipping their products through African nations, domestic jobs could be lost. To dispute this, proponents say that the bill contains certain stipulations, such a 35 percent local content requirement and a provision that eligible goods must be "substantially transformed" in Africa, in order to thwart significant transshipment of Asian textiles (41).

In addition, the Sub-Saharan legislation has received opposition from labor, environmental and human rights groups. Their reasoning is that they believe this bill is simply "trade replacing aid" (41). When this bill went before Congress, Representative Charles Rangel (D-NY) argued that the increased trade would not automatically benefit Africans. He, as well as Africa advocacy organizations, feel that trade enhancement programs must also be linked to effective poverty reduction, social investment, debt eradication initiatives, and accountable government if they are to achieve long-term success (41). Furthermore, the sections of the bill that do acknowledge the importance of foreign aid and debt relief do not do so in any concrete way.

On the contrary, other sources claim that the 48 countries of Sub-Saharan Africa constitute a market of more than 700 million people and that the U.S. would benefit significantly from the two-way trade (9). Due to this, the legislation has had strong support from many African diplomats and business people. Paul Theron, executive

director of the South African Clothing Federation, predicted that because of this bill, South African output could double over the next three years in order to meet U.S. demand [42]. Even though South Africa is considered a "developed" country, while many others in Africa are not, this bill will hopefully have a positive impact on all the countries' economies.

4.5.3 China's Entry into the WTO

Recently, there has been many heated disputes surrounding China's entry into the World Trade Organizaiton. Much of this controversy has centered around the fact that China has a history of "playing dirty" and is now demanding a quota phase-out by 2005, like the other WTO members. Chastain said that, "China steals our nuclear secrets, they steal our intellectual property, and they have one of the worst records in the world on human rights and labor and environmental standards" [39]. He believes that WTO membership will not change China's behavior, since it has already broken all six of the previous bilateral textile trade agreements with the U.S. [43]. It is estimated that China currently illegally smuggles billions of dollars worth of textiles and apparel into the U.S. each year, which also violates earlier trade agreements. This transshipment takes jobs away from the U.S. As one author put it, "if this is the engagement, what would the marriage be like?" [44].

When ATMI went before the U.S. House of Representatives' Subcommittee of Trade, Committee of Ways and Means, in order to address China's accession to the WTO, the speaker, Charles Moore, pointed out that granting China a 5-year phase-out period is simply bad trade policy. Moore continued in saying that it would be "an

abnegation of the principles of equity and equal treatment which are (or should be) the cornerstones of the WTO" (45). He believes that when the WTO agreed to a 10-year period, they did so because the time was necessary for both developed and developing countries to make the adjustments needed. China, which is the world's largest exporter, is entering with only a 5-year phase-out. WTO members must be allowed ten years to make the further adjustments newly required (45).

ATMI commissioned a study by Nathan Associates, which found that once China gains quota-free access to the U.S. market, its share of apparel imports will grow from its current 9 percent to more than 30 percent, costing the U.S. textile and apparel industry more than 150,000 jobs. These jobs will be lost on top of the ones which will occur by the phase-out of quotas by the end of 2005 (46).

Despite all of these reasons, there are still those who believe China's accession into the WTO will be beneficial. In a report by the United States International Trade Commission, it was estimated that the phasing-out of China's textile and apparel quota's in 5-years would have a positive impact on the U.S. economy by resulting in gains of $2.4 billion (47). Another source pointed out that China has a population nearly 10 times that of the U.S., and trade experts believe that country could be a tremendous market for U.S. clothing, home furnishings, industrial textiles and other products, if its trade barriers are taken down (35). In this same article, the author stated how the agreement received high marks from both the U.S. government and the U.S. textile and apparel industries, although no specific examples were cited.

4.5.4 Agreement on Textiles and Clothing

Surprisingly, not much literature has been published about the effects that the ATC might have on the textile industry. Reasons for this could be due to the fact that 1) it will definitely happen, so there is no use in arguing about it and 2) it has not happened yet. Currently, it is hard to see what changes the U.S. textile industry has incurred. During the first seven years of this 10-year transition period, 93 percent of the trade in textiles and apparel will remain restricted. Until January 1, 2005, 89 percent of the quotas on clothing will remain in place (48). The author of the article, which cited these statistics, believes that this is the U.S.'s way of avoiding the liberalization of the ATC.

No matter the reasons, 2005 will be very hard for the U.S. In a recent speech, Norwood explained how the elimination of quotas and tariffs will make 1998 look like "kid's play" (30). She continues by saying that companies that are not competitive now, with significant protection in place, do not have a chance of surviving in 2005. Companies that are not already preparing for this by positioning themselves for a new work trade order in five years, "need to get on with it" (30). In an article featured in *Textile World*, their Washington Correspondent, James A. Morrissey, stated how that because of the elimination of quotas, the industry has turned to exports as a way to soften the blow (35). He wrote that while no one thinks exports can ever offset the impact of imports, industry trade experts believe the development of overseas markets is the key to survival in a global textile marketplace.

Dr. Konrad Neundörder, in an article featured in *Textile Asia*, gave his predictions of what will happen in 2005. First off, he said that he did not believe free textile trade to

be achievable by this time. He gave two scenarios of what he thinks could be the possible outcomes. The first scenario is that American producers will overturn the liberalization, and Europe will follow, but Neundörder does not see this as very probable. His second scenario is that all the terms and conditions of the ATC will be carried out by 2005, but all of the protective measures will be used, specifically environmental measures and social clauses (49).

Much concern has arisen about this agreement because of certain environmental issues. An article by Kevin Watkins, a senior policy adviser for Oxfam, focused on these concerns surrounding the ATC. He wrote that because of the WTO, "the environment, your rights as a consumer, and those of the world's poorest people are under attack" (50). He pointed out that under this agreement governments are entitled to use trade restriction against products on scientifically established health grounds, but cannot limit imports because of social or environmental concerns over the way they are produced.

Whatever the opinion, quotas and tariffs will be phased out by 2005. Hopefully, this global trading market will be beneficial for the U.S. textile industry. With NAFTA and the Trade and Development Act, the U.S. may be able find successful manufacturing platforms that will help them compete in the 21st century.

5 METHODOLODY

5.1 Use of data

As indicated earlier, the data available in various databases was "conditioned", and the selected data was transferred to Excel spreadsheets for further analysis. The majority of figures included in this thesis are constructed from these spreadsheets. Thus while, for example, Figure 7.1 cites (11), Census Bureau, as its source, it must be emphasized that data has been constructed from several yearly reports, and the charts are "orignals", constructed by the author.

5.2 Census Database

Perhaps the most important data found for this thesis was from the Census database accessed via the Internet. The United States Census Bureau is part of the U.S. Department of Commerce. The purpose of the Census Bureau is to collect and provide "timely, relevant, and quality data about the people and economy of the United States"(11). There were two main databases used for this thesis: "Consumption on the Cotton System"(11) and "Yarn Production" (51). Both of these reports were available on the Internet from 1993 to 1999. The preceding years were available at the North Carolina State D.H. Hill Library.

5.2.1 Consumption on the Cotton System

The data used from the report "Consumption on the Cotton System" included consumption and stocks of both domestic and foreign cotton and spindle data, including the number of spindles in place, as well as the number of active spindles and hours

operated. Also included was data on manmade fibers and linters, but these were not used due to their irrelevancy.

The data in this report was collected monthly and annually mainly for the Commerce Department's Office of Textile and Apparel and the Department of Agriculture. Figure 5.1 shows an example of a section of a table from this report.

The Department of Agriculture uses the data to make forecasts for the following year's cotton crops. The Commerce Department uses the data to determine market trends and other related activities. Also, trade associations, in addition to the commodities market, use the data for similar purposes.

Table 7. CONSUMPTION, STOCKS, AND SPINDLE ACTIVITY ON THE COTTON SYSTEM, BY INDUSTRY GROUPS

Product description	Unit of measure	All industries, Total	Weaving mills (SIC 221, 222, (223, and 224)	Yarn and thread mills (SIC 228)	All other industry groups
March 1997					
Domestic and foreign cotton:					
Consumption	Bales	1,009,775	571,634	419,832	18,309
Stocks	Do.	675,637	426,811	228,342	20,484
Manmade fiber staple:					
Consumption	1,000 lbs	143,483	81,162	47,374	14,947
Stocks	Do.	53,280	27,983	18,395	6,902
Cellulosic:					
Consumption	Do.	16,264	9,490	5,009	1,757
Stocks	Do.	9,054	3,183	5,343	528
Noncellulosic:					
Consumption	Do.	127,219	71,664	42,365	13,190
Stocks	Do.	44,226	24,800	13,052	6,374
Spindle activity:					
Spindles in place	Thousands	5,769	3,250	2,278	201
Active spindles	Do.	5,443	3,040	2,247	156
Hours operated	Millions	3,640	2,002	1,548	90
February 1997					
Domestic and foreign cotton:					
Consumption	Bales	810,605	450,406	346,019	14,180
Stocks	Do.	660,774	414,730	226,982	19,062
Manmade fiber staple:					
Consumption	1,000 lbs	120,834	68,593	39,960	12,281

Figure 5.1: Example of Data Table From Report "Consumption on the Cotton System" (11)

In this thesis, the data was used to see past cotton consumption trends, inventory trends and spindle trends. Once these trends were identifies, they were compared to yarn production and price trends in order to determine what type of relationship, if any, existed.

5.2.2 Yarn Production

The data used from the report "Yarn Production" contained the data on spun yarn production broken down by type of spinning system, yarn and geographic area. Also of importance to this thesis was information on domestic output, exports and imports of yarn.

Unlike "Consumption on the Cotton System", the data for "Yarn Production" was collected annually. In some instances, this made comparison difficult. Figure 5.2 shows an example of a data table from this report.

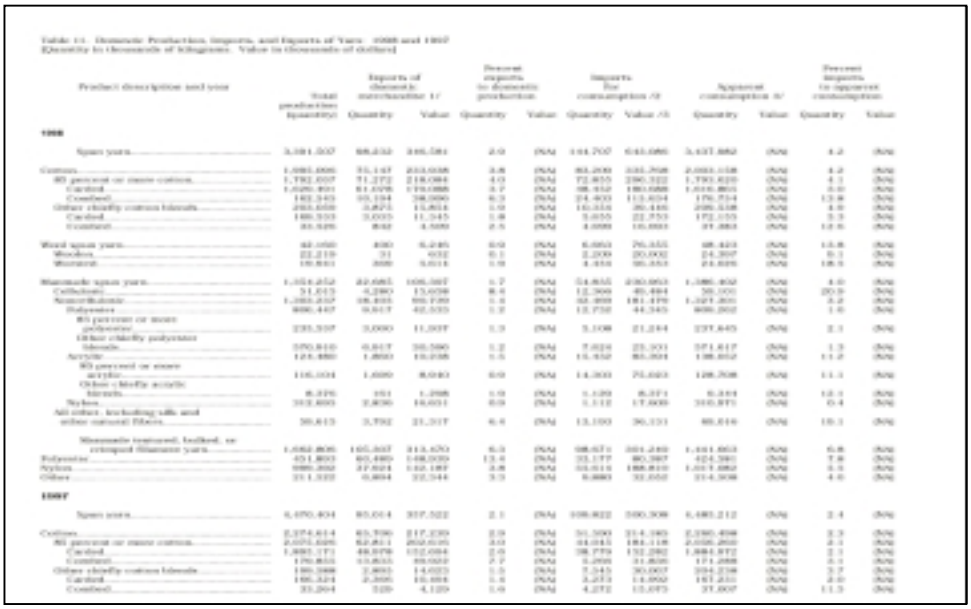

Figure 5.2: Example of Data Table from Report "Yarn Production" (51)

Like the first report, “Yarn Production” is also used mainly by the Commerce Department’s Office of Textile and Apparel and trade associations for similar purposes.

5.3 *America’s Textile International*

ATI magazine is produced monthly and provides “complete coverage of North America’s rapidly-changing textile industry” (52). Data was extracted from each edition beginning in 1984. The data included information found in the “Yarn Market” section of each issue. An example of one month’s report is shown in Figure 5.3. The data used most from this section is that dealing with the prices of cotton fiber and carded and combed cotton yarns.

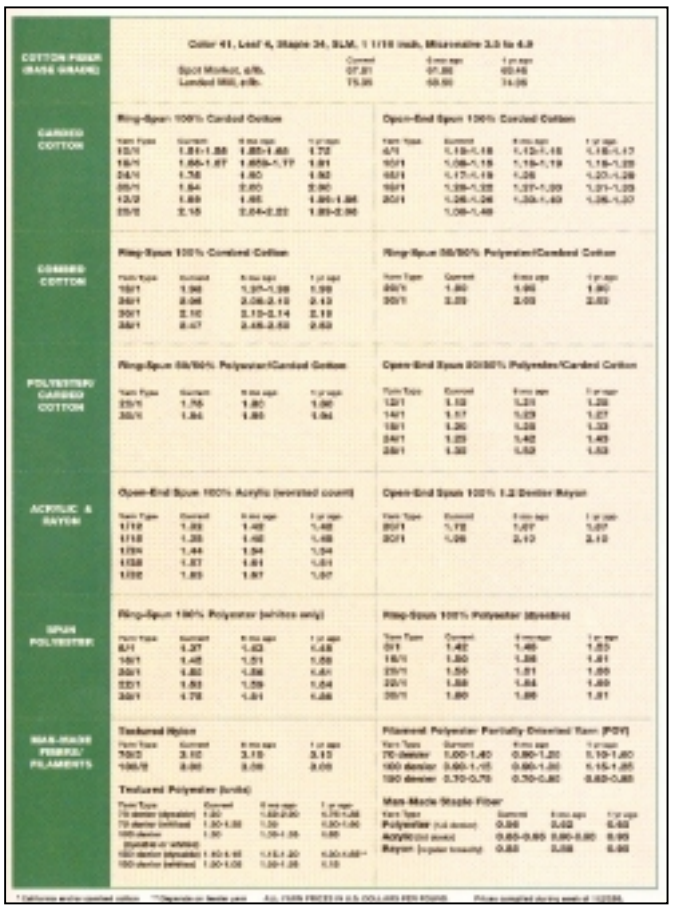

Figure 5.3: Example of Yarn Market Table (12)

The data listed in the “Business & Financial” section was also used in this thesis. The most important data here was the U.S. textile and apparel market indicators. Data was extracted dealing with employment numbers, average hourly earnings, textile production index, apparel retail sales, textile manufacturers’ sales, inventories, inventory-sales ratio, imports and exports. An example of this chart is shown in Figure 5.4.

The data was collected from each issue of *ATI* and put into a Microsoft Excel spreadsheet. Once all the data was entered, it was analyzed by charting certain factors in order to see the basic trends.

Textile Barometers

U.S. TEXTILE/APPAREL MARKET INDICATORS:	Latest month	Previous month	Year ago
Employment (Bureau of Labor Statistics, thousands)#	584.8	588.4	611.12
Production workers (BLS, thousands)#	493.9	497.1	518.12
Average hourly earnings (BLS)#	$10.50	$10.44	$10.16
Weekly hours worked (BLS)#	41.3	41.1	41.9
Unemployment rate, textile mill workers (BLS)#	3.7	3.2	7.2
Textile production index (Fed. Reserve Board, 1992=100)	111.7	112.6	114.1
Knit goods production index (FRB, 1992=100)*	119.2	121.1	115.7
Man-made fibers output index (FRB, 1992=100)*	102.9	107.3	105.4
Textile capacity utilization (FRB)	82.6	83.3	85.2
Consumer price index, apparel ex footwear (BLS, 1982-84=100)	129.3	129.5	129.2
Producer price index, textiles & apparel (BLS, 1982=100)†	122	122.3	122.9
Man-made fibers (1982=100)#	106.8	107.3	110.4
Processed yarns & threads (1982=100)#	111.3	111.9	114.2
Gray fabrics (1982=100)#	119.1	118.7	121.7
Finished fabrics (1982=100)#	122.6	123.6	123.7
Home furnishings (1982=100)#	123.2	123.2	123
Carpet (1982=100)#	123.9	122.8	124.1
Apparel retail sales (Dept. of Commerce, billions)	$10.386	$10.306	$9.902
Textile manufacturers' sales (DOC, billions)*	$6.593	$6.491	$6.855
Inventories (DOC, billions)*	$10.310	$10.307	$10.314
Inventory-sales ratio*	1.564	1.588	1.506
Imports (DOC, millions, year-to-date total)#	$56,650.0	$50,856.0	$51,099.0
Exports (DOC, millions, year-to-date total)#	$14,810.0	$13,207.0	$14,601.0
U.S. ECONOMIC INDICATORS:			
Employment (BLS, millions)	132.154	131.677	130.575
Unemployment rate (BLS)	4.4%	4.6%	4.6%
Disposable personal income (DOC, billions, annual rates)	N/A	$6,096.6	$5,884.0
Real disposable personal income per capita (1992$, a.r.)*	$19,896	$19,861	$19,437
Consumption outlays, clothing (DOC, billions, a.r.)	N/A	$253.097	$240.923
Industrial production index (FRB, 1992=100)	131.8	132.2	129.9
Housing starts (DOC, millions, a.r.)	1.649	1.694	1.523
Consumer price index (BLS, 1982-84=100)	164.3	164.0	161.8
Foreign exchange value of dollar (FRB, March 1973=100)	94.23	93.89	96.37

Not seasonally adjusted, otherwise all indicators adjusted for seasonality.
* October, otherwise latest month is November.

Figure 5.4: Example of Business & Financial Table [53]

5.4 International Textile Manufacturers Federation (ITMF)

ITMF is “an international association for the world's textile industries, dedicated to keeping its world-wide membership constantly informed through surveys, studies and publications and through the organization of annual conferences, participating in the evolution of the industry's basic raw materials and their application, through specialized committees, with the overall objective of creating growth and prosperity in all aspects of the industry” (54). Most of their publications are released once a year or once every two years. The main publications used in this thesis were “International Production Cost Comparison”, “International Cotton Industry Statistics” and “International Textile Machinery Shipment Statistics”.

5.4.1 “International Production Cost Comparison”

The report entitled “International Production Cost Comparison” gave information on the different cost factors for producing ring spun and rotor spun yarns, as well as knitted and woven fabrics for different countries. The cost factors included waste, labor, power, auxiliary material, capital and raw material to give the total manufacturing cost. Also included was a comparison of different factors for each country. These were the average hourly wages, average operating hours, cost of electric power, cost of buildings, annual building maintenance, depreciation, customs and sales tax, capital interest rate and raw material costs.

This report was published every two years. Unfortunately, the report was only available back until 1995. Another problem with this report was that the countries

included in 1995 were not all the same as the ones included in 1997 or 1999. But the U.S. data is the most important for this thesis and was included in each report.

5.4.2 "International Cotton Industry Statistics"

This report showed data on spinning machinery statistics. It gave the number of spindles installed at the end of each year, the average number active during the year and the hours worked per active machine for both ring spindles and open-end rotors. This data was shown by continent, then by country. The report is published annually.

5.4.3 "International Textile Machinery Shipment Statistics"

This report is very similar to the "International Cotton Industry Statistics" report. Both deal with machinery statistics. In this report, though, data is given on about short, long and rotor spindles. The information deals with the number of spindles installed for that year, the cumulative shipments for the past 10 years, and the number shipments for that year. The data is given both by both continents and by country. Unfortunately, this specific report was only available for 1998, but *Open End Report and Fiber News* prints this data annually, and was available back through 1988. Since this journal only released the data by continent, it created a problem because data for the U.S. could not be deciphered from the North America data. Therefore, this report was not as helpful or used as extensively as the other two.

6 TRENDS IN END USES

6.1 Introduction Trends in End Uses

When trying to determine what the future holds for the cotton yarn industry, it is important to look at what cotton's market share has been historically. This was done by extracting data from the National Cotton Council's publication *Cotton Counts Its Customers*. The data which was used contained information on the total amount of U.S. produced materials consumed by sector, the amount of U.S. produced cotton used by sector and cotton's percentage share of the total U.S. textile production market by sector. The sectors which were used for this chapter were "Apparel", "Home Furnishings", and "Industrial".

6.2 Total Materials Consumed

Figure 6.1 shows the total materials consumed by sector for the U.S. from 1977 to 1998. Home furnishings have consumed the most amount of material, and this sector has generally increased except for a large drop from 1995 to 1997, but it increased in 1998. Apparel, on the other hand, began to steadily decrease in 1994 and from this chart, the amount of materials consumed appears to be continuing this trend. This can most likely be attributed to the increase in foreign, cheaper apparel imports. The amount of materials consumed in the industrial sector has gradually increased since 1986. These observations are in accordance with the literature researched in the Literature Review (Chapter 4).

