Measurement and analysis of capital, productivity and economic growth

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Chapter 6

Ultimate Sources of Growth: The Role of Culture in ICT Adoption*

6.1 Introduction

So far this thesis has mainly dealt with two major issues. First, we dealt with a range of issues regarding the measurement of capital input; and, second, we studied the role of capital accumulation and MFP in explaining cross-country differences in economic growth. As discussed in the introduction, factor accumulation and technology are only proximate causes of cross-country differences in economic growth. It is important to know why some countries innovate more and are better in adopting technologies or accumulate capital faster than others. In this chapter, we delve into some deeper, ultimate, causes of cross-country differences that will shed some light on this issue.

The rate at which new technologies are adopted and incorporated into the productive process, i.e. the adoption or diffusion[1], differs across countries (Rosenberg, 1972; Maddison, 1982; Abramovitz, 1986; Rogers, 1995). Some countries adopt technologies faster than others. Such countries will achieve faster economic growth.[2] The economic factors behind these differences in technology diffusion have been subjected to considerable research (Griliches, 1957, 1992; Mansfield, 1963; Rosenberg, 1972)[3]. Empirical studies have highlighted, *inter alia*, the roles of adoption costs (prices), degree of openness to trade, human capital endowment, post-introduction improvements,

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[1] Adoption and diffusion may appear to be used as synonyms in this chapter, as they are closely related; diffusion occurs when a user adopts an external technology.

[2] For instance, in the technology-gap literature, where countries are assumed to achieve faster growth by catching-up with the leading country's technology, the catch-up speed depends on the diffusion of technology. See Los and Timmer (2005) for a recent empirical study that shows growth catch-up through technology assimilation. They also show that the assimilation of new technologies is slow and highly heterogeneous across countries. Similarly, Tressel (2008) shows that the diffusion of ICT has helped Australian industries to catch-up with best practice industries in terms of productivity and Jermanowski (2006) shows the importance of enhancing technology adoption for poor countries to improve their welfare.

[3] Also see Rogers (1995) and Geroski (2000) for a review of technology adoption theories.

growth of the economy, level of income and product and labour market reforms as the major economic factors determining the adoption decisions (Griliches, 1957; Rosenberg, 1972; Caselli and Coleman, 2001; Hall and Khan, 2003; Pohjola, 2003; Comin and Hobijn, 2004; Tressel, 2008).

There is, however, evidence that adoption rates differ significantly across countries even when they have comparable economic conditions (Meijer and Ling, 2001; Timmer and van Ark, 2005). A possible explanation may be that economic decision making in part also depends on socio-cultural attitudes that may vary from country to country (see Henrich, 2000). Hence, the socio-cultural ambience, perceived values, institutions, attitudes towards risk and political atmosphere might influence the perception of the individuals within a country, and these factors may consequently impact technology adoption decisions. Rosenberg (1972) acknowledges that, "…in fact, the number of variables — social, legal and institutional as well as economic and technological — which might retard the diffusion process is virtually limitless" (Rosenberg, 1972, p. 29).[4] Also Abramovitz (1986) has highlighted the role of social capabilities in realizing productivity gains that could accrue through advanced capital goods that embody better technology. Social capabilities are connected, and perhaps partly formed by social culture (see Jackson, 2005).[5] Similarly, Jermanowski (2006) suggests the possible role of institutional and cultural differences in hindering poor countries from adopting technologies. Therefore it may be argued that the cross-country variation in technology adoption is not only due to economic conditions, but also to prevailing social conditions or a country's national culture. Hence, cross-country cultural differences may constitute some of the ultimate causes of cross-country differences in economic growth.

This chapter poses the question of how the national culture of a country affects the adoption of a new technology, in this case Information and Communication Technologies (ICT). As mentioned in previous chapters, much recent growth literature has shown that the impact of information and communication technology (ICT) penetration on economic growth has been significant during the last decade (see Jorgenson and Vu, 2005; Inklaar et al., 2008 and the references therein). We argue that the cultural setting of a society plays an important role in ICT adoption. Most studies examining the impact of culture have been conducted in the context of economic growth

[4] For instance, the economic growth literature often highlights the effect that colonial past can have on economic growth by influencing culture (Landes, 1998). Also see Acemoglu et al (2001).

