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INVESTIGATING DETERMINANTS OF INFORMATION TECHNOLOGY INVESTMENTS BY INDIAN FIRMS

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ABSTRACT

Information Technology (IT) investment by firms in India and across globe is forecasted to increase at a good pace as per the recent reports published by various market research firms. However, very few research studies have been conducted to explain the factors that determine the level of IT investment by firms. In this research, we study the determinants of IT investment at the firm level in Indian context. Data from 239 Indian firms over 2007-2010 period were studied using multiple linear regression analysis. Results of the study reveal IT capital stock and slack resources as the determining factors of the level of future IT investment. Sales growth, financial leverage, and industry competition etc. does not influence IT investment of firms in India. The results can provide useful guidance to IT producers while planning their operations.

Keywords: Information Technology, slack resources, sales growth, financial leverage, industry competition

INTRODUCTION

Investment in IT has worked as a catalyst in productivity growth of firms in developed countries. According to past country-level studies conducted by Dewan & Kraemer [11], and Pohjola [28], the productivity benefits from IT were insignificant in developing countries. They hypothesized that developing countries did not have adequate levels of IT investment and lacked in complementary assets to realize productivity benefits of IT. However, since then economies of developing countries such as India have leapfrogged and investments by firms, especially IT investments have increased considerably. According to a report published by Gartner, IT infrastructure market of India which consists of servers, storage, and networking equipment is expected to reach US$2.05 billion in 2012, a 10.3% increase over 2011 and is expected to reach US$3.01 billion in 2016 [14]. While the annual average growth in global IT spending is forecast at a relatively low 3.9% through 2016 [13]. Therefore, understanding the factors that influence IT investments of firms becomes an important topic. Implications of such a study can be very handy to IT firms in formulating their strategies when they plan to seize advantage in new markets. Since many developing countries are now turning into big emerging markets, IT producing firms need to find out and exploit the factors, which shape IT investment of firms in these countries. It shall help these firms in gaining useful insights for formulating their strategies.

The research firms like Gartner and International Data Corporation keep publishing the global and nation-

wise IT spending forecasts. The reports and forecast about future IT outlook provided by these firms can be helpful to IT producing industries. IT producers and consultancy firms might use this information to predict future demand of IT and then plan their services and operations accordingly. However, the extant literature lacks the theory and arguments that can be used to explain the level of IT investments at firm level. The research related to the factors, which determine the level of IT investments is very scarce. Although past studies can be hypothetically divided at three levels- country or macro level studies, firm or micro level studies, and functional level studies, the majority of the studies in the extant literature are at country or macro level. For example, Gurbaxani & Mendelson [17, 18] conducted a study in United States and found growth in IT investment in the US to be positively associated with the economic growth rate, the declining computing cost, and the information intensity of different sectors of economy. Similarly, in a study based on 11 Asia-Pacific countries, Kraemer & Dedrick [26] found IT investment to be linked to factors such as diffusion of telecommunications infrastructure, education levels, technical skills, and the percent of the economy in services industries. In a study based on 89 countries, Caselli & Coleman [8] used value of computer hardware imports as a proxy measure of IT investment. IT investment was found to have a positive and significant association with factors such as educational attainment and openness to imports for three samples of countries they examined. In addition, in some of their samples, they found that IT investment was positively associated with property rights protection, and negatively associated with agricultural and government share of gross domestic product (GDP). Baliamoune-Lutz [4] studied the relationships between ICT diffusion and other factors such as per capita income, trade and financial indicators, education, and freedom indicators in developing countries and found that only income and government trade policies influence ICT diffusion. Shih et.al. [34] examined the factors that influence IT investment in developed and developing countries. They found IT investment to be negatively associated with interest rates, but positively associated with openness to trade and telecommunications infrastructure. They also examined the role of interaction effects between national income levels and other country factors in shaping IT investment. In developed countries, interest rates, size of the financial sector, teledensity, and intellectual property rights were found to have stronger impacts. While in developing countries openness to trade, the size of government and education levels were found to have greater impacts. Guerrieri et. al. [16] conducted a macro level study based on a panel of ten countries over the period 1992-2005 to investigate the determinants of ICT investment. They found changes in regulation, human capital, and sectoral composition of the economy as the relevant determinants for increasing ICT investment. Azam [2] examined the link between information and communication technologies (ICTs) and foreign direct investment (FDI) in the context of Pakistan's economic development and concluded that encouragement of FDI inflows into Pakistan shall lead to increase in ICT investments in the country.

