

Optimal Investment Strategies for Enhanced Productivity in the Textile Industry

Project No.: I01-P13

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Goal:

The goal of this research is to identify investment strategies to achieve maximum manufacturing productivity with the ultimate goal of increasing the market share of the US textile industry.

Abstract:

Using the total factor productivity index of textile firms, this study will assess the impact of investments in R&D, IT, capital and labor. Our objective is to develop a model that will measure the relative impact of the various investments on productivity using both industry and firm level data. To derive the optimal investment strategy to enhance productivity in the textile industry, we examine the combined effects of labor, R&D, IT investment and capital expenditures on productivity. Using time series data for a cross-section of firms (panel data), we will econometrically estimate the production function for textile firms. We will explore the increasing contribution if any of R&D over time, learning curve effects of R&D because benefits of such expenditure to increase over time. We also investigate if capital expenditure exhibits diminishing productivity returns over time and if offshore locations differ from domestic.

Objective:

Market share can only be gained if textile firms are more competitive, either through improved products or reduced costs. Improving productivity will reduce costs. This could be achieved through new plant investment (capital), information technology (IT) investment, labor training, or R&D directed at high technology manufacturing to reduce labor usage. However, these investments compete with expenditures necessitated by dynamic consumer demands, such as R&D directed at new product development. These competing demands pose the question of what is the optimal investment strategy; is it better to spend on product or process development, make better stuff or make stuff better.

Using the total factor productivity index of textile firms, we will assess the impact of investments in R&D, IT, capital and labor. The model will measure the relative impact of the various investments on productivity using both industry and firm level data. Trends that are observed for the industry do not necessarily hold true for an individual firm. However, firms must operate within the context of the industry, thus both analyses are important. Panel data will be developed; the time series aspect will allow us to analyze how these parameters change over time and the cross-sectional data will show how the parameters differ across firms. This will assist management decision-making in areas of uncertainty such as assessing the impact of R&D v. IT investment in enhancing productivity, taking into account the interactions between factors of production.

Relevance to NTC Mission:

Reducing manufacturing costs is imperative to enhance the market share of U.S. firms in the competitive international arena. However, capital budgeting decisions involve significant uncertainties. For example, R&D investment is problematic in that it has an uncertain pay-off; it is difficult to project the profitability of *potential* inventions. We address this difficulty by determining the impact of various investments on productivity gains for a cross section of textile firms. The impact of R&D can then be compared to other investment alternatives such as plant and equipment expenditure. Time series data allows us to ask: Does R&D have an increasing contribution over time? Do learning curve effects cause benefits of such expenditure to increase over time? Does capital expenditure exhibit diminishing productivity returns over time? How do offshore locations differ from domestic? Does IT expenditure exhibit increasing productivity returns over time?

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. This necessarily changes the way we view R&D investment. Analyzing total factor productivity, which includes the interaction between factors, will improve how the industry assesses productivity by including these costs of complexity. According to Cline (1990), productivity gains, not import penetration, have had the largest impact on employment in the textile industry. Productivity *growth* in the textile industry has outpaced the other manufacturing sectors in the U.S. economy. While the gains in labor productivity are great, the overall level of productivity is still below the level of labor productivity of the other manufacturing sectors. This suggests tremendous potential for continued productivity growth. Once production functions for firms in the industry are estimated, the impact of other variables can be tested. The data can be segmented to determine the importance of factors that may contribute to productivity such as the size of the firm, nature of the product (availability of close substitutes), ownership characteristics, sources of financing, and offshore plants.

Productivity:

Productivity studies (Mairaisse and Griliches, 1990) often cover a large sector of the economy, such as the manufacturing sector. These studies then report the impact of aggregate levels of capital investment on the overall manufacturing productivity of the economy. Although such aggregation is criticized, very few studies are industry specific, relying on firm-level data. Our study of the textile industry uses data from individual firms and thus will result in more useful estimates of the contribution of R&D, capital, labor, and IT investment to productivity. Based on this evolving area of methodological approaches, increasing access to data, and specific interest in textiles, we feel this is a fruitful area of research.