[5] Jackson (2005) examines the social capability-culture nexus in the context of Amartya Sen's capability approach to welfare economics.

in general[6] (e.g. Johnson and Lenartowicz, 1998) while ICT adoption has been linked to economic determinants only.[7] In this context, this chapter raises the question "do cultural factors play a role in determining the differences in ICT adoption rates across countries?"

The chapter is organized in six sections. The second section provides an overview of past studies on ICT adoption and its determinants across countries, which will help us situate the present study. The third section presents an analytical framework for examining the relationship between culture and ICT adoption, drawing from business, economics and organizational psychology literature. The data and methodology used in the study are discussed in section four, and the empirical results are presented in section five. The final section concludes the chapter.

6.2 ICT Adoption across Countries

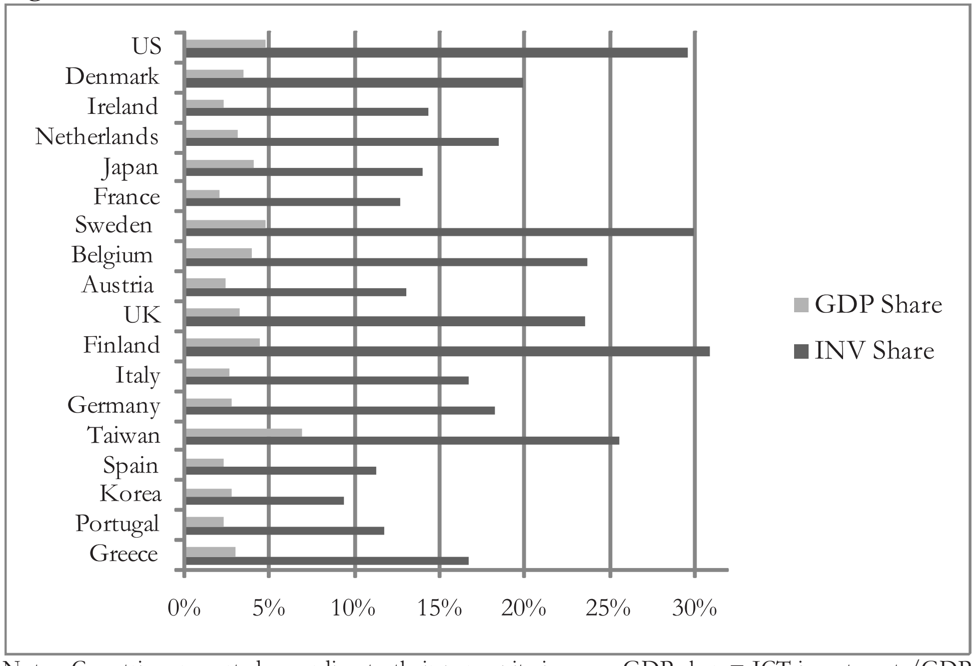
Information and communication technologies have spread rapidly across the globe, making researchers contemplate whether we are facing a 'new economy'. The proliferation of ICT has created a revolution by making the world seemingly smaller and improving the potential for economic growth. This remarkable spread of ICT and its impact on economic growth (e.g. Jorgenson, 2001; Timmer and Van Ark, 2005; Jorgenson and Vu, 2005) has created an interest among researchers to unearth the factors behind this phenomenon. For instance, the rapid spread of ICT has sometimes been attributed to substantial price declines in ICT equipment (Jorgenson, 2001), which is one of the major economic factors behind the decision to adopt a new technology. Other major economic factors related to technology adoption that have been highlighted in the literature are the level of human capital, the level of income and a country's openness to trade (Caselli and Coleman, 2001; Lee, 2001; Pohjola, 2003; Comin and Hobijn, 2004).

[6] Fang (2001), while examining the role of social culture in alleviating market failure, infers that it may affect the economic performance by altering a country's production technology. The role of cultural and social settings of countries in economic performance has been highlighted by many others as well. For instance, caste system in India, which has been part of India's social structure, and the consequent social bias that prevails even today (see Newman, 2007) is historically considered as a major obstacle to growth (Maddison, 1971). Also many experimental case studies have shown that economic decisions may be heavily influenced by cultural differences (Roth et al., 1991; Henrich, 2000).

[7] See Caselli and Coleman (2001) for a study on economic determinants of computer adoption, and Pohjola (2003) for determinants of ICT adoption in general. Our approach differs from both these studies in that we concentrate more on cultural factors in determining the adoption of ICT in general.

