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Global IT Expenditure Growth: An Empirical Investigation Across Nations

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ABSTRACT

Information technology (IT) expenditures across various nations around the world have been impressive but controversial lately. Research is needed to know how IT expenditures are growing in different nations. Do developed nations show a different growth pattern than developing nations? Do stages of IT development or price drops in IT infrastructure influence such growth? We intend to explore these issues with various growth models, using data from 49 nations (constrained by data availability) over a period of time. Our preliminary results show that previous IT expenditure growth models can be improved by including the impact of price and that a price drop in IT helps keep the growth unabated. We also include prediction results from our models, to exhibit the robustness of the models considered.

Keywords

IT expenditure, diffusion, S-curve, price-adjusted model, IT budget, cross-national study

INTRODUCTION

Information technology (IT) expenditures across various nations around the world have been impressive but controversial lately. According to a U.N. report, worldwide investment in IT in general decreased by 6.2 per cent in 2002 (U.N. Report, 2002).Let us consider the U.S situation. Some reports show that IT expenditures are showing a downturn. According to International Data Corporation (IDC) (2003), small businesses plan to purchase fewer PCs, but will expand their use of the Internet, high-speed services and PC networking products. In another report, Aberdeen Group (2003) found that global IT spending will remain robust through 2005.

In the face of these conflicting findings in industry, research is needed to know how IT expenditures are growing in different nations. For example, Argentina had IT expenditures at 3.8% of its GDP in 1999, whereas the same was 8.2% for the U.S, 10.1% for Columbia and 11.9% for New Zealand (World Bank, 2003). Why does New Zealand spend more than Argentina or the U.S.? Are the people in New Zealand more IT-prone than the U.S.? It is known that the U.S. is the acknowledged leader in IT innovations. Do nations with the least IT base spend more on their IT budgets? What determines the amount a nation typically spends on its IT budget? Is price-drop a factor in IT growth? We will try to find answers to some of these questions.

IT expenditure growth over time may reflect the nation's trend of IT adoption and use and so needs to be studied in detail. The nature of the growth of the IT expenditures of a given nation may yield many insights. Whether a nation's IT expenditures are growing normally, accelerating or declining depends on the rate of growth over time as well as a nation's IT level. In order to be able to properly assess a nation's IT budget growth, the curve has to be looked at over several measurements in time. A growth curve can provide clues in detecting anomalies in growth.

S-curve growth at national Level?

Computer or IT budgets drive IT expenditures. Nolan and his colleagues in a set of articles postulated that computer budget curve growth follows an S-curve, while studying the computer budgets over a period of time of three companies (Nolan and Gibson, 1974). Per his original theory, there are four stages of development of computer resources in an organization. These are Initiation, Contagion, Control and Integration. The inflection points on this curve divided the curve into these four stages. Later, Nolan added two more stages: Data Administration and Maturity (Nolan, 1979). The theory assumes that an organization's computer budget over time will have an S-shape. Nolan thus showed a relation between computer budgets and time. However, there are several assumptions in Nolan's model that restrict its use. (Benbassat et al., 1984; King and Kraemer, 1984). In particular, what is missing from this analysis is the impact of price drops in IT products and services (Gurbaxani and Mendelson, 1990).

Some empirical studies have shown that IT budgets don't follow the S-curve, but that budgets grow exponentially or linearly in time. Lucas (1977) examined the growth of the IT budget of California counties over a period of years and came to the conclusion that pure S-curves fail to model the budget growth of various counties. A linear model or even an exponential model can explain the growth better.

However studies are lacking at a national level that deal with how nations are investing in IT, primarily because of a lack of theory and available data. The growth nature of national IT expenditures is important for research purposes for other reasons. The main study that exists at a national level is that of Gurbaxani and Mendelson's (1990) on information systems (IS) spending growth in the U.S. They argued that in most cases, IT budget growth has two components. First, IT spending growth over time has peaked and then slowed down. What keeps IT expenditure growth going is the fact that IT prices are coming down. The reason is primarily because many firms can now afford cost-effective IT-based solutions with an increasing number of IT-automated tasks.

