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THE ROLE OF INFORMATION TECHNOLOGY ON THE GROWTH OF FIRMS: A VALUE ADDED ONSIDERATION

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ABSTRACT

This paper concentrates on growth; one of the important aspects of firm behavior, in the Malaysian manufacturing sector between 2000 and 2006. It attempts to analyze the effects of information technology on firms' growth in this period among 185 firms. By employing dynamic panel data and generalized method of moments (GMM), this work shows that information technology expenditure displays a positive effect on the growth of firms in the Malaysian manufacturing sector. The results also show that besides this factor, some elements, such as minimum efficient scale, productivity, technology, sunk cost, and capital-labor ratio have an effect on firms' growth. The findings show that information technology expenditure could not be an effective tool for enhancing growth for firms that are under a certain level of productivity.

Keywords: *Information Technology, Growth, Malaysian Manufacturing Sector, GMM*

1. INTRODUCTION

The evolution of firms in the market, from creation to demise, can have a prominent impact on the economy. This matter is more significant in the manufacturing sector. The creation of firms can help to create more jobs, new products and new technologies, increase competition in the market, develop the supply chain and reduce social exclusion. However, the demise of firms causes the waste of resources in social, financial and physical aspects, more unemployment, and a decrease in the economic growth rate.

Therefore, policymakers attempt to decrease the demise or exit of firms in the manufacturing sector and increase the survival and growth of firms. According to some studies, such as Mansfield [45], Arrighetti [8], Geroski [32], Audretsch [12], Arrighetti [8], Audretsch [12], Mata and Portugal [47], Arrighetti [8], Geroski [32], Audretsch [12], Mata and Portugal [47], firms' growth (increasing of size of firms) causes a higher survival rate and lower exit rate.

Previous studies emphasized the role of certain factors that affect the growth of firms. Mansfield [45] found that long run profitability and minimum efficient scale of firm affect the growth of firms. The role of industry differentiation was shown by Dunne, Roberts and Samuelson [28] [29], who found that the survival rate of new firms varies systematically across industries. Geroski [31] [32] emphasized the size and age of firms and found that firm size and age are correlated with the growth of entrants. Audretsch [12] analyzed the effect of innovation. Bernard et al. [20] and Melitz [49] argued that exporters have a higher growth rate than non-exporters. Esteve-Perez and Manez-Castillejo's research [30] showed that firms' strategies that allow a developing firm specific assets, such as advertising and making R&D, become a crucial determinant of firms' growth.

The information technology revolution in economic sectors has created more value during the last three decades in the world. This value is more considerable in the service sector and manufacturing sector. In the manufacturing sector, the importance of IT could be viewed as output, employment and export earnings arising from the production of IT related goods and services [42], and enhanced productivity, competitiveness, growth and human welfare into other manufacturing goods. Therefore it is expected that IT can create higher growth for firms, especially in the manufacturing sector.

As mentioned before, the effects of factors such as long run profitability and minimum efficient scale, size and age of firms, innovation, exports,

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advertising and R&D have been assessed thoroughly in earlier studies. However, the effect of information technology on a firm's growth remains an untested area. Since information technology is an embedded technology and constitutes a component of products and services, its usage helps to strengthen the growth of firms in several ways.

This paper focuses on growth, one of the important aspects of firm behavior, in the Malaysian manufacturing sector. It attempts to analyze the effects of information technology on firms' growth among 185 firms during 2000 and 2006. The main question is "does Information technology have an effect on the growth of firms in the Malaysian manufacturing sector?"

The next section begins by laying out the empirical dimensions of the research, and looks at some previous studies on firms' growth and factors that affect it. In the third section after describing the methodology, data, and their sources, the design, synthesis, estimation and evaluation of growth model for firms in the Malaysian manufacturing sector will be considered. Concluding remarks are given in the final section.

2. IMPORTANCE OF IT FOR MANUFACTURING SECTOR

IT and its usage play an important role in the development of the manufacturing sector. IT can assist managers to make decisions, introduce new products and services more quickly and frequently improves customer relations and enhances the manufacturing process. IT offers several advantages to businesses not only in promoting their current operations but also in providing opportunities for new markets, strategies, and relationships [55]. In fact, information technology is an embedded technology or integrated with other components of products and services.