While the level of income reflects the economic capacity of a nation to acquire new technology, the importance of human capital depends, to a large extent, on the level of the skill complementarity in the technology. Openness to trade is assumed to be significant, as the access to new technology depends on the level of exposure of technology-using countries to technology-producing countries (see Caselli and Coleman, 2001).

Figure 6.1: Share of ICT investment, 2000



Notes: Countries are sorted according to their per capita income. GDP share= ICT investments/GDP and INV share = ICT investments/total investment.
Source: Timmer, et al (2003)

However, even across countries with similar income levels and human capital endowments differences in ICT diffusion exist. For example, the proliferation of ICT in many EU countries has been slower than that in the US (Timmer and Van Ark, 2005). Similarly, large differences have been observed in mobile phone and internet adoption and in ICT spending between the EU countries (Meijer and Ling, 2001; Pohjola, 2003). In Figure 6.1, we portray the ICT investment spending as a percentage of GDP and total investment in advanced countries (see Timmer et al., 2003). The figure shows a significant divergence in adoption rates across developed countries. For instance, Sweden and Finland show higher ICT adoption rates than the Netherlands, Denmark and Ireland, although the latter are above the first two countries in terms of per capita income level. The coefficient of variation in ICT diffusion is almost double the one for per capita GDP level, indicating relatively larger variation in diffusion. This divergence in ICT adoption rates could be important in explaining the differences in economic growth between these countries, as most developed countries not only share high levels of income, but also have similar structural and institutional characteristics, such as a qualified workforce and a modern infrastructure.[8]

The variation observed in ICT adoption among countries with similar economic conditions creates the need to explore other explanatory variables.. We argue that national culture is such a variable.[9] Adoption decisions are highly subjective to cultural attitudes and may therefore be influenced by the country's social and cultural characteristics. The conventions on how to behave in certain situations, economic or non-economic, evolve gradually and are transmitted socially among the members of the country, forming the cultural base of the country. For instance, risk-averse behaviour can be an inherent cultural phenomenon (see Hofstede, 2001). Thus adoption decisions are to a large extent affected by a number of non-economic factors, related to cultural and psychological aspects of individuals, organizations, societies and countries. This idea has been applied in the context of ICT by prior researchers. For instance, with respect to mobile broadband service adoption within European countries, Meijer and Ling (2001) have drawn attention to the possible effects of political and cultural factors alongside the economic and technological factors. Fife and Perira (2002) have also highlighted the importance of social and cultural factors for broadband adoption, and Lee and Peterson (2000) proposes a cultural model of entrepreneurship based on the presumption that a country's entrepreneurial orientation is related to its cultural base. These studies, however, have made no robust empirical analysis of possible cultural effects on the ICT adoption decisions of countries. The few researchers who have analyzed this issue empirically have merely considered adoption of specific ICT products, for example

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[8] Most advanced countries have higher education attainment levels (see Lee and Barro, 2001 and their education indicators available at the Harvard University website), lower corruption and policy uncertainty, and better energy and infrastructure facilities than their poorer counter parts (World Development Indicators, 2006).

[9] Nevertheless, culture is not the only such factor. For instance, Gust and Marquez (2002) and Tressel (2008) have highlighted the role of labour market regulations in impeding ICT adoption.

Enterprise Resource Planning software (van Everdingen and Waarts, 2003). The present chapter differs from prior studies in that we consider ICT adoption in a much broader sense and have conducted empirical analyses on the impact of national culture on ICT adoption across a larger number of countries.

6.3 Culture and ICT Adoption: Toward an Analytical Framework

Within any national culture, there will be variations in individual needs as well as in individual, team, and organizational behaviour. Nevertheless, individuals live and work within a cultural environment in which certain values, norms, attitudes, and practices are more or less dominant and serve as shared sources of socialization and social control. Hofstede (1984, 2001) and Trompenaars (1993) have shown that differences in values and attitudes influence the way people interact and make use of their environment. Since national culture is presumed to influence the population of a country in a similar way, we need to derive a framework of how the differences in national cultures are transformed into the differences observed in ICT adoption across countries, at the macro level.

