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Economic freedom and the impact of technology on productivity

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Chapter 1
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ABSTRACT

A well-developed body of literature has detected positive effects of technology investments on economic growth. We contribute to this literature by studying the joint effects of technology and economic freedom on economic growth. Using two different time points, 1990 and 2000, and a sample of over 100 countries, we find that economic freedom enhances the effect of technology on economic growth. In fact, we find that the standalone effect of freedom is not as large as its interactive effect with technology.

INTRODUCTION

Economic growth is considered a key indicator of national success. A country's performance and status is often determined by its level and growth in economic income. Alternative measures such as Gross National Product (GNP) or Gross Domestic Product (GDP) (levels or percent changes) are used as proxies to measure economic growth. Because of its importance, considerable research has been directed toward determining factors influencing economic growth. This literature, inspired by Solow (1956), spans half a century and hundreds of publications. A recent offshoot, appearing in the Information Systems (IS) literature, seeks to assess the effect of technology on growth. No doubt, this research has been spurred by the advent of the Internet and the digital economy. Therefore, it is no surprise that a fairly narrow definition of technology is used in most studies. The independent variable (technology) typically reflects the following three elements: computer hardware, computer software, and communications equipment. The conclusion from these studies is that technology has a positive impact on growth.

We study the impact of economic freedom on the relationship between technology and economic growth. We use a sample of more than 100 countries and use two cross-sectional snapshots during 1990 and 2000. We argue that a climate

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of economic freedom allows various entities (individuals, teams, corporations, societies) the flexibility to harness the positive effects of technology. Not only would greater investments be made in technology but these investments would also have a greater possibility of bearing fruit. Thus, we expect technology to have a greater effect on economic growth when coupled with an environment of economic freedom. We test this proposition and find results consistent with our hypothesis. We report robust results indicating a significantly positive interaction between freedom and technology. We note that it is not economic freedom per-se that affects growth but technology accompanied by economic freedom.

In the next section of the paper, we describe the two streams of literature we draw on. We present our research models along with a description of our sample in the Data and Methodology section. We report the outcomes of our statistical tests in the Results section. Then we discuss the data and results of our research findings. In the following section, we outline the contributions of our study. Finally, the limitations of the research are highlighted and we conclude in the last section.

BACKGROUND AND LITERATURE REVIEW

Technology and Economic Growth

There is a large stream of literature relating technology and economic growth (for a comprehensive review of this literature, see: Dedrick, Gurbaxani and Kraemer, 2003; Indjikian and Siegel, 2005; and Merville, Kraemer and Gurbaxani, 2004). The vast majority of this literature focuses on a particular aspect of technology, namely IT. This is a logical focus in the last two decades because of the rapid computerization of various business processes and the advent of the Internet. Due to the focus on IT, key independent variables have reflected investments in computer hardware, software, Internet and communication technologies. The empirical relationship between technology and growth is studied using various specifications. Dedrick, Gurbaxani and Kraemer (2003) categorize these studies based on the aggregation level of data: firm-level, industry-level, and country-level.

The main debate in the literature centered on whether or not technology enhanced productivity (or economic growth). The evidence from the 1980s using data from the United States of America (USA) was predominantly negative (e.g. Roach 1987; Strassman 1985). This is in contrast to the evidence from the 1990s indicating a significant and positive relationship between technology and growth (e.g., Brynjolfsson and Hitt, 1996; Jorgenson and Stiroh, 2000; Lichtenberg, 1995). The so-called 'productivity paradox' (Solow, 1987) of the earlier time period has been attributed to various reasons. Perhaps technology investments were too small to create a positive effect (Oliner and Sichel, 1994), and these investments needed to go beyond some minimum value before they could affect growth (Osei-Bryson and Ko, 2004). Perhaps there was also a learning curve associated with technology (Dedrick, Gurbaxani and Kraemer, 2003). Additionally, the literature has suggested that other factors contributing to organizational performance may have been omitted in evaluating IT impacts (Devaraj and Kohli, 2000). For example, studies have suggested that organizational factors (e.g. type of IT, management and workplace practices, changes initiatives, the organizational structure and culture, and financial conditions), the competitive environment (e.g. industry competitiveness and regulation), and macro environment (e.g. level of development, public policies, cultural factors, education, IT infrastructure) are important factors influencing the extent of IT business value (Merville, Kraemer and Gurbaxani, 2004). Finally, the benefits of IT may expand beyond the frontiers of the company initiating the IT investments. Thus, part of these benefits may be captured by business partners

or the end customers (Bresnahan, 1986; Hitt and Brynjolfsson, 1996).

