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# Determinants of Business Productivity

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*Research conducted by economists and business scholars indicates that there are significant and persistent differences in productivity. This research contradicts arguments by business strategists who claim that cost advantages are short lived. This result also spearheaded a large number of studies in various fields including economics, strategic management, marketing and others. According to research, causes of differences in productivity include information technology, R&D, managerial practices, learning effects, product innovation, firm structure, complementarities, and other factors. This paper surveys and evaluates these academic studies and spells out the managerial implications of the research on the determinants of business productivity.*

**Field of Research:** Productivity, complementarity, information technology, learning

## 1. Introduction

Productivity is an important issue for business organizations. Firms that have a higher productivity enjoy a competitive advantage and a higher survival rate than their less efficient rivals. Research into the determinants of business productivity is an important topic in economics, business, and other disciplines. Companies that produce at a lower cost have a competitive advantage over less efficient rivals. The ability to capitalize on productivity advantage and adopt it throughout the organization enables firms to overtake their less productive rivals. Cost leadership is one of the generic strategies which can provide a firm with a competitive advantage (Porter 1980).

The efficiency with which firms turn inputs into outputs or productivity has been a topic of research over the past two decades. As a result of this research activity, several recent academic publications shed light on some important factors that affect business productivity. It is rather surprising that there haven't been studies that look at this issue in an attempt to summarize and synthesize what is already known about this important area of business. A related issue is the claim that productivity advantages are temporary and short-lived (Porter 1996, 2008). Several researchers have addressed this question and show that, productivity and cost differences can last for a long time.

Given that this important research question was not addressed in past studies, in this paper an attempt is made to close this gap by reviewing a number of studies that have looked at factors that affect business productivity. The paper contributes to the literature, by reviewing and making

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available to researchers and managers recent findings on the factors that enhance business productivity. This can help researchers that work in this area to become aware of such research and facilitate their own efforts. Academic researchers who are not familiar with such research may also be motivated and become themselves involved in this important area of research. Managers can find this paper useful, and they can learn about the levers that can be pulled to help enhance business productivity. This paper also can help dispel the misconception that cost advantages are temporary and short-lived. In the next section the concept of productivity is discussed and the various studies that show empirically how certain factors affect business productivity are reviewed. The conclusions and managerial implications are spelled out in the last section.

## 2. The Concept of Productivity

Productivity is an important concept for business scholars and economists due to its great importance for business success. Productivity expresses the degree of efficiency in production that is the amount of output yielded from the inputs used in production and expressed as an output-input ratio. Productivity measures the efficiency with which firms convert inputs into outputs.

Porter (1996) argues that there are differences in operational effectiveness or efficiency among business firms. The productivity frontier represents the sum of all best practices at a given point in time. It represents the maximum value that a company delivers at a given cost using the best available technology, management practices and inputs. A firm operating inside the productivity frontier is less productive than what is possible. A company that improves its operational effectiveness moves toward the productivity frontier. Such a change requires new technologies different management techniques, different personnel, or new capital investment, customer satisfaction techniques and cost improvements.

The productivity frontier is not static but it changes constantly as new management techniques and technologies are introduced and new inputs are used. New information technology developments, lean manufacturing and new software have contributed to productivity improvements. New management techniques such as benchmarking, six sigma, and continuous improvement can be used to reduce inefficiencies and improve productivity.

Improvements in operational effectiveness are necessary to increase profitability. But according to Porter (2008) improvements in operational effectiveness are not sustainable in the long run as rivals imitate innovative practices. Best practices diffuse rapidly as rivals imitate new practices.

Cost is caused by performing activities and a firm can obtain a cost advantage from performing certain activities more efficiently than competitors. Firms achieve operational efficiencies by performing similar activities better than competitors. Operational efficiency includes practices that allow a firm to better utilize inputs such as labour and capital and help reduce costs, produce higher quality products faster or offer more convenience or products with fewer defects.

Firms differ in the degree of their operational effectiveness. These differences in productivity enable firms to be more productive and better use their inputs than others by being able to

manage and motivate employees better, use better technology, have less waste or manage certain activities better than their rivals.

Fit is another factor that affects productivity. Fit measures how discrete activities affect one another. Poor fit implies that poor performance in one activity will reduce the performance of others. For example, salesforce's effectiveness is greater when the company's product is of higher quality or it incorporates highly desirable features. Complementarities among different activities are key to not only achieving an advantage but also maintaining the advantage. Any advantage built on a system of activities is far more sustainable than advantages built on particular activities. It is more difficult for a competitor to imitate several interrelated activities than it is to imitate a particular activity (Porter 2008).