Hofstede (1984, 2001) provides a set of cultural indicators, which has received a great deal of attention from scholars (e.g. van Everdingen and Waarts, 2003; Lee and Peterson, 2000). We use these indicators in order to explain cross-country differences in ICT adoption for two reasons.[10] First, by using Hofstede's indicators our results can be compared with earlier studies. The second reason is more pragmatic in that Hofstede's indicators are the only viable option for our purpose; other frameworks are found to be inadequate. For example, the framework of Hall (1976) is too broadly defined for our purpose, since it divides cultures only as low-context and high-context. In addition, later studies have observed that this broader classification of Hall (1976) can be related to Hoftstede's individualism-collectivism dimension (e.g. Gudykuns and Ting-Toomey, 1988). Although Schwartz (1994)'s framework shows much overlap with Hofstede's (van Everdingen and Waarts, 2003), the latter seems to be the more appropriate to analyze our research question as it is widely known and used in the literature. Hofstede's cultural

[10] It may be noted that Hofstede's measures of cultural dimensions have been subjected to criticisms (see for example Hampden Turner and Trompenaars, 1997; McSweeney, 2002). These criticisms even go as far as to deny the very existence of a concept such as *national culture*. However, it may be noted that human beings are social animals, who share their ethical and moral codes with their fellow human beings through means of social interactions (see Richerson, 1985; Henrich, 2000). Thus the rules on how to behave in certain situations are socially transmitted among the members of the country. This may justify the existence of a national culture as such sharing will bring similarities within countries.

indicators originally consisted of four cultural dimensions (Power-Distance, Uncertainty-Avoidance, Individualism and Masculinity). A fifth dimension was included later (Long-Term Orientation). Each dimension and its expected relationship with ICT adoption are briefly discussed below.

Power-Distance (PD)

The power-distance dimension refers to the inequality of the distribution of power in a country. In organizations this distribution of power is reflected by the hierarchy. Centralized decision structures, authority and the use of formal rules are therefore often the characteristics of organizations in countries with a high degree of power-distance. Organizations of this kind have been associated with lower rates of innovation and adoption (Zmud, 1982). The reason for this relationship can be found in more psychologically oriented research. Studies have shown that employees are more innovative when they are given more autonomy, are more empowered and work for leaders who have a less authoritative leadership style (e.g. Mumford and Licuanan, 2004). Furthermore, cultures with a high degree of power-distance are expected to be less open to new ideas, as adopting a new idea may entail decision-making on issues about which there is very little information or hardly any historical trend (Lee and Peterson, 2000). In the light of these observations, we hypothesize that *countries with a high PD score might show a lower rate of ICT adoption than countries with a low PD score.*

Uncertainty-Avoidance (UA)

Hofstede (1984, p. 83) defines uncertainty-avoidance as "The degree to which members of a society feel uncomfortable with uncertainty and ambiguity". It is an indicator of a society's tolerance for uncertain and ambiguous situations; to what extent a culture programs its members to feel comfortable with uncertain situations. Uncertainty-avoiding cultures try to minimize uncertain situations and the people in such countries are generally reluctant to accept unconventional ideas**,** while the countries of opposite types are generally more tolerant of opinions different from what they are used to. Uncertain situations are novel, unknown, surprising and unusual, and hence can be used to characterize the introduction of a new technology. Adoption of a new technology involves risk and uncertainty. This issue has been subjected to research in economics, largely advocated by Paul Stoneman, who has incorporated the idea that adopting a new technology is similar to any other kind of investment under uncertainty. Since the adoption of a new technology means getting involved into something new, the extent of uncertainty attached to it is also greater (Stoneman, 2001). Provided that the technology works, the question remains whether it can be put to profitable use, and therefore the risk is largely an economic one. Similarly, Freeman and Soete (2000) consider the variation in countries' ability to take risks and to assess new innovations as the cause of the slow diffusion rates across countries. The cultural dimension of uncertainty-avoidance may also find an economic interpretation in recent real option theory of investment propounded by Dixit and Pindyck (1994). This theory predicts a depressing effect of uncertainty and irreversibility on current investment, causing a delay in investment projects. Those countries which are uncertainty-avoidant may, therefore opt to delay the adoption of a new technology, due to the risk associated with adopting something new. Thus, any innovation, or as Woodman, Sawyer and Griffin (1993, p. 293) put it: "doing something for the first time", is associated with ambiguity and uncertainty. Since people in countries with a high score on uncertainty-avoidance are more risk-averse and do not approve of making changes (or "doing something for the first time") we expect *countries with a high UA score to show a lower rate of ICT adoption than countries with a low UA score.*