The contribution of technology to increased output, productivity and the stock market valuation of a firm has been shown to be significant in many industry studies, however the textile industry has been neglected. The importance of technology was first recognized when estimates of production functions initially showed unacceptably large residuals; that is, output was greater than one would have expected from given inputs of labor and capital (Abramovtz, 1956, Kendrick, 1956, and Solow, 1957). These residuals were later attributed to technological growth; greater output was due to the more efficient deployment of those inputs as a result of

technological change. (Denison, 1962 and Griliches & Jorgenson, 1967). Then in the 1970's there was a slowdown in productivity growth that could be explained by diminishing returns to science and technology. Thus the relationship between productivity and technological growth was understood to be positive but with a diminishing horizon (Nordhouse, 1972 & 1989, Olson, 1982, Scherer, 1983, and Baily & Chakrabati, 1988). This is one of the most complex yet vital issues in today's business world (Griliches, 1998).

Productivity Trends

The Bureau of Labor Statistics (BLS) provides productivity data for the industry over a period of fifty years with attention to input costs, which we present here. In addition, we present the Annual Survey of Manufacturers from the Bureau of the Census that is disaggregated to the three digits SIC code. The Compustat Dataset provides detailed financial data for individual firms, which will be compiled to estimate productivity on an individual firm level.

Chart 1 indicates productivity growth for both the textile and apparel industries. The textile industry is compared to the apparel industry because these two industries are vertically linked. The tremendous growth in productivity in textiles is not found in the apparel industry due to the labor intensity of that industry. While the textile industry has greater ability to adopt advanced technology, demand for textiles derives in large part from the apparel industry. The chart indicates that fifty years ago the textile industry was 35% as productive as it was in 1996 and that between 1996 and 1999 productivity increased by 8 percent. The data is indexed at 100 in 1996

Chart 2 shows the productivity trends for the textile industry, broken down to the level of three digits SIC codes, where 1987 is the base year, indexed at 100. This chart highlights types of firms that have had the greatest productivity advances. Broadwoven cotton mills as well as yarn and thread mills have had declines in productivity.

While these sectors require greater study, the chart highlights the need to disaggregate. Industry level data are discouraging however plant level data may tell a different story. Table 1 documents the significant exit and entry in the textile industry. Historically, firms that exit an industry are generally the more inefficient firms. Those that remain and the ones that enter, on the other hand, are typically more productive and technologically advanced.

Traditionally, labor productivity has been used to measure productivity growth however labor is decreasing in importance in the production of textiles. Technologically advanced manufacturing processes substitute more sophisticated machines (capital) for labor. As a result, measuring labor productivity when labor is decreasing is going to exaggerate productivity gains just as output per unit of capital (capital productivity) will underestimate productivity growth. Chart 3 below, compares these productivity measures with the preferred multi-factor productivity index. This index also captures interactions between inputs, which can be significant, such as R&D investments that enhance both capital and labor productivity.