According to UNIDO and ECLAC [60], IT is an effective tool to overcome obstacles for SMEs and it facilitates international trade. The main objectives for private firms to introduce IT are to:

- improve information access
- improve internal administrative management
- improve product management and quality control
- enhance productivity by improving internal management as listed above
- facilitate collaboration with other companies and seek economies of scale and
- acquire new business opportunities

Two kinds of usages could be considered for IT in the manufacturing sector. The first one is general usage, such as Email, E-commerce, Enterprise Resource Planning (ERP), Supply Chain Management (SCM) and Customer Relation Management (CRM). The second one is specific usage such as Computer Integrated Manufacturing (CIM),[1] Manufacturing Automation Protocol (MAP),[2] Material Requirements Planning (MRP),[3] Manufacturing Resource Planning (MRP II),[4] Computer Aided Design (CAD),[5] Computer Aided Manufacturing (CAM)[6] and Flexible Manufacturing.[7]

3. THEORY AND PAST STUDIES

The existing theories could be categorized into two groups. The first one shows the literature that explains the factors that are important to the performance of firms, their growth and chance to stay in the industry and the second is related to the role of information technology and how it can be important in respect of the performance of firms.

3.1. Performance of Firms

Important new literature has emerged in the last few years, which focuses on the performance of firms after entering the market in terms of both their probability of survival and their growth patterns.

The literature concerning firm performance started with Gibrat [45]. Robert Gibrat's study presents what is called the law of proportional effect. His model attempts to dynamically relate the size of firms to industry structure [58]. He found

[1] A manufacturing system that uses computers to link automated processes in a factory to reduce design time, increase machine utilization, shorten the manufacturing cycle, cut inventories, and increase product quality

[2] A protocol used by factory designers to provide a common language for the transmission of data

[3] A system that tracks the quantity of each part needed to manufacture a product, essentially, an important component of MRP II

[4] An advanced MRP system that ties together all the parts of an organization into the company's production activities

[5] A system that uses a powerful computer graphics workstation to enable product designers and engineers to draw design specification on a display

[6] A system that relies on IT to automate and manage the manufacturing process directly

[7] A manufacturing system that automatically sets up machines for the next job, thus, reducing set up time and making smaller job runs feasible

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that the rate of firm growth is independent of its size. Bain [16] emphasized entry as one of the main mechanisms by which long run equilibrium levels of profitability and price are restored. A level of profitability in excess of equilibrium induces entry into the industry. Thus, entry is a function of long run profits.

In the same way, Jovanovich [38] maintained that a firm always maximizes the expected present discounted value of profit. He introduced this concept to make the case that efficient firms will grow and survive and that learning is central to gaining efficiency. By emphasizing efficiency and learning, Jovanovich was making the case that firm size does not play a role in terms of growth. Rather, it is "learning by doing" that enables a firm to accumulate expertise from the beginning through invention, innovation and refinement, which, together, constitute new capital goods. Thus, a firm can grow from a low-tech to a high-tech entity.

A new wave of research discovered what Paul Geroski [31][32] systematically arranged as the stylized facts, in which both firm size and age are correlated with the survival and growth of firms. Some researchers, such as Wagner [61], Arrighetti [8], Baldwin [17], Mata et al. [48], Mata and Portugal [46], and Jamali and Norghani [37] in their case studies have confirmed this relationship.

The most important rational behind this relationship is that most of the firms, typically, enter the market below the minimum efficient scale. Therefore, they are faced with a cost disadvantage, which makes their survival and growth more difficult [48]. In addition, as mentioned by Jovanovich [38], at birth, firms do not know their true ability. They decide about the entry scale based on their beliefs about their ability level, however, this level is very imprecisely estimated.

Based on Audretsch et al. [13], when the minimum efficient scale in an industry scale is high, the post entry growth rates of the surviving firms will also be high. In such an industry, however, the exit rates may be high since some of the new firms may not be able to grow and approach the MES. Moreover, in industries where the minimum efficient scale is low, relatively lower growth rates but higher survival rates would be expected, since, in this case, the need for growth and the disadvantage of operating at suboptimal scales will not be as severe.

Agarwal and Audretsch [1],[5] , Jamali and Norghani [37] and Agarwal [3],[4] point out that the positive relationship between size and the likelihood of survival and growth holds in particular in industries that are in the earlier stages of their life cycles. Dunne, Roberts and Samuelson [28] [29] showed that the survival rate and growth of firms vary systematically across industries. However, they provided no insight as to why such variation in survival rates should exist.