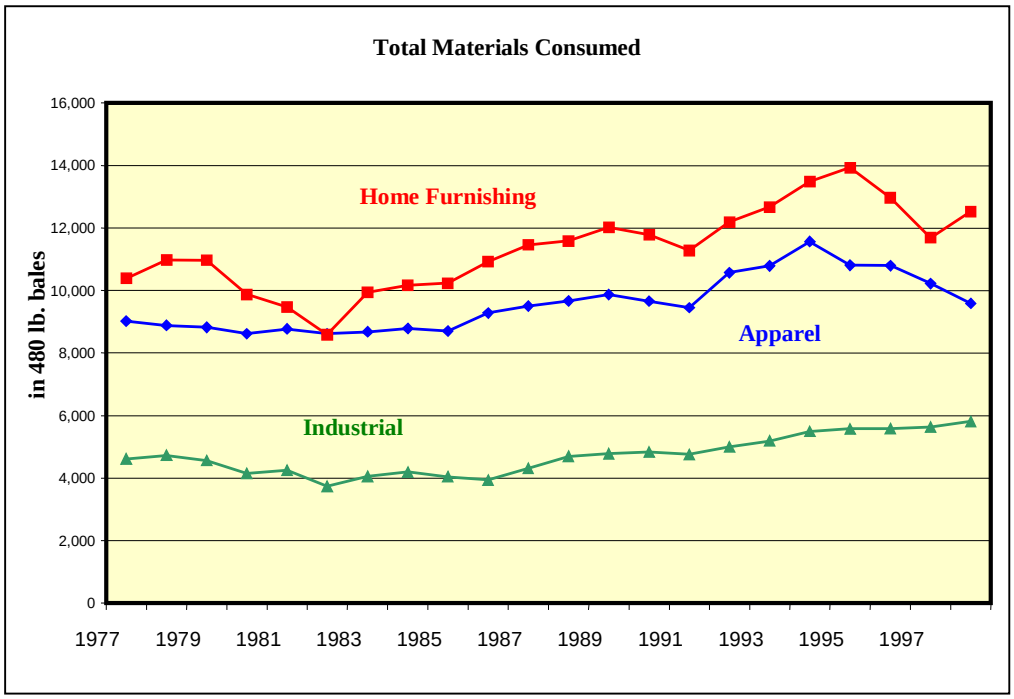

Figure 6.1: Total Materials Consumed by Sector [55]

6.3 Cotton Consumed

Since this thesis deals with 100 percent cotton yarn, it is important to examine the amount of cotton consumed by sector. This is shown in Figure 6.2 for the same time period as Figure 6.1.

Here, cotton's percentage of the apparel market has increased dramatically since 1989, increasing from around 55 percent to around 68 percent. In the home furnishings market, cotton's market share was only around 20 percent until 1995, where it increased up to around 35 percent in 1998. A lot of this can be attributed to the advancements made in wrinkle resistant 100 percent cotton sheets. The amount of cotton used in industrial textiles was never very large, but has continuously decreased since 1986. One important aspect to note is that some industrials textile do not contain yarn, but are made

from nonwovens. Knowing that the amount of cotton used is decreasing is important, since some of this is yarn, but it is also important to understand that the amount of cotton used as yarn would only be a small share of cotton fiber used.

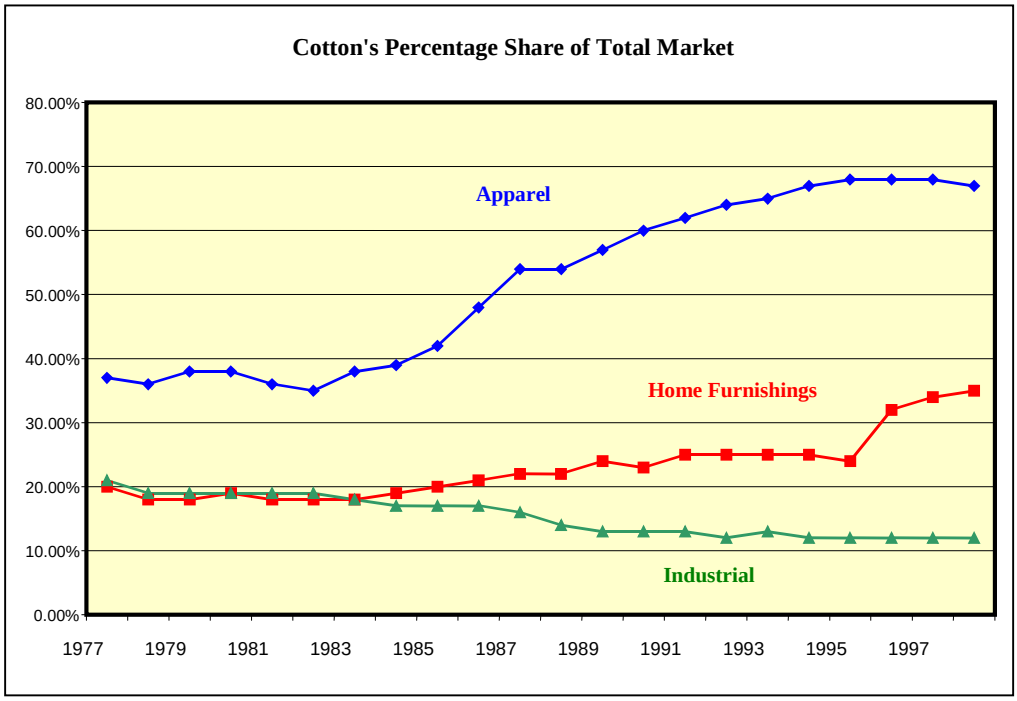

Figure 6.2: Cotton's Percentage Share of Total Market [55]

In order to tie these two charts together, the amount of cotton consumed by each sector was examined. This is shown in Figure 6.3 over the same time frame as the two previous charts. This chart shows that even though the cotton's percentage of the apparel market is growing, the decrease in apparel production levels shown in Figure 6.1 are still causing the total amount of cotton consumed in U.S. manufacturing industry to decrease. The amount of cotton consumed in the home furnishings market is increasing. The amount of cotton consumed in the industrial market has decreased by almost 300 thousand pounds since 1977, which is consistent with the data shown in the two previous

figures, which showed that the industrial market was growing, but cotton's percentage of this market was falling, no doubt replaced by cheaper synthetic fibers.

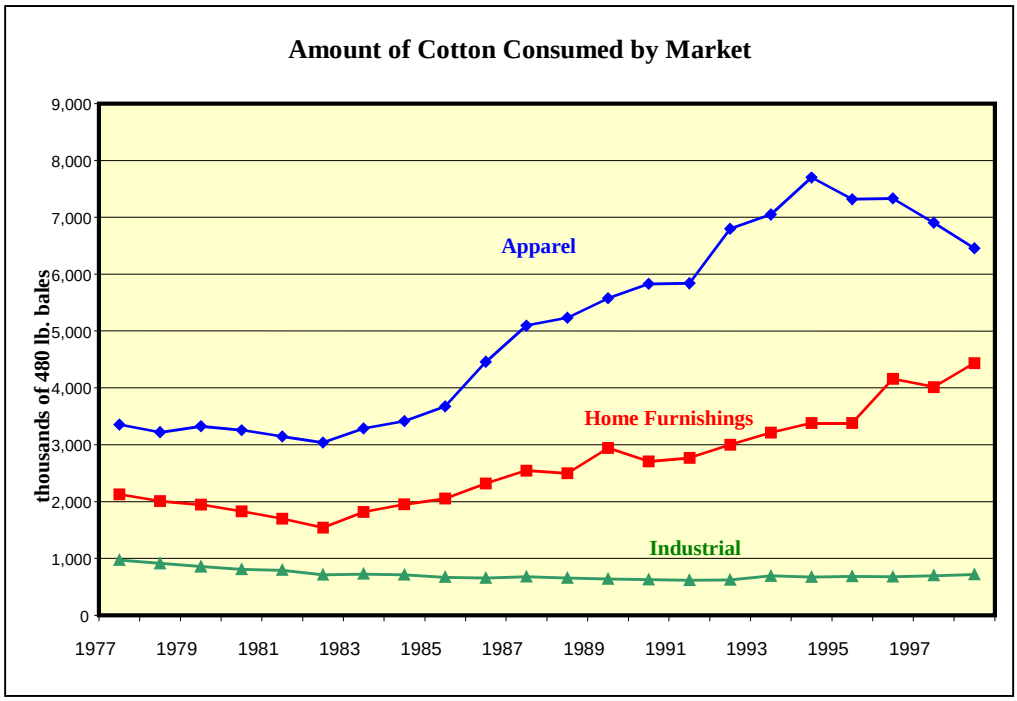

Figure 6.3: Amount of Cotton Consumed by Market [55]

6.4 Conclusions Based on Trends in End Uses

The conclusions which can be drawn from this chapter are as follows:

- The total amount of materials consumed in the U.S. industry supplying the home furnishings market decreased from 1995 to 1997, and increased in 1998.
- The total amount of materials consumed in the U.S. industry supplying to the apparel market has decreased steadily since 1994.
- The amount of materials consumed in the U.S. industry supplying to the industrial market has increased steadily since 1986.

- Cotton's percentage of the home furnishings market has increased since 1995.
- Cotton's percentage of the apparel market has increased since 1989.
- Cotton's percentage of the industrial market has decreased since 1986.
- Even though cotton's percentage market share of the apparel market is increasing, the overall decrease in apparel production is resulting in a decrease in the amount of cotton consumed by the apparel sector.

7 TRENDS IN COTTON

7.1 Introduction to Trends in Cotton

Cotton trends play an important role when trying to determine the future of the spinning industry. This is because raw materials are a major cost of yarn production. Due to this, the price of cotton has a tremendous impact on the price of yarn. Also, cotton consumption can provide some insight into the amount of yarn spun in the future, depending on the lag time. This section will analyze the historical trends in cotton consumption and price and its relationship to yarn.

7.2 Cotton Consumption

Figure 7.1, constucted from data obtained from the Census Bureau, shows cotton consumption in the U.S. since the beginning of 1980. A trendline was added in order to see the basic trend through the large amount of variation. Cotton consumption has increased steadily from around 1983 to the middle of 1996, where it began to decrease. As explained in the Literature Review (Chapter 4) of this thesis, the decline in the demand for cotton is most likely due to the Asian financial crisis. Also, it appears that since the implementation of NAFTA, in the beginning of 1994, there has been a slight decrease in overall cotton consumption.

Figure 7.2 shows cotton consumption compared to cotton price, in this case for the last 10 years. A trendline was also added here to show the long term picture. This chart shows to some extent an inverse relationship. As cotton price decreases, consumption increases and vice versa. The reasons for this will be examined later in this section.

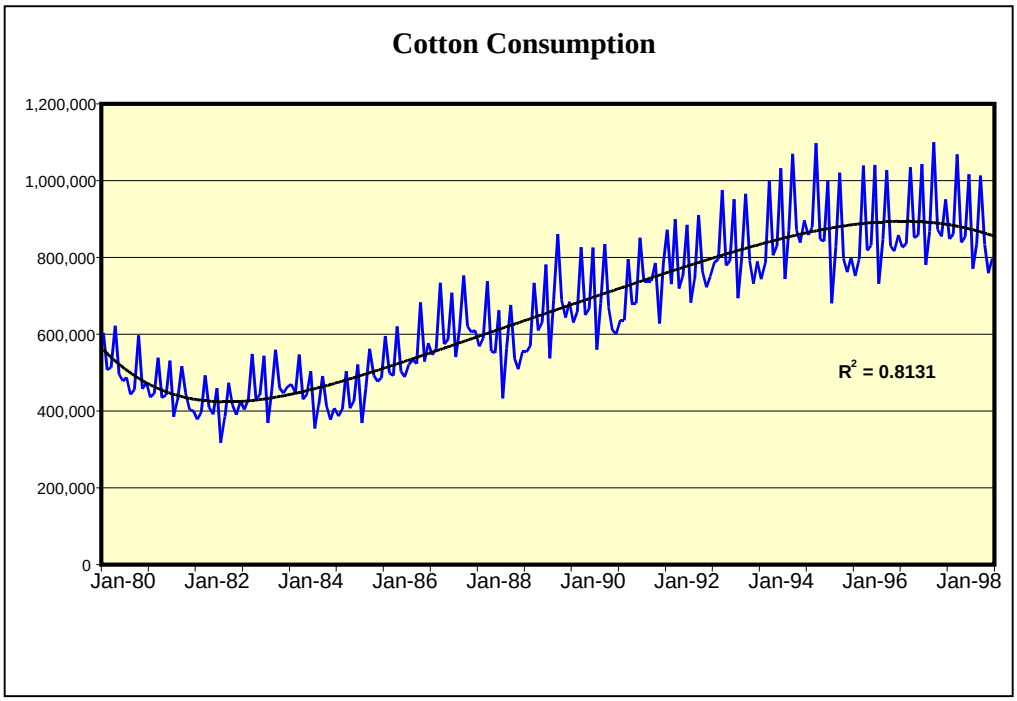

Figure 7.1: Cotton Consumption (11)

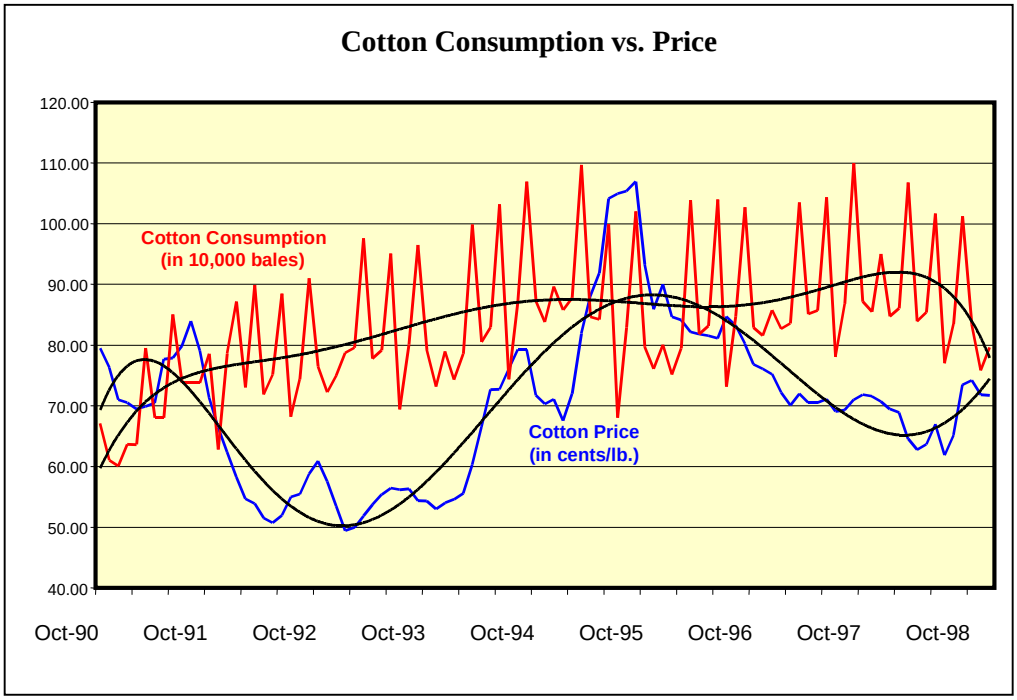

Figure 7.2: Cotton Consumption (11) vs. Cotton Price (12)

Figure 7.3 shows cotton consumption compared to yarn production. Yarn production and cotton consumption data were both gathered from the annual data from the Census database.

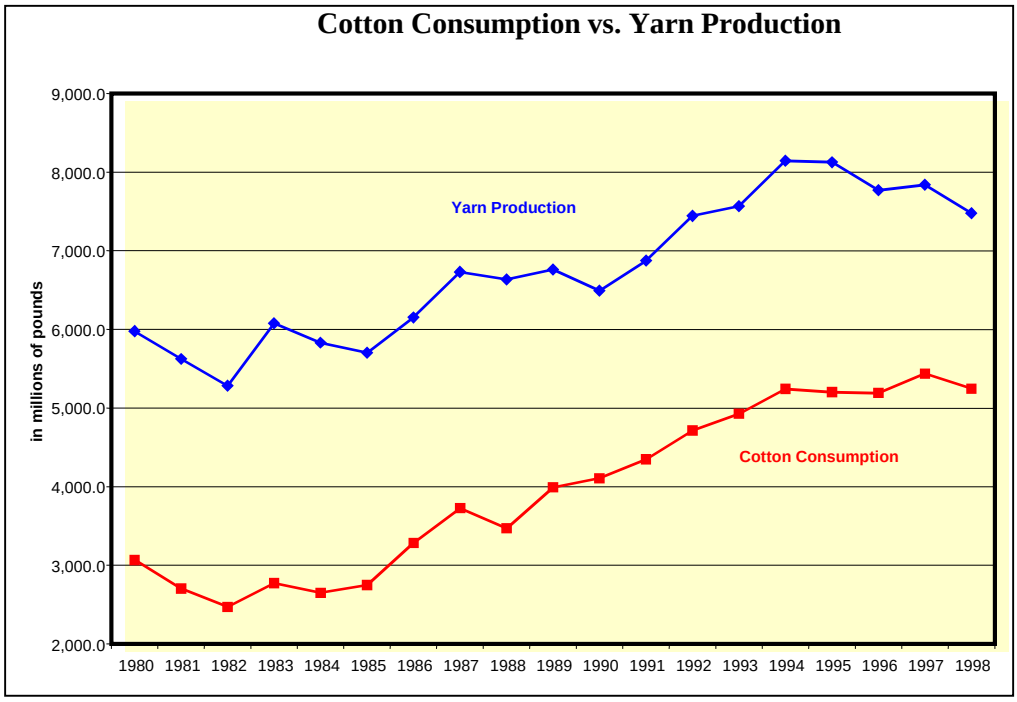

Figure 7.3: Cotton Consumption [11] vs. Yarn Production [51]

The yarn production data was published by year, unlike cotton consumption data which was published monthly. In order to compare both factors on the same scale, the monthly values for the cotton data were summed up for that year and displayed as an annual total.

Whereas the cotton consumption and yarn production do not follow exactly the same path, the trends are very similar. They both show a general increase from 1990 to 1994, and both begin to decrease after that. As examined in the introduction (Chapter 3), this decline was most likely caused by the effects of NAFTA. In 1997, both increase slightly from the 1996 levels and then drop off again in 1998. The decreased yarn

production and cotton consumption here are probably due to the effects of the problems in Asia, as stated earlier.

One issue to address when comparing these factors is that the cotton consumed might not be used immediately. Despite the similar trend shown in Figure 7.3, there should logically be some sort of time lag between when cotton is purchased and when it is used. Many yarn producers might buy the cotton and then put this cotton into storage for many possible reasons. One reason might be that producers buy cotton when the prices are low in order to offset the cost when cotton prices are high. This possibility will be examined further in Section 7.4, which will address cotton stocks versus cotton consumption.

7.2.1 Seasonality

Figure 7.4 showed the amount of variation from month to month in the amount of cotton consumed. One of the main causes of this type of variation is seasonality. In order to determine the possible cause of the variation, cotton consumption was looked at monthly by year. This is shown in Figure 5.4 for the years 1993-1998.

In this chart it is hard to see which year is which, but the trend is obvious. Cotton consumption is high in March, June and September of every year since 1993. It is low during the months of April and May, July, and October through February. This chart shows a very similar trend to the one presented in the introduction in Figure 3.5, which illustrated cotton system spindle hours by month. This resemblance establishes that there is a parallel relationship between cotton consumption and yarn production.

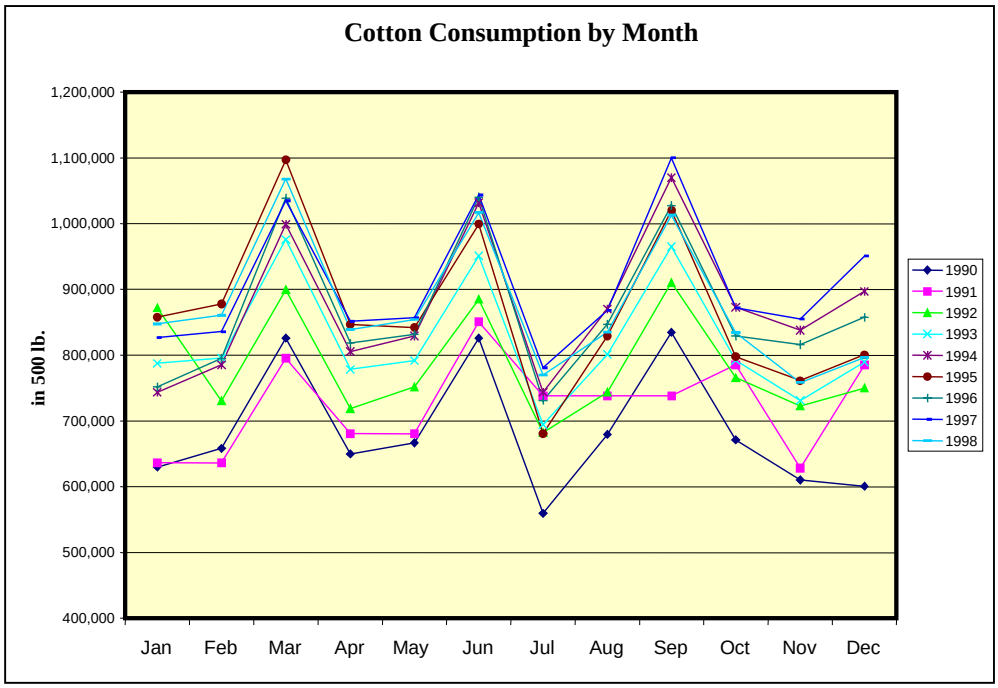

Figure 7.4: Cotton Consumption by Month [11]

7.3 Cotton Price

Since the relationship between cotton consumption and yarn production has been considered, it is important to next look at the relationship between the price of cotton and the price of yarn. This relationship is shown in Figure 7.5. This figure includes the prices of both 10/1 ring and 10/1 rotor spun yarn constructed of 100% carded cotton. Also included is the price of cotton on the spot market. The trendline was added for the sole purpose of smoothing out short-term variations and enabling the general trends to be seen. The patterns displayed in the chart for 10/1 yarn are congruent with the patterns for 18/1 yarn.

Figure 7.5 demonstrates that there is a relationship between the price of cotton and the price of yarn, although, the relationship is not as strong as would be expected. The cotton price decreases around the beginning of 1993, and then the yarn price decreases

around the beginning of 1994. This would seem to suggest the conclusion that the time lag between when the cotton is purchased and when this cotton price affects the selling price of the yarn would be around one year. But when the cotton price increases mid-1995, the yarn price increases simultaneously. From 1996 to the beginning of 2000, yarn price decreases steadily, until the price of cotton suddenly peaks in September 1998. The price of rotor spun yarn follows by increasing in October 1998. Strangely, the price of ring spun yarn did not appear to be affected. The main difference between cotton price and yarn price is that the fluctuations are not as extreme for yarn as they are for cotton.

