

***Optimal Investment Strategies for Enhanced Productivity in the Textile Industry***

Principal Investigator: **S. Christoffersen, Ph.D.**, Economics / Industrial Organization,  
Philadelphia University

**Anusua Datta, Ph.D.**, Econometrics / Productivity, Philadelphia University

**Mikhail Kouliavtsev, Ph. D.**, Econometrics / Game Theory, Philadelphia University

**D.K. Malhotra, Ph.D.**, Finance / Quantitative Analysis, Philadelphia University

**Philip Russel, Ph.D.**, Finance/ Quantitative Analysis, Philadelphia University

**Goal:**

In this research we identify investment strategies to achieve maximum manufacturing efficiency with the ultimate goal of increasing the global market share of the US textile industry. We analyze production efficiency with regard to capital and labor usage, R&D expenditures, and the impact of foreign competition. We then analyze the financial repercussions of these decisions.

**Abstract:**

At the *industry level*, we determine the sources of productivity growth by regressing total factor productivity on capital-labor ratio, R&D employment, import penetration and IT investment. The results indicate that higher capital intensity and R&D leads to higher productivity. The effect of import competition is ambiguous. The effect of IT investment is small but negative.

At the *sector level*, we estimate production functions that allow us to calculate the elasticities of scale, which indicate the optimal size of a firm. We also estimate elasticities of substitution between capital and labor to identify possible efficiency gains from adopting more high technology v. more labor intensive technology, that is, we examine if production is based on the most efficient allocation of inputs.

At the *firm level*, we perform financial analysis in three areas: Operations, Investments, and Financing. Operating measures suggest that the industry has been able to effectively maintain manufacturing efficiency. However, global competition from low cost countries warrants that a policy of maintenance is not good enough. Financing measures indicate that the industry is suffering from the repercussions of high leverage; investments undertaken have not yielded the requisite benefits.

**Overview:**

Our analyses make use of three levels of aggregation; trends that are observed for the industry do not necessarily hold true for an individual firm or industry sector. However, firms must operate within these contexts, thus each level of analysis is informative. In the following section, we identify the determinants of productivity on the industry level. Next, using panel data, we estimate production functions and elasticities for twenty three industry sectors, and the last section presents firm level financial analysis.

**Industry Level Analysis: Productivity**

Reducing manufacturing costs is imperative for U.S. firms in the competitive international arena. Capital budgeting decisions are particularly critical since today's investment determines tomorrow's production capability. However, these decisions involve significant uncertainties. Investment in high tech machinery may be desired to minimize payroll expenses, substituting capital for labor, but this reduces the availability of funds for R&D that, if directed at new product development, might create new markets. R&D is problematic in that it has an uncertain pay-off; it is difficult to project the profitability of *potential* inventions. Furthermore, there are costs of complexity; firms commercializing new products and processes must divert productive resources towards implementation. Such adjustment costs for R&D related projects are estimated to be seven times the adjustment costs of investment in new plant and equipment. Additionally, these investments compete with the investment in information technology (IT) necessary for leaner manufacturing and supply chain management. We estimate the impact of such investments decisions on productivity to mitigate some of the inherent uncertainty.

Productivity *growth* in the textile industry has outpaced the other manufacturing sectors in the U.S. economy. While the growth rate is great, the overall level of productivity is still amongst the lowest of the manufacturing sectors. Shanzi (1995) analyzes the U.S. textile-apparel industries and concludes that the returns to R&D in textiles are positive but much lower than that in apparel; also that textile mills operate in the slightly diminishing returns to scale range. Recent studies also identify information technology (IT) as a potential source of productivity gains (Stiroh 2001) which can occur through lower transactions cost and improved market information. Thus we analyze the impact of R&D, IT as well as deeper capitalization, and import competition on productivity, at both the level effects and growth effects. The regression specification is:

$$TFP_t = a_0 + a_1 \text{Output}_t + a_2 \text{KLRatio}_t + a_3 \text{R\&D-Intensity}_t + a_4 \text{Import Competition} + a_5 \text{ITKRatio}_t + \varepsilon_t$$

where TFP is the total factor productivity index for the textile industry at the 2-digit level at time t. Output represents real output, measured as nominal sales over price index and is included to measure scale effects. KLRatio, calculated as the ratio of capital input to labor input, measures capital intensity; R&D-Intensity is the ratio of R&D employment to total employment<sup>1</sup>. Import Competition is measured by the ratio of imports to domestic production, a measurement of market penetration. Finally, ITKRatio measures the real value of Information Technology investment as a share of total capital.<sup>2</sup> Table 1 gives estimates for the determinants of Total Factor Productivity based on level values. Since the data on R&D is available only from 1970, two specifications of the model, with and without R&D, are estimated. R-squares for both models is 0.98, indicating a good fit.