Chart 1: Comparison of MFP for SIC 22 and SIC 23

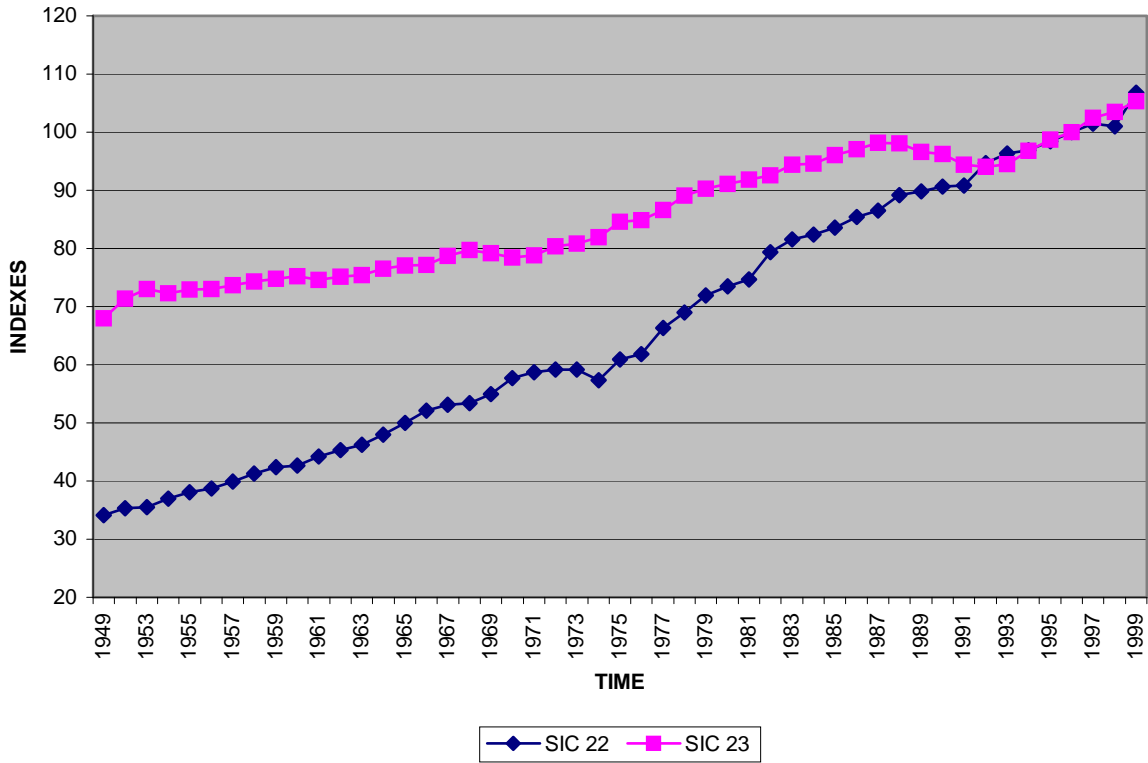


Chart 2: Comparison of MFP's of SIC-221, 