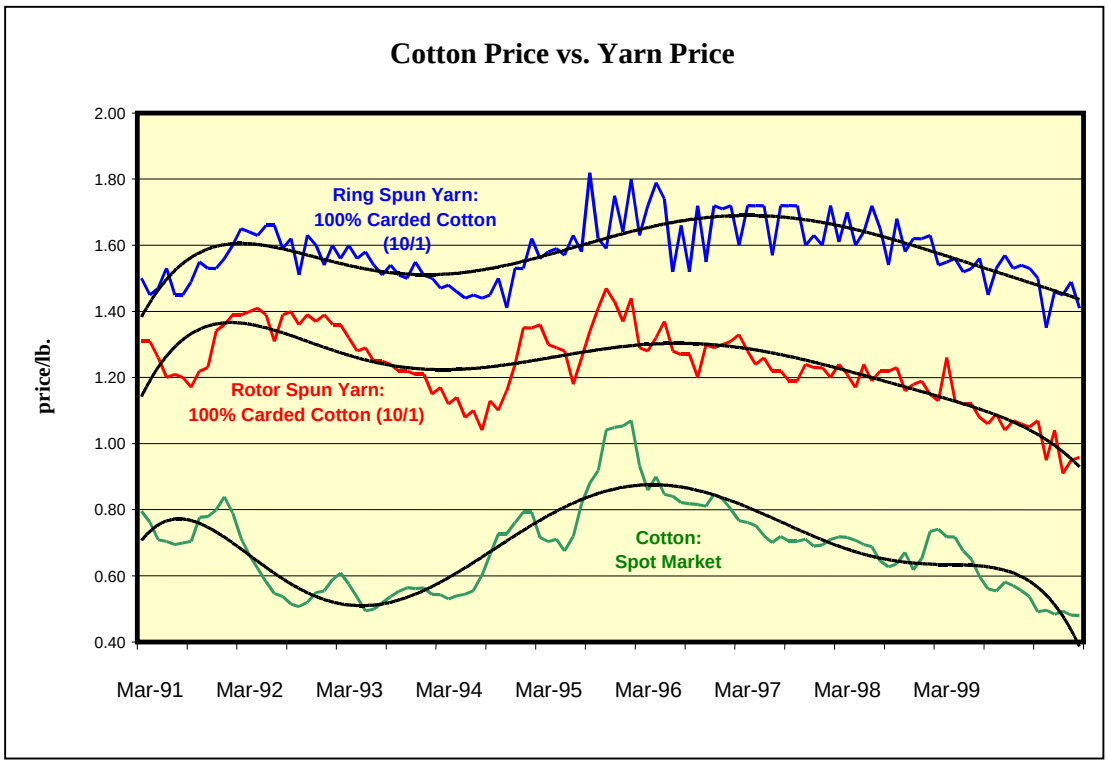

Figure 7.5: Cotton Price vs. Yarn Price (12)

This figure alone leads to the conclusion that when cotton prices are low, the effect that this has on yarn price is exhibited farther in the future than when cotton prices

are high. But when cotton prices are high, this effects yarn prices within the first few months.

It is also important to look at what percentage of total yarn price is attributed to the price of cotton. This is shown in Figure 7.6, constructed for data obtained from *ATI*.

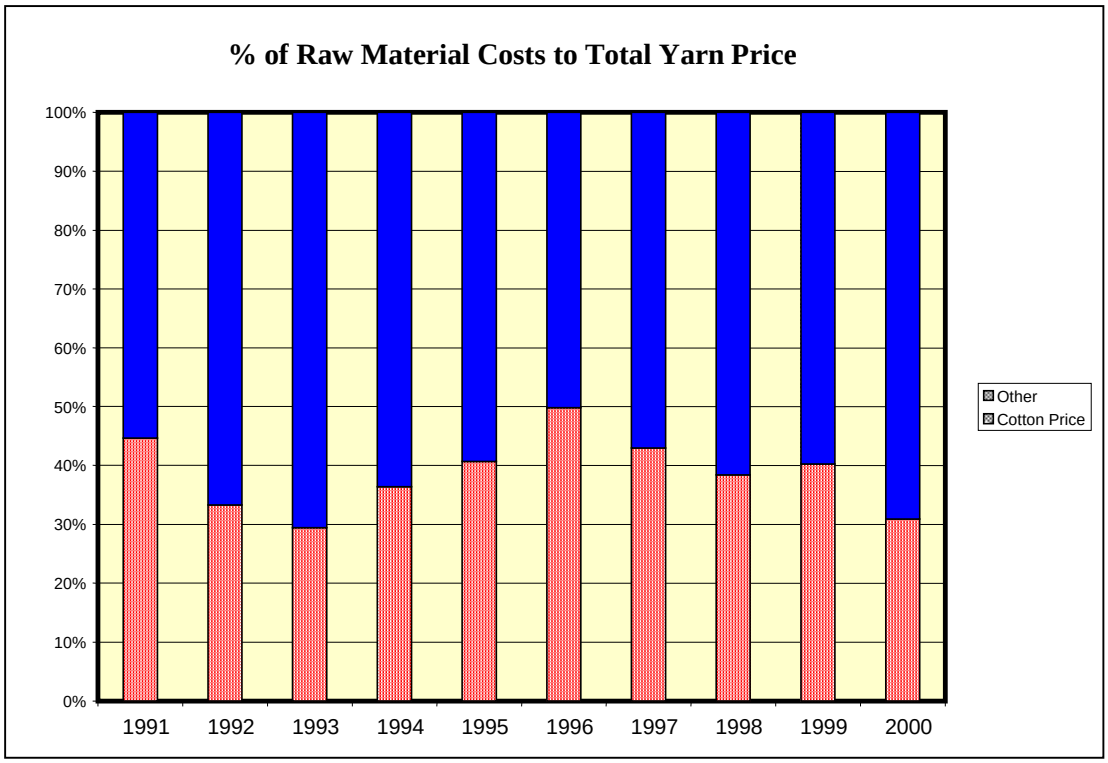

Figure 7.6: Percentage of Raw Material Cost to Total Yarn Price(12)

Logically, the raw material cost should always make up the same percentage of the yarn price. This figure shows that this is not at all the case. As mentioned in the Literature Review, retailers are now demanding a certain yarn price or threatening to take their business elsewhere. This means that when cotton prices are high, yarn producers must absorb the cost instead of passing on these extra expenses to the retailers.

Another important aspect to look at is cotton price compared to yarn production. One possible motive for the amount of yarn produced is that yarn manufacturers produce more yarn when cotton prices are low in order to build up inventory, and then sell this lower cost yarn at a later date. In order to examine this relationship, cotton price was plotted against yarn production. Since cotton price is given monthly and yarn production is given yearly, the price of cotton was averaged for the year and is displayed in Figure 7.7

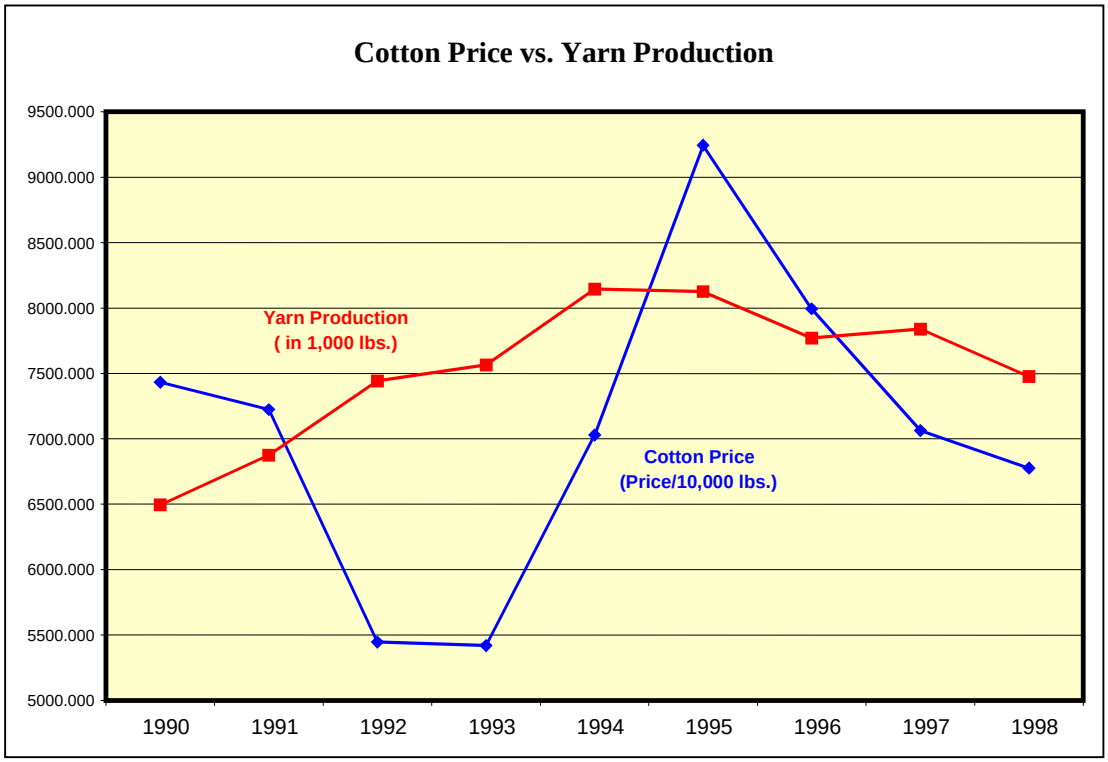

Figure 7.7: Cotton Price [12] vs. Yarn Production [51]

Even though the data had to be manipulated in order to carry out a comparison, there are still no obvious trends in this data. This leads to the conclusion that the amount of yarn produced is not dependent upon the price of the raw material.

7.4 Stocks

As mentioned earlier, the cotton consumed during a particular month might not be used immediately. The main reason why yarn producers would keep a high inventory of cotton is that they "stock up" when prices are low in order to offset the cost when cotton prices are high. Figure 7.8 illustrates the relationship of cotton stocks to cotton price.

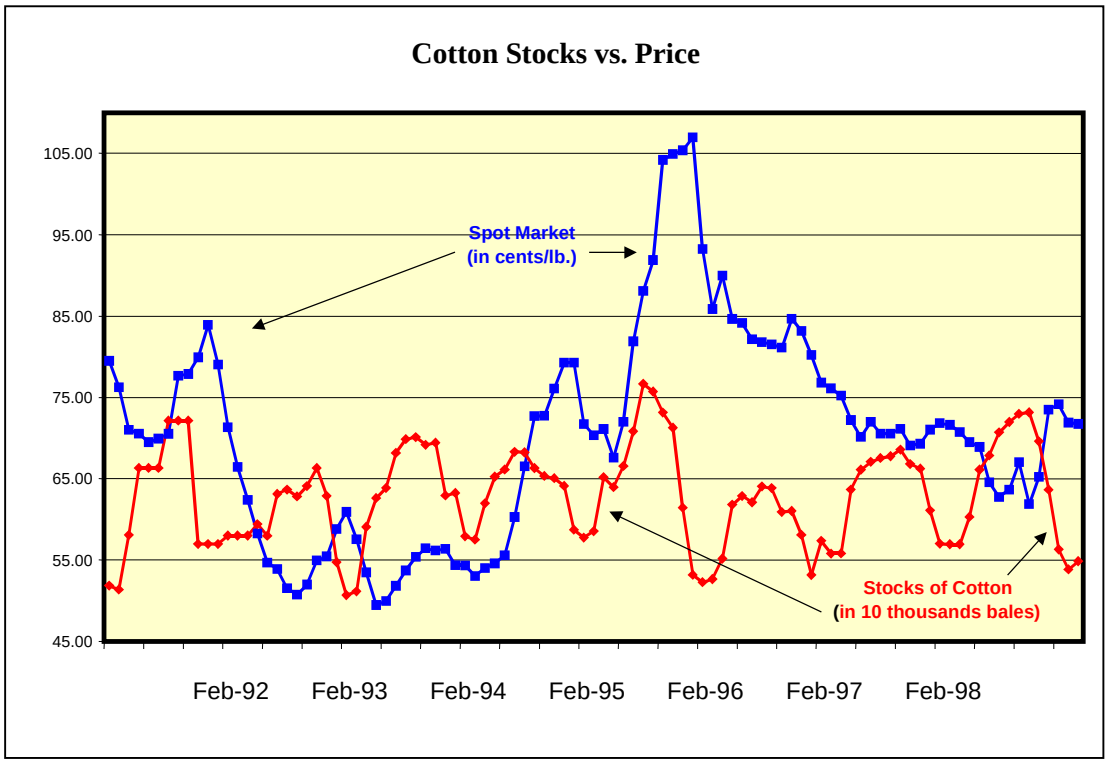

Figure 7.8: Cotton Stocks (11) vs. Cotton Price (12)

It appears in this graph that the level of cotton stocks has a strong inverse relationship with the price of cotton. When cotton prices are low, stock levels increase. When cotton prices are high, stock levels decrease, meaning that some yarn producers are buying more cotton when prices are low and using this inventory when cotton prices are high.

Rationally, this should means that cotton consumption increases as cotton price decreases, which was shown in Figure 7.2. This, in turn, would mean that as cotton consumption increases, cotton stocks would increase as well. This is shown in Figure 7.9.

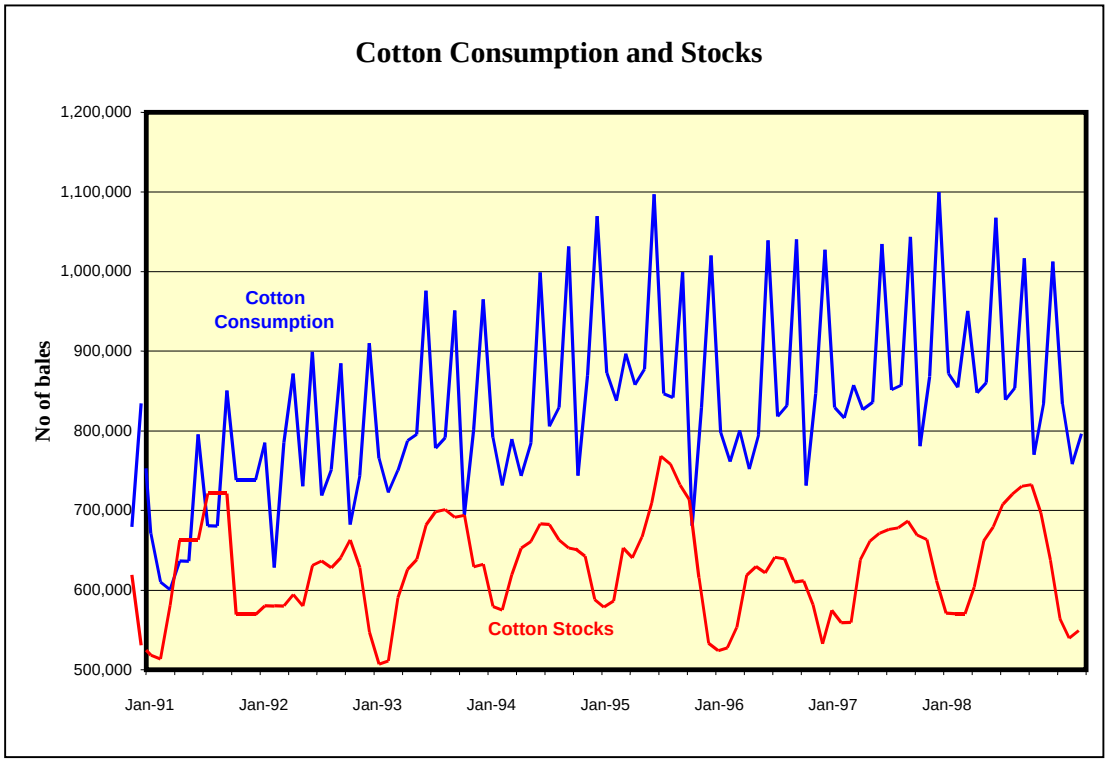

Figure 7.9: Cotton Consumption vs. Cotton Stocks [11]

Here, there is not an obvious trend, because of all the variation. Even though a trendline was added in order to try and overcome this, it is still difficult to decipher any meaning from this chart. Still, by looking closely, cotton consumption generally increases as stocks decrease, meaning yarn producers are using their accumulated inventory.

7.5 Conclusions Based on Trends in Cotton

The conclusions which can be drawn from this chapter are as follows:

- As cotton price increases, cotton consumption decreases.
- As cotton price decreases, cotton consumption increases.
- Cotton consumption is highest in March, June and September.
- Yarn production is highest in March, June and September.
- When cotton prices are low, this effects yarn prices months later.
- When cotton prices are high, yarn prices increases shortly thereafter.
- The effect that raw material costs have on yarn prices varies.
- The amount of yarn produced is not dependent on the price of the raw material.
- When cotton prices are low, stock levels increase.
- When cotton prices are high, stock levels decrease.
- Stocks decrease as cotton consumption increases, and cotton consumption increases as stocks decrease.

8 EFFECT OF SPINNING SYSTEMS

8.1 Introduction to Effect of Spinning Systems

As explained in Chapter 1 (Terminology), ring spinning requires two additional processes, when compared to rotor spinning. These extra processes, roving and winding, make ring spun yarn more expensive to produce. Other costs come in the form of raw material, capital, waste and labor. Figure 3.8 showed the prices of both ring and rotor yarn over a fifteen year period. Ring spun yarns have always been more expensive than rotor spun yarns, but recently, ring spun yarns have become much more so.

8.2 Advantages and Disadvantages of Each Spinning System

The main limitation of ring spinning is its speed, which reaches its limit at around 15,000 rpm. Better ring and traveler design can accommodate speeds up to 25,000, but these are rarely used. The reason for this is that at higher speeds, the traveler deteriorates and must be replaced. Rotor spinning was developed to try and overcome the speed limitations of ring spinning. Rotor spinning produces yarn at around 120,000 rpm. The maximum production speed is around 150,000 rpm, but very few spinners operate at this level. Rotor spinning also omits the steps of roving and winding, as mentioned earlier. While these are great production advantages over ring spinning, rotor spun yarns have different characteristics than ring spun yarn.

Ring spun yarns are finer and stronger, but rotor spun yarns have a more even “diameter”, are more absorbent, and are less variable in strength. On the other hand, rotor spun yarns are also bulkier, rougher and in some cases, more abrasive.

Fabrics, which are made from ring spun yarns, are stronger and have more recovery. Fabrics made from rotor spun yarns are more uniform, less likely to pill but can have a harsher hand. Rotor yarns are mainly used for denim, heavier bed sheets, and other fabrics where strength is not as important, but ring spun yarns are still preferred for knitwear and finer blends (2).

8.3 Manufacturing Components of Yarn Costs

Most people believe that labor costs are the main reason why U.S. manufactured yarns are more expensive than imported yarns. Figure 6.1 shows the main components of manufacturing costs associated with ring and rotor yarns.

Here, ring spun yarns are about fifty cents higher than rotor spun yarns. This is consistent with Figure 3.8 in the Introduction. Raw material makes up the largest percentage of yarn costs for both types followed by capital and then labor. Not surprisingly, ring spun yarns have a higher percentage of labor costs than do rotor spun yarns. This is most likely due to the extra processes and oftentimes manual doffing. Also, ring spun yarns require more capital and power and produce more waste. This figure still does not show why U.S. yarns are so often hurt by cheaper, imported yarns, if labor costs make up such a small percentage of total yarn costs.

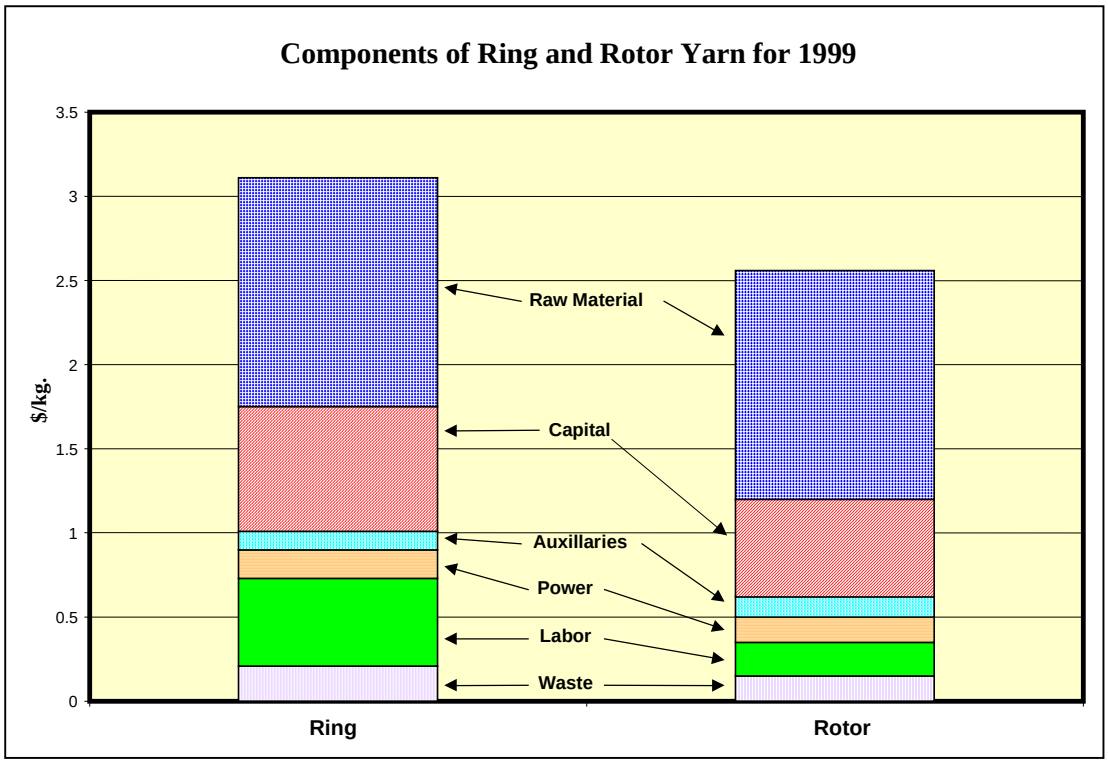

Figure 8.1: Components of Ring and Rotor Yarns for 1999 [56]

8.3.1 International Cost Comparison

In order to examine this, a comparison of the components of different countries' yarn costs needs to be analyzed. The manufacturing components for ring spun yarn are shown in Figure 8.2.