Table 1: *Dependent Variable: LNTFP*

	(1962-1994)	(1970-1994)
<i>Intercept</i>	3.230 (13.67)**	2.116 (4.87)**
<i>Log Q</i>	0.304 (5.88)**	0.632 (8.22)**
<i>Log KLRATIO</i>	0.403 (5.68)**	0.834 (6.50)**
<i>Log IMPEN</i>	0.189 (3.11)**	0.102 (1.69)
<i>Log RD.<sub>3</sub></i>		0.066 (1.39)
<i>Log ITKRATIO</i>	-0.019 (-0.65)	-0.104 (-3.02)**
<b>R<sup>2</sup> (adj.)</b>	<b>0.98</b>	<b>0.98</b>

Note: R&D data is not available for period before 1970.

Figures in parentheses represent t-statistics.

\*\*Indicates significance at 1% level, and \* indicates significance at 5% level.

<sup>1</sup> Data on R&D expenditures is not available for all the years in the sample because of disclosure issues.

<sup>2</sup> This study is based on data for the period 1962-1994. Data on the TFP, real output, capital, and labor and IT investment, compiled by the Department of Census, are published by the Bureau of Labor Statistics. The data on imports is taken from the NBER (National Bureau of Economic Research) trade data and R&D employment figures are obtained from the Survey of Industrial Research and Development Historical Database, published by the NSF (National Science Foundation).

The coefficient for output level is positive, indicating that productivity increases as the industry expands. Increased capitalization or downsizing also improves TFP. There is much debate in the literature about the impact of foreign competition. If imports reduce market share, they limit the potential for firms to realize economies of scale, however, they also force firms to become more efficient to survive. The coefficient on import competition, measured by the ratio of imports to domestic output, is positive and significant for the period 1962-1994 but is insignificant for the latter 1970-1994 period.

A three-year lag for R&D-intensity reflects a gestation period for innovation. While the estimated impact is positive, it is not highly significant. Finally, IT capital captures the impact of investment in computers and software on productivity. The coefficient value is small but *negative*. This result is in keeping with other studies, which find no significant relationship between investment in information technology and growth. In the initial years, the cost of IT investment may outweigh the returns in the textile industry.

One of the issues with using level values is that the  $R^2$  and t-values may be high because of common trends in the variables. To ascertain that the results are not spurious, we run the regression using growth rates. The results are reported in Table 2. Not surprisingly, the R-squares for the two specifications are lower at 0.56 and 0.65 respectively. However, the estimates are largely consistent with the level effect estimates, indicating that results are robust.

Table 2: *Dependent Variable: TFP Growth*

	1962-1994	1970-1994
<i>Intercept</i>	0.001 (1.97) *	0.013 (1.709)
<i>QGrowth</i>	0.286 (2.49) **	0.413 (2.918) **
$\dot{KLR}$	0.257 (2.31) **	0.538 (3.951) **
$\dot{IMPEN}$	-0.025 (-0.80)	-0.027 (-0.696)
$\dot{RDEMP}_{-3}$		0.091 (3.585) **
$\dot{ITKRATIO}$	0.046 (-1.64)	-0.097 (-2.562) **
$R^2$	0.56	0.69

Figures in parentheses represent t-statistics.

\*\* Indicates significance at 1% level and \* indicates significance at 5% level.

When measured in growth terms the coefficient of output measures scale effects (Denny, 1981), with a value greater than zero indicating increasing returns. The estimates indicate that scale economies are greater in the latter period. The coefficient for the growth in the capital labor ratio remains positive and highly significant; indicating that increasing in capital intensity is associated with increasing productivity.

The relationship between R&D and TFP growth is still positive and now significant. The magnitude of the coefficient however is small, most likely reflecting the small percentage of firms that conduct R&D in the textile industry. The effect of the growth in IT-capital investment on productivity remains small but negative. The coefficient for the growth in import competition is now negative but is insignificant; reflecting the ambiguous impact of foreign competition.

### **Sector Analysis: Production Efficiency**

To further investigate opportunities to increase efficiency, we study the production processes of twenty-three sub-sectors of the textile industry in an attempt to analyze the changing patterns of scale of operation and input use. Sophisticated econometric techniques allow us to distinguish sector and time specific trends.

