ASSESSING THE IT PRODUCTIVITY PARADOX: USING THE CONSUMER PRICE INDEX AS AN INDICATOR OF CONSUMER BENEFIT

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ABSTRACT

While some researchers report significant benefits resulting from investments in technology, others report no measurable impact whatsoever. Economists suggest this inconclusiveness may be a result of inadequacy of the metrics. In particular, conflicting findings are often related to the inherent difficulty in defining and measuring value. These debates are riddled with theoretical and philosophical ambiguities and contradictions. One unique approach is to assess and investigate value from the consumers' perspective. The idea is that the benefits of technology investments are often passed on to consumers through quality improvements, enhanced product variety, and lower prices. Consumer surplus is measured as the difference between what consumers are willing to pay (the reserve price) and the market-based price based on the aggregate demand. Brynjolfsson applied several sophisticated econometric indicators to assess the consumer surplus related to IT and estimates that consumer surplus is $50 to $70 billion a year. This paper strives to set aside the arguments regarding which approach is best and the philosophical and methodological difficulties related to value. We do this by focusing exclusively on the price component of consumer benefit. Specifically, we assess the change in consumer price index metric for various products and services between 1990 and 2000. Setting aside all concepts of value and not accounting for the benefits associated with quality improvements, we found that consumers are paying less for technology-oriented products and services and they are paying more for non-technology-oriented products and services.

Keywords: Computers, Productivity, Consumer surplus, Econometrics, Economics

INTRODUCTION

The cost effectiveness of Information Technology (IT) is a major concern for both managers and researchers. Several researchers estimate that spending on IT represents 50% of all capital expenditures (11). Furthermore, Schnitt (13) reports that IT spending has increased 400% to 1000% over the last decade. By 1996, IT spending exceeded $500 billion annually in the US and $1 trillion worldwide (7). "As the investment in the technology grows so does the need to more carefully evaluate the payback and to better understand the factors related to success or failure when applying the technology" (p. 83, 15).

While some studies report that IT has significantly improved organizational efficiencies, product and service quality, and/or production costs, it has been exceedingly difficult to measure IT effectiveness using traditional performance measures. The phrase technological productivity paradox describes the

"countless scatter diagrams illustrating the virtually nonexistent relationship between spending on computers and business profitability" (p. 42, 1).

Hitt et al. (9) offers an insightful interpretation of the issues associated with measuring IT effectiveness. The authors suggest that the inconclusiveness of IT impacts is related to differing definitions of value, rather than the actual effectiveness of the technology. Through the identification of three distinct definitions of value (productivity, profitability, and consumer benefit) the authors found consistent patterns of IT effectiveness and ineffectiveness.

Organizations frequently report that IT reduces staff, increases throughput and/or improves quality. Back (2) that a major manufacturing company used IT to reduce its purchase order processing time from 22 weeks to 7 days. The author also found that a utility company implemented IT to reduce its material procurement cycle time from 23 to 8 days. Hitt et al. (9) also found strong evidence that IT positively impacts productivity.

Despite these significant, empirically supported improvements in productivity, IT generally does not improve organizational profitability. Baatz (1) reports that the $750 billion investment in information technology during the 1980's failed to produce measurable business profitability improvements. Many researchers attribute this lack of profitability to the impacts of competition and competitive reactions to technological advances. Insofar as competitors detect organizational gains associated with IT, they mimic the applications and receive similar benefits, thereby eliminating any competitive disparities (10; 9).

There are several levels of organizational risks associated with competitive reactions to IT implementations. To the extent that IT improves efficiency and is universally available, it may lower entrance barriers and thereby intensifies competition. This increase in competition consequently lowers prices and eliminates the market inefficiencies that enable firms to maintain monopolistic control over their customers (9). Furthermore, as competitors detect these new developments, they may react by developing better solutions. "Systems that cannot sustain their business impact have only transient value or offer negative value if they lead to a 'bigger and better' response from competitors" (p. 32, 10). Accordingly, investing firms are often unable to capture the full value of IT investments and in some situations they may be worse off for it. However, the resulting IT investments are necessary to maintain competitive parity and are often not sufficient to gain competitive advantage. As a result, Hitt et al. (p. 139, 9) found that "there is no inherent contradiction in the idea that IT can create value but destroy profits."