Why consider price?

However, is price drop really significant in IT budget across all nations? The importance of price can be looked at from an economic viewpoint. As the price of one good or service (IT expenditures) decreases in relation to other goods and services, more will be demanded of the relatively lower priced good or service. Goods and services are demanded up to the point at which the marginal benefits just exceed the marginal costs. If the marginal costs are lowered in relation to other goods, more will be demanded, as a new gap will have been created between marginal benefits and costs (Samuelson and Marks, 2003).

From an operational standpoint, a chief financial officer or chief information officer would look at the return on investment (ROI) and positive net present value (NPV) of an investment in anything, including IT expenditures. The higher the ROI and positive NPV, the more attractive the investment. ROI has investment as the denominator, hence a lower cost of investment will lead to a higher ROI and more attractive investment. NPV is likewise affected by the investment, with a lower investment causing a higher NPV. Other measures of investment attractiveness such as the payback period also become more attractive as IT prices come down (Horngren et. al. 2000).

Pure diffusion models that capture growth over time may not be able to model IT expenditure growth; the impact of price needs to be considered. However, the Gurbaxani and Mendelson's price-adjusted model (1990) is based on results from only one nation (the U.S). One needs to test this theory by considering a large set of nations.

THE NATURE OF IT EXPENDITURE GROWTH

As mentioned earlier, it would be helpful to gain insight into how the IT expenditure curve of a given nation grows—is it linear or exponential in nature? Linear growth implies that growth has been flat over the years and nations are not making investments that are unusual. Exponential growth could mean a given nation is making unusually large amount of investment that calls for explanations. Can pure S-curve models explain such growth at a national level in general? If so, that will mean that growth still follows a traditional diffusion pattern and time is the most important factor in growth. Or do IT budget growth curves demonstrate a price-adjusted growth as postulated by Gurbaxani and Mendelson (Gurbaxani and Mendelson, 1990)? That would imply that price-drop may have an effect on IT budget growth across nations. The present paper attempts to resolve these questions.

Research Question 1: Are traditional growth models (S-curve) adequate to explain IT growth rates in different nations?

IT spending and IT infrastructure

Many nations with rich infrastructures are forward looking and regard IT spending as a good investment. However, nations with low infrastructures may try to spend more to play catch up. It is also true that nations with low infrastructures are usually poor nations. Poor nations, due to economic difficulties may find it hard to spend more on IT than on other essentials.

Research Question 2: Are nations with low IT infrastructures spending more on IT as a % of GDP?

MODELS AND DATA

Models

Diffusion studies try to explain and analyze patterns of diffusion of innovations, usually over time and across a population of potential adopters. A typical approach used by diffusion researchers is to define adoption as the purchase of the innovation. Observations of adoption or percentages of adoption are put in the form of a time series, and finally the time series is fitted to some functional form, such as the logistic, Gompertz, modified exponential or mixed models (Mahajan and Peterson, 1987). IT budgets, however, show a different diffusion pattern. The diffusion of many IT budget curves shows no sign of slowing down over the years. This appears to contradict the diffusion theory. One of the reasons could be a price drop in IT products. Gurbaxani and Mendelson's study (1990) on the development of IS spending curve for the U.S. shows that the cost of IT has gone down substantially over the years. Therefore, pure diffusion models that overlook the effect of price may not be able to appropriately capture the growth process of IT products in many nations.

An augmented version of diffusion models with price incorporated may act as a better analyzer and predictor of the diffusion process of IT expenditures where price drops have been substantial. It must be mentioned that there could be other indicators, such as social and institutional, that play a role in IT expenditure growth processes (Fichman, 1992; Rogers, 1981).

Previous research has relied on a number of price-adjusted diffusion models (Gurbaxani and Mendelson,1990; Mahajan and Peterson, 1987). For a price-adjusted diffusion model, assume *f(t)* denotes the cumulative adoption of an IT expenditure over a period of time *t*. The diffusion models are described below. The price-adjusted version of the diffusion model is of the form f(t)*exp(L *t), where f(t) is the cumulative adoption curve of IT expenditures of a given nation and L is the price-effect.