First we estimate the production function, from this we will derive elasticities. The production functions commonly used to study a particular industry, such as the Cobb-Douglas (CD) or the constant elasticity of substitution (CES) functions, are often deemed too restrictive. An alternative approach is to use a variable elasticity function (VES), which allows for the needed flexibility. The VES production function, introduced by Hicks (1932) and used by Vinod (1972, 1976) to study the telecommunications industry, and applied to the textile industry as a whole in Ramcharran (2001), can be written as

$$Y_{it} = e^{b_i} K_{it}^{b_1} \quad (1)$$

The function in equation (1) describes production in sector  $i$  in period  $t$  given the available inputs. Then for each sector, the marginal elasticity of output with respect to each factor can be derived as

$$\varepsilon_K^i = \partial \ln Y_i / \partial \ln K_i = b_1 + b_3 \ln L_i \quad \text{and} \quad \varepsilon_L^i = \partial \ln Y_i / \partial \ln L_i = b_2 + b_3 \ln K_i \quad (2)$$

Then marginal products, MPK and MPL, are given by

$$MPK^i = Y_i / K_i \times \varepsilon_K^i \quad \text{and} \quad MPL^i = Y_i / L_i \times \varepsilon_L^i \quad (3)$$

Note that equations (2)-(3) imply that marginal products are decreasing in their own inputs and increasing in the other input, consistent with accepted theory and intuition.

It can be shown (Vinod, 1972) that the scale elasticity is the sum of all input elasticities:

$$SE_i = \varepsilon_K^i + \varepsilon_L^i = b_1 + b_2 + b_3 \ln (L_i \cdot K_i) \quad (4)$$

Finally, the elasticity of substitution between inputs, which depends on the levels of both  $K_i$  and  $L_i$ , is

$$S_i = (\varepsilon_K^i + \varepsilon_L^i) / (\varepsilon_K^i + \varepsilon_L^i + 2b_3) \quad (5)$$

Since our goal here is extending the empirical literature to the textile industry, we keep the discussion of theoretical issues to a minimum and omit any derivations. The interested reader is referred to the classic theoretical papers of Lu and Fletcher (1968), Sato and Hoffman (1968), Revankar (1971), Christensen, Jorgenson, and Lau (1973), and Lovell (1973).

### **The Econometric Model**

The basic estimable model is obtained by taking the natural log of the production function, equation (1), which, in terms of a panel regression equation, becomes

$$\ln Y_{it} = \beta_i + \gamma t + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 \ln K_{it} \ln L_{it} + v_{it} \quad (6)$$

where

$Y_{it}$  is real output of sector  $i$  in period  $t$ ,

$K_{it}$  is capital stock employed by sector  $i$  in period  $t$ ,

$L_{it}$  is a measure of labor input in sector  $i$  in period  $t$ ,

$\beta_i$  is a sector-specific intercept term,

$\gamma_t$  is a period-specific trend factor,

$\nu_{it}$  is the error term, which may include a random component plus a pure white noise term.

Panel data methods for estimating equation (6) include a wide range of models, differentiated by applying the appropriate restrictions. For example, constraining  $\beta_i = \beta_0$  for all  $i$ ,  $\gamma_t = 0$  for all  $t$ , and assuming that  $\nu_{it}$  is pure white noise, produces a pooled regression, which can be estimated by Ordinary Least Squares (OLS). Alternatively,  $\beta_i = \beta_0$  and  $\nu_{it} = u_i + \epsilon_{it}$  yields a two-way random effects model.

Our sample is drawn from the NBER Manufacturing Productivity Database (Bartelsman and Gray 1996). It covers all twenty three four-digit SIC textile sectors over the period 1958-96. The data include observations on values of shipments (i.e., sales), real capital stock (including plant and equipment), and various measures of labor inputs, such as total number of workers, numbers of production and non-production workers, hours, etc. The data also include implicit price deflators for variables measured in nominal terms, such as value of shipments and cost of materials. For output, we use real value added. We construct the real value added series for each sector by separately deflating the value of shipments (VISHIP) and cost of materials (MATCOST) using the appropriate price indexes, and then taking the difference. The natural log of the result is our dependent variable. The computation of real value added resulted in several negative values, which were discarded, yielding 881 usable observations. For  $L$  we use total number of production workers, PRODE, as it appears to be the most adequate measure of the labor input involved in the actual production; for capital we use the natural log of total value of capital.