The chart proves labor cost is not the main determinant of total ring spun yarn cost. Each country represented here produced similar amounts of waste, and had comparable power costs and auxillaries. The main difference between countries was capital and labor costs. All countries had similar raw material costs (+/- ten cents). Surprisingly, Indonesia had the cheapest labor costs, but it also had the highest yarn cost. What offset the low labor cost was the high capital costs. This goes to prove that labor

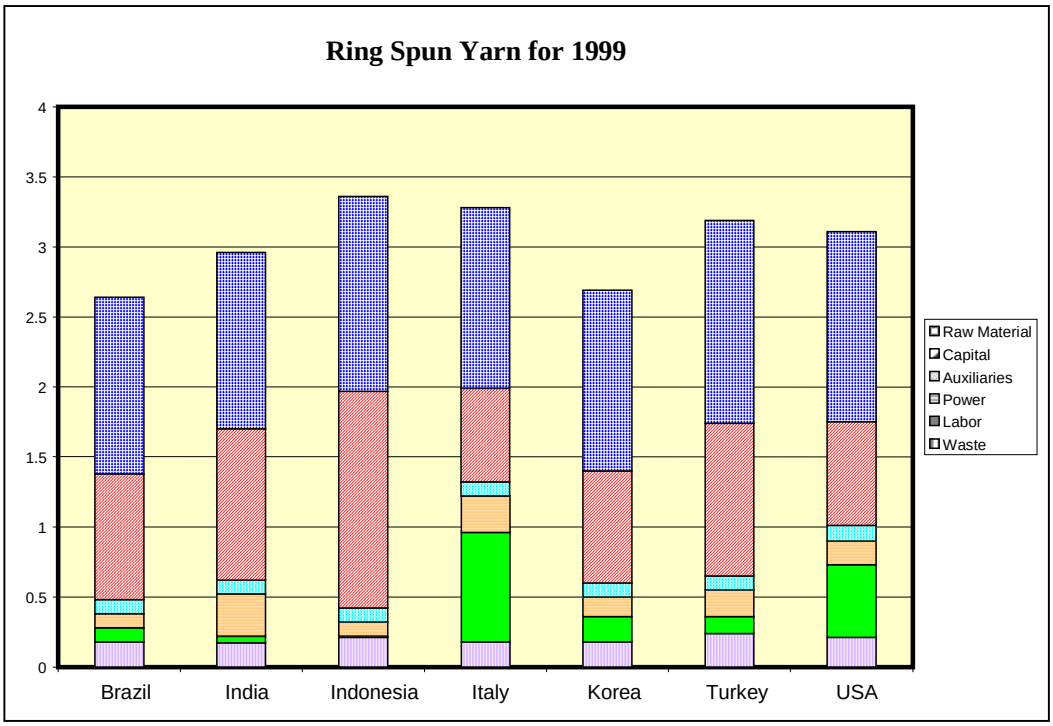

Figure 8.2: Ring Spun Yarn Costs by Country (56)

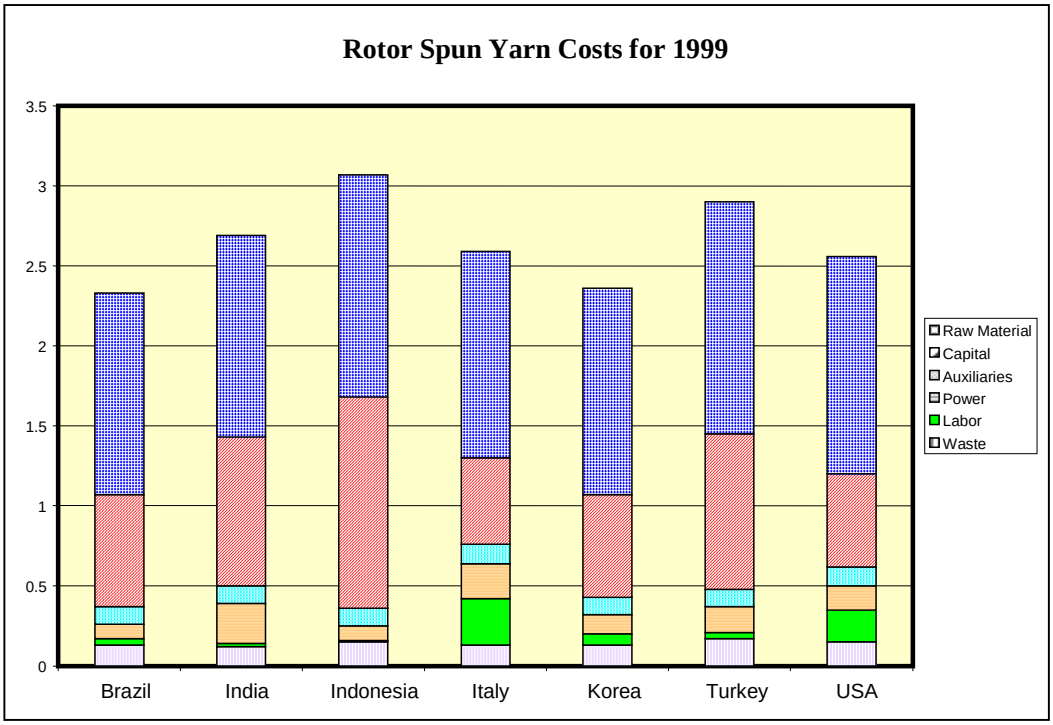

Figure 8.3: Rotor Spun Yarn Costs for 1999 (56)

does not always have a strong influence of yarn cost; it more so depends on every component put together. Figure 8.3 shows the same components of rotor spun yarns for the same countries.

This chart shows very similar trends when compared to the previous chart. Again, Indonesian yarn is the most expensive, even though that country has the lowest labor cost. One interesting observation here is that the three countries with the cheapest labor costs, Indonesia, Turkey and India, produce the most expensive yarn. Also, these same three countries also have the highest capital costs, which, in turn, offsets the low labor costs.

8.4 International Comparison of Cost Index

Figure 8.4 shows another way to compare international ring spun yarn costs to the U.S., which is by comparing the cost indices. In order to do this, each countries' total yarn cost was divided by the U.S.'s total yarn cost, so that the U.S. cost index came out to be 100. After that, the U.S.'s cost index was subtracted from each country's new cost index. An example would be that Brazil's cost for producing ring spun yarn is $2.64. This was divided by the U.S. cost for producing ring spun yarn, which is $3.11. This resulted in Brazil having a cost index of 85. One hundred was then subtracted from 85, resulting in –15, in order to compare to the U.S. manufacturing cost. This was done for all countries in this study.

Here, the three countries which have higher manufacturing costs than the U.S. are Indonesia, Italy and Turkey. Since Italy's labor cost is significantly higher than that of the U.S., it is expected that Italy's production cost is higher than that of the U.S. Brazil,

India and Korea all produced ring spun yarn cheaper than the U.S., but while labor costs are lower for all three, capital costs are higher. Figure 8.5 shows the cost indices for rotor spun yarns.

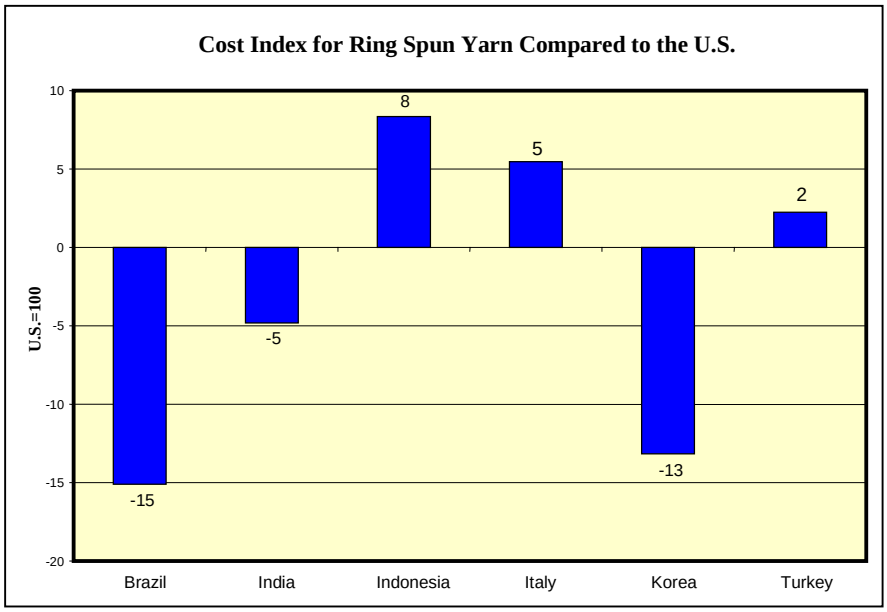

Figure 8.4: Cost Index for Ring Spun Yarn Compared to the U.S.

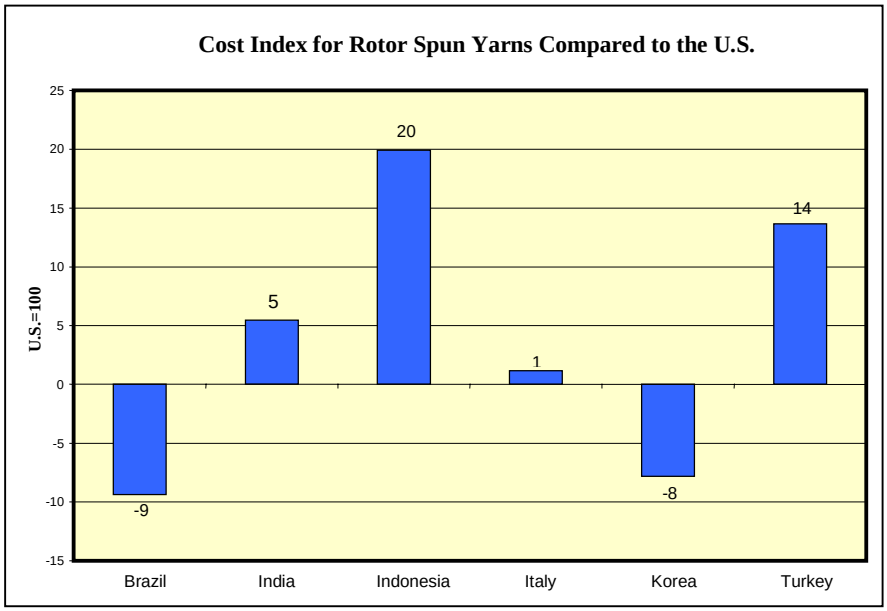

Figure 8.5: Cost Index for Rotor Spun Yarns Compared to the U.S.

In this chart, it is easy to see that the U.S. produces rotor spun yarns significantly cheaper than either Indonesia or Turkey. U.S. yarn is more expensive to produce than in either Brazil or Korea. The is consistent with the conclusions formed from Figure 8.4.

8.5 Conclusions Based on the Effect of Spinning Systems

The conclusions which can be drawn from this chapter are as follows:

- Ring spun yarns are more expensive than rotor spun yarns.
- Raw material is the largest component of total yarn cost, both domestically and internationally.
- Labor is not the main determinant of yarn cost.

9 TRENDS IN LABOR

9.1 Introduction to Trends in Labor

In all of the debate surrounding recent changes in trade agreements, labor in the U.S. has been very much at the center. Some of the research in the literature review (Chapter 4) focused on how NAFTA and the ATC will have a detrimental impact on textile employment in the U.S. The previous chapter on the effect of spinning trends indicated that despite normal expectations, labor does not have the strongest impact on total yarn cost. Other factors, such as raw material cost and capital cost, play just as large of a role, if not bigger, in the final manufacturing cost.

9.2 U.S. Employment Trends

Figure 9.1 shows the national employment numbers for the U.S. compared to the number of people employed in the textile industry. For this chart, the data is shown in different magnitudes in order to see the basic trend. National employment has steadily increased over the fifteen-year period, where textile employment has steadily decreased. Surprisingly, this decrease has been gradual. It would be expected that there would have been a dramatic decrease in 1994 after the implementation of NAFTA, but this is not evident. Indeed, the decrease in the number of people employed in the textile industry can most likely be attributed to the increase in productivity of machinery since production has pretty much increased over this same time period.

Figure 9.2 shows the average wages of textile workers over this same time period. Here, the wage rate has significantly increased, and this could in part be due to the

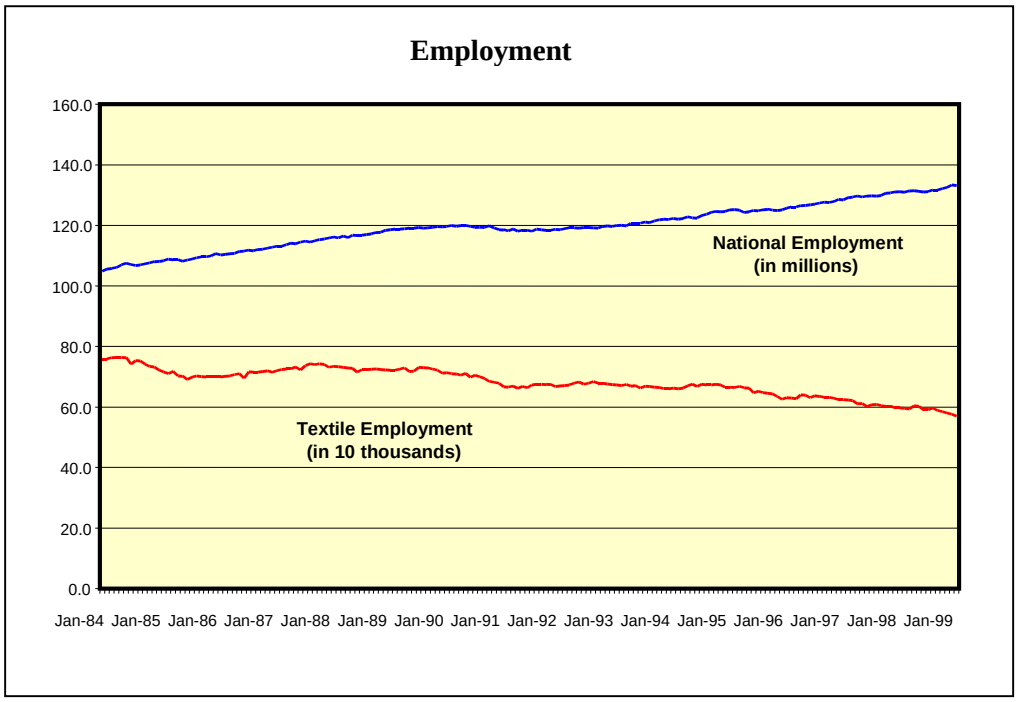

Figure 9.1: Employment Data for the U.S. (53)

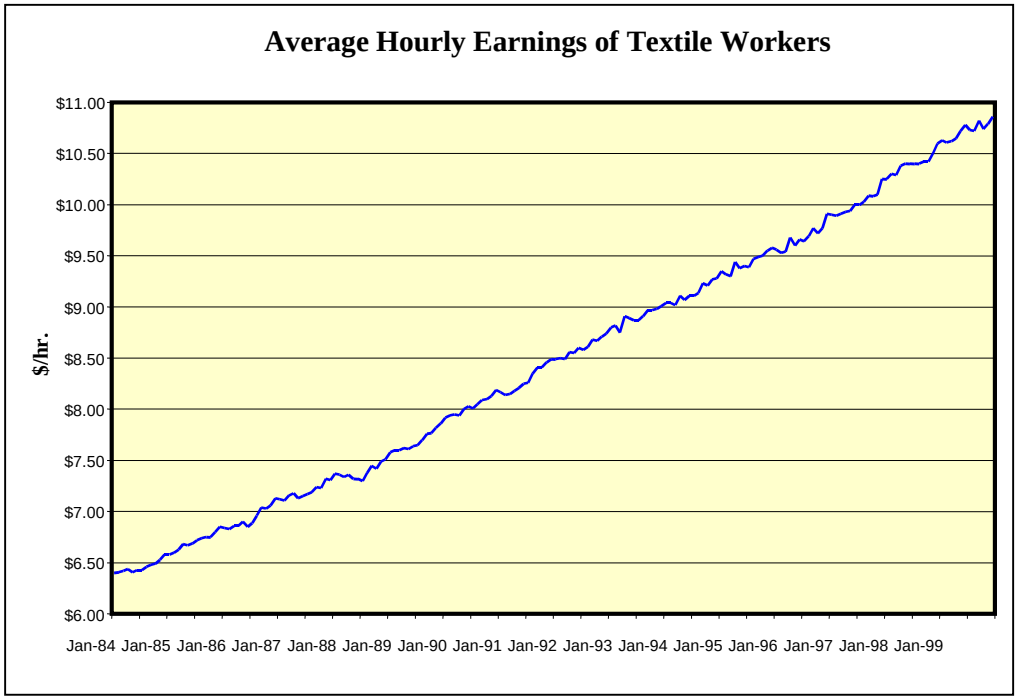

Figure 9.2: Average Hourly Earnings of Textile Workers (53)

increased productivity per operative. An additional factor is that increased sophistication of machinery has necessitated an increase in the skill levels needed in employees and this, in turn, implies higher wages. A final issue is that with the present low unemployment level in the U.S., it is necessary to offer competitive wages in order to recruit employees.

9.3 International Employment Wages

Throughout the literature review, most of the papers found mentioned how cheap imports have hurt the U.S. textile industry. The research stated that their inexpensive wages are what have allowed them to import their products at a much lower price when compared to U.S. products, even though Chapter 8 proved this not to be fully true. Figure 9.3 shows the hourly wages of countries around the world, included the U.S.

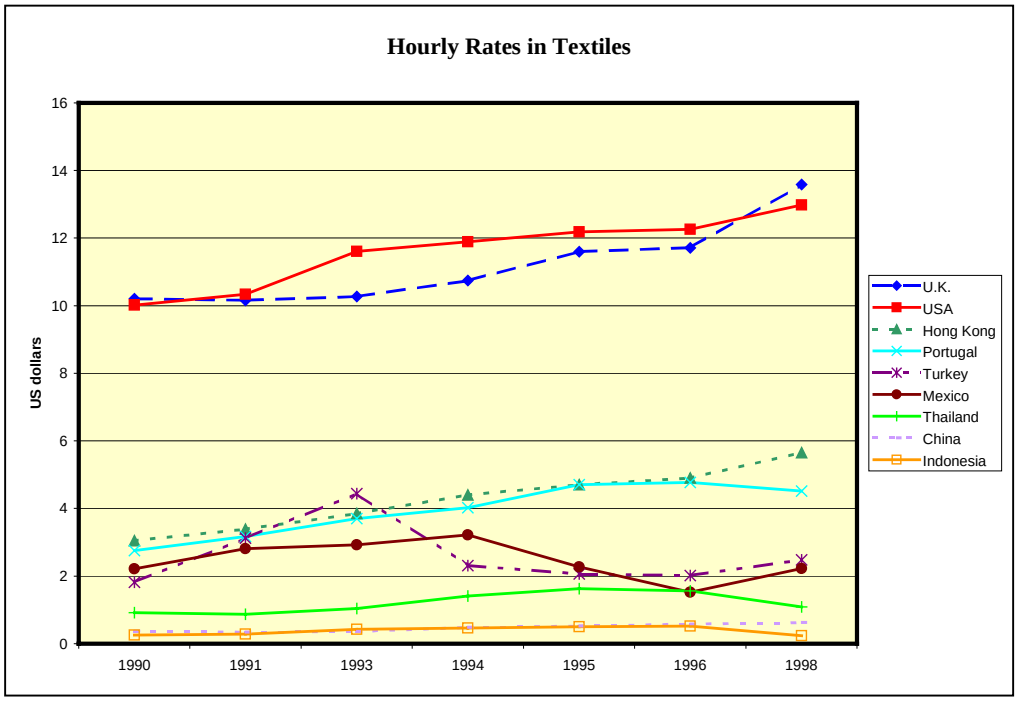

Figure 9.3: Hourly Rates in Textiles

This chart shows that the U.S. and the U.K. have considerably higher wage rates than other countries listed here. Indonesia has the lowest, but as mentioned in Chapter 8, Indonesia also has a very high end yarn cost. China also has a very low wage rate, although data for other manufacturing costs from China was not available to be studied. One possible reason for there being such an abundance of cheap imports, since it is not solely dependent on wage rate, is that these countries might be taking a bigger profit cut in order to be able to compete. It was stated in the literature review that China was selling their products below cost during the Asian financial crisis in order to make any money at all. This could be true of other countries as well.

One important aspect to consider is the productivity rates of these countries. More and more domestic textile manufacturing is moving to Mexico and the Caribbean, but even though the wages are less, the productivity may not always be as high as in the U.S. Figure 9.4 shows the labor productivity for five countries, including the U.S. This figure was taken directly from a presentation by Mary O'Rourke that she presented at the Sourcing USA Summitt in 1999.

This figure shows that the U.S. is significantly more productive than Mexico or the Caribbean. The U.S. is also more productive than India and China, as well as Turkey. Figure 8.4 in the previous chapter showed the cost index of ring spun yarn compared to the U.S. India produced this type of yarn cheaper than the U.S., but Turkey produced yarn with a higher final cost. In some cases, such as with Turkey, the low wage rates might not be able to offset the lower productivity rates. This could be the reason why certain countries with a lower wage rate than the U.S. might have a higher final yarn cost.