222, 223, 224, 225, 226, 227, 228 and 229

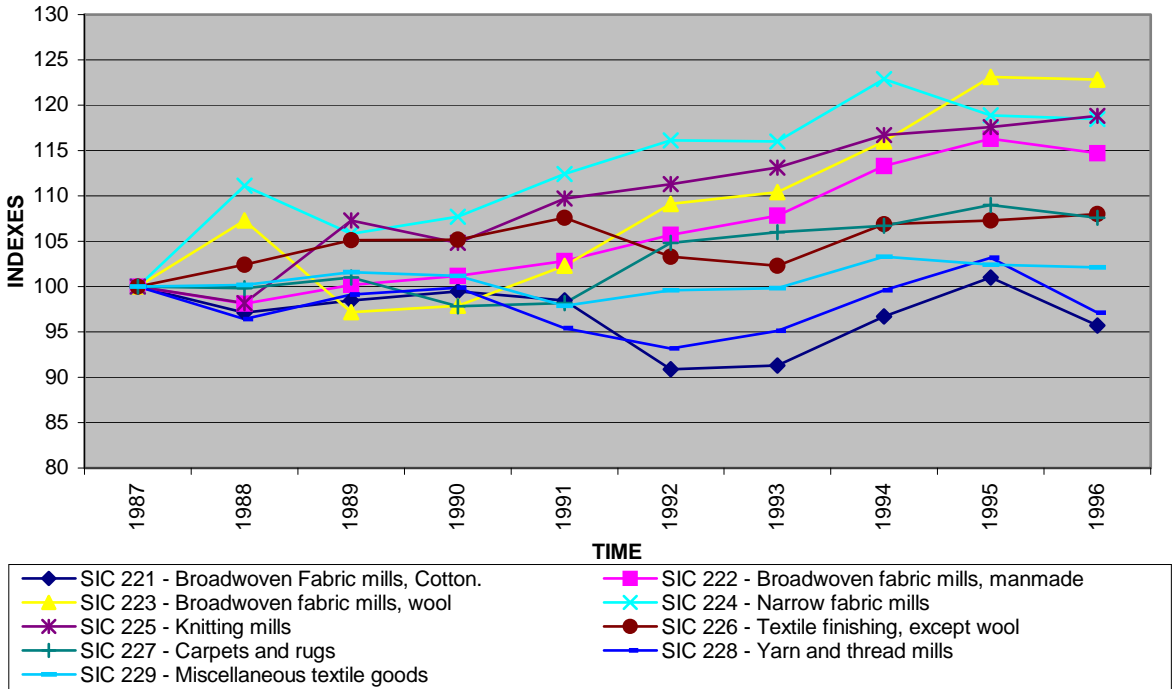
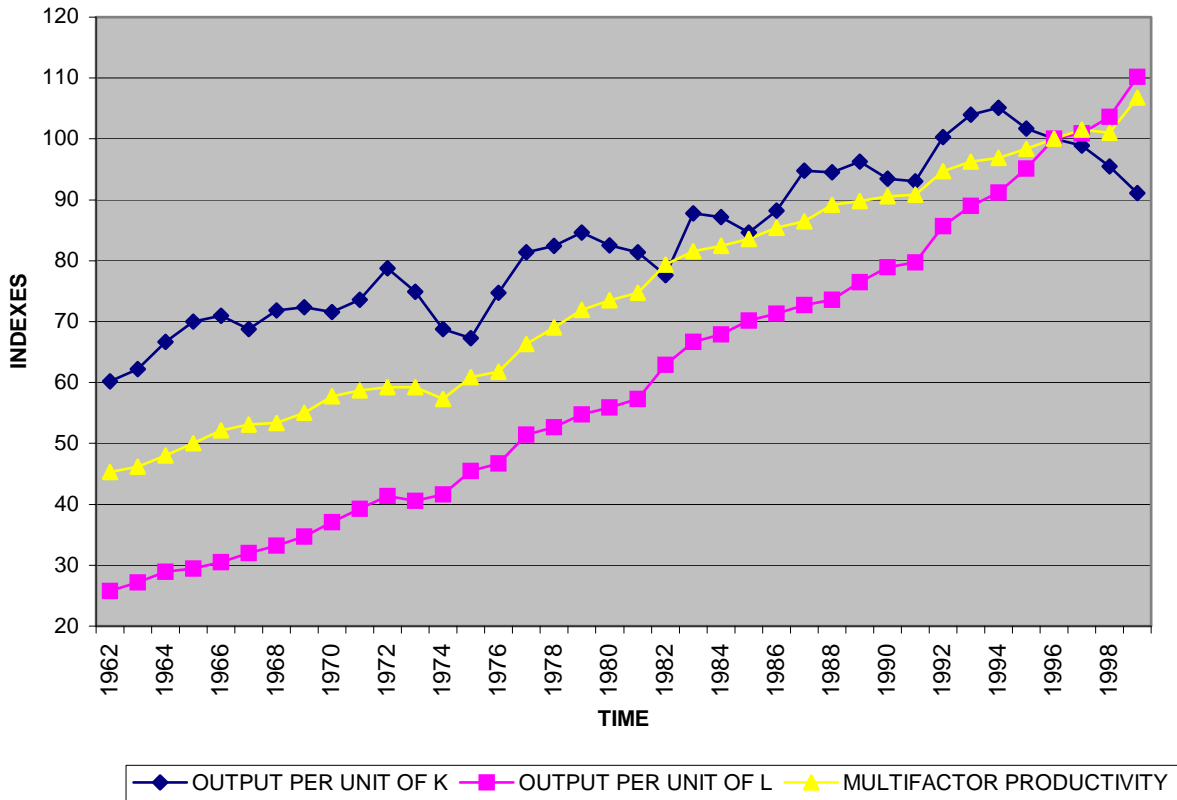