Since country level studies are especially pertinent to our research, we list some of the key studies using country level data in the table in Appendix A. This table is obtained from Dedrick, Gurbaxani, and Kraemer (2003) and has been modified to include some more recent studies. This literature can be characterized as follows: Most studies are of recent vintage (mid-1990s onward); most use univariate tests associating technology investments with economic growth and focus on developed countries. The link between technology and economic growth is significant and positive in developed countries and newly developed economies (e.g., Daveri, 2000; Lee, Gholami, and Tong, 2005; Oliner and Sichel, 2000; Pook and Pence, 2004). However, this link is not significant in developing countries as shown by most prior studies (e.g., Dewan and Kraemer, 2000; Lee, Gholami, and Tong, 2005).

The latter finding ties-in with the results from the 1980s: it appears that a certain threshold of investments is required or perhaps a certain level of infrastructure is needed before a clear link between technology and growth can be detected in developing countries. Complementary factors can modify the impact of technology on growth. This is the main issue considered in our paper. At the firm-level such crucial factors may include complementary investments such as workforce training (Dedrick, Gurbaxani and Kraemer, 2003). At the country level, environmental factors may play a big role. For instance, Shih, Kraemer and Dedrick (2007) show that environmental factors (openness to trade) can affect the level of technological investments. Other authors such as Mbarika, Byrd, and Raymond (2002) have suggested that macro-level factors including policy, economical, financial, technological, political, and geographical factors are key determinants of the level of IT/telecommunications infrastructure growth, thus economic growth, in Least Developed Countries (LDC). The current study builds on this recent work. However, our focus is on how economic freedom, as an environmental factor, affects the impact of technology on growth.

Our study is related to Meso, Datta, and Mbarika (2006) and Meso, Musa, Straub and Mbarika (2009). These studies examined the link between IT, governance and economic growth. The Meso, Datta and Mbarika (2006) study is especially relevant because it examines the modifying effects of governance variables on the relationship between economic growth and IT and reports an interaction effect for certain governance-related variables such as 'Voice/Accountability' and 'Rule of Law'. The more recent Meso, Musa, Straub and Mbarika (2009) study uses structural equations modeling techniques to examine similar issues and reports statistically significant links between IT and governance and between IT and socio-economic development. However, there are important differences between our research and these two studies. Our study uses different dependent and independent variables as well as data from different time periods. More significantly, our focus is on economic freedom, not governance. Thus, our approach is different and complementary.

Finally, the literature on foreign direct investment (FDI) and its effects on economic growth offers an interesting parallel to the literature on technology and growth. The connection is evident when one realizes that FDI often involves the transfer of technology and knowledge capital by MNCs. Azman-Saini, Baharumshah and Law (2010) study the nexus between FDI, freedom and growth and find that the effect of FDI on growth is contingent on the level of economic freedom in host countries. The explanations they offer—that an environment of freedom allows entrepreneurs/firms to take risks and to try new ideas and to deploy labor flexibly and generate positive spillovers—are easily adaptable to a discussion on technology and growth.

Economic Freedom and Economic Growth

While our study contributes to the literature linking technology to growth, it is influenced by a long literature stream linking freedom and growth. This literature stream dates back to the 'growth' literature in mainstream economics (e.g., Solow, 1956). There are multiple approaches to explaining national economic growth. Perhaps the most intuitive approach is the production function approach that relates output to inputs such as labor and capital. Technology may be considered a modifier of this relationship. Economic freedom could be another modifying factor.

Economic freedom refers to the degree to which a market economy exists. Components of economic freedom are: an environment favoring a voluntary exchange, free competition, protection of persons and property, and a limited degree of interventionism in the form of government ownership, regulations, and taxes (Gwartney and Lawson, 2002; Berggren, 2003). One should distinguish economic freedom from both civil and political freedoms. Civil freedom includes such elements as the freedom of the press, the freedom of association, the freedom of religion, and the freedom of speech whereas political freedom involves the free and open participation in the political process, and elections that are free, fair, competitive and corruption-free (Gwartney and Lawson, 2002). While civil and political freedoms may allow societies to express themselves fully, economic freedom has the potential to directly affect economic activity. Historic events such as the breakup of the former Soviet Union have focused attention on this important issue. We focus on economic freedom rather than political freedom because we are more interested in the policies that directly affect economic productivity.