Audretsch [12] showed that in industries with high innovative activities, especially in small firms, the likelihood of new entrants' surviving over a decade is lower than in industries with low innovative activities. At the same time, those entrants that are able to survive, exhibit higher growth. Audretsch [12] implied that two of the traditional characteristics of structural barriers, which are the scale of economies and product differentiation, do constitute a barrier to survive.

Some researchers, such as Audretsch [11], Audretsch and Mahmood [10], and Mata and Portugal [46], in their studies emphasized the important role of market structure. Their findings show that structural factors like the height of the entry barriers, the shape of average cost, the size of the firms and speed of technological progress, have an impact on the performance of firms.

Furthermore, Dome et al. (1995) in their study focused on the role of technology in the growth of manufacturing firms and found that increases in capital intensity and usage of advanced manufacturing technologies (AMTs) are negatively correlated with firm exit and positively correlated with the growth of firms. Dome et al. (1995) also indicate that growth of firms generally increases with technology using, capital intensity, and productivity.

Olley and Pakes [51], Bailey et al. [15], Liu and Tybout (1993), and Bailey et al.[14] concentrated in their studies on the role of productivity. They found that higher measured productivity is correlated with higher growth rates and lower failure rates for firms in the manufacturing sector. However, there remain considerable variations in plant-level growth and failure, which is unexplained by plant-level productivity differences.

Another factor, which has an effect on the survival and growth of firms, is sunk costs, which typically arise from investments in assets that are durable, immobile, and specific to the firm or the product. Advertising, R&D and marketing expenses are examples of sunk costs. Dixit [26] and Hoppenhayn [35] argued that new-firm survival would be influenced by the amount of sunk costs in the industry. A greater degree of sunk costs should reduce the likelihood of exit and lead to lower observed growth rates for surviving firms. Audretsch [11] [12] provided the empirical

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evidence linking the extent of sunk costs to a lower likelihood of exit and lower observed growth rates of surviving firms.

Dunne et al.[29], Audretsch and Mahmood, [9], and Ozler and Tymaz [52] analyzed the role of the ownership of firms (foreign and domestic or governmental and private) on survival and growth. They suggested that the patterns of plant growth and failure are systematically related to the firms' ownership type.

3.2. Information Technology

In this paper, literature about economic aspects of Information technology is categorized into three groups: Neoclassic, general purpose technology and resource based view.

3.2.1. Neoclassical view

Most studies use neoclassical assumption in estimating the contribution of information technology as a traditional input factor. As a standard production function, information technology contributes to output through capital deepening [57]

The standard neoclassical model is well known and has been used extensively to evaluate and to examine the link between information technology and productivity. In a Neoclassical model, which assumes a Cobb-Douglas production function, information technology is modeled as a special form of capital and distinguished from other forms of capital to study the impact of information technology capital on productivity.

An important point about this framework is that there is no special role for information technology capital, as there is no direct impact on total factor productivity (TFP) growth from capital deepening. TFP growth, by definition, is the output growth that is not explained by input growth. Any output contribution associated with information technology investment is attributed to information technology capital deepening and not TFP. The profit function for firms under neoclassical assumption is shown in formula1

$$\pi = P.AL^{\beta_0} K_{IT}^{\beta_1} K_{Non-IT}^{\beta_2} - wL - r_1 K_{IT} - r_2 K_{NonIT} - FC \quad (1)$$

Where π is profit, P is price, L is labor, K_{IT} is IT capital, K_{Non-IT} is non IT capital and A is technology or total factor productivity, TR is total revenue, TC is total cost, w is wage of labor, r1 is price of K_{IT}, r2 is price of K_{non-IT}, and FC is fixed cost.

Information technology can affect this equation in several ways. IT investment decreases the fixed costs of operating a firm [59]. An example is the traditional idea of automating the firm's payroll or accounting and E-office functions. Therefore, a decrease in FC causes more profit.

IT investment that reduces the costs of designing, setting up and developing a product with a specified quality level is represented by a decline in FC [40]. Examples of this type of technology are Computer-Aided Design (CAD) tools or Computer-Aided Systems Engineering (CASE) tools, which ideally enable a firm to design and develop a product of a given quality, at lower cost (or design and develop a better-quality product at the same cost).

IT investment can decrease labor cost by improving the managerial abilities of firms and the coordination of the labor force [44]. The efficiency of the labor force in the firm will increase, resulting in higher profit.