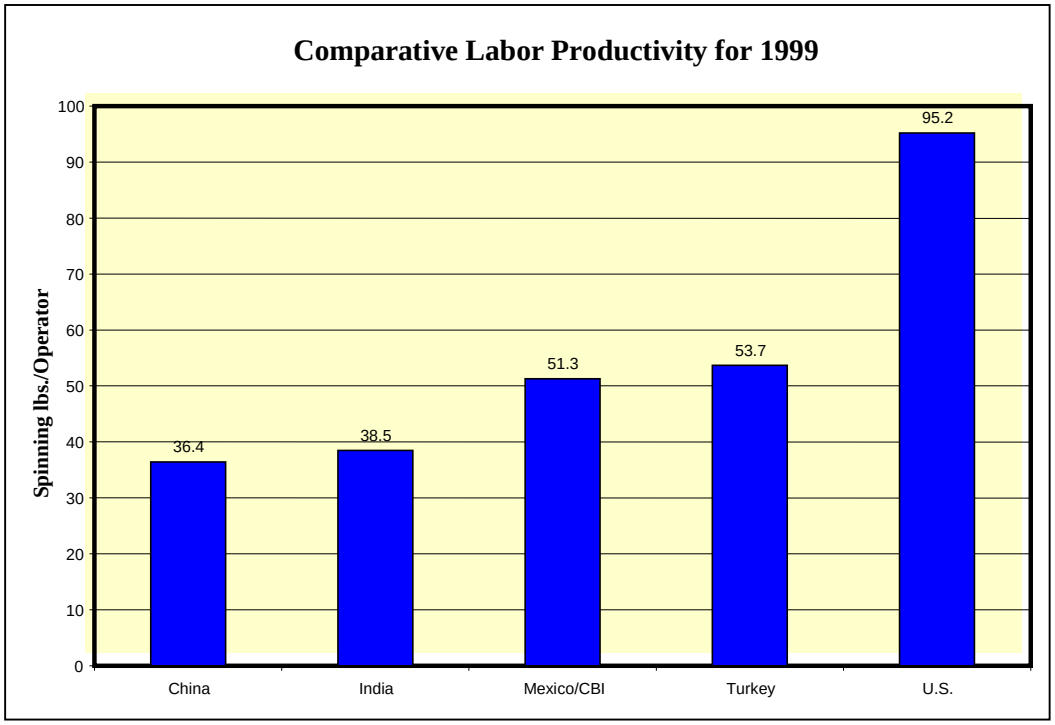

Figure 9.4: Comparative Labor Productivity for 1999 [57]

9.4 Conclusions Based on Trends in Labor

The conclusions which can be drawn from the first section of this chapter are as follows:

- National employment has steadily increased over the past fifteen years.
- Textile employment has steadily decreased over the past fifteen years.
- The hourly wage rate of textile workers in the U.S. has steadily increased.

It is hard from this chapter alone to make any precise conclusions. There are still many unknown factors, which would have a considerable impact of yarn production costs. But,

by examining this chapter in relation to the previous chapters, certain assumptions can be made.

It has been proven that labor is cheaper overseas. But, as shown in Chapter 8 (Figures 8.2 and 8.3), U.S. total yarn production cost is not always higher than these countries, as would be assumed. One explanation could be that machinery is cheaper in the U.S. than in these overseas countries. The reason for this is that the U.S. currency is stronger than these other countries, and therefore, the U.S. would receive a much lower interest rate. As proven in these charts, capital makes up a much larger portion of total cost than does labor.

It is also important that the machinery be run efficiently, but looking at Figure 9.4, this is not the case for overseas operators. The U.S. is significantly more productive than the countries shown in either Asia or Mexico/CBI. One critical aspect, which is not examined in this thesis, is the hours worked per year by these countries. This would have a significant impact on the productivity levels, as well as total labor cost.

The producer determines how all of these factors are integrated into a total yarn cost, and since there is not universal standard costing, it is hard to compare which countries are able to produce yarn with the lowest overall cost. Also important is the fact that it is not known how much of a mark-up yarn manufacturers make on their final yarn selling price. It has been stated earlier that China sold products below cost in order to stay in the market during their financial crisis. This could also be true of other countries.

What this goes to show is that it might not always be less expensive to produce yarn in countries with cheaper labor. Currently, this has been a major issue for U.S. yarn

manufacturers due to NAFTA, the Trade and Development Act and the WTO. In the research examined in the Literature Review (Chapter 4), many analysts stated that the only way for the U.S. to compete in the years to come was to move production overseas. For some textile industries, which are labor intensive, this is true. But, for spinning, this might not be the most economical solution. The main reason for moving spinning to Mexico and the CBI is not lower labor costs, but transport costs. U.S. yarn producers could save money and keep clients by having their production close to their customers. This still does not change that at some point something will have to be shipped, whether it is cotton, yarn or fabric.

10 TRENDS IN MACHINERY

10.1 Introduction to Trends in Machinery

After looking at the recent trends in the technology of both ring and rotor spinning, it is important to examine how this has statistically affected the U.S. spinning industry. The new advances that have been made have had a definite impact on what types of machinery yarn producers are purchasing, as well as where these machines are located.

10.2 U.S. Trends

For the past 20 years, the overall number of spindles has been decreasing in the U.S. This is shown in Figure 10.1.

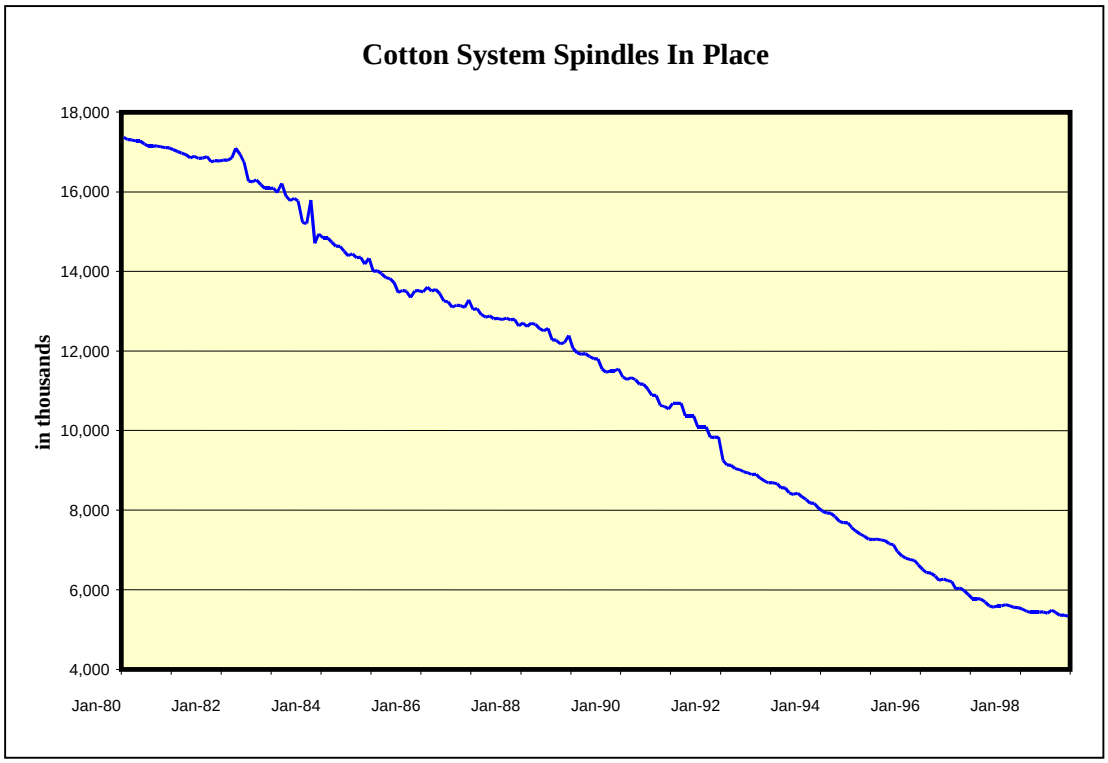

Figure 10.1: Cotton System Spindles In Place [11]

This chart shows that the number of spindles located in the U.S. has decreased by over 10 million since 1980. Going back to the Introduction (Chapter 3) and Figure 3.1, it is thus surprising to find that the amount of spun yarn production in the U.S. has increased from 1980 to 1994, with a slight decrease since the implementation of NAFTA. One possible reason for this is that these machines are operating for longer periods of time, which would explain why yarn production has increased. But by looking at Figure 10.2, the number of spindle hours has also decreased. The trendline was added to this chart in order to see the basic trend through the variation caused by the seasonality (Figure 3.5).

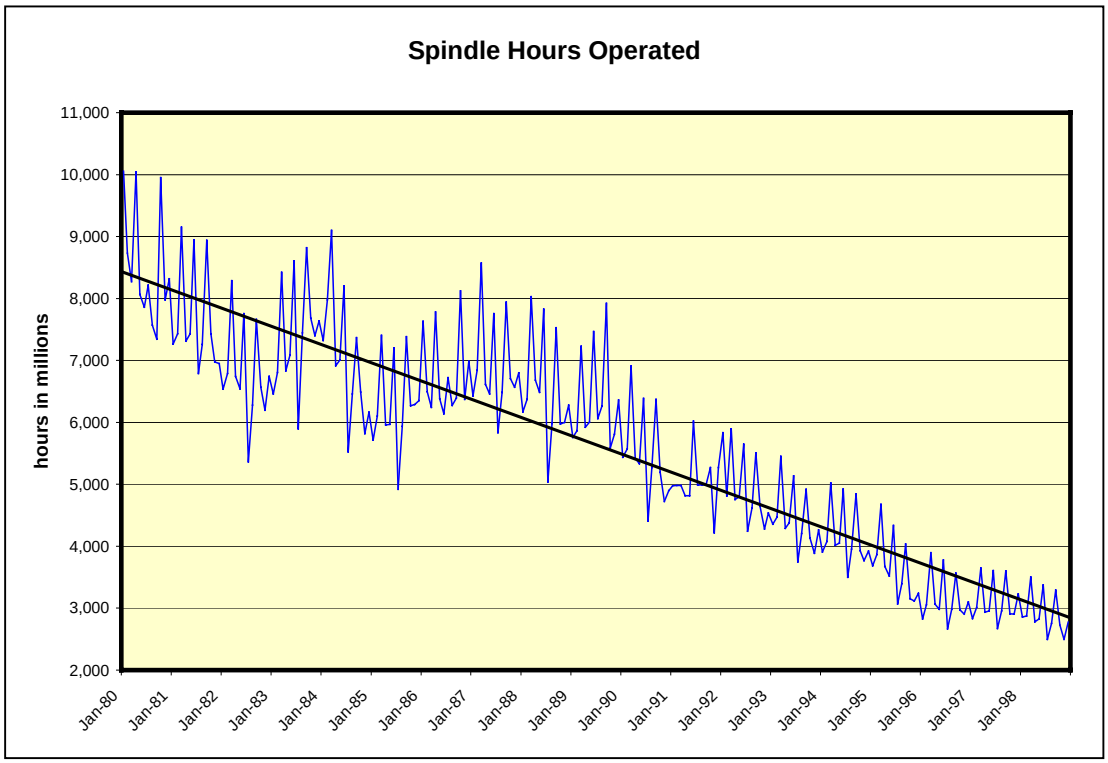

Figure 10.2: Spindles Hours Operated in the U.S. [11]

What this means is that less machines are operating less hours and producing more yarn. This leads to the conclusion that while the number of spindles in the U.S. has

decreased, the productivity of these machines has increased, and fewer spindles are producing more yarn.

10.2.1 Types of Spindles

The next step is to examine what types of spinning machines are being used. Figure 10.3 shows the number of ring spindles installed in the U.S. (Ring, rotor and air jet are all shown separately because of the large difference in the numbers installed of each.)

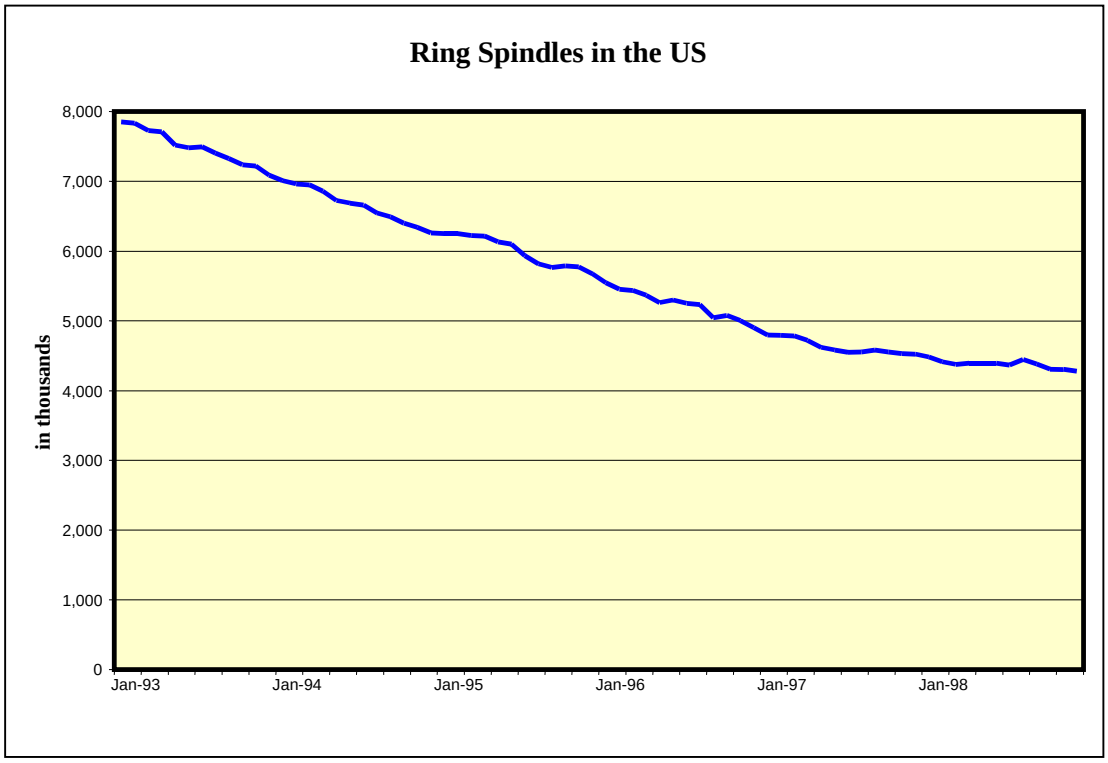

Figure 10.3: Ring Spindles in the U.S. [11]

The number of ring spindles in the U.S. has steadily decreased by over three million spindles, since 1993. On the other hand, the number of rotor spindles has remained fairly constant over the same time period. This is shown in Figure 10.4, from which can be

seen that the number of rotor spindles was around 150,000 more at the end of 1998 than at the beginning of 1993.

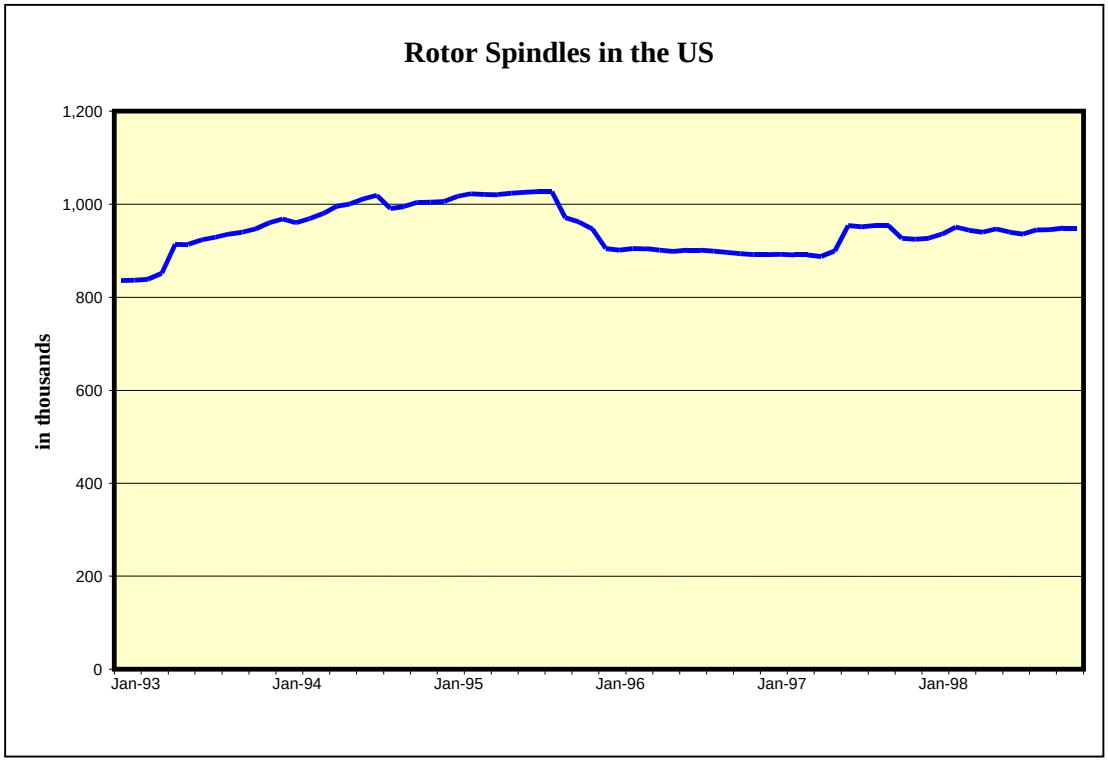

Figure 10.4: Rotor Spindles in the U.S. [11]

The trend for air jet spindles is, however, different from ring or rotor spindles. This is shown in Figure 10.5. Data for air jet spindles was only available for 1996 due to the fact that there were so few manufacturers using air jet spinning before this time. The number of air jet spindles installed in the U.S. has steadily increased since the beginning of 1996, even though there are still significantly less air jet machines in the U.S. compared to ring and rotor spindles.

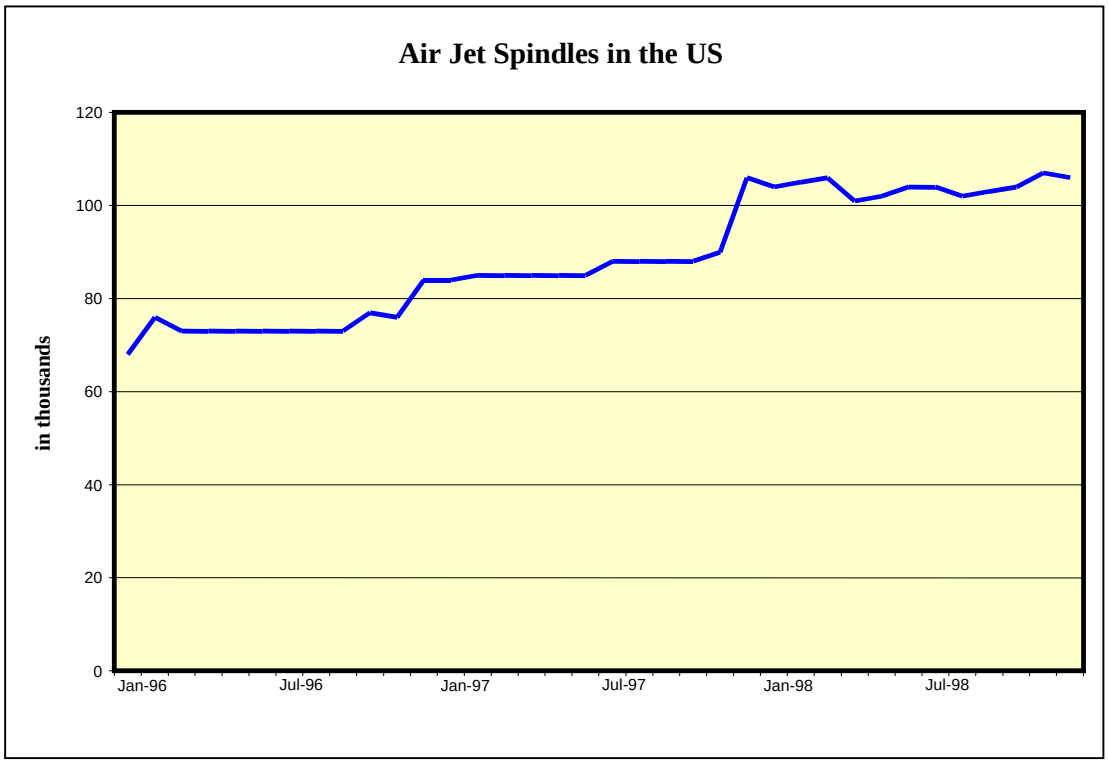

Figure 10.5: Air Jet Spindles in the U.S. [11]

One interesting observation is that while the total number of spindles in the U.S. is decreasing, but both the number of air jet and rotor spindles are increasing. The reason for this is that the number of ring spindles installed in the U.S. is decreasing at a much greater magnitude than either rotor or air jet are increasing. This is resulting in an overall decrease in the total number of spindles. However, rotor spinning and jet spinning produce yarn at about eight to fifteen times faster than ring spinning, thus fewer spindles can still produce signifcantly more yarn.

10.3 World Trends

After examining the amount of spinning machinery in the U.S., it is important to look at where other similar equipment is located throughout the world. Figure 10.6 shows the distribution of short staple spindles in the world.