Among the S-curve models, the logistic model turns out as the most used one in the literature (Mahajan and Peterson, 1985). We selected this one over others. The price-adjusted S-curve model considered is a price-adjusted logistic model. Non-S curve models are linear and exponential. The formulations of various models are given below:

(1) Logistic model :Pure S-curve

$[1/\text{IT-Expenditure}(t)] = (K + A*B^t)$ (1)

Parameters to be estimated: A(>0), B (0<B<1) and K(>0). Saturation limit of adoption: 1/K

(2) Price-adjusted logistic model

$[1/\text{IT-Expenditure}(t)] = (K + A*B^t)*\exp(-L * \text{time})$ (2)

Parameters to be estimated: Same as (1) and L(>0). L denotes the price effect.

(3) Linear model:

$[\text{IT-Expenditure}(t)] = A + B*t$ (3)

Parameters to be estimated: A and B.

(4) Exponential model:

$[\text{IT-Expenditure}(t)] = b0 * (e^{b1*t})$ or

$\ln[(\text{IT-Expenditure}(t)] = \ln(b0) + (b1 * t)$ ….(4)

Parameters to be estimated: bo and b1.

The measure of goodness of fit used is R^2. The fit statistics of all models except model (3) are obtained directly from non-linear least square regression. Model (3) is evaluated directly from ordinary least square regression.

The countries were grouped using a cluster analysis based on average adoption figures of four types of information technology, measured as per 1000 population (PC, telephone, cell phone and the Internet) for years 1994 and 1995. The five clusters thus obtained can be categorized as sets of nations with IT infrastructure categorized as: very high, high, medium, low, very low. The nations falling in these clusters are shown below:

Very high IT infrastructure: Finland, Iceland, Norway, Sweden and the U.S.

High IT infrastructure:

Australia, Canada, Denmark, Hong Kong, New Zealand, Switzerland.

Medium IT infrastructure:

Austria, Belgium, France, Germany, Ireland, Japan, Netherlands, Singapore, the U.K.

Low IT infrastructure:

Czech Republic, Greece, Hungary, Italy, Korea, Malaysia, Portugal, Slovenia, Spain.

Very low IT infrastructure:

Argentina, Brazil, Bulgaria, Chile, China, Columbia, Egypt, India, Indonesia, Mexico, Philippines, Poland, Rumania, Russia, Slovak Republic, S. Africa, Thailand, Turkey, Venezuela, Vietnam.

Data

To conduct the analysis, we used data obtained from the World Bank WDI data base [1]. The IT expenditure numbers are measured as Information and communication technology expenditure per capita in U.S. dollars. The years considered in growth rate are: 1992-1999. The dollar value is adjusted using the 1996 value as the deflator. The data from 1994 and 1995 are used for the cluster analysis, as the years are in the middle range and most nations have available data for these years. The data from the year 2000 are reserved for forecasting purposes only. A comparison of IT expenditures across various nations requires data from various nations and raises several issues such as how the data were collected, how the calculation of IT spending is done in various nations. A reliable secondary data source such as the World Bank (as used in this study) may alleviate some of these concerns. It may be mentioned that the World Bank data is routinely used in macro economic and other studies. Although the data are for 49 nations, some of the results use a lesser number of nations due to data availability.

RESULTS

The results from each country are depicted in Tables 1-3. The R^2 values from all models are usually very high, indicating a good fit of the model. The R^2 values are best for the price-adjusted logistic model (Table 1). For the price-adjusted logistic model, lambda (L) values (representing the price-effect) are significant for all nations, thus showing a very good and statistically relevant fit. All other coefficients are also significant in this model. Other models, without price adjustments, as shown in Table 2 (exponential, linear and pure logistic (which is an S-curve model)) also show good fits; however, these models provide worse fits when compared to the price-adjusted logistic model. Table 3 summarizes the results and ranks the models in terms of values of R^2. The sum of absolute errors was also least for the price-adjusted model for all nations.