3.2.2. General purpose technology

General Purpose Technologies (GPTs) are radical new ideas or techniques that have the potential to have a significant impact on the industries. A GPT can be defined as "a technology that initially has much scope for improvement and eventually comes to be widely used, to have many uses, and to have many technological complementarities" [43]. Their key characteristics are: pervasiveness (used as inputs by many downstream industries); technological dynamism (inherent potential for technical improvements) and innovation complementarities with other forms of advancement (meaning that the productivity of R&D in downstream industries increases as a consequence of innovation in the GPT). Thus, as general purpose technologies improve, they spread throughout the economy, bringing about overall productivity gains [34].

Malone and Rockart [44] found that the effects of information technology are very similar to the effects that automotive technology had in the past. The primary purpose of information technology is to reduce coordination costs. This lowering in costs creates three effects. First is the "substitution effect", whereby information technology will result in manual labor being substituted by information systems. The second is "increased use", which means information technology will result in increased use of coordination. The third effect is the "emergence of new structures", in other words the use of more coordination intensive structures.

Bresnahan and Trajtenberg [23] claimed that information technology is essentially enabling technology that facilitates innovations in the application sector. For example, computers have

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been extensively used to automate back office operations, and network applications help to coordinate processes between organizations. There are two central arguments that support the notion of information technology being a general purpose technology. First, a significant component of the value of information technology is its ability to enable complementary organizational investments such as business process and work practices. Second, these investments, in turn, lead to productivity increase by reducing costs and, most importantly, by enabling firms to increase output quality in the form of new products or in improvements in intangible aspects of existing products like convenience, timeliness, quality, and variety.

3.2.3. Resource based view

Resource based view (RBV) theory suggests that there can be heterogeneity or firm-level differences among firms that allow some of them to sustain competitive advantage. Therefore, RBV emphasizes strategic choice, charging the firm's management with the important tasks of identifying, developing, and deploying key resources to maximize returns [19].

Bharadwaj et al. [21] develops information technology business value models from the resource-based perspective. He defines information technology capability as a firm's ability to deploy information technology enabled capabilities in combination with other complementary resources to achieve competitive advantage. Key IT based resources were classified into tangible IT resources comprising the physical components of IT, human IT resources comprising the technical and managerial skills, and intangible IT-enabled resources, including knowledge assets, customer orientation, and synergy.

Here, some of the general characteristics of information technology and the factors that have an effect on performance of firms have been explained. The analysis of information technology and its impact on the performance of firms are explained as follows.

According to Mata et al.[48], Audretsch et al. [13] and Jovanovich [38] minimum efficient scale (MES) is an important factor for the growth of firms. This is because firms face challenges, such as reduced profit margin, heated price competition, a low rate of technological change outside the industry, and increasing entry barriers due to incumbents' accumulated experience. The Neoclassical model shows that information technology can increase output through capital deepening. In the general purpose technology approach information technology can decrease coordinating cost and increase output quality in the form of new products or improvements in intangible aspects of existing products like convenience, timeliness, quality, and variety, which enhance the firm's ability to growth in the market.

Furthermore, some researchers, such as Bain [16] Mansfield [45] and Jovanovich [38], argued that profitability is an important factor for the growth of firms. Information technology can decrease coordinating cost (general purpose technology), increase output (neoclassical theory) and create competitive advantages (resource based view) for firms enabling them to obtain higher profits. Therefore, information technology, by having a positive effect on the profit function can increase the profit of firms. Based on the theories, by increasing the usage of IT, the growth of firms will be greater.

4. MODEL AND DATA

The model for answering to the question of this study was introduced by Ijiri and Simon [36], and developed by Del Monte and Papagni [25]. Based on their studies the growth of firms can be affected by:

i) A growth factor that affects all firms in the industry equally, indicated by intercept

ii) The individual growth ratio of a firm, which is dependent on a firm's characteristics indicated by X matrix

iii) The individual growth ratio in one period is related to the firm size in the previous period

iv) A casual factor of multiplicative type indicated by e^{Vit}

$$g_{it} = \alpha_i \, (X)_{i,t}^{d} \, S_{i,t-1}^{B-1} \, e^{Vi,t} \quad (2)$$

$$\frac{S_{i,t}}{S_{i,t-1}} = \alpha_i \, (X)_{i,t}^{d} \, S_{i,t-1}^{B-1} \, e^{Vi,t} \quad (3)$$

After taking logarithm we have

$$\log S_{i,t} - \log S_{i,t-1} = log\alpha_i + d\,logX_{i,t} + (B-1)logS_{i,t-1} + V_{i,t} \quad (4)$$

And

$$\log S_{i,t} = log\alpha_i + d\,logX_{i,t} + BlogS_{i,t-1} + V_{i,t} \quad (5)$$

Equation 5 is employed in this study, where $S_{i,t}$ is size of firms *i* in time *t*, $X_{i,t}$ is matrix of variables

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for firm at time *t*, $S_{i,t-1}$ is size of firms *i* at time *t-1* and $V_{i,t}$ is a random factor or an error term.