Individualism (ID)

The individualism dimension concerns the relation between the individual and the group to which that individual belongs. People in individualistic countries are inclined to make their own choices, while people in collective countries are more readily willing to conform to the norms of the group. Noelle-Neumann's (1974) spiral-of-silence theory argues that people will be deterred from expressing their true opinion if they feel that it runs counter to the majority opinion. Since adopting something new can be contrary to the prevailing group norm**,** countries with a strong emphasis on the group are expected to show a lower degree of ICT adoption. Individuals in individualistic countries feel free to express their own views and are therefore more inclined to innovate and adopt new ideas. In other words, the people in individualistic countries are generally self-reliant and freethinking. As reflected by Joseph Schumpeter's views on the subject, such freedom to think and act independently is expected to nurture the creativity of entrepreneurs making them more innovative (also see Shane, 1993). Consequently, we hypothesize *countries with a high ID score might show a higher rate of ICT adoption than countries with a low ID score.*

Masculinity (MA)

Masculinity (MA) versus femininity refers to the distribution of roles between the genders. Based on the evidence from Hofstede's study, assertive societies are considered as 'masculine' and modest, caring societies 'feminine'. Masculine cultures are characterized by competition, ambition and a focus on performance and material values. The relationship between masculinity and competition is often highlighted in economics literature also (Van de Vliert et al., 2000; Niederle and Vesterlund, 2007). Feminine cultures are characterized by solidarity, equality, consensus seeking and concern about social relationships. According to Hofstede (2001), organizations in masculine cultures emphasize rewards and recognition of performance as well as training and improvement of the individual. These are characteristics which promote innovative behaviour. Hence, *countries with a high MA score are expected to show a higher rate of ICT adoption than countries with a low MA score.*

Long-Term Orientation (LTO)

Hofstede added a fifth cultural dimension, which is the long-term orientation (see Hofstede, 1991). This dimension deals with to what extent a culture values its traditions and how much it focuses on its past and future. It is based on the Confucian work dynamism and hence influenced by the teachings inherent to Confucianism (Peterson et al., 2002). Values associated with long-term orientation are thrift and perseverance, while those associated with short-term orientation are respect for tradition and fulfilling social obligations. According to Hofstede, the main attributes of LTO includes willingness to save for the future and perseverance to wait for long-term results, while the short-term cultures look for quick results, and do not save for the future (Hofstede, 1991, 2001). The passion of short-term oriented countries for their past traditions constrains them moving ahead, while the LTO countries are able to adapt their traditions to a modern context (Peterson et al., 2002).[11] Since high LTO cultures attribute less importance to tradition they are more open to new ideas, and thus in such countries the rate of adoption of new technologies is expected to be higher than in countries with cultures that are more short-term oriented. On the contrary, countries that look for quick progress, which are short-term oriented by Hofstede's definition, will also be faster in adopting new technologies that will bring faster growth. Therefore, it is hard to have a clearer view on the effect that this dimension can have on ICT adoption. For instance, these indices place the United States, a country that is far ahead of many others in terms of adopting technologies, in the short-term oriented group; the LTO score for the US is lower than the average for the entire sample. Nevertheless, given the ascendancy of a multiple factors, such as saving habits, perseverance and the ability to move away from

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[11] See Table 1 in Peterson et al (2002) for a list of factors that distinguishes long-term oriented cultures from short-term oriented ones.

traditions on tentative grounds, *we expect countries with a high LTO score to show a higher rate of ICT adoption than countries with a low LTO score.*

6.4 The Data and Methodology

To conduct our study we required information on ICT adoption as well as on cultural differences across countries. The latter is represented by the Hofstede indices available at http://www.geert-hofstede.com/hofstede dimensions.php. These indices were developed by Hofstede in a comprehensive study of how culture influences the values in the workplace. To this end he collected data from over 100,000 individuals within 50 individual countries and 3 additional regions during 1967-1973. Over time, the database has been extended to 66 individual countries along with the 3 regions. The data on all the dimensions except long-term orientation is available for all these countries and regions. The latter dimension is available only for 26 countries and 2 regions. Though the initial analysis was based on surveys conducted among IBM staff, subsequent extensions included airplane pilots, students, civil service managers and consumers. The Hofstede cultural dimensions for the countries in our sample are provided in Appendix Table 6.1.