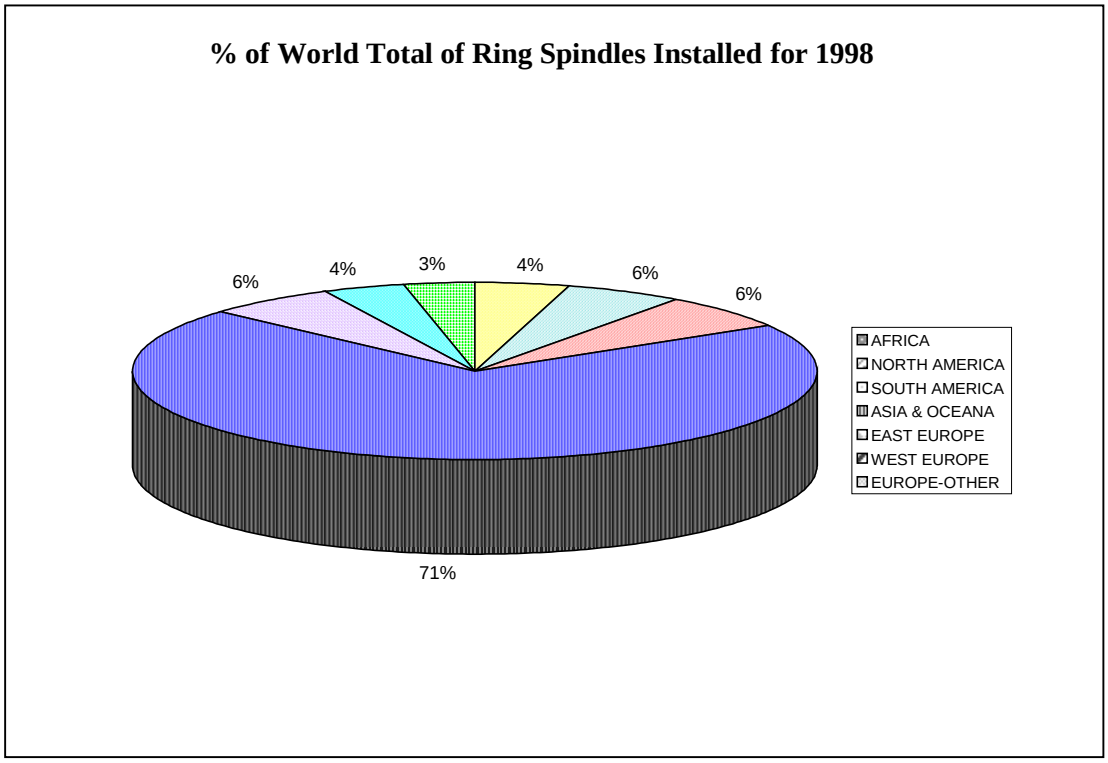

Figure 10.6: Percentage of World Total of Ring Spindles Installed for 1998 [58]

The data did not contain information on air jet spindles, but it did contain information for both ring and rotor spindles. As seen in this chart, Asia and Oceania have 71 percent of the world total of all ring spindles. North America, South America and Eastern Europe contain the second most with each having just six percent of the world total of ring spindles. Figure 10.7 shows this same information for rotor spindles. Here, the numbers show a very different picture. Asia and Oceania only have 28 percent of the

world total. On the other hand, Eastern Europe has the highest percentage, with 36 percent, and North America only has 15 percent of the world total of rotor spindles.

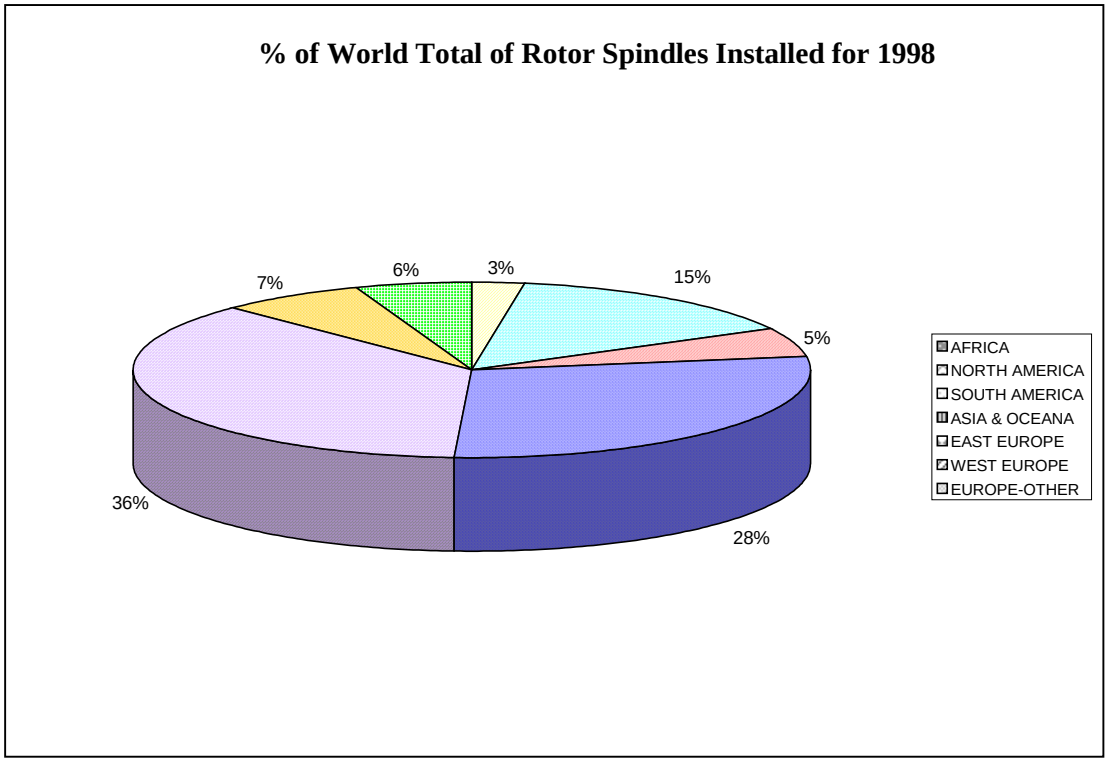

Figure 10.7: Percentage of World Total of Rotor Spindles Installed for 1998 (58)

Another important aspect to consider is the amount of changed capacities. This is shown in Figure 10.8 and 10.9. Figure 10.8 shows the changes for ring spindles, and Figure 10.9 shows the changes for rotor spindles.

From looking at Figure 10.8, North America has had the largest change in the number of ring spindles over the last ten years. Their capacities have decreased by 48 percent. Asia and Oceania, which have the largest number of ring spindles, has only had an increase in capacity by 30 percent. Most others have had only slight changes, except Europe which has had a 32 percent decrease since 1988.

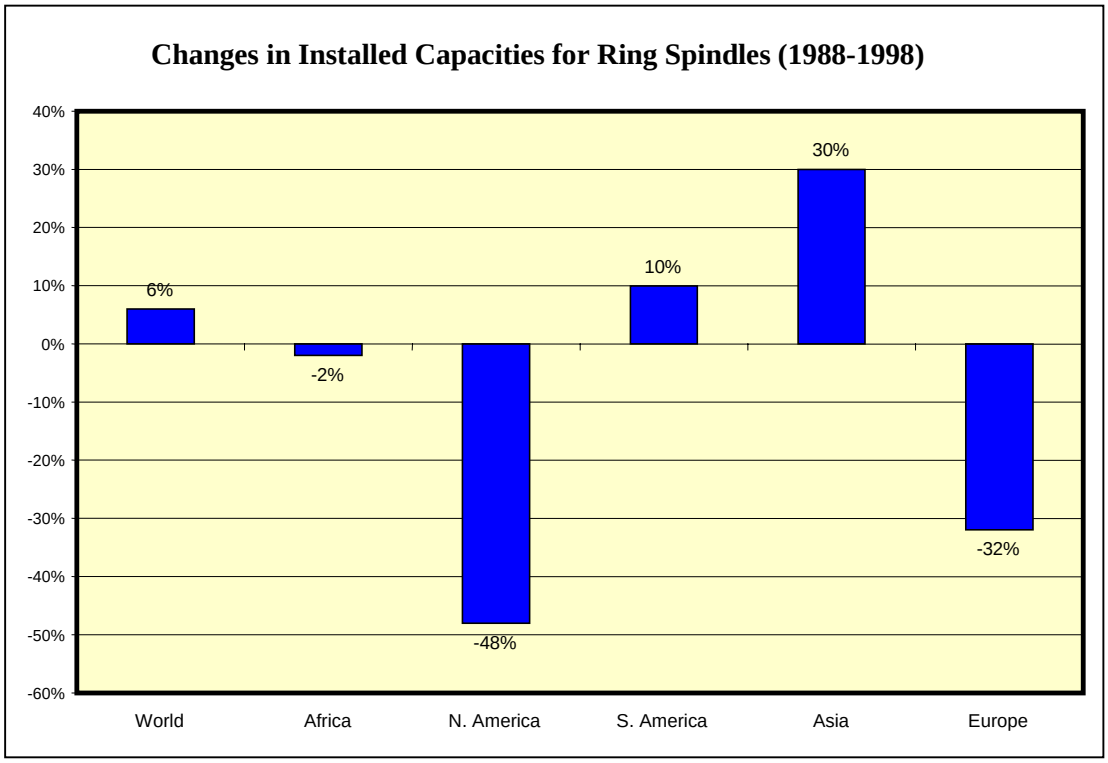

Figure 10.8: Changes in Installed Capacities for Ring Spindles (1988-1998) [59]

Figure 10.9 shows the changes in installed capacities for rotor spindles. Here, South America had the largest increase, increasing by 130 percent. Asia had the second largest, 117 percent. Asia and Oceania had 28 percent the same year. Another observation is that Figure 10.9 shows that Europe had a 32 percent decrease in the number of rotor spindles, but Figure 10.7 shows that Europe still had 49 percent of the world's total of rotor spindles in 1998. Both North America and Africa are consistent with their percentage shares of the total world market and their changes in installed capacities. North American had a 50 percent increase, but had 15 percent of the world total of rotor spindles. Africa had an increase of 40 percent, but had 3 percent of the world total. Care must be exercised in interpreting these figures since the percentage increase depends on the original base line. Thus, even though South America has a very

large percentage increase in rotor positions, this still only accounted for 5 percent of the world share of rotors.

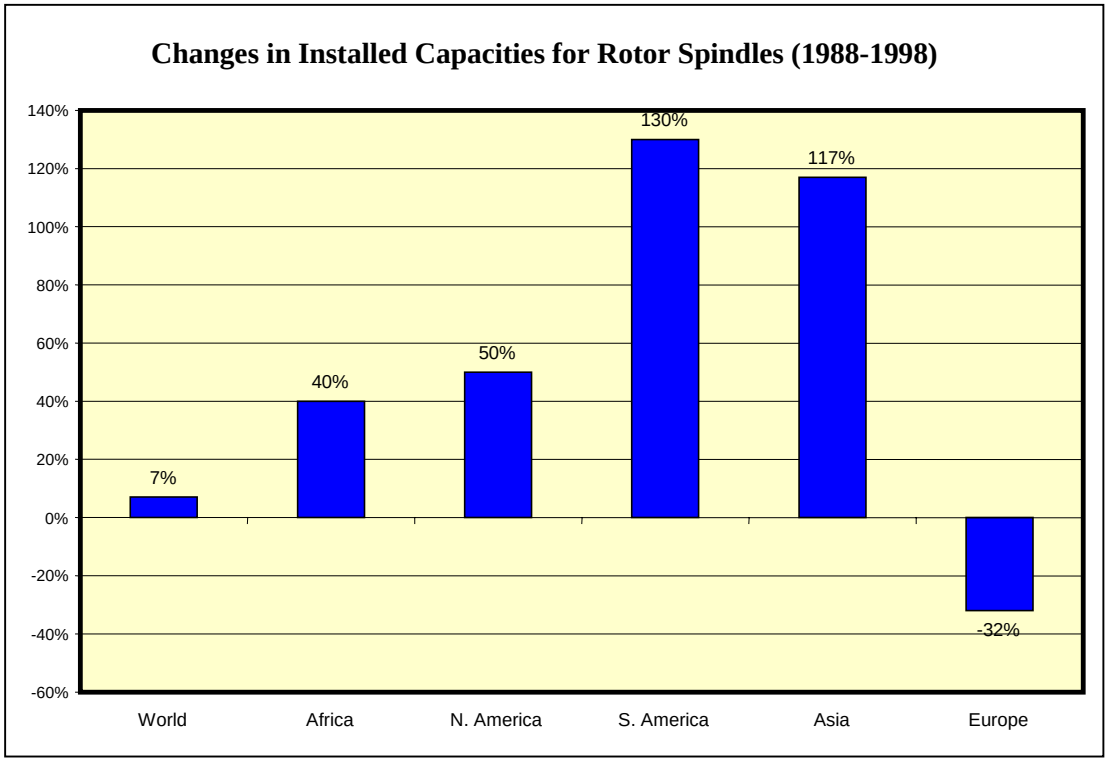

Figure 10.9: Changes in Installed Capacities for Rotor Spindles (1988-1998) [59]

By looking at Figure 10.8, the world change in increased capacity for ring spindles is 6 percent. Figure 10.9 shows that the world change for rotor spindles is 7 percent. What this can be interpreted to mean, by comparing these figures to Figures 10.6 and 10.7, is that there has been a significant displacement in the location of these types of spindles. More and more spinning facilities are moving to South America and Asia.

10.4 North America vs. World Trends

Figure 10.10 shows the percentage of both ring and rotor spindles installed in North America from 1987 to 1996. This was calculated from data produced by ITMF [58]. The percentage of ring spindles has decreased by over 50 percent. The percentage of rotor spindles has increased by almost 50 percent. This is very consistent with Figures 10.8 and 10.9, which show similar numbers, considering the numbers are representative of a different time period.

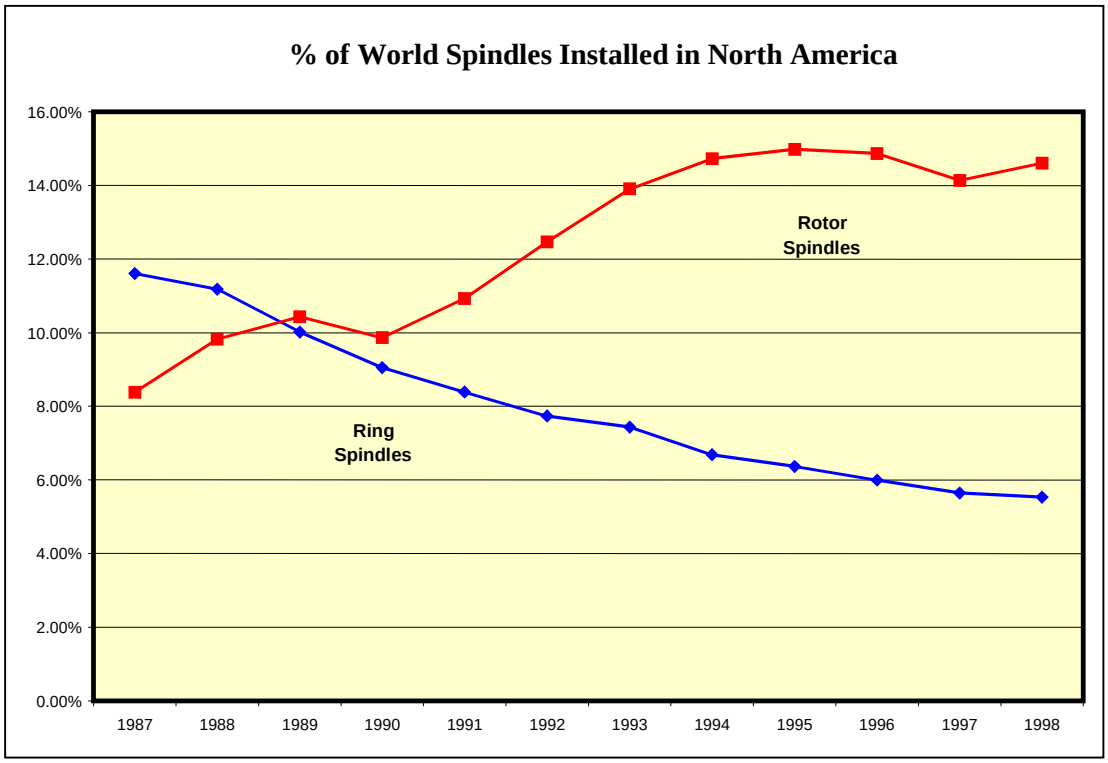

Figure 10.10: Percentage of World Spindles Installed in North America [58]

10.5 North America

Another important aspect to examine is where in North America the change has occurred. Undeniably, the number of rotor spindles in North America has increased, and

the number of ring spindles has decreased. An additional factor is that the production level of rotor machines is higher for newer machines and thus, even though the number of spindles may be constant, production levels may still increase significantly. Figures 10.11 and 10.12 show the number of ring and rotor spindles in North America broken down by country.

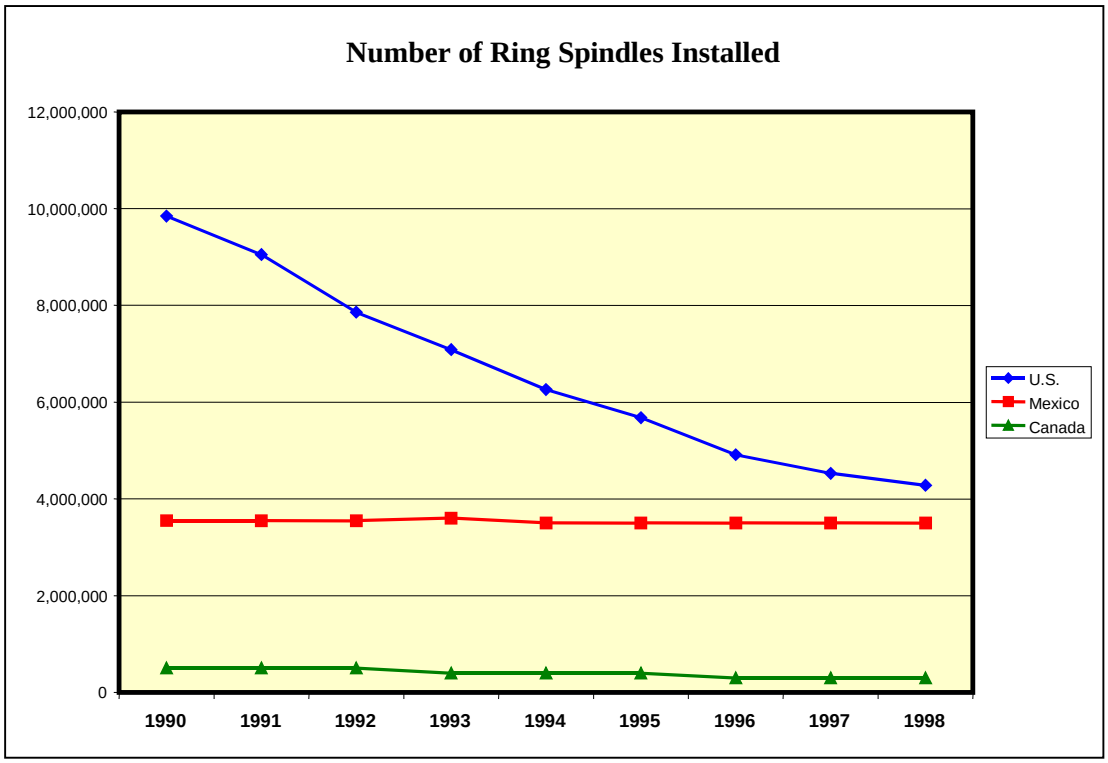

Figure 10.11: Number of Ring Spindles Installed in North America [59]

It is hard to decipher from these two figures the changes in the amount of either types of spindles in Mexico or Canada due to the scale of the charts. The number of ring spindles installed in the U.S. has significantly decreased since 1990. The number of rotor spindles installed in the U.S. increased from 1990 to 1994. But in 1994, with the implementation of NAFTA, the number of rotor spindles began to gradually decrease.

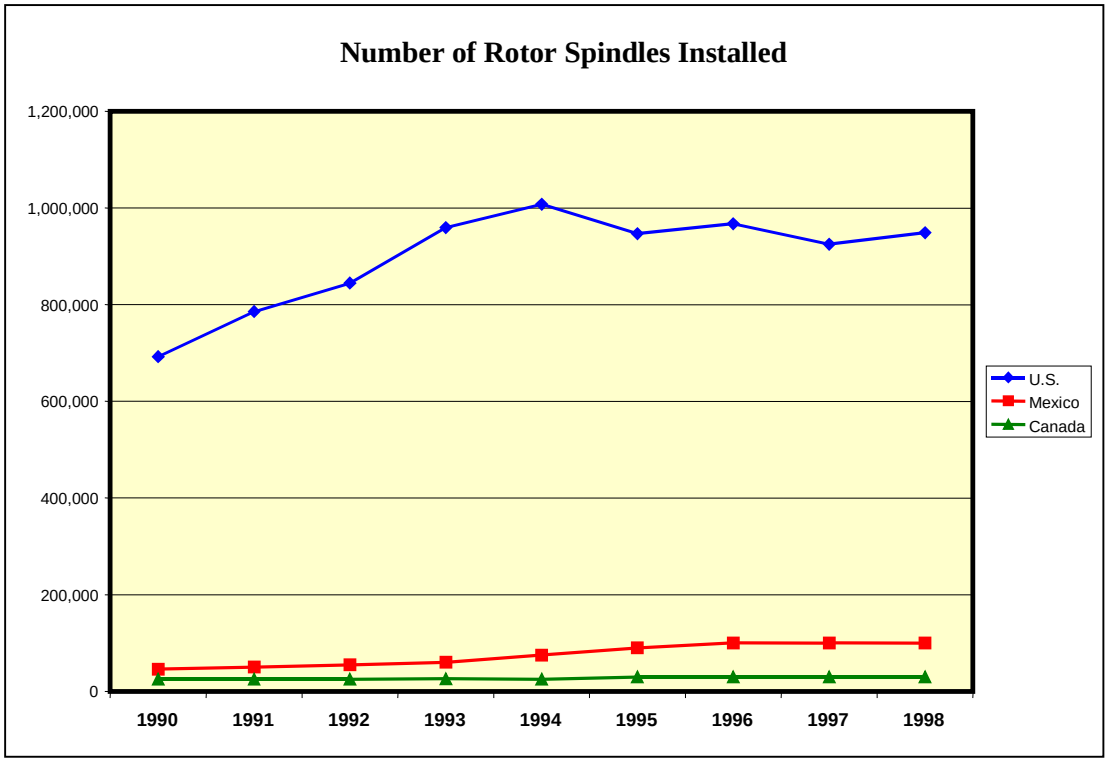

Figure 10.12: Number of Rotor Spindles Installed in North America (59)

Table 10.1 lists the percentage changes for all three countries from 1990 to 1998.