Since the data is annual, the dynamic panel estimator is considered to allow the growth to partially adjust to their long run equilibrium values. Since in model 5 there are group fixed effects the model suffers from Nickell [50] bias, which only disappears if T tends to infinity. Among the existing methods to remove this biasness, GMM is the preferred estimator, which was suggested by Arellano and Bond [7] and developed by Arellano and Bover [6]. This method basically changes the model to get rid of group specific effects or any time invariant industry specific variable. To test this model the System GMM estimator proposed by Arellano and Bover [6] is used.

To test the consistency of the GMM estimators, two tests, which were proposed by Arellano and Bond [7], will be used. The first is a Sargan test of over-identifying restrictions, which tests the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation procedure. The second test examines the assumption of no second-order serial correlation. Failure to reject the null hypotheses of both tests gives support to our estimation procedure.

The data for running the model is taken from the Department of Statistics (DOS), Malaysia. There are two main resources for collecting the data in the Malaysian manufacturing sector one is the *census of manufacturing sector* for 2000 and 2005 the other one is the *survey of manufacturing sector*[8] for 2001, 2002, 2003, 2004 and 2006. The key indicators for 185 firms[9] offered by DOS based on related questionnaires.

It should be emphasized that some researchers like Dunne et al. [29], Audretsch [12], Boeri and Bellman [22], and Doms et al. [27] use the change in number of employees as a proxy for the size of firms, while other researchers, such as Jovanovich [38] and Piergiovani et al. [54] use change in value added as a proxy for size. In this paper, the size of firms, which is defined by the value added of each firm and the change in the size of firms in each period, is considered as the growth of firms.

Since analyzing the effect of information technology on growth of firms is our concern, information technology expenditure is considered as the main independent variable in the model. This variable is measured by total information expenditure and denoted by IT in the model.

The minimum efficient scale (MES) is the other factor that has an effect on firms' growth and is measured by the average production per firm for firms in the midpoint class size (defined by product shipments), as a percent of shipment values in each year [24] .This measure is derived from the DOS and it is expected that firms' growth will be positively correlated with MES. As the MES increases, a firm of any given size must grow in order to realize maximum efficiency, or at least to attain a size similar to those firms in the industry accounting for most of the shipments. Thus, a positive relationship is expected to emerge between the proxy measure of the MES level of output and the post-entry growth rate (Autretsch, 1995). In the model, minimum efficient scale is denoted by MES.

Productivity (PRO) is another variable in the model, which is measured by total output divided by total input of each firms. In the model PRO shows the productivity and it is expected that PRO should have a positive relation with the growth of firms. It should be mentioned that total output is measured by total value of production and total input is measured by the summation of total costs of packing materials and containers consumed, electricity and water purchased, value of fuel, lubricant and gas consumed, cost of materials used for repairs and maintenance of assets, research and development expenditure, payment for non-industrial services and other input costs.

Based on Doms et al. [27] increases in the capital intensity are positively correlated with firm's growth. They considered capital intensity as a proxy for technology usage. In the model, capital-labor ratio is another variable for technology usage, which is measured by total capital of firm divided by total employees of firm for each year. Capital refers to the summation of total value of purchases and own-account construction of fixed assets during the reference year (Major addition, alteration and improvement to existing assets that extend their normal economic life or raise productivity are also included) and total value of a producer's acquisition, less disposal, of fixed assets during the accounting period and certain additions to the value of non-produced assets. In the model, CALA denotes this variable and it is expected that CALA should have a positive relation with the growth of firms.

The importance of some costs such as R&D, marketing and advertising, and learning in growth of firms, has compelled their inclusion in the model

[8] This survey is based on systematic sampling, which covered more than 40 percent of firms in the Malaysian manufacturing sector

[9] The data for this number of firms was traceable among the 2001, 2002, 2003, 2004 and 2006 surveys

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as an aggregate variable named sunk cost. Sunk cost is measured by the total nonproductive cost in each firm. It should be stated that based on DOS definition nonproductive costs include research and development, learning, advertising, journals and books and communication costs. This variable is denoted by SUNK in the model. Descriptive statistics on the mentioned variables is included in table 1 in the appendix.