We have measured ICT diffusion by per capita ICT spending in each country. These data have been taken directly from World Development Indicators (WDI), provided by the World Bank. The original source of this information for the WDI is WITSA. They constitute a composite measure of IT hardware, office equipment, software, IT services and telecommunication and they represent a large number of countries (74) during 2001-2005. We have used this data for the latest available year, 2005, and for those countries for which the corresponding Hofstede indices are available. Hence we have data on per capita ICT spending in GDP of 53 individual countries and 3 additional regions,[12] for which Hofstede does not provide individual country data (see Appendix Table 6.1).

To cross-check our results we have also used a second measure of ICT adoption: the per capita number of computers in each country. This measure has the advantage of being strictly expressed in terms of quantities rather than values. Moreover, a bifurcation of different components of ICT investment shows that over the years the share of computers (or IT equipments) in total ICT investment has increased faster than other

[12] These regions are Arabian countries, which include Egypt, Iraq, Kuwait, Lebanon, Libya, Saudi Arabia and United Arab Emirates; East African countries, which include Ethiopia, Kenya, Tanzania and Zambia; and West African countries which include Ghana, Nigeria and Sierra Leone. The regional per capita ICT spending has been calculated by aggregating country specific ICT spending and population for each region.

components such as software (calculated using data from Timmer et al., 2003). The World Bank has provided the number of stand-alone computers that are designed to be used by an individual, per 1000 people in a country. We considered the data for those countries for which Hofstede dimensions are available, and hence we had a sample of 46 countries and three regions. The regional numbers have been derived by aggregating country specific data in each region.

In order to examine the role of cultural factors on ICT adoption, we use regression analysis. Since the data on cultural dimensions over time are not available, we assume that culture remains constant over time. Hence, we decided to conduct a cross-section regression. Based on our earlier discussion about the expected relationship between cultural dimensions and ICT adoption, the following multiple regression model has been estimated.

$$ICT_j = \beta_0 + \beta_1 PD_j + \beta_2 ID_j + \beta_3 MA_j + \beta_4 UA_j + u_j \tag{6.1}$$

where *ICT* represents the ICT adoption, measured in terms of per capita computers and per capita ICT spending, the βs are parameters to be estimated, *PD* is power-distance, *ID* is individualism, *MA* is masculinity, *UA* is uncertainty-avoidance and *u* is the random error term with standard assumptions. The subscript *j* stands for countries. Note that the long-term orientation dimension is excluded from the regression equation, as the number of countries in this dimension is too small.

Table 6.1: Correlations between Hofstede dimensions and control variables

		1	2	3	4	5	6	7
1	PD							
2	UA	0.13						
		(0.16)						
3	ID	-0.64	-0.19					
		(-0.71)	(-0.24)					
4	MA	0.20	0.02	0.07				
		(0.09)	(0.15)	(0.005)				
5	Per capita GDP	-0.67	-0.23	0.74	-0.11			
		(-0.66)	(-0.22)	(0.71)	(-0.09)			
6	Dummy	-0.38	0.11	0.51	0.03	0.64		
		(-0.39)	(-0.02)	(0.54)	(0.06)	(0.73)		
7	Education	-0.34	0.13	0.46	0.00	0.46	0.47	
		(-0.4)	(-0.003)	(0.47)	(0.07)	(0.56)	(0.5)	
8	ICT adoption	-0.66	-0.32	0.72	-0.09	0.95	0.61	0.52
		(-0.67)	(-0.42)	(0.68)	(-0.17)	(0.92)	(0.62)	(0.56)

Note: Figures in parentheses are for countries for which per capita computer data was available, and others are for countries for which per capita ICT spending data was available.

In order to avoid bias in the parameter estimation, which may emerge due to the omission of other relevant variables identified in the literature, we have included some control variables into our model. Following the literature, one obvious control variable to be used is per capita income level (e.g. Pohjola, 2003, also see our discussion in section 2). Unfortunately, as can be observed in Table 6.1, per capita GDP is highly correlated with the power-distance and individualism dimensions. This poses a multicollinearity problem. Therefore we have controlled for income by replacing per capita GDP with a dummy variable. The dummy variable for countries belonging to the low-income and lower middle-income groups is attributed a zero value, and those countries belonging to the upper middle-income and high-income groups is attributed value one.[13] The dummy appears to have a high correlation with GDP per capita, while it is less correlated with the Hofstede dimensions (Table 6.1).