Table 10.1: Percentage Change in Installed Capacities (59)

	Ring	Rotor
U.S.	-56.52%	36.94%
Mexico	-1.44%	118.82%
Canada	-40.00%	20.00%
North America	-38.82%	41.48%

Of importance to note is that the numbers for North America include, not only the U.S., Mexico and Canada, but also Costa Rica, Cuba, Dominican Republic, El Slvador, Guatemala and Nicaragua.

It is obvious from Figure 10.12 that the number of rotor spindles installed in Mexico has increased since the implementation of NAFTA in 1994, most likely due to the U.S. moving its spinning operations south. Table 10.1 reinforces this point, showing that Mexico's increase in the number of installed rotor spindles has increased 118 percent. Even though the U.S.'s amount of rotor spindles has decreased since 1994, the level in 1998 was still almost 38 percent higher than the level in 1990. From 1994 to 1998, Mexico's percentage increase in installed rotor spindles was 33.33 percent. The U.S.'s percentage decrease was 5.85 percent, meaning that the rate of increase of the number of rotor spindles in Mexico is much higher than the rate of decrease in the U.S. Regardless of country of reason, the overall total number of ring spindles in all of the North American countries is decreasing, while the total number of rotor spindles in increasing.

10.6 Conclusions Based on Trends in Machinery

The conclusions which can be drawn from this chapter are as follows:

- The overall number of spindles in the U.S. is decreasing.
- The number of spindle hours in the U.S. is also decreasing.
- Less machines are operating less hours and producing more yarn, meaning that fewer spindles are producing more yarn.

- The number of ring spindles in the U.S. has decreased by over three thousand since 1993.
- The number of rotor spindles in the U.S. has remained fairly constant since 1993.
- The number of air jet spindles in the U.S. is increasing.
- Asia and Oceania had the highest percentage of ring spindles in the world in 1998.
- Eastern Europe had the highest percentage of rotor spindles in the world in 1998.
- Both ring and rotor spinning facilities are being set up in South America and Asia.
- The number of ring spindles in North America is decreasing.
- The number of rotor spindles in North America is increasing.

11 TRENDS IN IMPORTS AND EXPORTS

11.1 Introduction to Trends in Imports and Exports

Throughout this thesis, it has been stated that imports hurt the U.S. textile industry. Much of the research presented in the Literature Review claims that many of the current problems that this industry faces are due to less expensive products being imported into the U.S. Cotton yarn production has unequivocally decreased in the U.S. since the implementation of NAFTA. When the Asian financial crisis occurred, the U.S. market was flooded with inexpensive Asian products, many illegally imported. This had a substantial negative impact on the U.S. textile industry. Many efforts, which were mentioned earlier, have been taken in order to try and prevent this same scenario from happening again in 2005.

11.2 Imports and Exports of Textile Products

Figure 11.1 shows the imports and exports for all textile and apparel products for the U.S. Imports have steadily increased since 1990, with no change in 1994 with the implementation of NAFTA. Imports have, of course, increased, since 1994, but at a similar rate as that prior to 1994. There was a sharp increase from 1996 to 1997, which can most likely be attributed to the Asian financial crisis. Exports have also steadily increased over the same time period. Again, there was not a significant change in 1994, but the amount of exports, beginning in 1997, has decreased, probably for the same reason as for the sharp increase in imports.

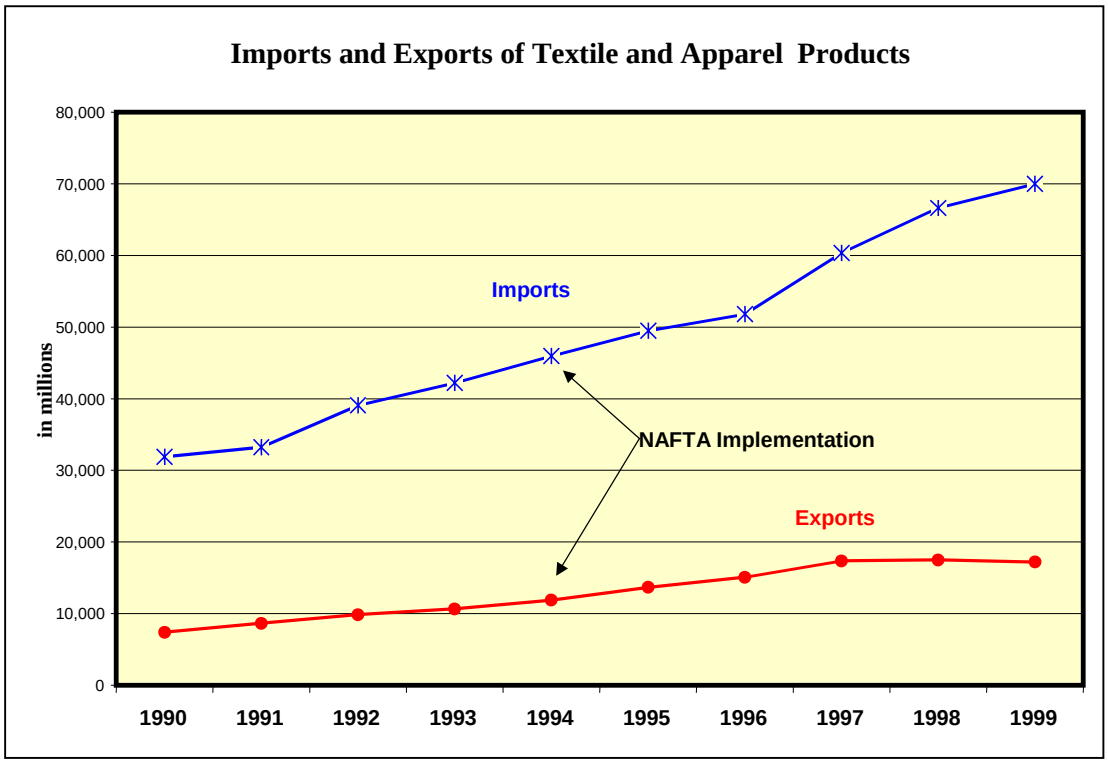

Figure 11.1: Imports and Exports of Textile and Apparel Products (53)

Figure 11.2 shows the percentage of U.S. textile imports from NAFTA and CBI countries since 1997. This chart shows that the number has increased, but only by around 3 percent. Figure 9.3 shows the percentage of U.S. textile imports for Asia over the same time period. Despite the Asian financial crisis, the number of imports from Asia has decreased by around 4 percent. This, of course, does not include illegal imports from China, which are estimated to be worth billions of dollars (43). Still, considering that around two-thirds of the products imported from NAFTA and CBI countries contain U.S. cotton, yarn or fabric, these numbers look promising.

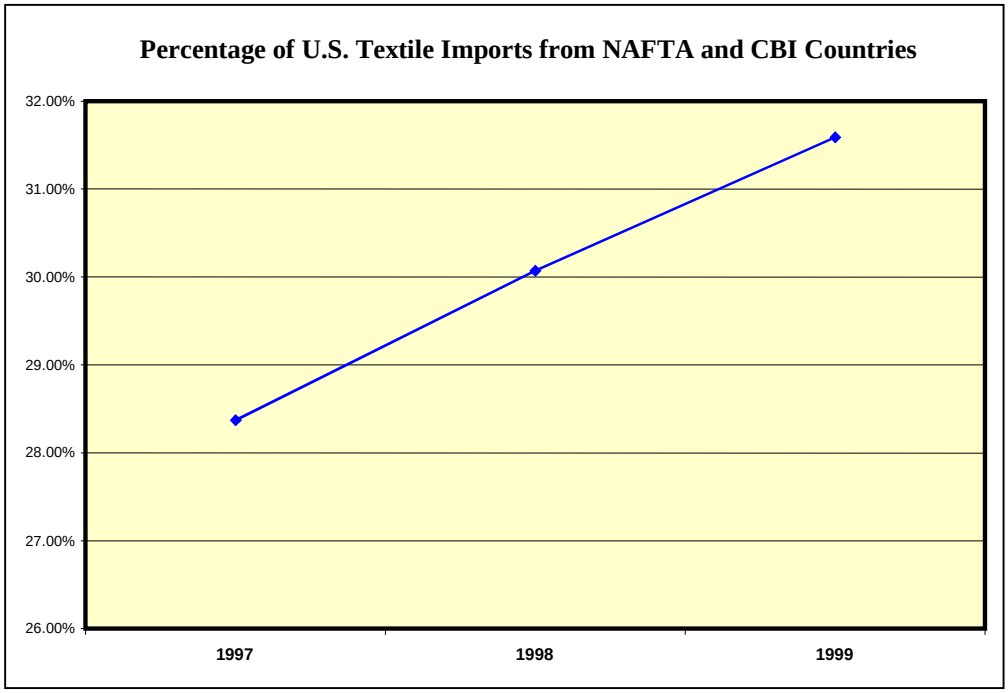

Figure 11.2: Percentage of U.S. Textile Imports from NAFTA and CBI Countries [32]

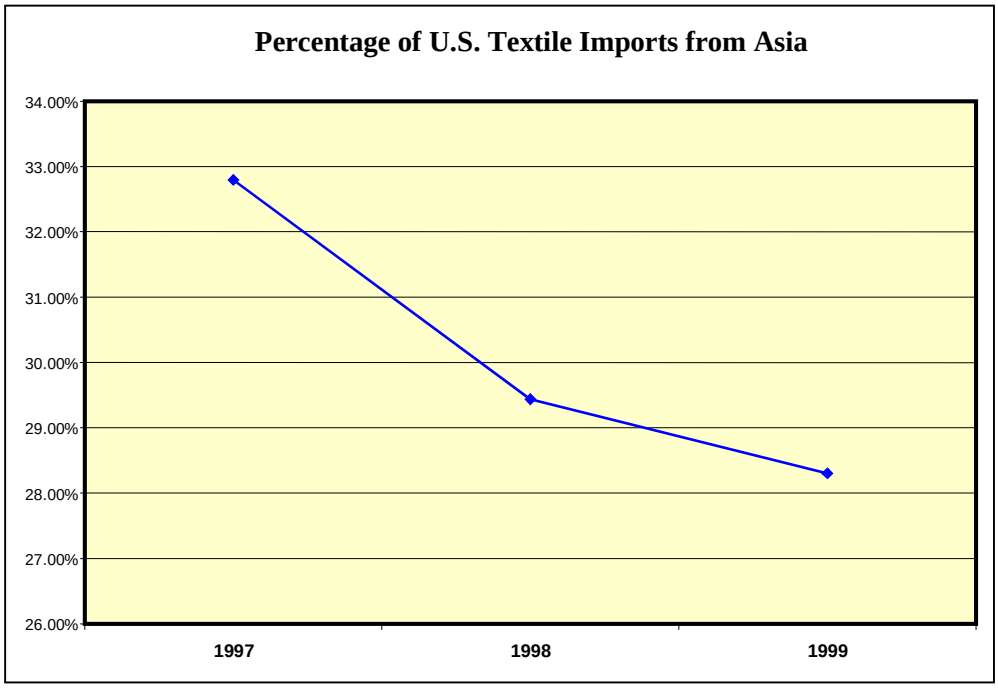

Figure 11.3: Percentage of U.S. Textile Imports from Asia [32]

After looking at the import and export trends for all textile and apparel products, it is important to focus on yarn, since cotton yarn is the major focus of this thesis. Figure 11.4 shows the imports and exports of cotton yarn.

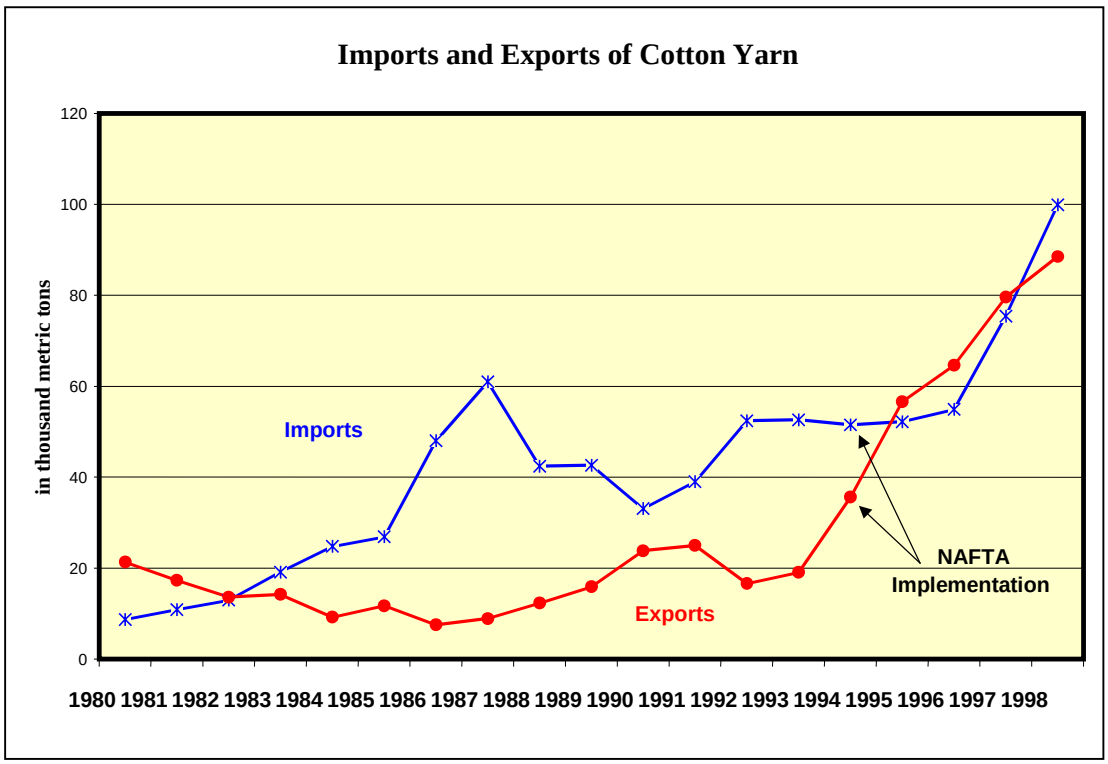

Figure 11.4: Imports and Exports of Cotton Yarn [10]

In Figure 11.1, when compared to this chart, has a much greater amount of imports than exports. But, when considering that the U.S. is one of the largest importers of apparel in the world, this is not surprising.

Figure 11.4 shows a lot more variation than Figure 11.1. Also, the amount of imports and exports seem to be much more closely related. Here, there is almost an inverse relationship. When imports increase, exports decrease, and vice versa. Also, NAFTA's implementation had very little effect on the imports and exports of cotton yarn

to and from the U.S. Actually, exports have considerably increased since 1994. Most likely, this yarn is being exported to NAFTA and CBI countries for further production processes. Imports, on the other hand, decreased from 1993 to 1995, where starting in 1996, also drastically increased. This again can be attributed to the influx of imports from Asia during their financial crisis.

Another important aspect to examine, considering the increased amount of exported yarn, is the percentage of exports of total production. This is shown in Figure 11.5.

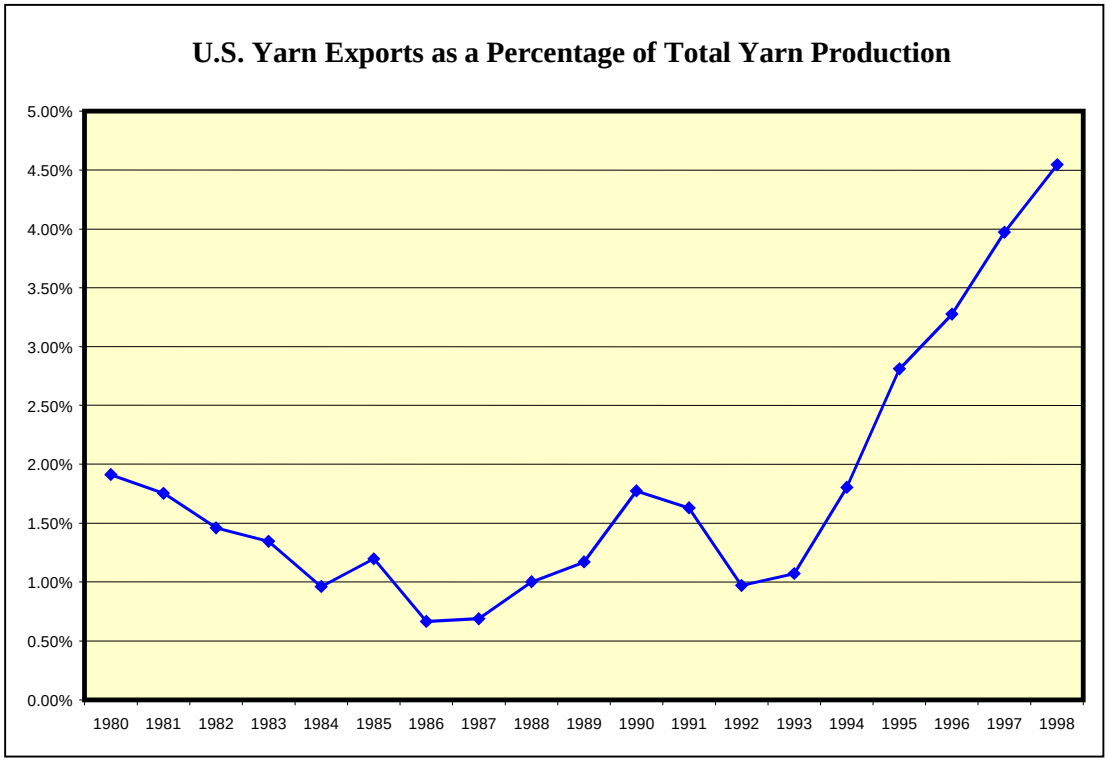

Figure 11.5: U.S. Yarn Exports as a Percentage of Total Yarn Production [10]

Since 1992, this percentage has increased, but only by around 4.5 percent. This verifies the previous statement that the U.S. is exporting their yarn to be processed elsewhere.

It is also important to address the issue to yarn trade balance. It is a fact that the U.S. has a negative textile trade balance with Mexico, -3,857 million dollars in 1999, and the CBI, -4,716 million dollars in 1999. The U.S. had a positive textile trade balance with Canada of 83 million dollars in 1999 (32). Figure 11.6 shows the U.S.'s yarn trade balance with NAFTA and CBI countries.

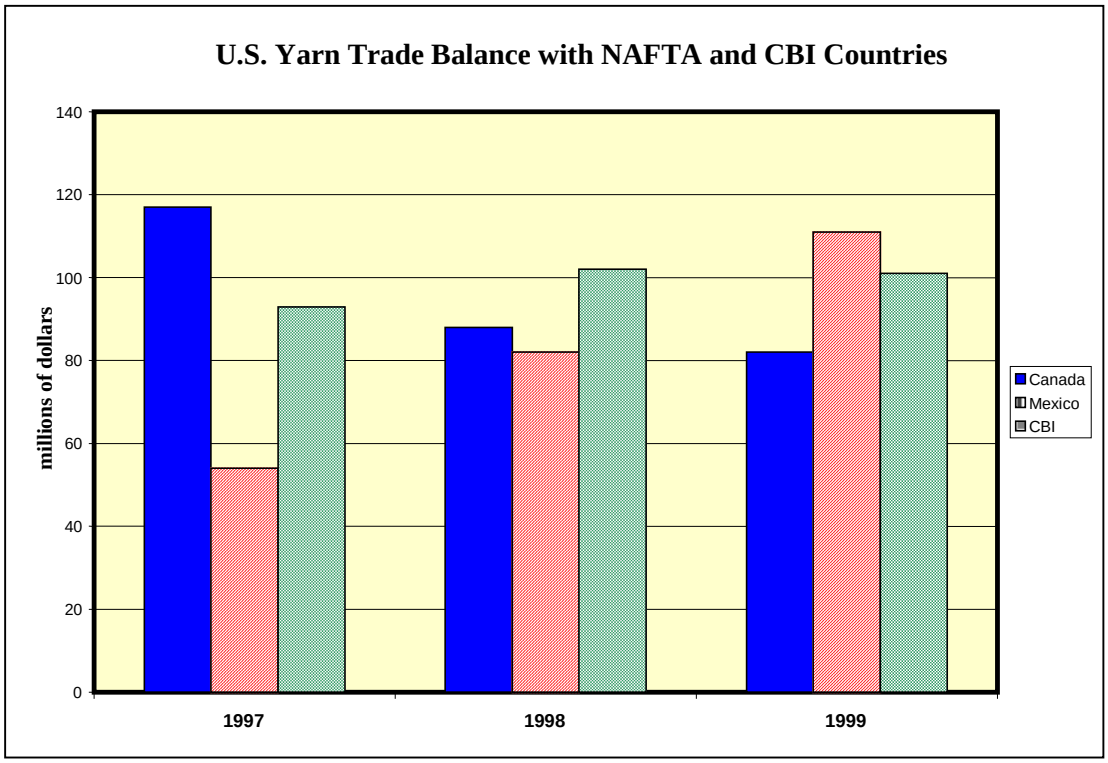

Figure 11.6: U.S. Yarn Trade Balance with NAFTA and CBI Countries (32)

Despite popular assumptions, the U.S. maintains positive trade balances of yarn with Canada, Mexico and the CBI countries. The trade balance is decreasing with Canada, but this decrease is being offset by the increase with Mexico.