A number of studies have been conducted that investigate the factors that affect business productivity. Despite Porter's admonition that cost advantages are short-lived, these studies show almost unanimously that there are large and lasting differences in productivity among business organizations not only in broadly defined but in narrowly defined industries (Syverson 2011).

Syverson (2004) found that the average difference in total factor productivity between an industry's $90^{th}$ and $10^{th}$ percentile plants within four-digit SIC industries in the US manufacturing sector is 0.651 which translates to a TFP ratio of 0.651:1.92. This implies that the plant at the $10^{th}$ percentile of the productivity distribution produces at less than half the output with the same amount of input as the $90^{th}$ percentile plant, Since this is the average amount, several industries are much less productive than this result indicates. More specifically, in studies measuring productivity differences in China and India the differences in TFP between $10^{th}$ and $90^{th}$ percentile was 5:1 (Hsieh & Klenow 2009). These productivity differences are also found to be persistent and not short-lived (Arpad & White 2006; Foster, Haltiwanger & Syverson 2008).

Given the finding of large and persistent differences in efficiency among businesses, the relevant question is to find out if there are systematic reasons for these significant differences in productivity among firms. Are the factors that determine productivity controllable by the firms or are influenced by external forces? In the following sections several studies that examine factors that determine business productivity are reviewed.

## 3. Complementarity and Substitution

Complementarity examines how interactions among firm activities shape organizational performance. Complementarity is part of systems thinking where the whole is greater than the sum of its parts. Two activities are complements when the presence or an increase in the level of one activity increases the impact of the other activity on some measure of organizational performance (Roberts 2004). Activities include service levels, product quality, exploitation versus exploration, frequency of product redesign, price levels, debt levels, liquidity, performance pay, degree of centralization, and others. For example, price and product quality are complements if higher product quality makes demand less sensitive to price increases. The improvement in quality makes the product more valuable and a price increase is accompanied by a smaller decline in the quantity sold than it would if the quality had remained the same.

Two activities are substitutes if the presence of one activity or an increase in one activity reduces the attractiveness of another activity (Roberts 2004). For example, if introducing performance pay provides a stronger incentive for employee productivity because the behavior is rewarded, decreasing the value of monitoring as a means of enforcing the desired behavior and therefore it should be reduced or eliminated.

Complementarity and substitution creates challenges for the design of organizations. Complementarity can be beneficial when the activities are performed together and at comparable levels. For example, the variety of product offerings and flexibility of a firm's manufacturing system are complementary concepts. Flexibility is measured by the speed with which the firm can change over from producing one product to another. Product variety is measured by the breadth of the product line or by the frequency of product changes. Flexibility and product variety can be complements under certain conditions. Extending the product line can increase the total demand for the firm but it decreases the sales potential of each product as customers are offered more choices. This will cause shorter production runs and more frequent changes, otherwise inventory levels must be allowed to increase. In this case, greater manufacturing flexibility in the form of an ability to carry out changeovers faster and cheaper becomes essential. Consequently, product variety and manufacturing flexibility are complements since more flexibility can lead to greater product variety and vice versa. That is, a more flexible manufacturing system lowers the cost of having a broader product line. The symmetry holds if returns to increasing one variable are non-decreasing in the level of a second variable and the returns to increasing the second are also non-decreasing in the level of the first variable (Roberts 2004).

It should be noted that changing all complementary activities together enhances organizational performance, but it is possible that changing any one of the activities alone can impact performance negatively. Many business processes consist of a series of activities in which underperforming or making mistakes in any of them can dramatically reduce the value of the product or service. For example, companies fail due to a faulty design even if production, marketing or human resources are done well. The space shuttle Challenger exploded because one of its thousands of components, the Q-ring malfunctioned when it was launched at the wrong temperature (Krenan 1993). If a product's quality is low, large advertising support cannot help achieve desired product sales. Similarly, a product whose price is too high relative to what the market is willing to pay will fail regardless of its quality or features. In situations like these, all tasks have to be performed at the optimal level in order for the product to have a chance of succeeding in the marketplace.

van Ark, O'Mahony and Timmer (2008) found evidence of complementarity between human resource practices and IT capital which explains the US productivity edge in the European Union countries. Brynjolfsson et al. (2008) also studied how investments in information technology impacted productivity. They showed that costly investments had little impact on productivity if other activities remained unchanged. They argue that when investments in one activity are matched with investments in complementary activities, there are significant improvements in productivity. However, investments in information technology or automation, or organizational changes will have no impact or can even be detrimental if not matched by changes in other areas of the organization such as hiring employees with the necessary training or train existing personnel in how to use the new technology. If, on the other hand, these investments are

implemented together with required changes in complementary activities they will have a substantial positive impact on productivity.