Various studies have examined the cross-section of country level data to determine whether economic growth is correlated with indicators of economic freedom. Overall, studies have found that the level of economic freedom exerts a positive and significant effect on economic growth (Goldsmith, 1997; Ali and Crain, 2002; Vega-Gordillo and Alvarez-Arce, 2003). A number of studies that have used changes in economic freedom (as opposed to the level of economic freedom) as an independent variable have concluded that the change in economic freedom is also positively and significantly correlated to growth rate (Dawson, 1998; Gwartney, Holcombe, and Lawson, 2004).

It is conceivable that not all dimensions of economic freedom impact economic growth. The index of economic freedom used in most studies (e.g., Gwartney and Lawson, 2002) covers various aspects of freedom such as size of government, legal structure and property rights, access to sound money, freedom of exchange and regulation of business. Carlsson and Lundstrom (2002) decompose the various aspects of economic freedom and find that the most significant effects are associated with legal structure and freedom of exchange. These results, especially those pertaining to legal structure, are an excellent complement to the well-known 'law and finance' literature where a key result is that country level investor protection enhances corporate value (La porta, Lopez-De-Silanes, Shleifer, and Vishny, 2002). More recently, studies have focused on the effect of government size (usually measured using government expenditures or revenues) on growth and carried out robustness tests: an example is Bergh and Karlsson (2010) that reports a negative relationship between government expenditure and growth even after controlling for the overall level of economic freedom and globalization.

While most of the studies on economic freedom focus on its effects on economic growth (typically measured using GDP), a small stream examines the effects on freedom on entrepreneurial activity. Studies in this genre report a negative relationship between government size and entrepreneurial activity (e.g., self-employment). Bjornskov and Foss (2008) and Nystrom (2008) are examples of studies reporting this negative relationship. The

Table 1. The ArCo Indicator

Creation of Technology	Technology Infrastructure	Development of Human Skills
• Patents • Scientific Articles	• Internet Penetration • Telephone Penetration • Electricity Consumption	• Tertiary Science and Engineering Enrolment • Mean Years of Schooling • Literacy Rate

first named study offers a systematic discussion of why economic freedom can be expected to affect entrepreneurial activity. If a government's size is particularly large, say it has nationalized a certain industry, a consequence is that there is no scope for entrepreneurial activity. More generally, the heavy hand of the government (high taxes, regulations, incentive-distorting pricing/ subsidies) can deter entrepreneurial activity. Although we do not study entrepreneurship in our paper, the preceding ideas have relevance: just as the benefits of entrepreneurial activity are better reaped in an environment of economic freedom, the benefits of technology are better harvested in an environment of economic freedom.

DATA AND METHODOLOGY

The dependent variable in our study is GDP per worker adjusted for purchasing power parity and expressed in the US currency (Prod2000 and Prod1990). We use this as a proxy for economic growth and refer to it as 'productivity.' We collected values for this variable for the years 1990 and 2000 from the Global Market Information Database issued by Euromonitor International. The database covers 205 nations from 1977 to 2006. We use GDP per worker while other similar studies used GDP per capita. We believe that GDP per capita can potentially be affected by factors such as demographic shifts and employment levels. For example, if a country has a large percent of retired individuals, its GDP per capita will be low because fewer people are working.

Our independent variables are technology and economic freedom. Our measure of technology is the Indicator of Technological Capabilities for Developed and Developing Countries (Tech2000 and Tech1990). The indicator was compiled by Archibugi and Coco (2004). Values range from 0 (lowest capability) to 1 (highest capability). We use this index because it comprehensively covers most of the countries in the world with a ranking of 162 countries in 1990 and 2000. It is one of the most widely used and detailed indexes. Furthermore, the authors use publicly available data and explain their methodology very clearly. The scale has three major dimensions and eight sub-Indexes of the Indicator of Technological Capabilities for Developed and Developing Countries which are listed in Table 1.

Our economic freedom variable is the Economic Freedom of the World (EFW) indicator by Gwartney and Lawson (2002) from the Cato Institute (Free2000 and Free1990). The EFW index has been compiled since 1970 and the data is publicly available at www.freetheworld.com. The EFW for a country is measured on a ten point scale with 10 denoting the highest level of economic freedom. EFW contains five major areas: Size of government, legal structure and property rights, sound money policies, freedom to exchange, and business regulations. Each major area has several components explained in Appendix B. We use this index because it comprehensively covers most of the countries in the world with information on 123 countries in 2000 and 113 in 1990. It is also one of the most widely recognized and detailed indexes of economic freedom. The index has been stable over time and has been used in several published papers (Cole, 2003; Heitger, 2004; Mbaku, 2003; Vega-Gordillo and Alvarez-Arce, 2003).