In order to capture for the role of technology, a dummy variable, TEC, is added in the model. It takes the value of one for firms in high technology sectors and zero for others. According to Porter (2001) and OECD (2004), the high tech sectors are Aircraft (aerospace), Office & computing equipment, Communications equipment, Drugs and medicines, Scientific instruments and Electrical machinery. It is expected that TEC has a positive relation with the growth of firms.

To show the effect of productivity on the growth of firms that emanates from information technology, an interaction variable between information technology and productivity is considered in the model denoted by IT*PRO. Besides t year dummies are included in the model for considering the impact of the aggregate effects of unobserved factors in a particular year that affect the performance of all the groups equally.

5- EMPIRICAL RESULTS

The results of estimation are presented in table 2. Each column of the table corresponds to a different model.[10]The first model includes all the variables except Lit and interaction variable Lit*pro. The second model includes all the variables and Lit except interaction variable Lit*pro. The third model considers the variables without lagged of two variables Lit and Lit*pro and the fourth model includes all the variables and Lit and Lit*pro.

STATA and its command are used for model estimation in this paper. As mentioned in the previous section the generalized method of moments (GMM) estimator[11] [7] has been used to estimate the model. This approach allows Lvadt to partially adjust to its long run equilibrium value. It should be stated that the GMM estimator by taking first difference from the model eliminates group specific effects from the model. Based on the endogeneity test in the GMM model, CALA and PRO need to deal with endogeneity problem. Therefore, for treating the endogeneity problem of CALA and PRO, the lagged two of the variables are considered as the instrument.

The specification tests in all the models are satisfactory. The Sargan test in any of the models rejects the null hypotheses and this failure proves that the instrumental variables are uncorrelated to a set of residuals, and are therefore acceptable instruments. Also, the second order autocorrelation test (AR (2)), which is used to detect AR (1) in the underlying variables in all the models is greater than the critical level of 0.1, which shows that there is no autocorrelation in any of the models.

It is necessary to explain that some researchers, such as Weil and Olson (1988), Banker et al. [18] and Shaft et al. [56] pointed out the impact of information technology expenditure on firms' performance with a time lag, so the IT is considered in a model with lag.

Comparing the four models shows that model 1 and model 2 could not be chosen. The reason could be the insignificant effect of technology on the growth of firms in these two models, which is based on the theory that technology has a positive significant effect on the growth of firms and the insignificant effect of information technology in the second model.

In addition, model 3, which includes the lag of information technology, cannot be considered as the best model, as table 2 shows that this model information technology, interaction between information technology and productivity and also sunk cost do not show a significant effect on growth of firm. Model 4, which includes information technology and its interaction with productivity, is considered as the best model since all the variables compatible with the theories show a significant effect on the growth of firm.

As was shown in Table 2, the year dummy for 2005 is significant, which means that there is year effect in the models for 2005. Based on the estimation results in this table, the best-estimated model is as below:

$$Lvad_{it} = -2.29465+0.11306Lvad_{it-1} +$$

[10] It is necessary to explain that all the data that are used in the models are in logarithm form.

[11] Arellano, Bond, developed one and two-step generalized method of moments (GMM) estimators for panel data analysis. GMM is usually robust to deviations of the underlying data generation process to violations of heteroskedasticity and normality, insofar as they are asymptotically normal but they are not always the most efficient estimators

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(0.23259) *(0.03509)*

$+ 0.25562Lemp + 0.15905Lit_{it} + 0.36972Lmes_{it}$
(0.04507) *(0.04466)* *(0.03329)*

$+0.2541Lsunk_{it} + 0.12983LCALA_{it} +$
(0.03283) *(0.03354)*

$+ 0.9713Lpro_{it} + 0.097Lit_{it}{*}pro_{it} + 0.5306Ltec$
(0.29909) *(0.03139)* *(0.12239)*

$- 0.0806D2005$
(0.01606)

The results show that the size of firms in previous period ($Lvad_{it-1}$) has a positive impact on growth of firms. This means that firms with a bigger size in the previous year have a higher growth rate in the current year. This result in Malaysian manufacturing industry rejects Gibrat's Law, which states that the size of a firm and its growth rate are independent.