The extent to which organizations introduce productivity improvements yet fail to realize its benefits defines the degree of consumer benefit. Few researchers have empirically tested the relationship between consumer benefit and the productivity paradox. A notable exception is the study of Consumer Surplus Theory (4; 9; 5). Grover, et al. (p. 470, 8) offers a concise definition of consumer surplus.

> "…the consumers' reservation price [is] the maximum amount they are willing to pay for each successive unit of the product… The difference between the reservation price and the market price (summed across all customers) is the consumer surplus." (p. 470, 8)

Using data from the U.S. Bureau of Economic Analysis Brynjolfsson (4) developed several sophisticated calculations to estimate consumer surplus. Looking at a few broadly defined industries, the author found evidence that IT spending in 1987 generated $50 billion to $70 billion in net value in the United States. Hitt et al. (9) also found substantial consumer surplus as a consequence of IT spending in the United States.

The difficulty in using Consumer Surplus Theory to measure consumer benefit is the complexity and inherent inaccuracy in calculating the aggregate demand curve and the reservation price. In addition, detailed, comprehensive data are difficult or impossible to find (3). As a result, Consumer Surplus Theory has received limited exposure within MIS literature. Consequently, we are searching for a simpler metric to assess consumer benefits associated with IT investments. In doing so, we strive to explain the productivity paradox in a manner that is easily replicated and understood by professionals and researchers alike.

While consumer benefits may include additional product features, improved quality, higher consistency, and/or increased availability, arguably the most significant and most closely watched change is related to consumer product pricing. The purpose of this study is to examine the relationship between the degree of IT integration in a product/service and the change in consumer product/service prices. Specifically, using Consumer Price Index (CPI) information from the U.S. Bureau of Labor Statistics, we calculate the percent change in CPI for 52 different product/service sectors between the years 1990 and 2000. The resulting calculations are sorted in descending order, then graphed using Microsoft Excel. This graph is used to demonstrate the relationship between consumer prices and technology. Based on the results of prior research, we expect to see positive changes in Consumer Price Index for non-IT related products/services and a negative change in Consumer Price Index for IT-related products/services.

In this paper we seek to demonstrate that much of the benefit realized through corporate investment in Information Technology is passed on to consumers in the form of lower prices. The next section describes the theory of market effectiveness, which provides the conceptual foundation for this paper. Following this theoretical section is a practical discussion relating the impacts of IT with market effectiveness and consumer benefit. The Consumer Price Index is then defined and it is followed by a description of the methodology. Lastly, a discussion and conclusion is presented.

CONCEPTUAL PERSPECTIVES AND PRIOR RESEARCH

Investment in IT makes markets more effective. Improvements in networking, communication, and processing power allow buyers and sellers to locate each other more easily and carry out transactions more efficiently (8). IT also provides consumer information to producers very inexpensively. This information allows suppliers to offer a wider range of customized products/services at minimal cost (12).

The economy's progression toward customization arises from producers' attempts to provide consumers with exactly what they want. Since the 1970's, variety in the marketplace has exploded.

> "This is nowhere more true than in the United States, where the choice of new vehicle models has risen from 140 to 260, soft drinks from 20 to more than 87, TV channels from 5 to 185, over-the-counter pain relievers from 17 to 141…What we buy yields a lot more utility when it exactly matches our needs, and we are reaping enormous benefits as new tools help business cater to markets of one." (pp. 3-6; 6)

Mass customization is not necessarily new. Before the start of the Industrial Revolution, customization was the norm. However, at that time, the disadvantage of custom-made products was high prices. Industrialization and mass production solved the price issue by spreading high fixed costs over large numbers of output produced at minimal variable cost. Obviously, the downside to mass production was a significant decline in customization. However, recent advances in IT enable sellers to offer the best of both worlds. These advances allow sellers to efficiently and inexpensively collect individual consumer preferences and to incorporate these preferences into products and services at reasonable prices. Through customization, a higher standard of living is achieved while using fewer resources (6). This phenomenon increases the consumer's reservation price (the price consumers are willing to pay for the product/service). At the same time, increased competition decreases prices and allows the buyer to extract more benefit (8).