The various specifications of the regression model amount to different assumptions on the intercept term. In particular, the constant term (i.e., intercept) in our two-way fixed effects model is made up of three components: the overall constant  $\beta_0$ , the sector-specific effect  $\beta_i$ , and the time specific effect,  $\gamma_t$ . The computations of the elasticities and marginal products themselves, however, involve only the estimates of the coefficients on the input measures and not the constant term and are thus affected only indirectly. In the remainder of this section, we summarize our empirical results.

### **Elasticity of Substitution**

The elasticity of substitution,  $s$ , measures, in relative terms, the ease with which capital and labor can be substituted one for another while maintaining a constant level of output. Our estimation approach allows for a nonconstant substitution elasticity parameter, which proves important in distinguishing different sectors. We are interested in the *change* in  $s$  as well as its absolute *level*. Rising elasticity of substitution indicates greater degree of interchangeability between inputs; falling  $s$  means capital and labor are becoming poorer substitutes for each other. A priori, one would expect those sectors, which have become relatively more capital-intensive with the development of new technological processes to exhibit falling elasticities of substitution.

Our estimates for most sectors lie in the 0.6-0.8 range, while the values found in the literature rarely exceed 0.25. Nevertheless, our results are consistent with the theoretical expectation of negatively-sloped isoquants ( $s < 1$ ), as well as with the empirical regularity of observing elasticities of substitution in the (0, 1) interval.

Ten sectors exhibited rising  $s$ , albeit all but two of them were rather modest increases. The largest increases were observed for Lace and warp knit fabric mills and Nonwoven fabrics. For Lace and warp

knits, this observation appears consistent with the conduct and performance of the firms: following the adoption of GATT, many producers moved their operations to Mexico, where labor is relatively more abundant while capital is not. Thus, the two factors appear quite interchangeable there. The Nonwovens, on the other hand, are quite a puzzle: the sector is relatively capital-intensive as the production of these fabrics requires mechanical, chemical or thermal bonding of individual yarns. We take a closer look at Nonwoven fabrics at the end of this section.

Five other sectors had declining elasticities, with three of them falling substantially. The two largest declines were observed for Knit underwear and nightwear mills and Tire cord and fabrics. Overall, fewer sectors displayed declines in their substitution elasticity parameters than did increases. However, the declines were bigger in magnitude (on average) than the corresponding increases. This is consistent, once again, with the overall pattern of declining substitutability between factors in the textile industry (see Ramcharran (2001) and sources cited therein.) In other words, it appears that greater reliance on the capital input by at least some sectors in the recent years has made the two factors less substitutable.

### **Elasticity of Scale**

Intuitively, elasticity of scale (*SE*) measures the relative increase in productivity due to increases in scale, proportional increases in both inputs. Values of *SE* larger than one indicate the presence of increasing returns to scale (IRS), whereby, say, doubling of both inputs leads to more than doubling in output. Conversely, *SE* of less than one is a sign of decreasing returns to scale (DRS), less-than-doubling of output in response to doubling of all inputs. The intermediate case,  $SE = 1$ , is constant returns to scale (CRS). We are interested not only in the *level* of scale elasticity, but also in *changes* in this level. If one observes a rising *SE* for a particular sector, it implies that that sector should be able to achieve lower average costs of production by increasing its output over time. Conversely, a falling value of *SE* means that increasing output further would lead to smaller reductions in cost-per-unit.

Generally constant scale elasticity was observed for the following sectors: Knit underwear and nightwear mills, Lace and warp knit fabrics, Coated fabrics, not rubberized, all of which had the scale parameter approximately equal to 1, indicating the presence of constant returns to scale; as well as Finishers of textiles, not elsewhere classified, Tire cord and fabrics, and Cordage and twine, which all exhibited decreasing returns to scale ( $SE < 1$ ).

Falling elasticity of scale parameters were observed for Broadwoven Wool, Women's full- and knee-length hosiery, and Finishers of broadwoven cotton fabrics. In all three cases, the scale elasticity gradually fell from about 1.5 to 1.1, indicating perhaps that these sectors took better advantage of the economies of scale in the 1990s than in the 1960s.