Table 2. Descriptive Statistics. This table reports descriptive statistics for the technology, freedom and productivity variables. These variables are obtained from two different time points: 2000 and 1990

Variable	N	Min	Max	Median	Mean	Sigma
Tech2000	162	.028	.867	.313	.329	.190
Free2000	123	3.500	8.700	6.500	6.399	1.066
Prod2000	166	183	105,064	3,978	13,273	19,377
Tech1990	162	.017	.735	.277	.278	.164
Free1990	114	1.300	9.300	5.350	5.632	1.743
Prod1990	156	193	67,100	3,138	10,902	15,664

Our main analysis uses data from the year 2000 and hence uses Tech2000 (Technology 2000), Free2000 (Economic Freedom 2000), and Prod2000 (Productivity 2000) respectively. Similarly, our robustness tests use data from 1990: Tech1990, Free1990, and Prod1990.

We performed linear regression analyses on the above data. Four models (A-D) are used as follows.

Model A: $Prod\ 2000 = \beta_0 + \beta_1 Tech2000$

Model B: $Prod\ 2000 = \beta_0 + \beta_1 Free2000$

Model C: $Prod\ 2000 = \beta_0 + \beta_1 Tech2000 + \beta_2 Free2000$

Model D: $Prod\ 2000 = \beta_0 + \beta_1 Tech2000 + \beta_2 Free2000 + \beta_3 Tech*Free$

Model A is the basic model relating productivity to technology that has been extensively studied in the literature. Model B is the basic model relating productivity to freedom; this model is once again fairly well researched. The focus of our paper is on models C and D. Model C assesses the separate effects of both technology and freedom on productivity. Model D adds further complexity by also considering the interaction between technology and freedom in their impact on productivity. Here, the variable *Tech*Free* is defined as the product of *Tech2000 (or Tech1990)* and a 0/1 dummy variable assuming the value of 1 when *Free2000 (or Free1990)* is median or higher, and 0 otherwise. Models C and D, to the best of our knowledge, are not found in the literature.

Similar models were applied to data from 1990. The interaction variable, although using the same label as with data from 2000 in the interest of shortening the label, is defined using data from 1990. The purpose of using data from 1990 is two-fold: (a) to provide a test of robustness and (b) to search for shifts in productivity relationships.

RESULTS

Descriptive Statistics and Correlations

Table 2 reports descriptive statistics on the three key variables: technology, freedom and productivity. We focus first on the most recent values, from 2000. Tech2000 ranges from 0.028 to 0.867, and has a mean and median of 0.329 and 0.313 respectively. Free2000 ranges from 3.5 to 8.7 with mean and median values of 6.399 and 6.5 respectively. Prod2000 ranges in value from 183 to 105,064 and has a mean and median of 13,273 and 3,978 respectively. We note the presence of skewness in Prod2000: this is caused by a few countries having extremely high values thereby increasing the mean. Finally, we note that values of all three variables are higher in the latter time period (2000).

Table 3. Correlations. This table reports correlations and p-values

	Tech2000	Free2000	Prod2000	Tech1990	Free1990
Free2000	.691 <.0001				
Prod2000	.772 <.0001	.694 <.0001			
Tech1990	.982 <.0001	.650 <.0001	.727 <.0001		
Free1990	.703 <.0001	.794 <.0001	.758 <.0001	.664 <.0001	
Prod1990	.816 <.0001	.665 <.0001	.961 <.0001	.775 <.0001	.740 <.0001

Table 3 reports correlations between model variables. We note significant correlations between each of the independent variables (technology and freedom) and the dependent variable (productivity). We note that the correlation between Tech2000 and Prod2000 is 0.772, and that the correlation between Free2000 and Prod2000 is 0.694. These values are significant at the 1% level. We note a similar pattern with 1990 values with analogous values of 0.775 and 0.740 respectively.

Table 3 also indicates a strong relationship between technology and freedom. Higher technology investments appear to be associated with higher levels of freedom. For instance, the correlation between Tech2000 and Free2000 is 0.691 and significant at the 1% level. A practical concern is that the high correlation creates problems of multi-collinearity in the regression tests noted below.

Finally, in Table 3, we note that productivity in the year 2000 is significantly related to technology and freedom values in 1990.

Regression Analysis and Models of Productivity

Table 4 reports the main results of the study. All models are statistically significant: the F-statistics for all models have p-values (not reported) of less than 1%. Model A is a regression of Prod2000 on Tech2000. Consistent with results reported in the literature, we find high R-squares (0.6416) as well as a significant coefficient for Tech2000 (t-statistic of 14.45). We also find strong results with Model B that uses Free2000 as the independent variable: the coefficient has a t-statistic of 10.44. However, the R-square of Model B is lower. Model C uses Tech2000 as well as Free2000 as independent variables. Here both coefficients are significant (t-statistics of 8.36 and 3.64 respectively) but the R-square for model C is only slightly higher than the R-square for model A.