Country Name	R^2	K	A	B	L	Country Name	R^2	K	A	B	L
ARGENTINA	0.99988	0.002205	0.013092	0.349222	0.191365	**KOREA**	0.99947	0.001155	0.005517	0.392962	0.197676
	t-value	11.75615	31.75101	21.59906	13.41117		**t-value**	4.887856	17.85702	10.31134	5.971773
AUSTRALIA	0.99993	0.000346	0.0016	0.355016	0.190435	**MALAYSIA**	0.99964	0.002817	0.014113	0.360214	0.202182
	t-value	17.12105	38.31629	24.42745	19.54695		**t-value**	6.781721	18.04194	11.39276	8.197699
AUSTRIA	0.99968	0.0004	0.0017	0.3273	0.1868	**MEXICO**	0.99992	0.003114	0.018841	0.283132	0.162566
	t-value	10.81	15.45	10.22	11.75		**t-value**	23.56295	29.03801	22.53592	22.07183
BELGIUM	0.99982	0.00037	0.001508	0.367651	0.185365	**NETHERLANDS**	0.99992	0.00032	0.001289	0.364213	0.18599
	t-value	11.61707	26.12305	15.85268	13.09757		**t-value**	11.94088	25.55514	15.60726	13.46166
BRAZIL	0.99984	0.007793	0.033858	0.182603	0.299042	**NEW ZEALND**	0.99991	0.000385	0.001763	0.385361	0.181948
	t-value	17.95726	6.03775	4.898462	25.88577		**t-value**	13.829	42.30394	25.18876	15.58564
BULGARIA	0.99997	0.015607	0.07869	0.348203	0.189212	**NORWAY**	0.9997	0.000305	0.001069	0.356899	0.197221
	t-value	27.05242	60.98613	40.22542	30.52846		**t-value**	9.794601	17.32905	10.41672	11.55101
CANADA	0.99992	0.000343	0.001345	0.345182	0.180825	**PHILLIPPINES**	0.99973	0.103863	0.021426	2.600027	1.15513
	t-value	21.06561	34.94194	22.46083	22.78194		**t-value**	23.79352	7.027619	14.05974	12.75331
CHILE	0.99992	0.003423	0.0161	0.286662	0.228677	**POLAND**	0.99993	0.051545	0.016076	3.512667	1.572876
	t-value	20.24037	23.40076	16.72674	25.51925		**t-value**	16.03421	17.19109	10.32791	14.80897
CHINA	0.99965	0.093279	0.311165	0.327157	0.345528	**PORTUGAL**	0.99997	0.000726	0.006656	0.499979	0.124858
	t-value	5.445971	9.470768	5.212364	9.964816		**t-value**	8.980173	133.4768	134.7653	8.045177
COLUMBIA	0.99995	0.010771	0.035964	0.23783	0.302352	**RUMANIA**	0.99999	0.044175	0.180876	0.317398	0.232855
	t-value	26.0099	13.92928	10.135	39.52166		**t-value**	63.67958	91.88309	60.22398	83.6678
CZECH REPUBLIC	0.99966	0.002647	0.011161	0.37267	0.233948	**RUSSIA**	0.99987	0.008471	0.046917	0.323734	0.157551
	t-value	6.311365	17.87166	10.09517	8.756335		**t-value**	16.16134	28.11266	20.38281	15.18929
DENMARK	0.99974	0.000261	0.001041	0.363874	0.189721	**SINGPORE**	0.99979	0.000345	0.001687	0.362001	0.215253
	t-value	9.711363	20.74751	12.60426	11.13854		**t-value**	8.474942	23.30231	14.35023	10.83564