There are a couple of studies, which have investigated the determinants of IT investments at the functional level. Sriram et. al. [36] empirically examined the relationship between purchasing related IT investments like base computer systems and support, purchasing-specific applications and vendor communications with several antecedent conditions like quality commitment, desire for internal efficiency, firm's resources and commitment, governmental influences and competitive climate and found that different types of IT investments respond in varying fashion to different antecedent conditions. In another study, Sriram & Stump [35] examined the motivations for investing in IT like quality orientation and competitive environment as well as the influence of IT on communication frequency, relationship quality, purchasing process improvements, purchasing costs, and purchasing cycle times.

To the best of our knowledge, we did not find a study, which has examined the determinants of IT investments at the firm level, though a few studies have analyzed the factors driving IT adoption at firm level. For example, Haller & Siedschlag [19] found that firms, which are larger, younger, fast growing, skill-intensive, export-intensive, and located in the capital city region are relatively more successful in ICT adoption and usage. Bayo-Moriones & Lera-Lopez [5] analysed the role played by five groups of factors: environment, structural firm characteristics, human capital, competitive strategy, and organizational structure in adoption and usage of different ICT tools.

In our study, we intend to fill the existing research gap by investigating the factors that determine the IT investment levels in Indian firms. Specifically, we examine the variables like IT capital stock, industry competitiveness, financial leverage, slack resources and sales growth of the firms as potential determinants of IT investments at the firm level. Data from 239 Indian firms over 2007-2010 period were analyzed using multiple linear regression modeling.

The rest of this article is divided into four sections. We review the literature and develop our hypotheses in the next section. The second section discusses the

data set, measures, and research model. In the last two sections, we have discussed the results and conclusion with an overview of the implications and limitations of this study.

THEORETICAL DEVELOPMENT AND HYPOTHESES

There are a few research studies, which throw a light on the firm's thought process, motivations, and rationales behind investing in IT. For example, Ravichandran et al. [33] suggest that while deciding the overall IT spending, the decision makers analyse and discuss many important factors like firm's financial conditions, IT spending of competitors, relationship with trading partners, and the firm's image as perceived by shareholders, apart from considering the economic benefits of IT spending.

In the following subsections, we discuss the various potential factors that might influence the IT investments of firms.

IT Capital

For Investments in IT, firms tend to follow a block-building approach instead of investing in IT in a bits and pieces manner. Installation of specific IT applications typically comes after the installation of base IT systems including networked PCs and general application software (for example, email client, text editor etc.). In addition, firms prefer to conduct BPR exercises as prerequisite for further digitization of internal processes before investing in related IT systems and applications. Therefore, firms might invest in IT in order to gain more from existing and related IT capability. Thus, we hypothesize:

Hypothesis 1: IT investments of Indian firms are positively associated with the existing IT capital of the firms.

Industry Competitiveness

Sometimes, firms tend to imitate the IT investment trend set by the competitors or industry as reflected in the comments made by one Chief Information Officer (CIO), "when making IT spending decision, the Chief Executive Officer (CEO) just came up with a consultant's average IT-to-revenue ratio for our industry, and then asked us to match it" [37]. Although firms often invest in IT because of competitive necessity, IT can be used by firms to achieve strategic advantage or at least maintain competitive parity. It has been recognized by past studies that firms' IT commitments can be the result of competitive pressures and strategic initiatives [3, 12]. Strategic considerations such as creating a sustainable competitive advantage through cost reduction and/or product differentiation motivate some firms to invest in IT [38, 6, 31, 32]. For example, Wal-Mart's phenomenal success relative to the other major retailers is often credited to its improved operational efficiency and reduced costs (inventory, shipping, order processing etc.) besides other reasons [21]. Some IS researchers have raised their doubts on the competitive advantage argument for IT investments and consider IT as a means to achieve and maintain competitive parity [7, 15, 23, 39]. However, whether IT is viewed as a means to create competitive advantage or considered as competitive necessity, both of these views share the argument that competitive pressures force firms to improve their cost-efficiency, agility, and responsiveness to deal with the market dynamics. Thus, we hypothesize:

Hypothesis 2: IT investments of Indian firms are positively associated with the industry competitiveness of the firms.