Significant increases in scale elasticity parameters were observed for 10 of the 23 sectors, although some of these increases were modest. Further increases in scale in these sectors would bring about increasingly positive returns. Several sectors saw growth in the scale elasticity until the mid-1970s and modest decline thereafter. These increases may be a result of falling output caused by weakening demand for these sectors' output. Several sectors – Narrow fabric and other smallwares mills, Hosiery, and Thread mills – displayed rather wild swings in their returns-to-scale measures, but had little overall change from the beginning to the end of the sample period. Not surprisingly, the products of firms with constant *SE* have experienced relatively stable demand and, consequently, stable output, while those with rising *SE* have faced growing demand.

These results are consistent with those reported for the industry as a whole for a similar period by Ramcharran (2001). He finds, for example, that the overall scale elasticity grew from 0.094 to 1.638 between 1975 and 1993. Additionally, we find that the observed increases on the returns-to-scale are largely due to increasing marginal elasticity of labor (and, consequently, MPL) rather than increasingly

productive capital, which also agrees with previously cited results. The sector-level analysis, however, sheds additional light on the intraindustry developments. The relatively modest overall contribution of capital to productivity should be a source of some concern.

### **Marginal Productivity of Labor**

Marginal Product of Labor (MPL) measures the change in output that would result from a small change in the quantity of labor employed. Increasing labor input should, typically, increase output; therefore, MPL is positive. Holding other inputs (i.e., capital) fixed in their quantities, MPL declines as more labor is added to production. In theory, it is possible that MPL becomes negative: with a fixed amount of capital, increasing the number of workers indefinitely eventually causes additional workers to “get in the way” and reduce the productivity of existing labor. A competitive market for labor implies that workers’ wages are equal to their productivity. The implication for our discussion is that changes in labor productivity should be accompanied by changes in wages earned by workers in each sector.

We observe positive MPL’s for all twenty-three sectors in our panel. Additionally, all MPL’s grew over the observed period, indicating that labor has become relatively more productive between 1958 and 1996. However, for Thread and Handwork Yarns this productivity grew very little; at the same time, industry observers report that wages tend to grow more slowly than average in this sector. Thus, we have some evidence in support of competitive factor markets assumption. All of the sectors appeared to experience significant adverse labor productivity shocks in the early-to-mid 1970s, following a period of steady growth in MPL in the 1960s.

### **Marginal Productivity of Capital**

Similarly, Marginal Product of Capital (MPK) measures the change in output in response to an incremental change in the capital input. Holding other inputs fixed (i.e., labor), MPK declines with successive additions to capital stock – *diminishing marginal productivity of capital*. We observe several patterns of changing MPK’s across sectors.

For Hosiery, Circular Knit Fabrics, and Carpets and Rugs, the MPK is positive and increasing throughout the thirty-nine year period. Thus, these sectors have become increasingly more productive. This observation is confirmed by reports of growing demand for these products and increased merger activity following the changes in international trade agreements. In other words, firms in these sectors grew both internally – through expanding output in response to stronger demand – and externally – through acquisition – and became more productive as a result.

For Broad Woven and Narrow Woven fabrics, Knit Underwear and Nightwear, Finishers of Broadwoven cotton, and Other Textile Goods the MPK’s exhibited a declining pattern. Although, capital productivity remained positive, *additional* capital investments would be less productive in the 1990s than similar additions in the 1960s. It turns out that these sectors are characterized by weakening demand and increased competition from abroad. Additionally, even though output of some sectors grew in the 1990s, firms were adversely affected by stricter environmental regulations, imposing constraints on disposal of byproducts. These external supply shocks may be the source of lower productivity that is otherwise not explained by our model.

Several sectors exhibited little or no change in capital productivity. Among these are Broadwoven Man-made Fiber and Silk, Warp Knits, Yarn of Cotton, Thread and Handwork Yarns, Knit Outerwear, Women’s Hosiery, and Yarn Texturizing, Throwing, Twisting, and Winding mills. Some of these sectors’ MPK’s are characterized by rather large upward and downward swings with little overall change, while others displayed relatively constant MPK’s throughout.

The remaining sectors exhibited negative marginal capital productivity throughout the period. Three of these saw visible improvements in capital productivity – for Knitting mills, not elsewhere classified, the MPK rose throughout; for Coated fabrics, not rubberized it rose through about 1974, but fell significantly thereafter; and for Cordage and twine it grew slightly throughout but with some mild downward swings. One sector, Tire cord and fabrics, displayed negative and substantially decreasing MPK after 1974.

All of these sectors are typically made up of small- to-medium-sized firms (many with 20 or fewer employees), which tend to have older structures and equipment. Falling employment here also contributes to lowering productivity of capital. In other words, old capital by itself is likely to possess low productivity characteristics; additionally, the relative size of the capital stock may be too large in sectors experiencing declining employment. This forces already low MPK down into negative values.