EGYPT	0.9999	0.035544	0.143538	0.311844	0.229885	**SLOVENIA**	0.99992	0.005685	0.02264	0.335964	0.23774
	t-value	17.18274	22.78683	15.14826	22.22591		**t-value**	16.14376	28.3914	17.58262	21.94422
FINLAND	0.99991	0.000366	0.001559	0.473942	0.17205	**SLOVAK REP.**	0.99987	0.002623	0.011335	0.353993	0.227223
	t-value	9.21746	61.45001	33.34334	10.80536		**t-value**	11.25426	25.74922	15.56969	14.96421
FRANCE	0.99991	0.000339	0.001392	0.352047	0.182055	**S. AFRICA**	0.99986	0.002635	0.012526	0.34455	0.189727
	t-value	10.66492	20.05432	12.74158	11.67181		**t-value**	12.99908	26.54835	17.45159	14.658
GERMANY	0.99977	0.000335	0.001447	0.349242	0.176649	**SPAIN**	0.99972	0.00089	0.002737	0.368074	0.181727
	t-value	11.32073	21.38972	13.88204	12.03405		**t-value**	11.23675	18.94539	11.04377	12.45271
GREECE	0.99992	0.000784	0.007536	0.506538	0.11704	**SWEDEN**	0.99981	0.000237	0.000739	0.369061	0.18001
	t-value	5.031945	79.04636	84.42978	4.272532		**t-value**	13.5548	23.30582	13.60175	14.90874
HONG KONG	0.99987	0.000499	0.003186	0.277606	0.23165	**SWITZERLAND**	0.99962	0.00019	0.0007	0.3517	0.1827
	t-value	12.86327	18.31555	13.81975	16.27327		**t-value**	8.5	15.91	10.16	9.77
HUNGARY	0.99996	0.003653	0.01772	0.283349	0.2293	**THAILAND**	0.9996	0.006056	0.033293	0.392283	0.153565
	t-value	26.81122	30.8153	22.23298	33.7891		**t-value**	6.324412	23.09243	14.72401	6.156135
ICELAND	0.99995	0.000598	0.002524	0.350046	0.193756	**TURKEY**	0.99988	0.009174	0.046	0.145257	0.213968
	t-value	23.55549	45.9847	29.10191	27.18541		**t-value**	35.54462	6.82434	5.970284	38.23814
INDIA	0.99994	0.415223	0.091839	2.768766	1.244824	**UK**	0.99988	0.000385	0.001355	0.356461	0.200522
	t-value	41.36964	15.93109	24.76601	25.25828		**t-value**	15.24325	27.17536	16.29554	18.23248
INDONESIA	0.99972	0.019349	0.159352	0.395462	0.131051	**US**	0.99991	0.000256	0.001156	0.328157	0.194966
	t-value	5.970292	31.61299	23.71643	5.038119		**t-value**	18.23484	29.78618	20.02621	20.76526
IRELAND	0.99994	0.000538	0.001967	0.429364	0.196062	**VENEZUELA**	0.99959	0.005644	0.020087	0.26346	0.232132
	t-value	14.37621	60.27895	29.68731	18.07977		**t-value**	11.3341	7.646744	5.55201	14.2011
ITALY	0.9999	0.000588	0.00199	0.405151	0.174099	**VIETNAM**	0.9998	0.171171	0.767865	0.338292	0.367282
	t-value	15.33743	42.50001	22.70062	16.92871		**t-value**	5.216035	14.82828	8.08815	10.12619
JAPAN	0.99984	0.00026	0.001191	0.342218	0.197788						
	t-value	12.19402	23.93372	15.58699	14.23144						