Firm's Resources

As pointed out by Ravichandran et.al. [33], firm's financial condition also facilitates IT investments. A firm with better debt management will be better equipped to consider their overall IT investments. In addition, availability of slack resources allows firms to deal with the problem of lacking knowledge and skills required in IT domain as they can approach consulting firms for advice [22]. Thus, we hypothesize:

Hypothesis 3: IT investments of Indian firms are negatively associated with the financial leverage of the firms.

Hypothesis 4: IT investments of Indian firms are positively associated with the availability of slack resources of the firms.

Expansion and Downsizing of Operations

In economic boom periods, new opportunities arise and most of the firms look to cash in and expand their businesses. While during economic busts, firms look to downsize and cut non-profitable and non-sustainable operations. This whole expansion and downsizing situations also impact the IT investments of the firms. Lee et al. [28] observed that investments in IT rise at an increasing rate during economic booms and fall during economic busts. Therefore, firms may choose to change their level of IT investments depending on their expansion or downsizing plans. Thus, we hypothesize:

Hypothesis 5: IT investments of Indian firms are positively associated with the sales growth of the firms.

The proposed hypotheses are displayed in the 'IT Determinants Model' depicted in figure 1.

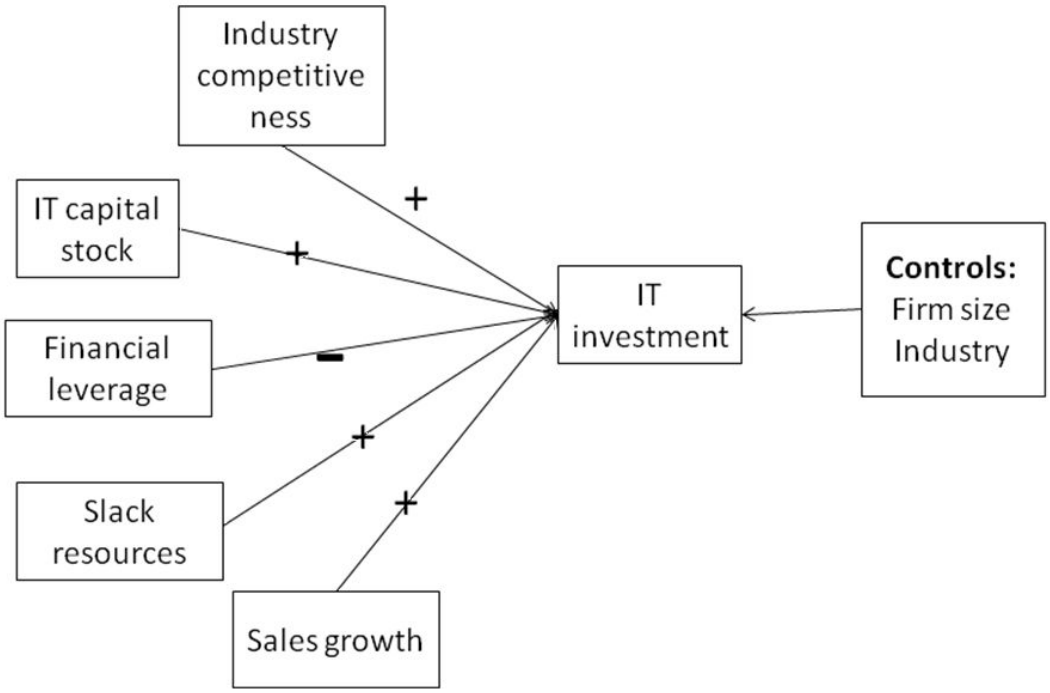

Figure 1: IT Determinants Model

METHODOLOGY

This study examines the hypothesized relationships using the data of 239 Indian firms over a period of 2007-2010. The relationships between IT investment and industry competitiveness, IT capital stock, financial leverage, slack resources and sales growth are tested using multiple linear regression model. The following subsections discuss the data collection and statistical analyses in detail.

Data Set

An archival empirical study is conducted to test the hypotheses with data covering 2007-2010. The data for the sample period are obtained from Centre for Monitoring Indian Economy Pvt. Ltd (CMIE) Prowess database. CMIE Prowess has IT investment data for more than 1500 firms for the sample period, 239 of which had complete data for all the variables in the model. The distribution of firms by industry is shown in table 1. The independent and control variables data of years 2007, 2008 and 2009 is examined for their relationship with dependent variable (IT investment) data of years 2008, 2009 and 2010 respectively.

