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ITP4678

IT-Labor Intensities and Firm-Level Productivity

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The continued growth in US productivity which began in the mid-1990's and continues today, attracted the attention of economists and analysts who conducted empirical studies to identify the fundamental underpinnings behind this noteworthy trend. The results of these works largely attributed this new productivity pulse to investment and utilization of new forms of technologies, largely classified as information technologies. The incredible increases in economic growth from 1995 to 2000 had involved significant investment in information technologies including, hardware, software, and telecommunications, as companies augmented existing business processes with the purpose of increasing productivity, profitability and market share.

This investment resulted in a more technologically intensive corporate infrastructure which quickly changed the required activities of the corresponding organizational labor force as firms were increasingly dependent on employees who possessed hi-tech intensive skills. The new corporate labor force increasingly required a combination of IT employees; individuals who could develop and implement software applications and build and maintain IT networks, along with existing less IT skilled employees. In order to extract the fullest productivity potential from newly acquired technologies, firms were required to incorporate an employee base that included an appropriate balance between IT skilled and non-IT skilled workers.

This study focuses on identifying the ramifications investment in IT and Non IT employees have on firm output. Utilizing data from large IT intensive organizations over the years from 1995 to 1997 in a production function, this analysis concludes that higher intensities of IT employees in the overall employee base results in increased productivity at the firm level. The period from 1995 to 1997 is particularly insightful as it captures the initial period of increased productivity in the US but avoids the IT "bubble" period, which began towards the year 1998. The results of this study therefore are not affected by the potential adverse ramifications of misallocation of factor inputs and questionable financial reporting practices by organizations that transpired during the "bubble" period. This work is therefore particularly insightful as it incorporates detailed firm level data over a period of time that avoids potential adverse events affecting the performance of organizations. It also analyzes the changing characteristics of evolving firm level labor given increased investment in Information Technologies and utilizes established economic theory (a Cobb-Douglass production function) to estimate changes in productivity resulting from different IT skilled worker concentrations.

PRODUCTIVITY AND THE INFORMATION ECONOMY

As investment in information technology increased across industry sectors of the economy, analysts began to study the effects this new technology would have on corporate productivity. A number of benchmark studies addressed this topic in detail. Earlier works by Lichtenberg (1995) and Brynjolfsson and Hitt (1996a, 1996b) concluded that investment in IT led to increased productivity at the firm level. These early conclusions were further support by their later works (Brynjoffson, 1998) and (Lichtenberg, 1998) and more recently by (Kudyba and Diwan, 2002) who identified increasing returns to investment in IT as the information economy began to progress.

However when taking a detailed look at individual IT initiatives, it is evident that not all IT investments were a success, as failed projects were many times the result of inappropriate resource allocations and organizational structure. Firms realized that in order to effectively implement new technologies to enhance business processes, they were required to incorporate a workforce with greater concentrations of IT skilled labor which also involved interaction between technically skilled labor and less technically skilled business, managerial labor. Accordingly, this study analyzes whether increases in IT skilled labor to the overall employee base results in increased productivity at the firm-level by utilizing a standard Cobb-Douglas production function.

ECONOMIC THEORY AND PRODUCTIVITY

In order to achieve increased efficiencies in their operations, firms seek to optimize the use of inputs and invest in an input such as labor, until the output it generates adds no more value than the last unit added. To estimate payoff of factor inputs, investment in an input is maintained to the point where marginal input cost is equal to the value of marginal output. Given the changing character of organizational labor, production theory can be applied to measure the impact of IT intensive labor on corporate output. This work utilizes the Cobb-Douglas production function since this form facilitates the estimation of elasticity of production function inputs through linearization of the equation. The Cobb-Douglas function in this study takes the simple form:

$Q = (L^{\beta}, K^{\beta})$ *where Q is output and (L, K) are Labor and Capital.*

The linearized version becomes:

$ln(Q)_{ij} = \beta 1 ln(L)_{ij} + \beta 2 ln(K)_{ij}$

where the (β) values are the parameters that denote the elasticity of each of the input factors.

Accordingly this paper attempts to test the following hypotheses:

$Q = f (L, K)$

H1. IT skilled intensive labor results in increased productivity at the firm level.

$dQ/dL > 0$

DATA SOURCES

The primary source of data for this study utilizes the information available in *InformationWeek*'s 500 survey published on an annual basis from the years 1994–1997. It includes firm level attributes including revenue, number of workers employed and number of IT skilled employees of the top 500 corporate users of information technology. Data was also gathered from corporate disclosure reports, which contained information on firm level Capital along with financial related information to determine firm level value added output. Generally, production function inputs in this study consist of Capital and Labor:

1) Capital
2) Labor

Where output is measured by economic Value Added.

Variable Inputs

Capital is defined as Net Property Plant and Equipment (PP&E), which adjusts total plant property and equipment for accumulated depreciation. Net PP&E includes expenditures on information technologies.

Table 1.

(1995 – 1997) IT Skill Labor Intensity Regression Results Output (Value Add)

	Low		Normal		High	
Parameters	Coefficient	(t-stat)	Coefficient	(t-stat)	Coefficient	(t-stat)
Labor	0.152	***(4.78)	0.331	***(10.19)	0.526	***(12.51)
Capital	0.415	(11.1)	0.399	(13.5)	0.253	(9.09)
Adj R^2		.60		.72		.75
N-Observ		190		257		200

*** Significant at the 0.01 level

Unit labor skill intensities involved classifying the pool of firm level labor according to the ratio of the number of IT workers to non-IT workers. The resulting ratios depict the corresponding IT skilled intensity of the overall firm level labor pool.

Value Added refers to firm level gross sales less variable costs, where variable costs includes CGS and SG&A for corresponding firms in the data base.

RESULTS

The Cobb Douglas equation was estimated over the entire period from 1995 through 1997 and the corresponding results are given in Table 1.

The results indicate that labor forces with higher IT skill concentrations have made statistically significant increased contributions to firm level output measured by Value Added.

A possible explanation of this increased productivity of higher concentrations of skilled labor pools follows from the assimilation of the significant increased investment and implementation of software, hardware and communications equipment by organizations that began in 1993. This investment had transformed existing corporate infrastructures to higher "IT technological" infrastructures. As a result, firms who incorporated a higher concentration of IT skilled labor achieved increased efficiencies as they were better able to take advantage of the process enhancement capabilities these new technologies introduced to their organizations (e.g., CRM, Supply Chain Networks and the like).

Future work could involve a more detailed analysis of the type of IT skills that are essential to driving corporate productivity and business efficiency and perhaps the returns to IT labor outsourcing.

REFERENCES

Brynjolfsson , E. and L. Hitt. "Productivity, Profitability and Consumer Surplus: Three Different Measures of Information Technology." *MIS Quarterly*, (0:2), (1996).

Brynjolfsson, E. and L. Hitt. "Beyond the Productivity Paradox," *Communications of the ACM*, Aug. 41 (8), (1998) 49-55.

Kudyba, S. and R. Diwan. *"Increasing Returns to Information Technology,"* Information Systems Research, March (2002).

Kudyba, S. and R. Diwan. *"The Impacts of Information Technology on US Industry,"* Japan and the World Economy, August (2002).

Lehr, W., and F. Lichtenberg. *"Computer Use and Productivity Growth in US Federal Government Agencies"* 1987–1992, Journal of Industrial Economics, (June 1998).

Lichtenberg, F. *"The Output Contributions of Computer Equipment and Personnel: A Firm-Level Analysis."* Economic Innovation and New Technology, (3), (1995).