IT networks facilitate outsourcing by mitigating the transaction costs associated with finding, screening, and overseeing supplier engagements. In addition, technology simplifies critical processes such as product manufacturing and design. It also enables firms to increase outsourcing of product components to specialized independent manufacturers who convert economies of scale and scope into cost savings (8). Finally, technological improvements such as inventory control systems, bar code scanners, and e-mail also reduce costs associated with distribution of products and services to customers (6).

However, to the providers' dismay, information about sellers and products/services are more readily accessible and customer switching costs are reduced. This phenomenon reduces the information asymmetry between the consumer and the seller that allows for price discrimination in the market (8). A generally accepted economic principle holds that in a competitive market where information flows freely and completely, producers receive no excess return over and above the cost of capital (14). "If IT reduces the buyer's costs associated with conducting marketplace transactions, namely searching for suppliers, information seeking, and negotiating contracts, then comparative shopping is feasible and the supplier's ability to generate monopolistic rents is reduced…[and] excess profits are eventually competed away" (p. 472, 8).

CPI

The Consumer Price Index (CPI) is a measure of the average prices paid by consumers for goods and services in the U.S. competitive market. Specifically, the CPI includes products, services, and imports purchased for personal consumption by U.S. households. It also includes the sales taxes and

distribution costs of these purchases. The U.S. Bureau of Labor Statistics classifies all expenditure items into eight major categories namely: Food and Beverages, Housing; Apparel, Transportation, Medical Care, Recreation, Education and Communication, and Other Goods and Services. A primary use of the CPI is to measure time-to-time changes in price levels in these specific areas (p. 1, 6).

METHODOLOGY

Consumer Price Index (CPI) data from 1990 and 2000 were collected from the U.S. Bureau of Labor Statistics for 52 product/service sectors. All available product/service sectors were considered for inclusion in this analysis. However, those product/service sectors subjected to governmental price regulations and/or other non-competitive, significant price altering factors were disqualified. In the end, three major product/service sectors were excluded from this study namely: food, housing, and tobacco products.