Table 4 Model D indicates another interesting result. Here we test for the explanatory value of an interacting variable. Tech*Free is the product of Tech2000 and dummy variable indicating whether Free2000 is above its median value. The coefficient of Tech*Free is significantly positive with a t-statistic of 2.71. In contrast, the coefficient for Free2000 is insignificant with a t-statistic of 1.12.

Tests of Robustness

We repeat tests using data from 1990. In addition to providing another set of data for verifying robustness of results, data from 1990, when compared to 2000, have the potential to reveal trends in how productivity is determined. Table 5

Table 4. Regression Analysis Using Data from 2000, All Countries.

	Dependent Variable: Prod2000			
	(A)	(B)	(C)	(D)
Intercept	-15898 -6.37 <.0001	-74165 -8.48 <.0001	-43146 -5.50 <.0001	-21675 -1.97 0.0512
Tech2000	87530 14.45 <.0001		67147 8.36 <.0001	48624 4.69 <.0001
Free2000		14030 10.44 <.0001	5397 3.64 .0004	2113 1.12 0.2642
Tech*Free				26254 2.71 0.0077
N	117	117	117	117
F	208.66	108.97	122.10	88.39
Adj. R^2	.6416	.4821	.6762	.6933

For each regressor identified in the first column, we report the coefficient, t-statistic and p-value.

is analogous to Table 4 but uses data from 1990. The results for the overall sample found in Table 5 confirm the results of Table 4. Overall, we find a great deal of consistency between the results using 1990 and 2000.

DISCUSSION OF DATA AND RESULTS

Before turning to our main results, we note a few patterns in the key independent variables. First, values of technology as well as economic freedom are higher in 2000 compared to 1990. The rapid evolution of electronic commerce in the second half of the 90's resulted in its adoption by organizations and the general population worldwide. As a consequence, various investments were made in IT infrastructure in general and Internet technologies in particular, mainly in developed countries but also in LDC. These investments may explain why the technology variable has a higher score in 2000. Other explanations for the high value of technology in 2000 include Y2K related IT investments and deregulation. As with technology, economic freedom is also higher in 2000. A plausible explanation may be the sweeping political changes across the world (e.g., dismantling of the Soviet Union); the resulting political freedom may have led to economic freedom. An alternative explanation for higher values of economic freedom is the success of global institutions such as the WTO in instilling values of economic freedom and prosperity. Second, we find a significant correlation between the technology and freedom variables. Although possible, we do not assume or infer a causal relationship between these two variables. It is possible that the high correlation between technology and freedom is caused by the effect of other variables (e.g., education levels) not studied in this research. Third, consistent with expectations conditional on higher values of technology and freedom, the value for productivity is higher in 2000 compared to 1990. The higher value of productivity supports suggestions in the literature (Dedrick, Gurbaxani and Kraemer, 2003) concerning (a) lagged effects of IT and (b) the IT learning curve. Our data suggest that the gain in

Table 5. Regression Analysis Using Data from 1990

	Dependent Variable: Prod1990			
	(A)	**(B)**	**(C)**	**(D)**
Intercept	-12088 -6.37 <.0001	-29126 -7.42 <.0001	-24387 -8.27 <.0001	-11918 -2.41 .0179
Tech1990	85604 15.49 <.0001		62804 9.41 <.0001	47992 5.98 <.0001
Free1990		7547 11.33 <.0001	3386 5.11 <.0001	943 0.93 .3566
Tech*Free				29520 3.07 .0027
N	108	108	108	108
F	239.97	128.46	161.55	119.50
Adj. R^2	.6907	.5436	.7501	.7687

For each regressor identified in the first column, we report the coefficient, t-statistic and p-value.

productivity observed in 2000 may be attributable in part to IT investments made by corporations as well as governments in the 90s to embrace e-commerce and to face the Y2K issue.