### **Summary of Sector-specific Production Analysis**

There are substantial differences in the evolution of the production processes in different textile sectors, something industry-level analysis cannot uncover. In particular, negative and sometimes falling MPK indicates that the industry has over invested in capital. It would pay to reduce the size of the capital stock or, alternatively, expand labor employment while maintaining a constant quantity of capital, provided that demand for the industry's output remains strong or grows.

With respect to the economies of scale, sectors with products that have experienced growing demand in recent years (and consequently have been able to increase their output) tend to have higher and faster-growing elasticities of scale. Conversely, those sectors faced with declining demand (and falling output) have lower values of scale elasticity.

Our estimates of the elasticities of substitution are somewhat higher than the overall values reported previously for textiles as an industry. Moreover, for several sectors, the substitution elasticity parameters actually rose, indicating greater substitutability between labor and capital. While this may be consistent with the notion of a "declining industry" for some sectors, it appears rather puzzling for, say, Nonwovens, widely touted as the fastest growing textile sector (Marlow-Ferguson, 2001).

### **Nonwoven Fabrics**

The nonwoven fabric industry is unique, experiencing relatively strong growth in terms of employment, wages, and output, as well as in the number of firms engaged in production. The relative capital intensity of the production process currently makes nonwoven fabrics immune to much of the competition from abroad: the governments of developing countries, whose prime objective is finding employment for its labor force, tend to avoid subsidizing such industries requiring large capital investments and small work force.

We estimate that the marginal productivity of labor grew especially fast in the late 1970s and early 1980s, accompanied by higher than average wage rates for textiles. The marginal product of capital, on the other hand, remains negative indicating that perhaps investment still outpaced the growth in other factors and output. Overall, the industry has become more efficient, as is indicated by the significant increase in the scale elasticity, from 0.62 in 1958 to 1.2 in 1996. This is consistent with the description of a capital-intensive sector, where production involves large fixed costs.

Substitution between labor and capital has increased, albeit modestly, from 0.62 to 0.76 over the thirty-nine year period. While this is somewhat unusual for a production process requiring very specific machinery, it may be indicative of the technological developments that took place since the early 1960s giving firms greater flexibility in the choice of technological methods to employ in production. If past performance is a good predictor of future conditions, the sector will continue to grow and evolve.

**Firm level: Financial Analysis**

We use firm-level financial data for publicly traded firms, compiled by Compustat for the period 1991-2000, on two levels: (a) for the entire sample of firms; and (b) a bifurcated sample based on firm size. We analyze decisions faced by textile firms within three categories: investment decisions, financing decisions and operating decisions. We present only the summary table here due to space constraints.

*Textile Industry in the 1990s: Performance Trends*

▼=unfavorable trend; ▲=favorable trend; \*\* = relatively stable trend ▼▲= unstable trend

	Performance Measure	Full Sample	Large Firms	Small Firms
Descriptive	<b>Market Value</b>	▼	▼	**
	<b>Relative Shareholder Return</b>	▼	▼	▼
	<b>Sales</b>	▲	▲	▲
	<b>Net Trade Cycle</b>	**	**	**
	<b>Z-Ratio</b>	▼	▼	**
Investment Decisions	<b>Return on Assets</b>	▼	▼	▼
	<b>Return on Investments</b>	▼	▼	▼
	<b>Return on Equity</b>	▼	▼	▼
	<b>Equity Growth Rate</b>	▼	▼	▼
Financing Decisions	<b>Debt-Equity Ratio</b>	▲	▲	▲
	<b>Free cash flow per share</b>	▼▲	▼▲	▼▲
	<b>Interest Coverage Ratio</b>	▼	▼	▼
	<b>Earnings Per Share</b>	▼	▼	▼
	<b>Dividend Payout</b>	▼	▼	▼
Operating Decisions	<b>Asset Turnover Ratio</b>	**	**	▲
	<b>Inventory Turnover Ratio</b>	**	**	**
	<b>Receivables Turnover Ratio</b>	**	**	**
	<b>Gross Profit Margin</b>	**	**	**
	<b>Net Profit Margin</b>	▼	▼	▼

These trends are based on mean values; the disaggregation of full sample into equal sized groups of large and small firms is based on average market value of equity of individual firms during the ten years.