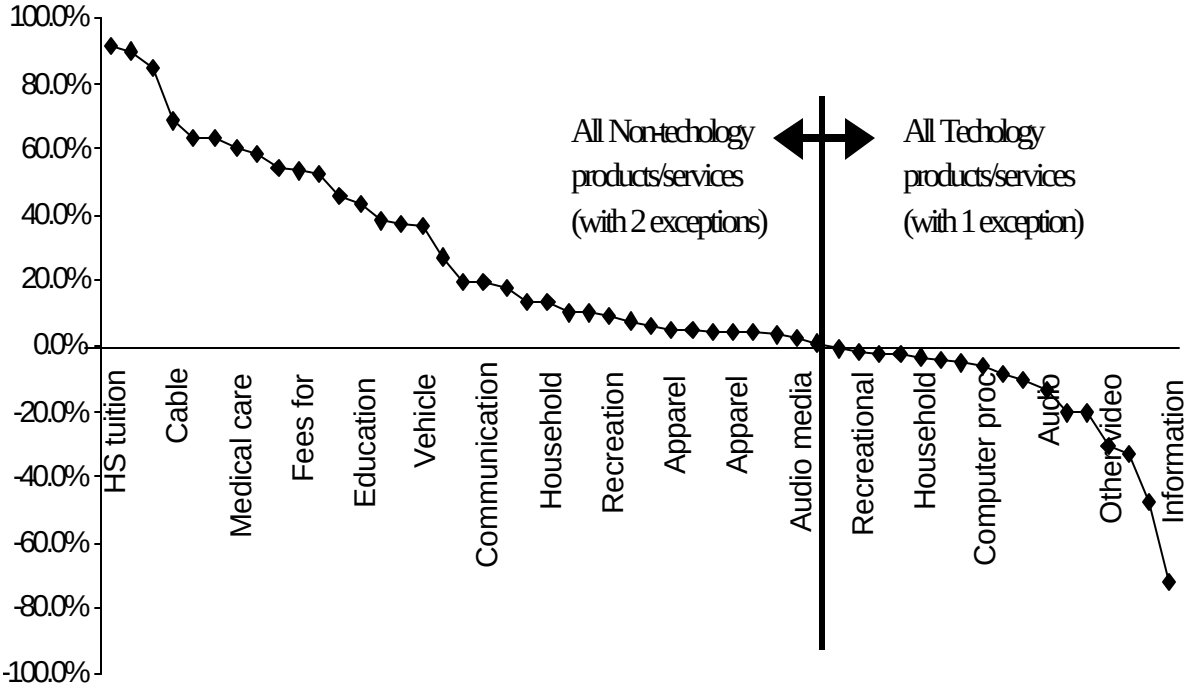

Figure 1. Percent Change in CPI from 1990 to 2000

Based on the recommendations of the Bureau of Labor Statistics, we use a percent change calculation to compare 52 product/service sectors, rather than specific data points. Since we are measuring and comparing percent changes, we do not need to consider CPI reference base years (which vary among the product/service sectors) or inflationary impacts (since they are uniform throughout the product/service sectors). As well, we are able to detect trends and anomalies in consumer prices across a vast array of product/service sectors.

Since the Bureau of Labor Statistics did not collect CPI data for several of the high-technology product/service sectors in 1990, we did not have a complete data set. However, for comparison purposes, we calculated the percent change in CPI for the year closest to 1990 for those product/service sectors that did not have 1990 CPI data. To validate this assumption, we calculated and graphed the entire data set using the percentage change in CPI for 1998 and 2000. We did not detect any change in direction. However, since the time difference is less, the percent changes for these product/service sectors on the 1990 to 2000 figure may be significantly understated. Even though this underestimation dilutes our argument, we chose to use the 1990 data or the closest date to 1990 as the surrogate for 1990 CPI data. By using 1990 data, it allowed us to capture more of the long-term CPI trend, see Figure 1.

DISCUSSION AND CONCLUSION

This study found that 17 product/service sectors had a reduction in overall consumer prices during the 1990's. Of these 17 product/service sectors only one, recreational books, was not technology-based. The remaining 35 product/service sectors show an increase in overall consumer prices during the 1990's. Of these 35 product/service sectors, only two, telephone service –local charges and cable television, are technology-based.

We predicted that consumer benefits of IT could be shown by analyzing and comparing product/service sector pricing information. As such, we can calculate the predictive accuracy as a percentage of technology-oriented product/service sectors with a decline in CPI and the percentage of non-technology-oriented product/service sectors with an increase in CPI. The calculated predictive accuracy for the technology-oriented product/service sectors was 94%. Similarly, the calculated predictive accuracy for the non-technology-oriented product/service sectors was 94%.

As a result, based on the findings of this study we conclude that the Consumer Price Index may be used to demonstrate the existence of a relationship between IT-spending and consumer benefit. In addition, we found support that consumers are benefiting from technology in a very real way, through reduced product/service prices.

While this study effectively demonstrates a relationship between CPI and consumer benefit, it has a two notable limitations.

The first limitation is that the study is unable to measure the degree of strength between IT-spending and consumer benefit. The authors of this study are currently exploring techniques that may be used to specifically quantify IT-spending and to assess the strength of the relationship between IT-spending and consumer pricing.

A second limitation lies in the multi-faceted nature of the CPI. Consumer prices changes for a variety of reasons, many of which have little to do with IT. Further studies quantifying the relationship between IT-spending and CPI may help address this issue by providing the ability to factoring-out the IT-spending contributions.

The ultimate goal of this study was to provide researchers with a metric that may help show the consumer benefits associated with IT-spending. Data for this metric should be readily accessible and the calculations should be easily interpreted. Furthermore, we sought to provide professionals with a metric that can be used to understand and help justify IT-investment decisions. The findings in this paper suggest that Consumer Price Index information may serve to satisfy these objectives. If the Consumer Price Index shows year over year reductions, this may serve as an indicator of technological advancement/integration/investment within the product/service sector.

Lastly, as organizations continue to spend hundreds of billions of dollars each year on IT, it is reassuring to show that these investments are paying off –even if the payoff may not be directly benefiting those organizations footing the bill.

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