In this part of the paper, we discuss the results of our research models. We replicate and confirm fundamental results relating productivity to technology and economic freedom. We find significant relationships between technology and productivity as well as between freedom and productivity. These results arise from long literature streams in the IS and economics fields respectively. We report correlations as well as regression coefficients consistent with these prior results in Tables 3 and 4 respectively. What is perhaps novel about our results is the use of a more comprehensive variable for technology, the ArCo variable. Also, we are able to compare the relative importance of technology and economic freedom as influencers of productivity. We find that technology is a more important variable. In Table 4, model A (using technology as the independent variable) has a higher R-squares than model B (using economic freedom). We confirm this result with 1990 as well as 2000 data. The relative importance of technology is also confirmed with model C where both technology and economic freedom are used as independent variables: we note a marginally higher R-squares compared to model A. Thus, the addition of freedom in model C as an explanatory variable does not appear to add much beyond the use of technology.

A key result of our study is that freedom modifies the effect of technology on productivity. Model D adds the interaction variable indicating how freedom modifies the effect of technology on productivity. We note that this variable has a significantly positive coefficient of 26,254 with a t-statistic of 2.71; this indicates that countries with higher levels of freedom have a greater link between technology and productivity. Since the coefficient of Tech2000 is 48,624 (Table 4), we note that the response coefficient (productivity related to technology) for high freedom countries is 54% (54% = 26,254/48,624) greater than the figure for low freedom countries. Our robust-

ness test using data from 1990 displays an even greater response coefficient for high freedom countries. This is consistent with Gompert (1998) who argues that there is synergy between IT and economic freedom. Arguably, the marginal effect of IT investments is greater when companies in a country have the freedom to creatively obtain value from it. Freedom appears to influence productivity through technology. Interestingly, when the interactive variable is added in model D, economic freedom as a stand-alone variable is no longer significant. We know of no other study indicating these results.

CONTRIBUTIONS OF THE STUDY

Our study contributes to the IS literature in two ways. First, we build on recent efforts by Archibugi and Coco (2004; 2005) to measure the technological capability of a country. We use the ArCo index compiled by these authors to more comprehensively measure the technological prowess of a country. Although the ArCo index and the more traditional IT measurements are highly correlated, we feel that our study allows us to make broader inferences about technology. Second, and perhaps more importantly, we assess the impact of economic freedom, particularly as a variable that modifies the effect of technology on growth. We draw on and complement the research stream (predominantly in economics) that uses country level data to examine the link between economic freedom and economic growth.

Our results can be understood at two levels: country level and firm level. Our tests use country level data, so the main inferences are at the country level. However, with appropriate assumptions, we can also obtain inferences at the firm level. Below, we explore these two issues. At the country level, the main implication is that policy makers should pay attention to the economic freedom infrastructure. As our empirical variable indicates, the extent of economic freedom in a country depends on: (a) size of government (b) property rights (c) sound money (d) trade barriers and (e) regulatory barriers. By taking the proper steps to create and shore up the institutions supporting these variables (e.g., an independent central bank is necessary for sound money), the conditions can be created not only for technology investments but also for bearing the fruits of such investment. We realize that politics, tradition and culture have a large role to play in this regard. It might be argued that historical factors concerning its societal and political landscape may predestine a country. Nevertheless, most governments, especially in democratic countries, are held accountable for economic growth. Therefore, government officials should know that it is in their own best interests to build up the economic freedom infrastructure. Our results do not just speak to government officials. Concerned and influential citizens of a country can use our results to lobby for greater economic freedom by articulating why it is useful. For instance, entities such as Chambers of Commerce could be interested in our results. Such activism may be especially valuable in developing countries where it may not just be an issue of shoring up institutions: the relevant task is the much more difficult one of actually creating these institutions. Our results have also some implications for international organizations such as the United Nations agencies that are promoting IT investments in developing countries. In order to make their actions more effective, these organizations should collaborate with governments in developing countries to put into place and strengthen institutions supporting economic freedom. Such an environment will create favorable conditions to attract more IT investments as well to maximize economic growth resulting from these investments.

We now turn to firm level implications. This is the age of global corporations. A typical large corporation headquartered in the USA or in an OECD country has operations in many foreign countries. Our results suggest that a firm's

technology investment strategy should take into consideration the location of the investment. Specifically, technological investments should flow toward locations (countries) with greater economic freedom. It is possible that this strategy would produce better financial results (profits) for the corporation. We realize that our data are not firm-level and that our independent variable is growth and not profit. This calls for caution in making firm-level inferences.

RESEARCH LIMITATIONS

The current research has the following limitations. Because we rely on cross-sectional associations, we cannot make strong statements about causality. Furthermore, our research design could be subject to the problem of correlated omitted variables. Nevertheless, our results are reasonable and consistent with expectations. Another limitation of this study concerns the data analysis technique. Instead of using regression analysis, we could have adopted different data analysis techniques such as structural equations modeling. Additionally, this study relies on data collected in 1990 and 2000. Using data from different periods may have yielded different results. Finally, our focus in the current study is economic freedom only. We realize that political freedom and economic freedom may be synergistic, especially in developing countries. Nobel laureate Becker (2007) notes that "private property and open markets help economies grow, which gives the political process a strong shove toward democracy." Other potential explanatory variables are geography and culture.