Measures

IT investment (ITINV) and IT capital stock (ITC) variables used in this study are computed as sum of the spending related to the computers and IT systems, software, IT/ITES & other professional services by firms. Similar measures have been used for IT investment by past studies as shown in table 2.

Table 1: Distribution by industry section

NIC Code (5 digit)	Industry Section	Number of Firms in the Sample
10-15, 18, 20-30, 34 xxx	Manufacturing	72
35 xxx	Electricity, gas, steam and air conditioning supply	5
41, 42 xxx	Construction	5
46, 47 xxx	Wholesale and retail trade; repair of motor vehicles and motorcycles	24
49, 51-53 xxx	Transportation and storage	11
55 xxx	Accommodation and food service activities	3
58, 61-63 xxx	Information and communication	89
64, 66 xxx	Financial and insurance activities	9
68 xxx	Real estate activities	1
70, 71 xxx	Professional, scientific and technical activities	6
79, 82 xxx	Administrative and support service activities	4
85 xxx	Education	2
86 xxx	Human health and social work activities	5
93 xxx	Arts, entertainment and recreation	3
Total		239

Table 2: Indicators of IT Investments

Study	IT investment measure
Ho et al. [22]	Hardware, software, and costs concerning maintenance, personnel, and training
Dewan & ren [10]	All computer systems such as mainframes, peripherals, minicomputers, and PCs
Leckey et al. [27]	Investment on computers
Han et al. [20]	Capital expenditure and expensed costs on computer hardware, communications equipment, computer facilities management services, computer input preparation, data storage, computer time rental, optical scanning services, and other computer-related advice and services
Chari et al. [9]	Ratio of dollar investment in IT to sales
Aral and weill [1]	Annual IT budget as a percentage of sales
Mithas et al. [29]	Annual IT budget per employee

Financial leverage (FL) is measured by debt-to-equity ratio of firms. Similar measures have been used by past studies as a proxy for financial leverage, for example, long-term debt divided by the market value of common equity and long-term debt was used by [25]. Slack resources (SR) is measured by net cash flow from operating activities. Similar measures have been used by past studies as a proxy for slack resources, for example, cash flow from operations less capital expenditures was used by [22]. Industry competitiveness (IC) is measured by concentration ratio four (CR4) as done by [22]. Sales growth (SG) is measured as $(sales_t - sales_{t-1}) / sales_{t-1}$. Similar measure of sales growth has been used by [25].

In this study, we control for firm size, industry and time trend. Research has mainly used sales or total assets as a proxy for firm size. But sales is vulnerable to business cycles, assets is not and assets has a valuation problem and understates the importance of the services sector, sales does not. Sales and assets, therefore are complimentary measures in many ways in determining the size of a firm. Therefore, we combine both sales and assets to create a measure for firm size. Firm size (FS) is defined as

three-year average of the total income and total assets of a firm. For industry, we use first two digits of National Industrial Classification (NIC) codes to create dummy variables for industry type (IN). First two digits of NIC code define industry section. We further categorize industry sections to industry sectors- primary, secondary, tertiary and quaternary, as defined by [24]. There were no firms from primary sector in our sample. Quaternary sector is defined as the reference category because of it being the largest category in our sample data. So, in the final data, we had two industry dummies one for secondary sector (D2) and one for tertiary sector (D3). Year dummies (Y) were used to control for time trend. We created two dummies for 2008 (y2008) and 2009 (y2009) and used 2007 as the reference category.

Research Model

Proposed hypotheses are modeled as per the following equation:

$$ITINV = \beta_1 ITC_{-1} + \beta_2 IC_{-1} + \beta_3 FL_{-1} + \beta_4 SR_{-1} + \beta_5 SG_{-1} + \beta_6 FS_{-1} + \beta_7 IN + \beta_8 Y + \beta_0$$

Where β_i's are the regression coefficients, ITINV stands for IT investment, ITC is IT capital stock, IC is industry competitiveness, FL is financial leverage, SR is slack resources, SG is sales growth, FS is firm size, IN stands for industry dummies and Y stands for year dummies. The suffix '-1' represents the one year gap between data of dependent variable and independent variables.

The research model and hypotheses are tested using multiple linear regression analysis. Results are discussed in the next section.

RESULT AND DISCUSSION

The means, standard deviations, minimum values and maximum values are shown for all the continuous variables in table 3.