## 4. Problem-Solving Teams and Incentive Pay

New human resource management practices often stimulate productivity. What are the effects of problem-solving teams and incentive pay plans on productivity? Such practices can be beneficial for many companies. Lines that adopt group incentives experience significant increases in productivity and lines that adopt problem-solving teams together with incentive pay experience an even larger gain in productivity (Boning, Ichniowski & Shaw 2007). The evidence indicates that in more complex production contexts, problem-solving teams are provided with a valuable opportunity to use their knowledge to solve problems, improving in the process productivity. In less complex environments following standard operating procedures is sufficient.

Boning, Ichniowski & Shaw (2007) found an interaction between the complexity of the production process and the ability of innovative human resource practices to raise productivity. While group incentive pay is used by most firms, problem-solving teams are used almost exclusively in companies with more complex products and production lines. A problem solving team is a group of workers who meet regularly with a goal of solving problems in the products identified by managers or workers. Innovative human resource practices such as problem-solving teams do help raise productivity but such practices are not equally important in all production environments. Boning, Ichniowski & Shaw (2007) show that such teams are adopted by companies with more complex production processes. The greater the complexity of production process the more valuable the productivity gains from problem-solving teams.

Overall, if production lines produce products of different complexity these practices have a different impact on the productivity of production lines even if these production lines are in the same plant. Boning, Ichniowski & Shaw (2007) found that complexity of the production process inhibits the ability of innovative human resources practices to enhance productivity.

Boning, Ichniowski & Shaw (2007) recommend that not all plants should adopt problem solving teams, as the benefits are high for plants with complex production processes but insignificant for plants without complex product processes. In job design, incentive pay can be made more effective by structuring jobs in a way that provides workers with opportunities to respond to incentives. Companies with complex production processes and products should employ problem-solving teams and incentive pay. Companies producing simpler commodity products, on the other hand, can adopt standard operating procedures in their production processes.

## 5. Management Ability and Talent

There is increasing evidence that the quality of management practices impact productivity. Research shows that the ability of management has a differential impact on productivity. This factor manifests itself in both the quality of management practices and the talent of the managers. Managers oversee the use of capital, labor, and other inputs. While effective management can lead to better performance, poor management practices can result in undesirable organizational performance.

A comprehensive study of the impact of management practices on productivity was conducted by Bloom and Van Reenen (2007). They surveyed plant managers about their day-to-day practices and operations, not the strategic decisions made by top management. They surveyed managers from over 700 medium-sized firms in four countries: United States, United Kingdom, France, and Germany.

An interviewer who spoke the participant's language conducted telephone interviews. Information was obtained on eighteen specific management practices in four broad areas: operations, monitoring targets, and incentives. The questions about best practice management in the questionnaire were based on recommendations of the management consulting industry.

In order to enhance accuracy and consistency the authors took several steps. Respondents were not told that they were scored and questions on practices were open-ended. Financial performance was not included in the questionnaire. In addition over sixty firms were surveyed twice, by different interviews. The correlation between the scores of the same firms was 0.73. Bloom and Van Reenen (2007) found that the quality of management practices is positively correlated with total factor productivity.

Bloom and Van Reenen (2007) also found that the quality of management practices is related to the intensity of competition. Bloom and Van Reenen (2007) found that the quality of management practices is lower when the firm is family-owned and when the eldest son of the founder is the CEO of the firm. Bertrand and Schoar (2003) found firms with managers with MBAs earn 1 percent higher return on assets. The authors explained this result to more aggressive behavior in terms of investment, leverage, and dividend paying choices.

Academic research links certain human resource management practices such as pay-for-performance plans, cross-training, teamwork, and frequent labor-management communication to higher productivity (see Ichniowski, Shaw & Prennushi 1997; Hamilton, Nickerson & Owan 2003; Bandiera, Barankay & Rasul 2007). These studies found that many of these practices are complements. That is, they have a modest impact on productivity when used by themselves, but when they are used together with others the total impact is larger than when used alone.