CONCLUSION

Computerization and the Internet have changed the world dramatically during the last few decades. This has spurred interest in determining whether IT in particular and technology in general has a positive economic impact. A major concern has been whether nations experience economic growth as a consequence of investments in technology. A well-developed stream of research has addressed this issue. We contribute to this stream by exploring the role played by economic freedom in the relationship between technology and growth. Our principal finding is that technology creates economic growth to a greater extent in countries with higher levels of economic freedom.

We also validate the important role played by technology in creating economic growth. While both technology and economic freedom produce economic growth, we find that technology is the more dominant factor. Economic freedom does affect growth, but this effect is primarily through its interaction with technology.

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ENDNOTE

GCR = *Global Competitiveness Report*;
ICRG = *International Country Risk Guide*

APPENDIX A

Table 5. Studies on IT Investment Implications at the Country Level

Study	Data sample	Independent Variables & Operationalization	Dependent variables & Operationalization	IT Investment and Economic Growth
Daveri (2000)	18 OECD and European Union (EU) countries	• IT: *Hardware, Software, Communications equipment* • Other Capital • Labor hours • Multifactor productivity	GDP growth	IT added to GDP growth in the 1990s for all countries studied, but the contribution in EU countries was smaller in 1992–1997 than in other industrialized countries. Within the European Union, differences in IT contribution to growth were also due to lower IT investment.
Dewan & Kraemer (2000)	36 Countries 1985-1993	• IT capital stock including Computer Hardware asset, data communication asset, software asset, and services asset • Non-IT capital stock • Annual labor hours employed	GDP Growth	A positive and significant relationship between IT capital investments and labor productivity was found in developed countries but not in developing countries.
Jorgenson (2001)	USA	• IT: *Hardware, Software, Communication equipment* • Non-IT capital • Labor hours • Labor quality	GDP Growth	IT investment contributed more than one half of the 1 percent increase in economic growth since 1995. About one half the productivity growth since 1995 has occurred in the IT-producing sector but growth has occurred in IT-using industries as well.
Jorgenson and Stiroh (2000)	USA	• IT Investments: *Computer hardware, Computer software, Communication equipment* • Other Capital • Labor hours • Labor quality • Multifactor productivity	Productivity growth	IT investment contributed one half of GDP and labor productivity growth between 1995–1999 and contributed moderately during earlier periods. IT contributes to productivity in the IT-using *and*-producing sector.
Lee, Gholami, and Tong (2005)	20 developed and developing countries 1980-2000	• Labor: *As measured by the World Development Indicators (WDI)* • Capital: *As measured by the World Development Indicators (WDI)* • ICT investments: *The International Telecomunication Union's (ITU) annual telecommunications investments were used as a proxy for ICT investment.*	Economic growth as measured by the GDP.	ICT contributes to economic growth in developed countries and newly industrialized economies, but not in developing countries. Developed countries are able to gain positive and significant returns from ICT because they have invested in these technologies over a long period, and they have accumulated a substantial installed base and complementary investments in telecommunications. This is not the case in developing countries.

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Table 5. continued

Study	Data sample	Independent Variables & Operationalization	Dependent variables & Operationalization	IT Investment and Economic Growth
Meso, Datta, and Mbarika (2005)	104 Countries	• ICT: *Operationalized as a combination of broadcasting ICT and interactive ICT: Broadcasting ICT measured as the summated effects of the average newspaper circulation density, radio ownership density, and television ownership density (per 1000 people) between 1997 and 2001; Interactive ICT infrastructure measured as the summation of average computer ownership, telephone density, and Internet acesss (per 1000 people) between 1997 and 2001.* • Governance: *Measured with six aggregated indices: Voice ad accountability; Political stability and absence of violence; Government effectiveness; Regulatory quality; Rule of law; Control of corruption.*	• Social Development: *Operationalized using a summation of two indices: Average rate of change in life expectancy Literacy between 1997 and 2001; Literacy between 1997 and 2001.* • Economic Development: *Measured as the average change in GDP between 1997 and 2001*	Contributions of ICTs to social and economic development in developing countries are influenced by socio-political governance. Governance is perceived as exerting a contingent (moderating) role on ICTs and national development in developing countries.
Oliner and Sichel (1994)	USA	• IT: *Computer equipment* • Other Capital • Labor hours • Multifactor productivity	Productivity growth	IT investment too small to have substantial economic growth. IT associated with 0.16–0.28 percent additional effects.
Oliner and Sichel (2000)	USA	• IT capital: *Computer hardware, Computer software, Communication equipment* • Other Capital • Labor hours • Labor quality • Multifactor productivity	Productivity growth	The contribution to productivity growth from the *use* of information technology — including computer hardware, software, and communication equipment — surged in the second half of the 1990s. In addition, technological advance in the *production* of computers appears to have contributed importantly to the speed-up in productivity growth between the first and second halves of the 90's.
Yoo (2003)	56 developing countries 1970-1998	• Physical capital: *Average of annual ratios of real domestic investment to real GDP as measured by the World Bank* • Human capital: *Average of percentage of the working-age population that is in secondary school as measured by UNESCO* • IT capital: *Average of annual ratios of gross domestic IT investment to nominal GDP as measured by the International Telecommunications Union*	GDP per person of working age as measured by the World Bank	IT investment has a significant impact on the level of GDP per capita in developing countries.