The data indicate that value of these variables vary considerably among firms. A correlation matrix for the variables in the model is shown in table 4.

Table 3: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ITINV	717	.17	955.33	30.5172	75.84559
ITC	717	.20	955.33	26.2572	71.35998
IC	717	.14	1.00	.5983	.21514
FL	717	.00	435.06	2.3520	23.19016
SR	717	-3102.31	9282.40	146.8604	822.54387
SG	717	-1.00	64.28	.5292	3.15583
FS	717	.79	69771.20	1236.5671	5317.57459
Valid N (listwise)	717				

Table 4: Correlation matrix for continuous variables

	ITINV	ITC	IC	FL	SR	SG	FS
ITINV	1 717						
ITC	.944** .000 717	1 717					
IC	.086* .022 717	.070 .060 717	1 717				
FL	.007 .842 717	.005 .885 717	.091* .015 717	1 717			
SR	.520** .000 717	.468** .000 717	.062 .097 717	-.010 .794 717	1 717		
SG	-.012 .744 717	-.016 .674 717	.000 .999 717	-.004 .920 717	-.016 .662 717	1 717	
FS	.511** .000 717	.471** .000 717	.095* .011 717	-.012 .749 717	.912** .000 717	-.021 .577 717	1 717

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The Pearson correlations between the variables suggest a priori that there are many significant relationships in the 'IT determinants model'. But Pearson correlations can be subject to spurious relationships. Therefore, more accurate conclusions require multiple regression analysis as discussed below. Results of multiple linear regression are shown in table 5. The ANOVA table report suggests a good model fit. Regression coefficients along with the significance statistics for each variable is displayed in table 6. Insignificant relationships have been struck through.

Table 5: ANOVA[b]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2317183.159	9	257464.795	849.519	.000[a]
	Residual	213059.071	703	303.071		
	Total	2530242.230	712			

a. Predictors: (Constant), SR, FL, SG, D2, y2009, IC, D3, y2008, ITC

b. Dependent Variable: ITINV

Table 6: Regression Results[a]

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
1 (Constant)	5.635	2.297		2.453	.014
ITC	1.117	.017	.930	65.058	.000
IC	-.828	3.076	-.003	-.269	.788
FL	.006	.028	.002	.197	.844
SG	.035	.208	.002	.171	.864
D2	-1.522	1.503	-.012	-1.012	.312
D3	-.113	1.827	-.001	-.062	.951
y2008	-1.584	1.602	-.013	-.989	.323
y2009	-7.287	1.609	-.058	-4.529	.000
SR	.003	.001	.047	3.291	.001

a. Dependent Variable: ITINV

Initial run of regression model revealed multi-collinearity between slack resources and firm size. VIF values were found to be greater than 2 for both the variables. We dropped firm size from the model to get rid of multi-collinearity. Firm size was dropped in favour of slack resources due to higher R square achieved in the model with slack resources. Table 7 shows new VIF values. VIF values for all the variables are now less than 2. Condition index values are less than 15 and Eigen values are different from 0, confirming the improvement in multi-collinearity. We also performed Durbin-Watson test to check for serial correlation of the residuals. A value of 1.923 (~2) indicates no serial correlation in the model as shown in the model summary depicted in table 8. We also checked for data points with large residuals (outliers) and/or high leverage using Cook's distance measure. We found 4 data points having Cook's distance greater than 1. These points were removed from further analysis of the model. Regression results shown in table 6 are based on 713 observations instead of original 717.

Table 7: Collinearity Diagnostics[a]

Model	Collinearity Statistics		Eigenvalue	Condition Index
	Tolerance	VIF		
1 (Constant)			3.628	1.000
ITC	.586	1.707	1.343	1.643
IC	.971	1.029	1.064	1.846
FL	.988	1.012	.993	1.912
SG	.986	1.014	.986	1.918
D2	.859	1.165	.906	2.001
D3	.864	1.157	.496	2.705
y2008	.745	1.343	.294	3.513
y2009	.740	1.351	.240	3.889
SR	.591	1.693	.050	8.477

a. Dependent Variable: ITINV

Table 8: Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.957[a]	.916	.915	17.40894	1.923

a. Predictors: (Constant), SR, FL, SG, D2, y2009, IC, D3, y2008, ITC
b. Dependent Variable: ITINV