Employment is another factor, which is considered in the model. The findings show that employment has a positive significant impact on the growth of firms and that an increase in the number of employees can help firms to grow more in the industry. In other words employing a larger labor force creates more value in the firms. In addition, the results of the model point out that sunk cost has a positive effect on the growth of firms. This means that some costs, such as R&D cost, marketing cost and other nonproductive costs, are very important for the growth of firms in the Malaysian manufacturing sector. This result is unlike the findings of Dixit [26] and Hoppenhayn [35].

Minimum efficient scale (MES) in the model has a positive effect on the growth of firms. This means that in each sub sector in which MES is high, the growth of firms is high and vice versa. This finding for the growth of firms in the Malaysian manufacturing sector supports the findings of Audretch et al. [13] about the positive impact of MES on the growth of firms.

The results of the chosen model indicate that firms that operate in technology based sectors have a higher growth rate than the normal firms. This finding is similar to the finding of Doms et al. [27] concerning the positive impact of technology on the growth of firms.

The role of capital-labor ratio (CALA) on the growth of firms is significantly positive; this result confirms the findings of Doms et al. [27] who mentioned that, generally, growth of firms increases with capital intensity (K/L).

Furthermore, year dummies had a significant negative effect on the growth of firms in 2005, which means that the growth of firms in the Malaysian manufacturing sector in 2005 has contracted.

The coefficient of interaction between productivity and information technology has a positive significant effect on growth, which means that the productivity emanating from information technology has a positive and significant effect on the growth of firms.

Since information technology in the equation appears as a part of the interaction term, to show its effect on the growth of firms, the marginal effect should be computed. Furthermore, to estimate the relative importance of productivity for the growth of firms, the marginal effect of productivity should be calculated. Based on equation 6 the marginal effect of information technology and productivity are:

$$\frac{\partial g}{\partial Lit_{it}} = 0.159054 + 0.09699 * \mathrm{Lpro}_{it} \qquad (7)$$

$$\frac{\partial g}{\partial Lpro_{it}} = 0.971303 + 0.09699 * \mathrm{Lit}_{it}$$

$$\frac{\partial g}{\partial Lit} = 0.0417602 + 0.105139 * Ltfp_{it} \qquad (8)$$

Where, g is growth of firms.

The results of the marginal effects based on mean, maximum and minimum of observations are shown in table 3.

In order to assess whether the information technology and productivity, which are used as a part of the interaction term, have a significant effect on the growth of firm it is necessary to compute the standard error of marginal effect. As Barmbor imply the standard error of interest for information technology is:

$$\sigma_{\frac{\partial g}{\partial Lit}} = \sqrt{Var(0.159054) + Lpro^2 Var(0.09699) + 2Lpro\, cov(0.159054, 0.09699)}$$

And for productivity is:

$$\sigma_{\frac{\partial g}{\partial Lpro}} = \sqrt{Var(\widehat{\beta_{lpro}}) + Lit^2 Var(\widehat{\beta_{lit}}) + 2Lit\, cov(\widehat{\beta_{lit}}, \widehat{\beta_{lpro}})} \qquad (10)$$

The results are shown in Table 3.

The table shows that the effect of information technology on the growth of firms is positive for those firms whose productivity is around the maximum or the mean of observations. However, for firms whose productivity is around the

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minimum of the observations the impact of information technology is negative. This means that in firms with the lowest level of productivity the role of information technology on the growth of firms is insignificant, otherwise its effect is positive and significant.

Moreover, the effect of productivity on the growth of firms is positive and significant for firms in which the information technology is at the mean or maximum level and for those that information technology is around the minimum of observations the effect is negative and insignificant. The result for productivity for the mean and maximum observations confirms the results of previous studies, such as Olley and Pakes [51], Liu and Tybout [41], and Bailey et al. [14], which implies that productivity has a positive effect on the growth of firms. The results for the firms that stand at the minimum level of information technology again show an insignificant effect on the growth of firms. One reason for the result obtained for information technology and productivity could be due to the fact that information technology could be effective for performance of firms. The firms have to cover the essential costs through the output and then invest in information technology.

Comparing the impact of the variables on the growth rate of firms in the Malaysian manufacturing sector emphasizes that in the estimated model, productivity has the highest effect on growth of firms followed by technology and minimum efficient scale.

4- CONCLUSION

This paper focused on the effect of information technology in enhancing the growth of firms in185 firms in the Malaysian manufacturing sector. By using dynamic panel data generalized method of moments (GMM) estimator, the results showed that in the Malaysian manufacturing sector, information technology expenditure has a positive effect on the growth of firms. Furthermore, certain other factors, such as size of firms in previous year, productivity, number of employment, capital-labor ratio, technology based firms, minimum efficient scale and sunk cost have a positive impact on the growth of firms.