Table 1. Results from Price-adjusted Logistic Model

Forecasting errors from the price-adjusted models ranged from 9-24% for a sample of nations for a one-year period. For longer forecasts, the error rates will probably be higher. This answers research question 1 in the negative: the price-adjusted model is better suited for explaining the IT expenditure growth.

Country Name	Exponential R^2	Logistic R^2	Linear R^2	Country Name	Exponential R^2	Logistic R^2	Linear R^2
ARGENTINA	0.9213	0.9968	0.9983	KOREA	0.9662	0.9972	0.9954
AUSTRALIA	0.932	0.9962	0.9978	MALAYSIA	0.9619	0.9966	0.9974
AUSTRIA	0.931	0.9945	0.999	MEXICO	0.9263	0.9939	0.9986
BELGIUM	0.9353	0.9962	0.9982	NETHERLANDS	0.9549	0.996	0.998
BRAZIL	0.966	0.9919	0.968	NEW ZEALND	0.9592	0.9969	0.9978
BULGARIA	0.9316	0.9953	0.9935	NORWAY	0.9574	0.9956	0.9971
CANADA	0.9344	0.9953	0.9986	PHILLIPPINES	0.9655	0.9971	0.9964
CHILE	0.9411	0.9941	0.9902	POLAND	0.9784	0.9949	0.9298
CHINA	0.9684	0.9967	0.9519	PORTUGAL	0.9824	0.9996	0.9904
COLUMBIA	0.9725	0.9935	0.9588	RUMANIA	0.9623	0.9946	0.9755
CZECH REPUBLIC	0.9152	0.9967	0.9899	RUSSIA	0.9347	0.9953	0.9992
DENMARK	0.8829	0.996	0.998	SINGPORE	0.9658	0.9967	0.995
EGYPT	0.8936	0.9947	0.9883	SLOVENIA	0.9665	0.9955	0.9786
FINLAND	0.9117	0.9985	0.994	SLOVAK REPUBLIC	0.9667	0.9962	0.9883
FRANCE	0.8737	0.9957	0.9992	S. AFRICA	0.9535	0.9959	0.9984
GERMANY	0.8694	0.9957	0.9995	SPAIN	0.9544	0.9955	0.9984
GREECE	0.9383	0.9996	0.9896	SWEDEN	0.9538	0.9956	0.9983
HONG KONG	0.9584	0.9949	0.9948	SWITZERLAND	0.9321	0.9955	0.9991
HUNGARY	0.9558	0.9935	0.973	THAILAND	0.9533	0.9974	0.9961
ICELAND	0.9552	0.9957	0.9949	TURKEY	0.957	0.9846	0.9739
INDIA	0.9679	0.9962	0.9737	UK	0.9585	0.9956	0.9952
INDONESIA	0.9588	0.9985	0.9887	US	0.9515	0.9952	0.9973
IRELAND	0.9697	0.9976	0.9922	VENEZUELA	0.9566	0.9923	0.9899
ITALY	0.9581	0.9968	0.9982	VIETNAM	0.9878	0.9974	0.956
JAPAN	0.9557	0.9958	0.9975				

Table 2. Results from Linear, Exponential and Logistic Models

Models	No. of countries			
	Rank1	Rank2	Rank3	Rank4
Price-adjusted	49	0	0	0
Pure S-curve	0	26	23	0
Exponential	0	0	4	45
Linear	0	23	22	4

Table 3. Ranking in Terms of Fit

IT Infrastructure Cluster Type	**IT Infrastructure**	**Information and communication technology expenditure (% of GDP)**					
		Year 1992	Year 1993	Year 1994	Year 1995	Year 1996	Year 1997
Very high IT infrastructure Cluster	Pearson Correlation	-.871	-.600	-.583	-.515	-.290	-.368
	Sig. (2-tailed)	.129	.285	.302	.375	.636	.542
	N	4	5	5	5	5	5
High IT infrastructure Cluster	Pearson Correlation	.119	-.008	-.130	-.155	-.297	-.294
	Sig. (2-tailed)	.823	.988	.807	.769	.568	.571
	N	6	6	6	6	6	6
Medium IT infrastructure Cluster	Pearson Correlation	.860**	.846**	.720*	.761*	.728*	.713*
	Sig. (2-tailed)	.003	.004	.029	.017	.026	.031
	N	9	9	9	9	9	9
Low IT infrastructure Cluster	Pearson Correlation	-.175	-.206	.138	.176	.129	.199
	Sig. (2-tailed)	.653	.596	.723	.651	.740	.608
	N	9	9	9	9	9	9
Very low IT infrastructure Cluster	Pearson Correlation	.515*	.577**	.647**	.459*	.502*	.450
	Sig. (2-tailed)	.024	.010	.003	.048	.029	.053
	N	19	19	19	19	19	19
All nations	Pearson Correlation	.769**	.790**	.813**	.799**	.770**	.762**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	47	48	48	48	48	48