IT capital has a significant and positive association with IT investment ($p < 0.001$) as shown in table 6. This suggests support for hypothesis 1, i.e., IT investments of Indian firms depend on their existing IT capital stock. The standardized regression coefficient for this association is 0.93, which suggests that IT capital stock explained about 86.5 % variation in IT investment. Slack resources has a significant and positive association with IT investment ($p < 0.001$). This suggests support for hypothesis 4, i.e., IT investments of Indian firms also depend on the slack resources of firms. The standardized regression coefficient for this association is 0.047, which suggests that slack resources explained about 0.2 % variation in IT investment. Therefore, most of the variation in IT investment is explained by IT capital stock. Other variables in the model such as sales growth, industry competitiveness, financial leverage are found to be insignificant and therefore, these variables do not have any influence on IT investment of Indian firms.

The shape of the histogram shown in the figure 2 follows the shape of the normal curve fairly well with mean approximately being zero and std. dev. being approximately equal to one. Therefore, error term has a normal distribution with a mean of 0 and std. dev. of 1. Research model follows the assumptions of linear regression analysis and results of this study are generalizable.

Results from the multiple linear regression analysis reveal that IT capital stock and slack resources are the two major determinants, which explain almost 92% of the variance in IT investment levels of Indian firms.

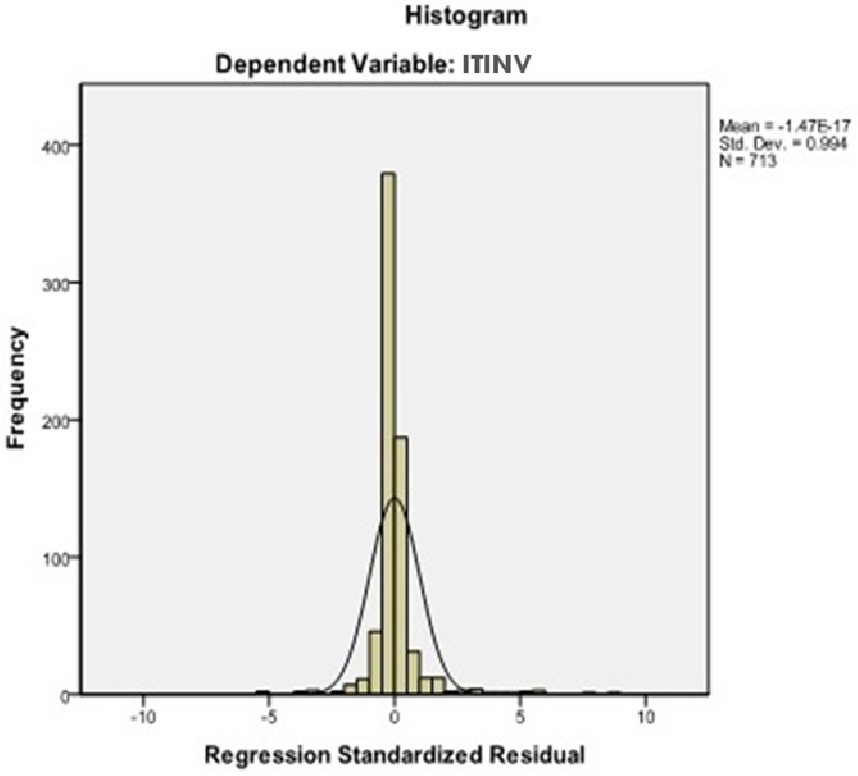

Figure 2: Histogram

CONCLUSION

In this research, we studied the factors that can be potential determinants of IT investment of Indian firms. The data of 239 Indian firms for a period of 2007-2010 were studied using multiple regression analysis. We found that IT capital stock and slack resources are the two determining factors of the level of IT investment of Indian firms. Some other factors such as sales growth, financial leverage and industry competitiveness were found to have no association with IT investment of Indian firms.

We have conducted an empirical study based on the secondary database. Therefore, this study suffers from the issues already known to be associated with a secondary database such as relevance, accuracy, availability, data mismatch, insufficient data etc. This study used data form CMIE prowess. Since the data availability of IT investment of Indian firms is limited, it resulted in a reduced sample size of 239 firms. Despite this limitation, our study has explained a significant portion of the variance in the dependent variable.

The current work is based on Indian firms and the results might be different in other country contexts. Therefore, future work can investigate the determinants of IT investment in other country contexts differing than that of India. The results of this study can be helpful to IT industry in planning their operations.

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