Table 1: Rates of Plant Entry and Exit

	Gross Rate of Entry	Gross Rate of Exit
Textiles		
1972-77	26%	32%
1977-82	31%	32%
1982-87	20%	38%
1987-92	28%	31%
Apparel		
1972-77	42%	44%
1977-82	48%	43%
1982-87	25%	55%
1987-92	49%	46%

Chart 3: Productivity Measures: Comparison of O/P per Unit of K, O/P per Unit of L and MFP



Changing Technology in Textiles:

Chart 4 shows how input use has changed over the last fifty years. Labor use has been cut in half while materials, purchased services and energy use have doubled.

Chart 4: Real Sector Input quantities and MFP: Comparison of Capital Services, Labor Hours, Energy, Materials, Purchased Services and MFP

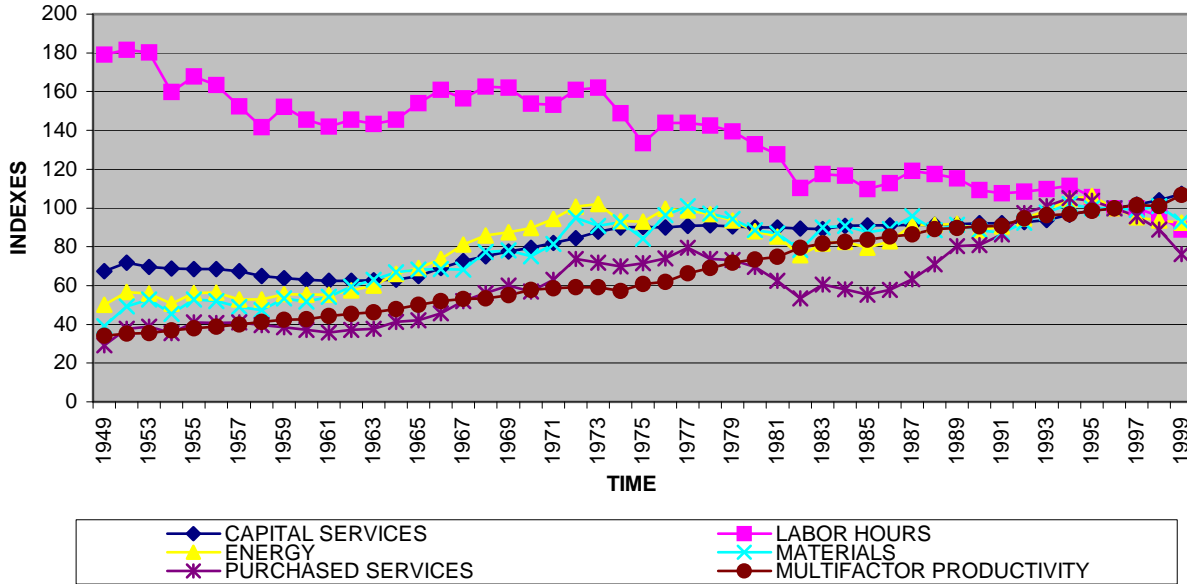
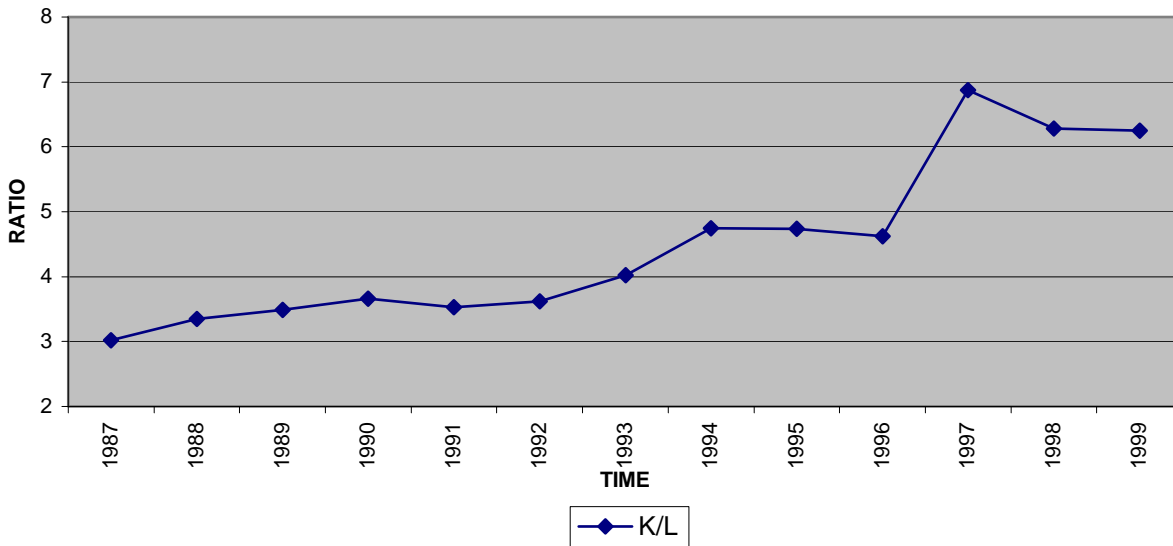


Chart 5: Capital Labor Ratios for Textiles



Between 1987-1999 the number of production workers declined by nearly 17%. The decline in non-production workers on the other hand was much less significant. This is likely explained by machines replacing production workers in textiles. Chart 5, shows that capital per worker has increased from 3% to 6.5% over the period, reflecting the technological change that textiles has undergone. This is also reflected by the high labor productivity figures shown before.

Prices and Costs:

The following price indices illustrate the price pressures on the industry. Input prices have increased five-fold while output prices and productivity have only increased 2.5 times their 1950's level. A breakdown of the input prices follows, showing the volatility of the costs of capital and energy.