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Table 4. Correlations of IT Clusters with Yearly IT Expenditures as a % of GDP

For answering Research Question 2, we use a correlation analysis to see if there exist significant relations between IT expenditures (as a % of GDP) of various nations of a given cluster with IT base infrastructure for the years 1992-1997 (based on availability of data). The results are shown in Table 4. Nations with medium and very low infrastructures have a positive and significant correlation with IT expenditures for all years under study. However, no significant correlation of IT expenditures with infrastructure was evident for the other three clusters, thereby showing that these nation clusters spend money on IT, irrespective of their IT infrastructure status. Considering all nations, we found a significant positive correlation of IT base infrastructure with IT expenditures for all years, as shown in the last part of Table 4. This mostly yields positive answer to research question 2.

CONCLUSION

We examined IT expenditure growth, using a global perspective. This preliminary study shows that pure S-curves are not adequate to model the IT expenditure growth rate of various nations. Price has an impact on IT expenditure growth of all nations and is associated with increased growth, independent of diffusion effects. This validates the results obtained earlier by Gurbaxani and Mendelson (1990) for the IS expenditures of the U.S. The results show that price-adjusted growth curves are well suited for explaining the growth of IT expenditures of various nations. The results do not lend credence to pure stage models of IS expenditures of a nation.

It was also observed that the lower the level of IT infrastructure, the higher was the price effect on IT expenditure growth (correlation coefficient=-.284, significant at 0.05 level), i.e., developing nations (those with low IT infrastructure) are benefiting from a price drop in IT as reflected in their high IT expenditure growth. What does this tell us? Without the price drop effect, many nations would have slowed down their IT expenditures. However, price drops have helped all nations to increase deployment of IT, as IT expenditures show. Emerging economies can thus potentially gain from more IT deployment. The price drop may benefit the national economy, firms and the individual consumers. Several advantages may result from such a price-drop: it can boost productivity, economic growth and competitiveness (Stiroh, 2001). It can even promote equity and reduce the poverty level of a nation. The results show that globally, IT expenditures may continue unabated, aided by a continuing drop in IT prices.

Thus, emerging economies benefit from price drops in IT. Demand for IT expenditures rises faster for a given price level of IT in emerging economies then developed ones. Why this is true is subject to conjecture. Income and substitution affects come into play (Samuelson and Marks, 2003). With a lower price for IT goods and services, the relative prices of competing goods and services becomes higher. And with these lower IT prices comes an increased real income. Higher income drives up demand for all goods and services, including IT goods and services. Emerging economies have lower incomes and thus less ability to afford discretionary goods and services such as for IT, as opposed to for necessities. Income and substitution effects may be more pronounced in emerging economies then developed ones.

A second result showed that for some nations (with very low and medium level IT infrastructures) there is a significant positive correlation between IT infrastructure levels and IT expenditures. So the stage of IT growth of a nation may play a role in the relationship between IT infrastructure level and IT expenditures, although the relationship is not clear cut and needs more investigation. The aforementioned income and substitution effects may play a role here, as emerging economies, low IT infrastructure levels, low income levels and enhanced price and substitution effects may all converge to produce the observed results.

There are several limitations to the study. Although the price-adjusted model is a powerful tool that can analyze how IT expenditures have grown over time, we did not perform rigorous forecasting with this model. Future research may consider several other price-adjusted models and standard forecasting models. Future research may also explore the possibility of a bidirectional relationship between GDP per capita and GDP growth rate with IT expenditures. Another limitation is the measurement data the study uses is secondary in nature and like most secondary data these are susceptible to measurement errors and other research problems.

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