The average number of workers employed in each firm is observed to be steady at around 6,000. The average exports increased from \$450.64 million in 1991 to peak at \$711.71million in 1998. The market capitalization of the firms experienced significant decline with the average market value dropping by nearly 60% during the period. This compares with overall stock market performance of an increase in S&P500 index by nearly 300% during this period.

The net trade cycle holds steady at around 100 although there are significant differences among firms. The average net trade cycle for UNIFI is only 54.42 days while for Albany International it is 220.62 days. A widely accepted measure of impending financial distress is the Z-ratio (Altman, 1968). A firm is considered to have a low probability of bankruptcy if the Z-score is greater than 2.90. While the average Z-score for textile industry is above 3 until 1996, it starts steadily declining after that year, falling to 2.12 in 2000. This correlates with NAFTA, followed by Asian currency crisis in 1997.

**Investment Measures**

Investment decisions set the trend for future growth. For the textile industry, the investment measures generally show a declining trend. The return on assets (ROA) is around 3% until 1997 and then steadily falls, dropping dramatically to negative 34.1% in 2000. Similar declines are noted for return on investments (ROI) and Return on Equity (ROE). Furthermore, smaller firms have significantly underperformed the larger firms. For example, in 2000, the ROI for large firms is -2.76% while for smaller

firms it is significantly lower at -19.4%. The average ROE is quite volatile during our sample period, ranging from a low of -11.74% in 1995 to a high of 12.89% in 1993. The figures on ROE suggest low profitability and unprofitable return on borrowings.

### ***Financing Measures***

Financing decisions are critical and reflect a firm's strategy with regard to raising funds for making investments and for financing the operations of business. Financing measures indicate the industry suffers from the repercussions of high leverage. The debt-equity ratio shows excessive levels of debt; this has tax advantages as the interest on debt is fully tax deductible. While each firm and each industry will have its own optimum debt-equity mix, in general a financing mix with more than 50% debt, or a debt-equity ratio of more than 1, is considered risky. While the average debt-equity ratio for textile firms has fallen from high of 2.59 in 1991 it is still relatively high at 1.66 in 2000. Interest coverage ratio (ICR) indicates firm's ability to service its debt obligations. This position has worsened from a healthy 3.36 in 1991 to 1.09 in 1998, and declined even further to -.33 in 2000. While larger firms are marginally better than smaller firms, they are not sufficiently safe either.

Cash flow figures are much more representative of the financial health of a company than earnings figures which can be distorted through legal accounting manipulations. For healthy firms, you will expect the free cash flow number to be positive with an increasing trend. The average numbers for free cash flow per share are generally low for our sample and range from -.26 to .92. Over the ten-year period, only three firms had a positive cash flow per share.

### ***Operating Measures***

Operating measures shed light on firm's effectiveness in managing working capital. Surprisingly, while there are firm-level differences, the mean values are consistently stable for the full sample for all the variables. For example, inventory turnover ratio fluctuates within a fairly narrow range over a ten-year period (4.78 to 6.09). Similarly, the average numbers for current ratio and gross profit margin are also observed to be fairly stable even at firm level. These measures suggest that the industry has maintained manufacturing efficiency. However, global competition from low cost countries warrants that a policy of *maintenance* is not good enough; firms will have to improve their manufacturing efficiency. Furthermore, the increased debt ratio should reflect equipment purchases that result in *improved* operating ratios. Clearly adjustment costs of innovation are high and managing technological change is difficult. Change, however, is inevitable.

### **Contributing Graduate Students:**

*Harshavardhan Chenna-Narendra*, B.Tech. (Textiles), Kuvempu Univ, MS Textile Engineering, Philadelphia Univ.  
*Rama Srinivasan*, M.Sc (Textiles & Clothing), Univ. of Madras; M.S Fashion Apparel Studies, Philadelphia Univ.

Industrial interactions: 5 [Burlington, UNIFI, Pillowtex, Toyobo Inc., Dow Chemicals]

5 Paper Presentations: at the annual conferences of the *North American Productivity Workshop*, *The Eastern Economics Association (2)*, *International Applied Business Research Conference (published in the Proceedings)*, and the *Northeast Business and Economics Association*.

Three scholarly publications under review

---

URL: <http://faculty.philau.edu/christoffersens/NTCGrant/index.htm>

### References:

Altman, E. I., 1983, *Corporate Financial Distress: A Complete Guide to Predicting, Avoiding and Dealing with Bankruptcy*, John Wiley & Sons, New York.