The results show that information technology expenditure affects the growth of firms at the current period for the Malaysian manufacturing sector and time lagged could not be effective in growth of the firms. Furthermore, information technology is not an effective tool for enhancing the growth of firms that are under a certain level of productivity.

The positive effect of information technology on the growth of firms in the manufacturing sector can inspire policymakers to consider IT as a tool for promoting growth of firms, and policymakers in developing countries in which the productivity in the manufacturing sector is not too high should be aware of the insignificant effects of this policy.

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Table 1.Descriptive Data

Variables	Obs	Mean	Std. Dev.	Min	Max
lvad	1288	0.67338	1.281291	-2.97915	6.383507
Lpro	1288	0.465741	0.212977	-1.82382	1.947291
Lsunk	1287	-0.93188	2.675162	-6.90776	7.873788
Lemp	1288	3.057338	1.18623	1.098612	7.244227
Lmes	1111	2.727255	1.152242	-2.06357	8.079552
Lit	527	-5.03489	2.287856	-13.9351	0.548118
Tec	1288	0.245342	0.430457	0	1
lcala	1258	-3.91065	1.492957	-8.88184	7.27647

Table 2 - Estimation Results

Variables	Model 1	Model 2	Model 3	Model 4
lvad t-1	0.200102* (0.057815)	0.061274 (0.070995)	0.046573*** (0.024739)	0.113059* (0.035092)
lcala	0.11501** (0.052667)	0.22104* (0.067711)	0.099458** (0.042033)	0.12983* (0.033538)
lpro	2.29097* (0.257774)	1.733287* (0.369659)	0.502986** (0.208669)	0.971303* (0.299091)
lemp	0.374029* (0.093249)	0.380813* (0.100803)	0.460186* (0.06131)	0.255624* (0.045068)
lmes	0.397993* (0.060226)	0.272242* (0.055755)	0.476847* (0.037778)	0.36972* (0.033288)
lsunk	0.098738** (0.045387)	0.32555* (0.066003)	-0.05465 (0.055538)	0.254127* (0.032836)
lit*lpro				0.09699* (0.031395)
lit		0.01503 (0.01849)		0.159054* (0.044659)
llit*lpro			0.002317 (0.018199)	
llit			0.04015 (0.025397)	
tec	0.235885 (0.216199)	1.154757 (0.314051)	0.307664* (0.0663)	0.530656* (0.122393)
D2003	0.167072* (0.028646)	0.001072 (0.032038)		
D2004	0.172962* (0.037043)	-0.00994 (0.035795)		
D2005	0.094352* (0.038674)	-0.06569 (0.048356)	-0.09818* (0.014296)	-0.08066* (0.016065)
D2006	0.181562* (0.052635)	0.068901 (0.045422)		
_cons	-2.36936* (0.437526)	-3.39364* (0.46783)	-1.62893* (0.175474)	-2.29465* (0.232587)
AR1	[0.003]	[0.0014]	[0.0288]	[0.0090]
AR2	[0.8115]	[0.8302]	[0.1696]	[0.2075]
Sargan test	[0.3440]	[0.5623]	[0.2102]	[0.4857]

Numbers in parentheses are SE, Numbers in brockets are probabilities

***) Significant at 10%, **) Significant at 5% *) significant at 1%

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Table 3.The Marginal Effects Of IT And PRO

	Information technology (Lit)			Productivity (Lpro)		
	Coefficient	Std error	T	Coefficient	Std error	t
Mean	0.204226	0.101178	2.018482279	0.482969	0.151054	3.19731
Minimum	-0.01784	0.58588	-0.03044992	-0.38026	0.900336	-0.42235
Maximum	0.347922	0.154271	2.255265085	1.024465	0.277343	3.693856

Table 4.Correlation Matrix

variables	Lvad	Lpro	Lsunk	Lemp	Lmes	Lit	Tec	Lcala
Lvad	1							
Lpro	-0.2815	1						
Lsunk	0.8183	-0.5223	1					
Lemp	0.8263	-0.4222	0.9168	1				
Lmes	0.911	-0.2758	0.6354	0.6496	1			
Lit	0.7185	-0.2909	0.5835	0.5899	0.6877	1		
Tec	0.5838	-0.1066	0.3706	0.4374	0.6135	0.5037	1	
Lcala	0.5229	-0.2685	0.6641	0.467	0.3358	0.3657	0.1556	1