11.3 Conclusions Based on Trends in Imports and Exports

The conclusions which can be drawn from this chapter are as follows:

- Textile and apparel imports into the U.S. have steadily increased since 1990.
- Textile and apparel exports have also increased since 1990.
- NAFTA did not have a significant impact on the number of textile and apparel imports into the U.S.
- NAFTA did not have a significant impact on the number of textile and apparel exports from the U.S.
- The percentage of imports from NAFTA and CBI countries is increasing.
- The percentage of imports from Asia is decreasing.
- In the U.S., cotton yarn imports increase as exports decrease, and cotton yarn exports increase as imports decrease.
- NAFTA did not have a major impact on cotton yarn imports and exports in the U.S.
- The U.S. maintains a positive yarn trade balance with NAFTA and CBI countries.

12 STATISTICAL ANALYSIS

12.1 Introduction to Statistical Analysis

After examining the basic trends in the factors that affect yarn production and yarn price, the next step was to determine the relationship that these factors have on the final production and price. In order to do this, the SAS program JMP 4.0 was used. This program was used mainly for determing the degree of the relationship of certain factors to the amount of yarn produced per year and also to determine the lag of certain variables with regard to yarn production. The same was done with yarn price.

12.2 Yarn Production

For yarn production, the available data was for 1984 through 1998. The factors that were compared were "yarn production", which is the amount of all short staple yarn types produced in the U.S.; the "lag of yarn production"; the "inverse lag of yarn production"; "cotton consumption", which is the amount of cotton consumed by the spinning industry in the U.S.; "spinning machine hours", which is the total amount of operating hours of all spinning machines in the U.S.; "number of employees in the textile industry", "amount of imports and exports of textile products", "the cost of labor", which is the average hourly wage of U.S. textile workers; "apparel sales" in the U.S.; "textile manufacturing sales" in the U.S.; and "inventories of textile materials", which are the level of stocks in all textile markets in the U.S. Using the statistical program mentioned above, the correlation matrix for all of these variables was found. This is shown in Table 12.1.

Of main interest is the magnitude of the numbers related to yarn production. The magnitude shows the strength of the relationship between the two. Whether or not the number is negative does not matter; a negative number simply implies that there is an inverse relationship between the two factors.

Correlations			
	Yarn Production	Invlag 1	Lag 1
Yarn Production	1.0000	0.8713	0.9164
Invlag 1	0.8713	1.0000	0.8220
Lag 1	0.9164	0.8220	1.0000
Cotton Consumption	0.9687	0.8951	0.9115
Machinery Hours	-0.8668	-0.8438	-0.9109
Labor Employed	-0.7714	-0.7629	-0.7789
Imports	0.9503	0.7929	0.9382
Exports	0.9222	0.8210	0.9337
Labor Price	0.9391	0.8643	0.9406
Apparel Sales	0.9473	0.8820	0.9317
Textile Mfg Slales	0.9587	0.8393	0.9224
Inventories	0.9225	0.8665	0.9490

Table 12.1: Correlation Matrix for Yarn Production

12.2.1 Results from the statistical analysis of yarn production

Cotton consumption is the most highly correlated with yarn production (0.9687). What this means is that the amount of cotton consumed in a year has a strong relationship with the amount of yarn produced that same year. Also, the amount of imports has a strong relationship with yarn production for the same year (0.9503). Surprisingly, the price of labor is also highly correlated with yarn production, but with the amount of yarn produced the previous year. Also, apparel sales and textile manufacturing sales both have a strong relationship to yarn production (0.9473 and 0.9587, respectively). In addition, the level of inventories of textile materials has a strong relationship with yarn production the previous year, obviously meaning that the inventories shown in one year is

most likely the result of excess yarn production the previous year. The three factors which were not highly correlated with yarn production were machinery hours, the amount of labor employed, and the amount of exports.

12.3 Yarn Price

For the analysis of which factors have the strongest impact on yarn price, the same techniques were used as with yarn production. Here, the data was available monthly from October 1990 through January 2000. The factors that were compared were "combed ring spun yarn price"; the "lag of combed ring spun yarn price"; the "inverse lag of combed ring spun yarn price"; "carded ring spun yarn price"; the "lag of carded ring spun yarn price"; the "inverse lag of carded ring spun yarn price"; "carded rotor spun yarn price"; the "lag of carded rotor spun yarn price"; the "inverse lag of carded rotor spun yarn price"; "cotton price", which is the price per pound of cotton in the U.S.; "labor price", which is the average hourly wage of textile workers in the U.S.; "apparel sales"; "textile manufacturing sales"; "inventories of textile materials"; "imports of textile materials"; and "exports of textile materials". The correlation matrix is shown in Table 12.2

Table 12.2: Correlation Matrix for Yarn Price

Correlations	COMBED RS	CORS Lag 1	CORS Invlag 1	CARDED RS	CARS Lag 1	CARD Invlag 1	CARDED OE	CAOE Lag 1	CAOE Invlag 1
COMBED RS	1.0000	0.7892	0.7863	0.7536	0.7578	0.7784	0.5096	0.5109	0.4902
CORS Lag 1	0.7892	1.0000	0.8386	0.7801	0.7528	0.6810	0.4676	0.4791	0.3572
CORS Invlag 1	0.7863	0.8386	1.0000	0.7558	0.7182	0.7513	0.5268	0.4849	0.5216
CARDED RS	0.7536	0.7801	0.7558	1.0000	0.7617	0.7605	0.5542	0.5450	0.4741
CARS Lag 1	0.7578	0.7528	0.7182	0.7617	1.0000	0.6990	0.4529	0.5288	0.4616
CARD Invlag 1	0.7784	0.6810	0.7513	0.7605	0.6990	1.0000	0.5602	0.5435	0.5657
CARDED OE	0.5096	0.4676	0.5268	0.5542	0.4529	0.5602	1.0000	0.9002	0.9051
CAOE Lag 1	0.5109	0.4791	0.4849	0.5450	0.5288	0.5435	0.9002	1.0000	0.8542
CAOE Invlag 1	0.4902	0.3572	0.5216	0.4741	0.4616	0.5657	0.9051	0.8542	1.0000
COT PR ($/LB.)	0.5602	0.4921	0.6042	0.5921	0.5348	0.6200	0.4117	0.3870	0.4074
LAB PR ($/HR.)	0.2382	0.2917	0.2027	0.1251	0.1734	0.0801	-0.5751	-0.5538	-0.5970
APRL SALES (B)	0.1286	0.1790	0.0616	-0.0059	0.0616	-0.0635	-0.6429	-0.6042	-0.6583
TEX SALES (B)	0.3520	0.3771	0.3169	0.3343	0.3521	0.3234	-0.2419	-0.2504	-0.2604
INVENT. (B)	0.3808	0.4099	0.3630	0.3457	0.3859	0.3272	-0.3456	-0.3319	-0.3594
IMPORTS (M)	0.2386	0.2980	0.1593	0.1523	0.2033	0.1070	-0.4111	-0.4012	-0.4661
EXPORTS (M)	0.3702	0.4215	0.3210	0.2833	0.3217	0.2667	-0.4041	-0.4012	-0.4301

12.3.1 Results from the statistical analysis of yarn price

The results from this analysis were somewhat surprising. None of the factors had a strong relationship at all with the price of any of the yarns analyzed. The most apparent reason for this is that the selling price of yarn was used instead of the total production

cost of yarn. The main factor in the selling price of yarn is how much the manufacturer marks up their price. Yarn cost was not used because this data is not available for an extended time period which is necessary for the JMP analysis to be accurate.

12.4 Conclusions based on the Statistical Analysis

The conclusions which can be drawn from this chapter are as follows:

- Cotton consumption and yarn production are highly correlated.
- Imports and yarn production are highly correlated.
- Apparel and textile sales are highly correlated with yarn production.

- Labor price has a strong relationship to the amount of yarn produced the previous year.

- The level of inventories has a strong relationship to the amount of yarn produced the previous year.

13 CONCLUSIONS

Throughout this thesis, data has been presented offering a glimpse into all the different factors which could have an effect on yarn production levels and price. First, data was gathered from different sources about yarn production and prices. Second, data was gathered about the different factors which could have an effect on these. Third, the data was compared and conclusions were made based solely on the obvious trends in the data. Fourth, current situations in the textile market were examined in order to conclude if any have had an effect on yarn production and price. Fifth, a statistical analysis was conducted.

Many conclusions can be made from the research presented in this thesis. There are definite conclusions drawn from obvious trends in the previous figures presented. There are also possible conclusions where a trend is thought to be, but not enough information is known to make a definite statement. Finally, there were surprises; places where trends were expected to be, but were not. But before these conclusions can be presented, it is important to address the weaknesses in this thesis.

The main weakness was that data was not available for the amount of ring, rotor and air jet yarn spun in the U.S. Therefore, it was not possible to see trends in the amount of these types of yarn spun. Data was available for the amount of machines installed, and conclusions were made based on this data. But, considering that most machines run at different speeds and efficiencies, no accurate conclusions could be made based on the amount of each type of yarn produced.

Also, data was also not available on the amount of U.S. yarn contained in products imported for NAFTA and CBI countries. This made it difficult to clearly see what effects NAFTA has had on just the yarn industry. Obviously, the amount of apparel imported from these countries has increased, but how much of this contains U.S. yarn is not exactly known. In the Literature Review, a few analysts stated that approximately two-thirds of the products imported from Mexico and Canada contain U.S. products. These products being either cotton, yarn or fabric. Since the exact figures are not known, it is hard to make any direct conclusions.

Despite these weaknesses, there are still definite conclusions which can be made based on the data presented in this thesis. These trends are as follows:

- Yarn production in the U.S. decreased after 1994.
- Yarn production is seasonal.
- The price difference between ring and rotor yarn is increasing.
- The price difference between fine and course count yarn is increasing.
- Cotton's percentage of the U.S. home furnishing and apparel markets is increasing.
- Cotton's percentage of the U.S. industrial market is decreasing.
- Cotton consumption is seasonal.
- There is an inverse relationship between cotton price and consumption.
- Raw material cost does not always make up the same percentage of yarn price.

- The level of cotton stocks and the price of cotton have an inverse relationship.
- Cotton stocks decrease as cotton consumption increases, and cotton consumption decreases as cotton stocks increase.
- Ring spun yarns are more expensive than rotor spun yarns.
- While the number of spindles in the U.S. has decreased, as well as the operating hours, the productivity of these machines has increased. Therefore, fewer spindles are producing more yarn.
- The number of ring spindles installed in the U.S. is decreasing.
- The number of rotor spindles installed in the U.S. is slightly increasing.
- The number of air jet spindles installed in the U.S. is increasing.
- Spinning production is increasingly moving to South America and Asia.
- The percentage of world rotor spindles installed in North America is increasing.
- The percentage of world ring spindles installed in North America is decreasing.
- In the past decade, the number of ring spindles installed in the U.S. has decreased by 56.52 percent.
- In the past decade, the number of ring spindles installed in Mexico has decreased by only 1.44 percent.

- In the past decade, the number of ring spindles installed in Canada has decreased by 40.00 percent.
- In the past decade, the number of ring spindles installed in North America has decreased by 38.82 percent.
- In the past decade, the number of rotor spindles installed in the U.S. has increased by 36.94 percent.
- In the past decade, the number of rotor spindles installed in Mexico has increased by 118.82 percent.
- In the past decade, the number of rotor spindles installed in Canada has increased by 20.00 percent.
- In the past decade, the number of rotor spindles installed in North America has increased by 41.48 percent.
- Textile and apparel imports into the U.S. have steadily increased since 1990.
- U.S. textile and apparel exports have also increased since 1990.
- The percentage of textile and apparel imports from NAFTA and CBI countries is increasing.
- The percentage of textile and apparel imports from Asia is decreasing.
- In the U.S., cotton yarn imports increase as exports decrease, and cotton yarn exports increase as imports decrease.

- The U.S. maintains a positive yarn trade balance with NAFTA and CBI countries.

From the statistical analysis,

- cotton consumption and yarn production are highly correlated,
- imports and yarn production are highly correlated,
- apparel and textile sales are highly correlated with yarn production,
- labor price has a strong relationship to the amount of yarn produced the previous year, and
- the level of inventories has a strong relationship to the amount of yarn produced the previous year.

Listed above are the definite trends concluded from this thesis. In addition to these, there were also possible conclusions where a trend is thought to be. These are listed below.

- U.S. spinning facilities are moving to Mexico.
- When cotton prices are low, the effect that this has on yarn price is reflected farther in the future than when cotton prices are high.
- The Asian financial crisis has had more of an impact on the U.S. yarn industry than NAFTA.
- NAFTA has not had a significant impact on the number of textile and apparel imports into the U.S.

- NAFTA has not had a significant impact on the number of textile and apparel exports from the U.S.

- NAFTA has not had a major impact on cotton yarn imports and exports in the U.S.

The reason why the last four conclusions can only be stated with reservation is that it is oftentimes difficult to distinguish which changes in the textile industry are a result of NAFTA and which are a result of the Asian crisis.

Finally, listed below are the conclusions that came as a surprise.

- Raw material makes up the largest percentage of yarn cost, followed by capital and then labor for both ring and rotor yarns.

- High capital costs can oftentimes offset the benefits of low labor costs.

- The labor productivity in spinning pounds per operator in the U.S. is almost twice that of Mexico and the CBI.

The reason why these conclusions were not expected is because of all the discussion surrounding how the U.S. textile market is being flooded by cheap imports from countries with inexpensive labor. This obviously leads one to believe that the inexpensive labor is why the imports are cheaper. From the research done in this thesis, it can be concluded that labor is not the sole reason why these imports are less expensive that domestically made products.

13.1 Future of the Spinning Industry

It is hard to determine the exact path that the industry will take due to the changes constantly taking place. As previously mentioned, advancements in speed and automation are continually being developed. There is the new Vortex spinning, which unlike air jet can spin 100% cotton yarn. Whereas air jet produces yarn at 250 to 300 meters per minutes, Vortex operates at 350 to 400 meters per minute. Once this system becomes mainstream, it will result in many changes for the yarn production industry. Table 13.1 illustrates the production rates of each spinning type compared to the others. This table assumes each spindle is producing the same count yarn. For example, a rotor frame can produce the same yarn 7.5 times faster than a ring frame. An air jet frame can produce yarn 13.75 times faster, and a Vortex frame can produce this yarn 18.75 times faster.

Table 13.1: Productivity Comparisons for Spinning Frames

	Rotor	Air Jet	Vortex
Ring	7.5	13.75	18.75
Rotor	N/A	2.0	2.7
Air Jet	N/A	N/A	1.1

In addition to the advancements being made in spinning technology, there are also unforeseeable trends. Currently, there is a trend favoring the use of ring spun yarns over rotor spun yarns. This, of course, is likely to change, as are most trends of this type. Also, in 2005, when tariffs and quotas are eliminated among textile products, it is impossible to see what effect this will have. In the literature review, many of the analysts researched believe that moving production facilities off-shore is the only way to survive the surge of imports which will definitely occur in 2005. But, as shown throughout this thesis, labor does not have as significant an impact on yarn price as expected. Also shown is that the productivity of these other countries is not a high as that of the U.S. Therefore, it is safe to say that moving spinning production would not be very economically wise. Although, one profitable reason for moving production would be to save money on transportation costs. There is no doubt that labor intensive textile industries will have to relocate, but spinning is not considered necessarily labor intensive. Therefore, if yarn production remains in the U.S., the yarn will have to be transported. But, there is still no way to avoid transportation costs somewhere along the way. In the scenario above, there remains the transportation costs related to the fiber shipments.

14 RECOMMENDATIONS FOR FUTURE WORK

This last section presents several recommendations for further study based on the research shown. The suggestions are would require additional research and the use of different analytical tools. The first suggestion is for a similar type of study done of different industries. For example, studying the trends and future of apparel or industrial textiles. Also, an analysis could be conducted on another type of fiber all together.

The second suggestion centers on this particular study. A more in-depth statistical analysis might show different trends which were not possible to see using these techniques. Also, a more in-depth study of this research could include specific case studies in order to see what people actually working in the spinning industry believe will happen. Also, these interviews could reveal the actual causes of certain trends that just looking at the data does not show. Hopefully, these recommendations will give a platform on which others can base their future research.

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16 APPENDIX

16.1 Published Materials

Differences in Yarn Prices - Some Cursory Observations

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There have been several recent comments in the textile press in connection with the differential pricing of ring spun and open-end (rotor) yarn. Furthermore concern has also been expressed about the difference in yarn pricing associated with yarn count, and how this potential difference is influenced by the yarn type (ring or rotor).

A project, currently underway at NC State, is investigating possible approaches to predicting future trends in yarn production in the US. Various sources of data are being utilized, including data associated with yarn pricing, some of which has been obtained from back issues of ATI. Based solely on data from ATI it is possible to clearly identify certain trends, which are apparent in the figures below.

Figure 1 shows a comparison of the prices for ring and rotor yarns of the same count (18Ne) from 1984 to the present. Additionally the difference in prices of the yarns is also included (ring yarn price – rotor yarn price) and it is clearly visible that the difference in prices has increased almost linearly with time. Indeed while the difference in price in October 1984 was $0.13 the difference in January 2000 is $0.51. This trend is also shown for other yarn counts, for which prices were available. The reason for the increasing difference in prices is that while ring spun prices showed a general increase (up to 1997) open end yarn prices either remained static of fell more rapidly than their ring spun counterparts.

Figure 2 compares the prices of 18Ne and 10Ne ring spun yarns (again from 1984 to the present) with the difference in yarn price due to count also being included. While there is considerable variation in price with time it appears that the difference in price between the finer and coarser yarn is increasing slightly.

Figure 3 is a similar exercise (comparing prices for 18Ne and 10Ne) for open-end (rotor) yarns. While the effects are small the data indicates that for open end yarns the difference in price between finer and coarser yarns is diminishing over the time period studied.

While the analysis is based on historic data and thus it is dangerous to extrapolate to make future predictions, the findings can be summarized as follows:

- the price difference between ring and rotor is increasing;
- the price difference between finer and coarser counts is increasing for ring spun yarns;
- the price difference between fiber and coarser count open-end (rotor) yarns is decreasing.

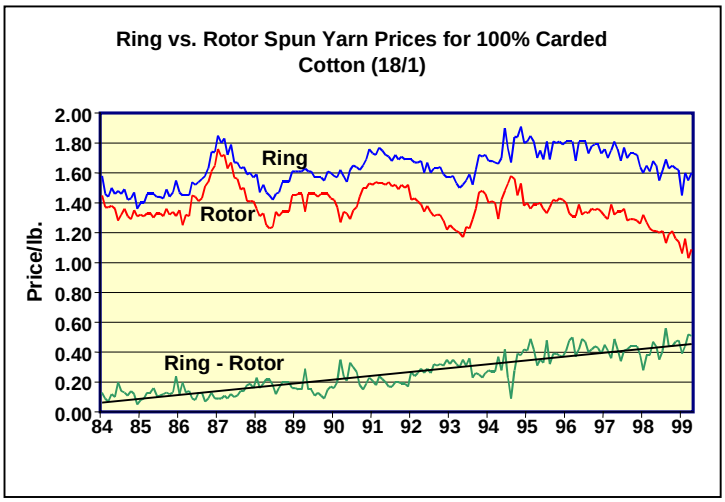

Figure 1

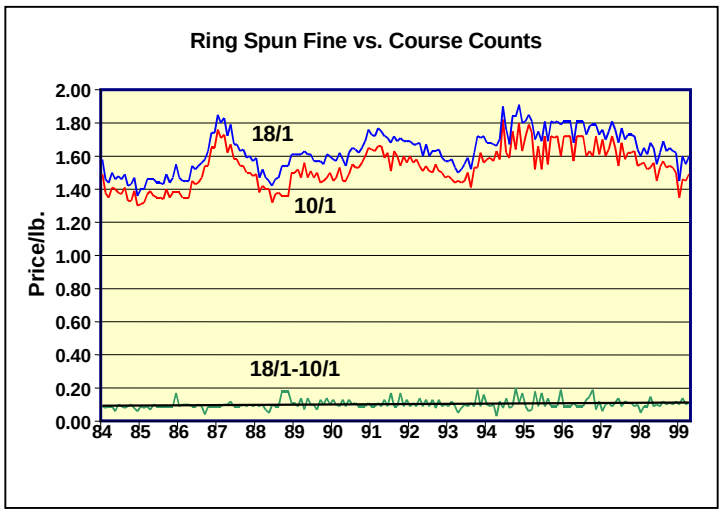

Figure 2

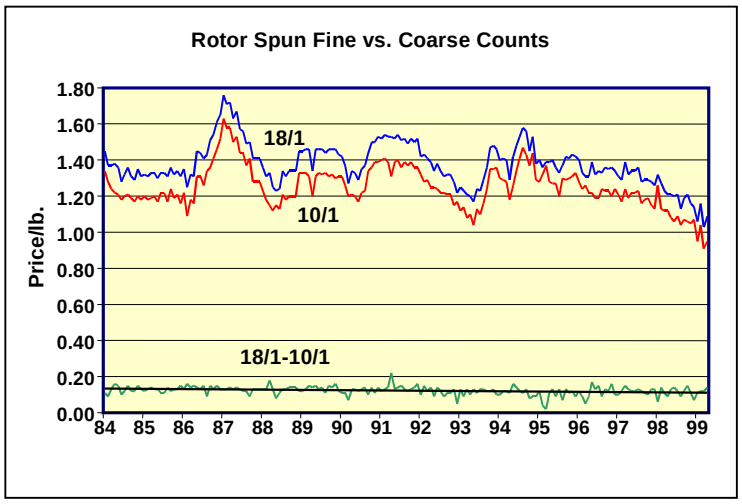
Rotor Spun Fine vs. Coarse Counts
Price/lb.
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
18/1
10/1
18/1-10/1
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99

Figure 3