Chart 6: Comparison of Sector Output Price, Combined Inputs Price and MFP

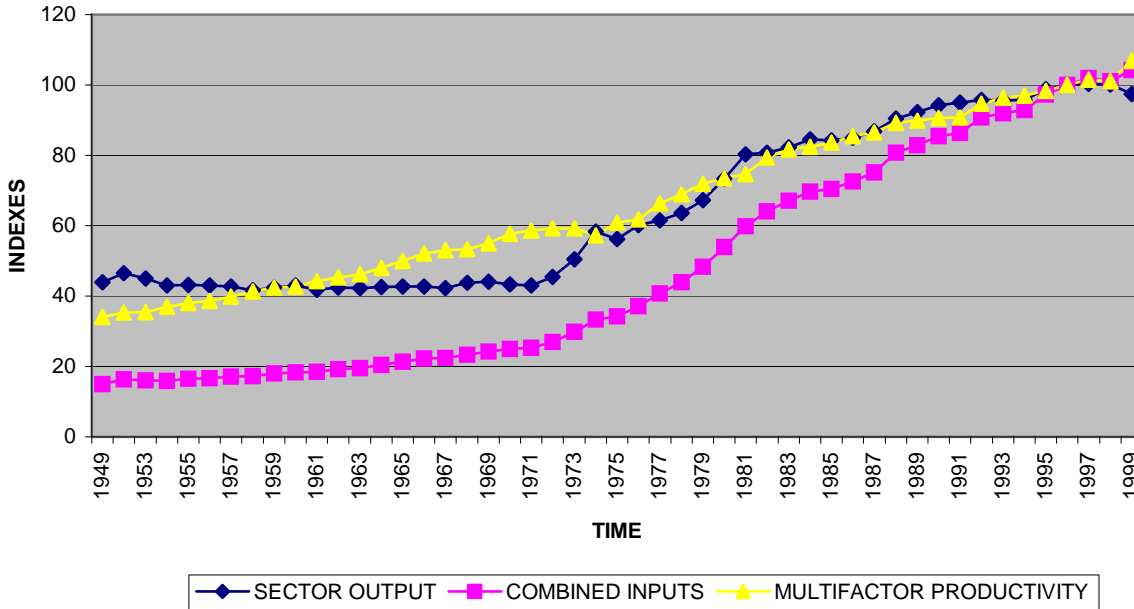


Chart 7: Input price and MFP: Comparison of Capital Services, Labor Hours, Energy, Materials, Purchased Services and MFP

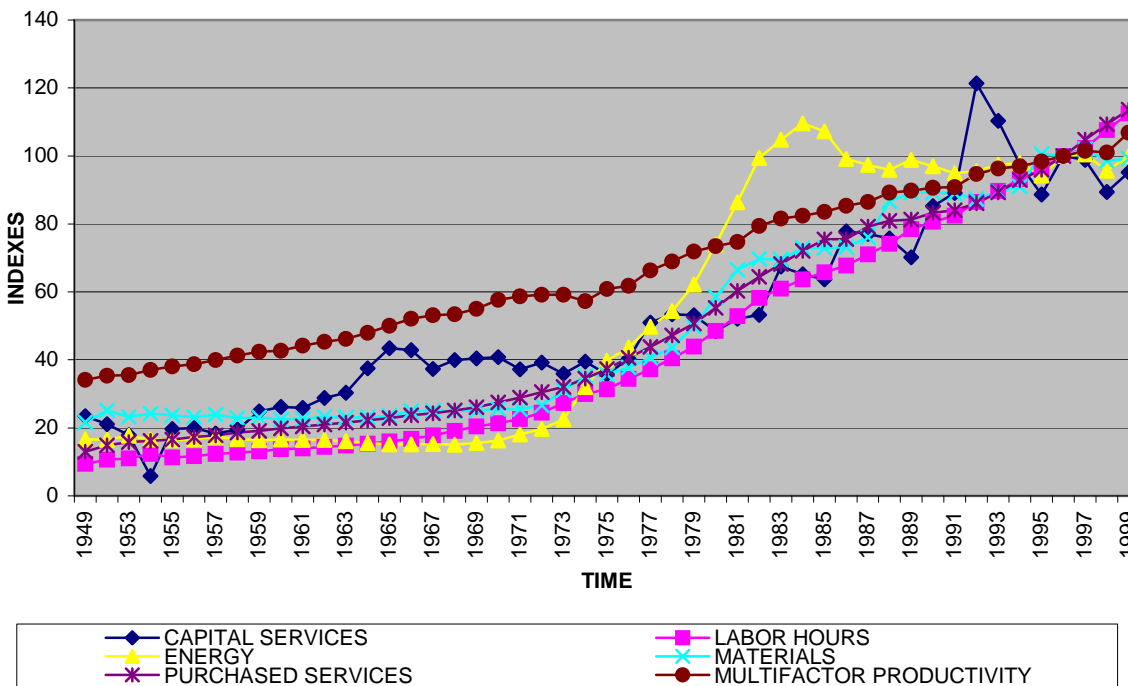


Chart 7 shows the value of production increasing up until the NAFTA period. While the costs of materials and labor shadow this trend, it is notable that, despite the large decreases in labor use, the labor bill still rises significantly.