## 6. Information Technology

Information technology has been found to be a significant factor in productivity increases in several industries and countries. Several studies document the impact of information technology on productivity (Jorgenson, Ho & Stiroh 2005, 2008; Oliner, Sichel & Stiroh 2007). IT advances are hypothesized to be behind the relatively high productivity growth in the US in recent decades. On the contrary, studies of EU productivity growth in relation to IT investment by van Ark, O'Mahony and Timmer (2008) found relatively smaller productivity growth during the same time. These authors attributed to the smaller size of IT investment in European economies than the U.S.

It is noteworthy that US-based multinationals based in the EU are more productive than European-owned companies. These cases show that it is the location of the parent company than geography that influences IT-led productivity improvements.

Hubbard (2003) explained how trucks with onboard computers installed raise average utilisation rates of trucks. Dispatchers receive real-time information on a truck's location and load status, which allows them to better match the available cartage capacity to demand.

Bartel, Ichniowski and Shaw (2007) show how computer numerically controlled (CNC) machining centres enhance productivity in the valve manufacturing industry by raising speeds of production runs, shrinking setup times, and enabling faster inspections. They also show that IT-intensive product design tools such as computer-aided design software make the design of customized parts easier and make multiple production runs less costly through quicker setup times.

The use of IT technology allows companies to better match their production capabilities to the needs of their customers by offering a broader assortment of parts gaining economies of scope and increasing their sales and profits. Measuring the gains in productivity in physical units of output such as number of parts per period of time may not fully capture the gains of the increased productivity. The increased ability to offer customized products from IT can raise the prices charged by the firm. In cases like this, productivity gains are reflected in revenues not in physical quantities.

Other studies also document increases in productivity resulting from IT investments. According to Brynjolfsson et al (2008), IT increases the speed with which companies can replicate successful practices in other parts of the organization. Recent research by Faggio, Salvanes and Van Reenen (2010) shows that within-industry productivity differences in the UK has increased in the past two decades. The increased dispersion of productivity is attributed to the wage dispersion that has occurred in the UK and other developed countries. Faggio, Salvanes and Van Reenen (2010) document that industries that experienced the largest increases in productivity also experienced the largest increases in IT investment, providing further evidence of the link between IT capital intensity and productivity growth.

## 7. Learning by Doing

Productivity increases by the mere act of producing goods and services. Producers identify opportunities for process improvement through experience. Benkard (2000) studied the reduction in the labor hours Lockheed required to build its L-1011 TriStar wide body aircraft. The first planes required more than one million person hours, which was equivalent to three shifts a day of 2,500 workers each working fifty work hours. By the $30^{th}$ plane, this requirement was reduced by half and it was halved again when the $100^{th}$ plane was produced.

In addition to learning there is forgetting taking place during production. The learning rate is how fast production increases productivity. The forgetting rate measures the speed by which the knowledge acquired through learning decreases. According to Benkard (2000), about 40 percent of the accumulated knowledge decreases each year. Part of the forgetting is due to shifting to a different variant of the plane and labor turnover.

Thornton and Thompson (2001) studied labor requirements for four design variants of 4,000 Liberty ships produced by multiple shipyards during World War II. They estimated the relative productivity contribution of four different measures of past producer experience. This included a particular design, the same yard's past production of other designs, other yards' experience with

the particular design, and other yards' production of other designs. They found that a yard's past production of a particular model matters most for productivity growth in the same model.

The yard's experience with other ship design accounts for about 60 percent of the amount of the own-design effect. Cross-yard learning effects are about five to ten percent of the own-yard, own-design learning effect. Although spillover effects seem quite small, they indicate that managers can learn from other businesses and become more productive.

Kellogg (2009) studied oil and gas drilling in Texas to investigate how learning is generated when upstream and downstream producers work together over a period of time. He studied pairs of producers and drillers. Both producers and drillers work with multiple drillers and producers respectively. This allowed Kellogg (2009) to separately measure the impact of the experience of producers and drillers and the joint experience of producers and drillers. Kellogg (2009) found that the impact of productivity when producers and drillers work in pairs is higher than the overall experience level of the firm.

## 8. Product Innovation

Product innovation is another mechanism to increase business productivity. There are different ways in which innovation can enhance productivity and performance. Product innovation can lead to an increase in the product's price and the firm's revenues without increasing the quantity of output.