American Textile Manufacturers' Institute Inc., 1130 Connecticut Avenue, NW, Suite 1200, Washington D.C. <http://www.atmi.org>

Cline, William R. 1990. *The Future of World Trade in Textiles and Apparel*, Institute of International Economics, Washington, D.C.

Krueger, A. 1980. "Protectionist pressure, imports and employment in the USA," *Scandinavian Journal of Economics*, vol 82, pp 133-146.

Lawrence, R.Z. 1983. "Is trade de-industrializing America?," *Brookings Papers on Economic Activity*, (1) pp 129-171.

Levinsohn J. and W. Petropoulos, 2001. "Creative destruction or just plain destruction?: The U.S. Textile and Apparel Industries Since 1972," NBER, Working Paper 5348, Cambridge, MA.

Denny, M., M. Fuss and L. Waverman (1981): "The Measurement and Interpretation of Total Factor Productivity in Regulated Industries," in T. Cowing and R. Stevenson (eds), *Productivity in Regulated Industries*, New York: Academic Press.

Griliches, Z. 1979. Issues in Assessing the contribution of research and development to productivity growth. *Bell Journal of Economics* 10, no. 1:92-116.

\_\_\_\_\_, 1980. R&D and the productivity slowdown. *American Economic Review* 70, no. 2:343-48.

Hawawini, G. and C. Viallet, 1999, *Finance for Executives*, South Western College Publishing, USA.

Kwoka, J. E. 1993. "The Effects of Divestiture, Privatization and Competition on Productivity in U.S. and U.K. Telecommunications." *Review of Industrial Organization*, 8, 49-61.

Levinsohn, J. and W. Petropoulos (2001): "Creative Destruction or Just Plain Destruction? The U.S. Textile And Apparel Industries Since 1972." NBER, Working Paper 5348, Cambridge, MA.

Mansfield, E. 1980. "Basic Research and Productivity Increase in Manufacturing." *American Economic Review*, 70, 863-73.

Scherer, F.M. 1983. "Concentration, R&D and Productivity." *Southern Economic Journal* 221-225

Shanzi, K. 1995. *Beyond Capital and Labor: The Contribution of Technology and Regional Milieu to Production and Productivity Growth*, Garland Publishing: New York.

Stiroh, K. 2001. "Investing in Information Technology: Productivity Payoffs for U.S. Industries." *Current Issues in Economics and Finance*, June, vol.7 (6), Federal Reserve Bank of New York.

---

**SUSAN CHRISTOFFERSEN, Ph.D.**, an Associate Professor of Economics and Finance, joined the School of Business Administration at Philadelphia University in 1996. Susan has a MA and Ph.D. in economics from NYU, earned in 1990. Her publications can be found in the *Journal of Business and Economic Studies*, *American Economist*, *Journal of Applied Business Research*, *Journal of Global Competitiveness*, and others. Recently she was elected to the Board of the Eastern Economics Association. Her research agenda includes strategic R&D competition, specifically, the incentives to subsidize Research

and Development within the context of an international innovation race, and empirical studies of the textile industry, focusing on productivity.

I01-P13

[ChristoffersenS@PhilaU.edu](mailto:ChristoffersenS@PhilaU.edu)

(215) 951-2821

<http://www.philau.edu/Christoffersens>

**ANUSUA DATTA, Ph.D.**, is Assistant Professor of Economics and Statistics at the School of Business Administration at Philadelphia University. She joined the University in 2000. Dr. Datta received her Ph.D. in Economics from *University of Wisconsin*, Milwaukee in 1999. Her fields of research include studies in market structure, productivity and R&D, industry studies and macroeconomic growth. She has expertise in econometric modeling. Her work has been presented at prestigious forums like the *American Economic Association* and *Econometric Society*; her research on productivity and R&D is forthcoming in the *Southern Economics Journal*.

[dattaa@philau.edu](mailto:dattaa@philau.edu)

(215) 951-2916

**D.K. Malhotra** is an Associate professor of finance. Dr. Malhotra has published over 30 research articles in various national and international refereed journals. In addition, he has presented over 35 research papers at various academic conferences all over the world. *New York Times*, *Investor's Business Daily*, *Philadelphia Inquirer*, *Business Credit Magazine*, *KPMG Online Newsletter*, and *Omaha World Herald* have quoted Dr. Malhotra. Dr. Malhotra is currently serving on the editorial board of **International Journal of Banking and Finance, International Journal of Management Research, and Journal of Insurance and Risk Management**