Import Competition:

With the increase in globalization, competition from imports is a major factor the U.S. textile industry must contend with. Increased openness in trade has come with intensified competition especially from the newly industrializing countries (NICs) and has also increased outsourcing possibilities for U.S. firms. Chart 8, presents the trends in textile exports and imports. From 1972-82 U.S. exports and imports of textiles remained at par with each other. Beginning around 1983 imports began a steady increase outstripping exports by a sizeable margin. Imports rose five folds between 1982-2000. Imports in textiles came from both developing and developed countries, although the share of the former is on the increase. Exports on the other hand declined for a while between 1982-85, but increased thereafter. However, exports continued to fall short of imports.

Chart 8: Comparison of Imports and Exports in \$millions

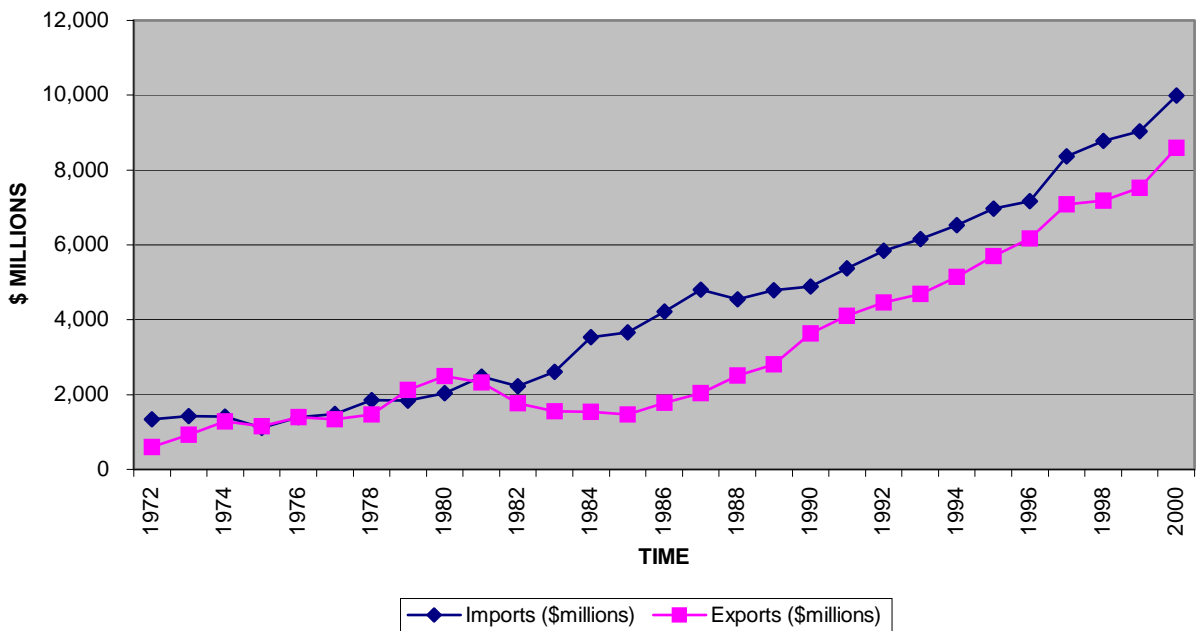
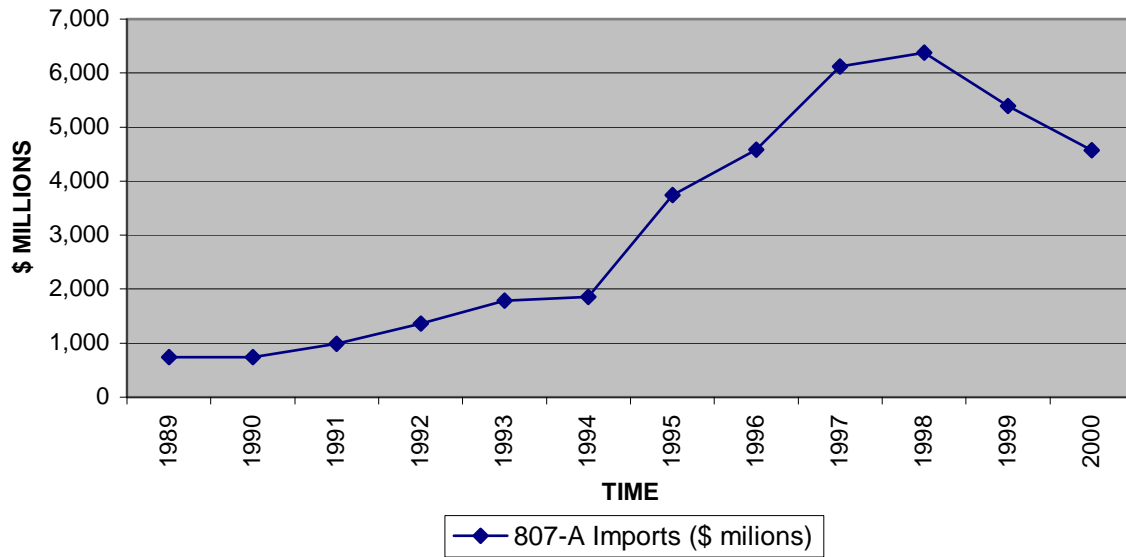