This table is obtained from Dedrick, Gurbaxani, and Kraemer (2003) and has been modified toinclude some more recent studies.

APPENDIX B

Areas and Components of the Economic Freedom of the World Index

1. Size of Government: Expenditures, Taxes, and Enterprises

A. General government consumption spending as a percentage of total consumption
B. Transfers and subsidies as a percentage of GDP
C. Government enterprises and investment as a percentage of GDP
D. Top marginal tax rate (and income threshold to which it applies)

2. Legal Structure and Security of Property Rights

A. Judicial independence: The judiciary is independent and not subject to interference by the government or parties in disputes (GCR)
B. Impartial courts: A trusted legal framework exists for private businesses to challenge the legality of government actions or regulation (GCR)
C. Protection of intellectual property (GCR)
D. Military interference in rule of law and the political process (ICRG)
E. Integrity of the legal system (ICRG)

3. Access to Sound Money

A. Average annual growth of the money supply in the last five years minus average annual growth of real GDP in the last ten years
B. Standard inflation variability in the last five years
C. Recent inflation rate
D. Freedom to own foreign currency bank accounts domestically and abroad

4. Freedom to Exchange with Foreigners

A. Taxes on international trade
   - Revenue from taxes on international trade as a percentage of exports plus imports
   - Mean tariff rate
   - Standard deviation of tariff rates
B. Regulatory trade barriers.
   - Hidden import barriers: No barriers other than published tariffs and quotas (GCR)
   - Costs of importing: The combined effect of import tariffs, license fees, bank fees, and the time required for administrative red-tape raises costs of importing equipment by (10 = 10% or less; 0 = more than 50%) (GCR)
C. Actual size of trade sector compared to expected size.
D. Difference between official exchange rate and black market rate

E. International capital market controls
   - i Access of citizens to foreign capital markets and foreign access to domestic capital markets (GCR)
   - ii Restrictions on the freedom of citizens to engage in capital market exchange with foreigners - index of capital controls among 13 IMF categories.

5. Regulation of Credit, Labor, and Business

A. Credit Market Regulations
   - Ownership of banks: Percentage of deposits held in privately owned banks
   - Competition: Domestic banks face competition from foreign banks (GCR)
   - Extension of credit: Percentage of credit extended to private sector
   - Avoidance of interest rate controls and regulations that lead to negative real interest rates
   - Interest rate controls: Interest rate controls on bank deposits and/or loans are freely determined by the market (GCR)

B. Labor Market Regulations
   - Impact of minimum wage: The minimum wage, set by law, has little impact on wages because it is too low or not obeyed (GCR)
   - Hiring and firing practices: Hiring and firing practices of companies are determined by private contract (GCR)
   - Share of labor force whose wages are set by centralized collective bargaining (GCR)
   - Unemployment Benefits: The unemployment benefits system preserves the incentive to work (GCR)
   - Use of conscripts to obtain military personnel

C. Business Regulations
   - Price controls: Extent to which businesses are free to set their own prices
   - Administrative conditions and new businesses: Administrative procedures are an important obstacle to starting a new business (GCR)
   - Time with government bureaucracy: Senior management spends a substantial amount of time dealing with government bureaucracy (GCR)
   - Starting a new business: Starting a new business is generally easy (GCR)
   - Irregular payments: Irregular, additional payments connected with import and export permits, business licenses, exchange controls, tax assessments, police protection, or loan applications are very rare (GCR)