Several studies have examined the effects of product innovation on productivity. Bartel, Ichniowski and Shaw (2007) show that the mechanism by which IT improves innovation and productivity is through an enhanced ability to customize products. Lentz and Mortensen (2008), using Danish firm-level data, estimate that about 75 percent of aggregate productivity growth results from reallocation of inputs to innovative companies. About two-thirds of the productivity improvement comes from moving inputs to growing firms from firms that experience market share declines due to quality issues.

Balasubramanian and Sivadasan (2011) studied firms' production and patenting activities to investigate the impact on productivity of patents using NBER patent data and US Census Business Registry data. They found that new patent grants are associated with increases in firm size, number of products the firm produces, and total factor productivity. The direction of causality is not clear, however, as patenting activity is just one aspect of a firm's effort to enter new markets or raise productivity.

Bernard, Redding and Schott (2010) show that the number of products a firm produces is correlated positively with higher factor productivity. The result holds for cross-section and longitudinal data. This result shows that increasing product variety makes firms more productive. This study, however, did not confirm whether it is innovative activity that increases both product variety and productivity or whether firms that experience general productivity increases expand their offerings to capitalize on these improvements.

## 9. Firm Structure

Traditionally, productivity studies focus on factories, plants, stores, and offices as the unit of analysis. Recent research focuses on firm-level factors such as organizational structure, vertical linkages, relative sizes, the industry the firm belongs to, and other such factors as possible determinants of productivity of individual divisions or business units.

Some research suggests that there is a correlation between the degree of decentralization and adoption of productive new technologies (Bloom, Sadun & Van Reenen 2009). As it was mentioned earlier, these authors among others (see Acemoglu et al 2007), attribute the lower productivity growth of European firms to higher centralization levels compared to US firms.

Forbes and Lederman (2011) examined how airlines are affected by vertical integration. Their study shows that airlines that own their regional affiliates experience fewer cancellations and shorter delays than airlines that contract with regional affiliates at arm's length. The superior performance is the result of better performance on days when adverse weather conditions are prevalent. Integration enables airlines to respond quickly to unexpected scheduling challenges. But the increased flexibility leads to higher wages for vertically integrated airlines, reducing the benefits of vertical integration.

Hortacsu and Syverson (2011) studied productivity in plants of vertically integrated firms using the Longitudinal Business Database, which includes most private non-agricultural establishments in the United States. They concluded that vertically integrated plants enjoy higher productivity levels than their non-integrated counterparts. But in most part, this productivity difference reflects the inclusion of high productivity plants in vertical arrangements rather than the result of integration.

Schoar (2002) finds permanent productivity levels in conglomerates are higher than non-conglomerates. According to Schoar (2002), when a conglomerate diversifies, the new plants experience higher productivity levels because the most capable managers are reallocated to them. On the other hand, the existing plants of the conglomerate experience productivity declines during the same time. The average productivity level of the entire firm declines for a period of time because the conglomerate has more existing plants than newly acquired plants. According to Schoar (2002), these productivity changes are due to a "new toy effect," that is, executives focus their efforts on integrating the business and they neglect the existing ones.

## 10. Conclusion and Limitations

As it was pointed out in the introductory section, the issue of productivity is an important one for business organizations. Firms that produce at superior productivity levels have a significant advantage over competitors that operate with inferior efficiency. The studies reviewed in this paper show that not only there are significant differences in productivity among firms but that these differences are sustained over long periods of time. This finding is contrary to theories which suggest that cost competitive advantages are not sustainable, and that firms have to continuously look for new competitive advantages.

A number of studies have been reviewed in this article. They include studies in complementarity and substitution, problem solving and team incentives, management ability and talent, information technology, learning by doing, product innovation, and firm structure decisions. What these studies have in common is that firms that follow the research findings about the factors that affect business productivity have higher efficiency and consequently perform better than their competitors. Some of the factors that affect productivity are endogenous to the firm because they exist inside the firm and they directly affect productivity. These factors are under the control of management and they can be used as levers by management to improve the productivity of their organization. Managers of manufacturing firms need to take these studies seriously and adopt practices that will help them improve their firm's productivity.

A limitation of the studies reviewed in this paper is that they involve only manufacturing firms. An economy consists of other types of organization including services, retailers, wholesalers, and non-profit organizations. Future studies should look into these important sectors of the economy and attempt to replicate the results obtained from research in the manufacturing sector. While one can hypothesize that many of the results obtained in the studies reviewed in this paper are applicant to these sectors, it is quite possible that some of these results may not be valid. It is incumbent upon academic researchers to short out this issue and improve our knowledge in this important area.

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