Chart 9, presents the data on section-807A imports. 807 imports are re-imported items whose components were first exported and assembled abroad, and duty is only paid on value added. These provide an approximate measure of the extent of outsourcing done by U.S. textile firms. Although a fairly recent phenomena, section-807 imports in 1998 were 3 times their value in 1993. This includes the period when NAFTA became operative (1996). However these figures register a decline after 1998, which is surprising.

Chart 9: 807-A Imports



Future Direction:

International competition has intensified in textiles, which has forced structural changes on the U.S. textile industry. Technology has also changed to adjust to the new market environment. International competition forces domestic firms to become more efficient and productive. However if a country's productivity is below that of its competitors it will quickly lose market share to its competitors. In the light of the changing dynamics of the global textile market it is imperative to examine how productivity in U.S. textiles has evolved to meet these challenges and also to study the impact of these changes on its competitive advantage. We conduct this study at two levels – at the aggregate industry level and at the firm level.

While industry level TFP measures are available from the Bureau of Labor Statistics, firm level analysis is necessary. Levinsohn and Petropoulos (2001), for example, find that evidence from firm-level data presents a very different picture about efficiency and productivity in U.S. textiles when compared to the broad industry trends available otherwise.

Estimating a TFP equation at the firm level is a complicated econometric task. Panel data will be used to econometrically estimate the production function for textile firms:¹ The results will shed light on the impact and interactions of factors of production.

$$Q_{it} = A\epsilon^{\lambda\tau} C_{it}^{\alpha} L_{it}^{\beta} K_{it}^{\gamma} M_{it}^{\delta} \epsilon_{it}$$

This function extends the standard Cobb-Douglas production function. K, representing knowledge was introduced by Griliches (1984) to the standard Cobb-Douglas production function to quantify the contribution of investment in R&D as measured by a distributed lag effect of past R&D investment.

The parameters of interest are α , β and γ . These represent the elasticities of output relative to capital, labor and R&D investment. For example, the elasticity of capital indicates the percentage increase in production to expect from increased investment in new plant and equipment. Similarly, the R&D elasticity will indicate the impact on production due to investment in R&D. Comparison of these

¹ Q is the output of firm i at time t , as measured by sales deflated by the relevant (two digit SIC level) National Accounts price index. Gross plant, adjusted for inflation, is the measure of capital stock, C , and L is the total number of employees. And M is materials; the value of purchases. $A\epsilon^{\lambda\tau}$ is the rate of disembodied technical change while ϵ is the perturbation or error term.

$K = \phi_r \omega_r R_{i(t-\tau)}$, where R is a deflated measure of R&D, and the subscripts t , $(t-\tau)$, and i stand for current year, lagged year and firm, respectively.

measures reveals the relative importance of various investments such as the impact of investment in R&D relative to capital investment on production (α/γ). The time series aspect of panel data will allow one to analyze how these parameters are changing over time.

TFP is derived from the production function. Changes in TFP will reflect movements in the production frontier caused by R&D and IT investment, as separate from disembodied technical change. Initial estimates of the production function for U.S. textile industry will require adjustments for inflation, depreciation of the capital stock, and estimation of the depreciation rate of R&D. This is likely to be very different than the depreciation of plant and equipment investment. Additionally, R&D is likely to have a lagged effect on productivity. The level of spending on labor and capital must also be corrected for “double counting”, 46% of R&D is spent on labor. Although the issues are challenging, there are precedents in the literature. Much of the work pertains to pharmaceuticals and aeronautics where the importance of R&D is recognized, but the potential to exploit enhanced productivity and lower costs is great in the textile industry.

In conclusion, this project will develop a model for deriving the optimal investment strategy to enhance productivity through labor decisions, R&D and IT investment and capital expenditures. The model will measure the relative impact of the various investments on productivity using firm level data as well as industry level data. The time series aspect will allow us to analyze how these parameters change over time and across firms to assist management decision-making. As the work progresses, we will better understand how to increase the productivity and competitiveness of the textile industry.

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