In addition, we have also considered the level of education in each country as another control variable.[14] This is of particular importance in the context of information technology in which, due to the high skill component of this technology, the role of an educated workforce is quite large (see Caselli and Coleman, 2001; Lee, 2001; Lucchetti and Sterlacchini, 2001). We represent the education variable by the total share of population possessing educational qualifications at the tertiary level. This has been captured by Barro-Lee estimates on the percentage of people who have completed high school in the total population aged 25 and above.[15] Fortunately, this variable is found to have little correlation with Hofstede dimensions and the income dummy variable (Table 6.1). In equation (6.2) the model with control variables is presented, where the level of education is represented by EDU, the level of income by the dummy variable D, and the other variables as explained in equation (6.1).

$$ICT_j = \beta_0 + \beta_1 PD_j + \beta_2 ID_j + \beta_3 MA_j + \beta_4 UA_j + \beta_5 EDU_j + \beta_6 D_j + u_j \quad (6.2)$$

Along with the basic model without control variables (6.1), we estimate four different versions of (6.2). In the first model we add only education as control variable,

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[13] This categorization of low-income and high-income countries is based on the World Bank. See footnote 12 in chapter 2 for more details.

[14] See Benhabib and Spiegel (1994) for a discussion on the role of human capital in affecting the speed of technology adoption. Also see Comin and Hobijn (2004).

[15] For the three regions, the averages for the countries in each region are taken. The data are available at http://www.cid.harvard.edu/ciddata/ Appendix%20Data %20Tables. xls. Accessed in July 2004. See Lee and Barro (2001) for a detailed description of these data.

and in the second model we add both education and income dummy. In the third model we exclude Power-distance, as it is found to be correlated with individualism dimension (see Table 6.1), and in the last model we exclude individualism.

6.5 Empirical Results

For both indicators, per capita ICT spending and per capita computers, countries are divided into two different groups according to their cultural dimension (low and high) by taking the median of each dimension in our sample as a split point.[16] Subsequently, the average ICT adoption rates in these low and high dimension groups are plotted to get a first understanding of the relationship between cultural dimensions and ICT adoption. In Figure 6.2a, the ICT adoption in the year 2005, measured in terms of per capita ICT spending, is plotted against the five cultural dimensions of Hofstede. The figure shows that low power-distance countries and low uncertainty-avoidance countries have higher rates of ICT adoption than high power-distance countries and high uncertainty-avoidance countries. Similarly, countries with more individualistic cultures show higher ICT adoption rates than cultures that are more collective. With respect to the masculinity dimension we observe only a slight difference. The adoption rates are a little higher in masculine countries. The long-term orientation also does seem to have some effect, but not in the expected direction. Short-term oriented countries appear to have a higher rate of ICT adoption. The corresponding picture for the per capita computer-variable is depicted in Figure 6.2b. The results are similar to the Figure 6.2a.

Table 6.2: Differences in ICT adoption: t-statistics

	PD	UA	ID	MA	LTO
Per capita ICT spending	4.10*	2.64*	-5.15*	-0.78	0.77
Per capita Computer	4.94*	3.14*	-5.21*	-0.27	0.21

Note: The figures are t-values tested with the null hypotheses, H0: The difference in ICT adoption between Low Dimension countries and High Dimension countries =0 (see Figure 6.2a). * indicates significance at a 1 per cent level. The number of observations with respect to all the variables for per capita ICT spending (per capita computer) is 56 (48), except for LTO, where it is only 24 (20). [17]

[16] Using the mean of Hofstede's dimensions rather than the median as a split point results in a smaller number of countries belonging to the group of low UA and PD dimensions and high LTO dimension group. Nevertheless, the results from both approaches are similar.

[17] Note that while performing the t-test, in order to assure the same number of observations in both high and low groups, we had to leave out one observation from the per capita computer sample, as it had 49 observations.

Figure 6.2: ICT adoption and Hofstede dimensions

Figure 6.2a: Per capita ICT spending and Hofstede dimensions, 2005[18]

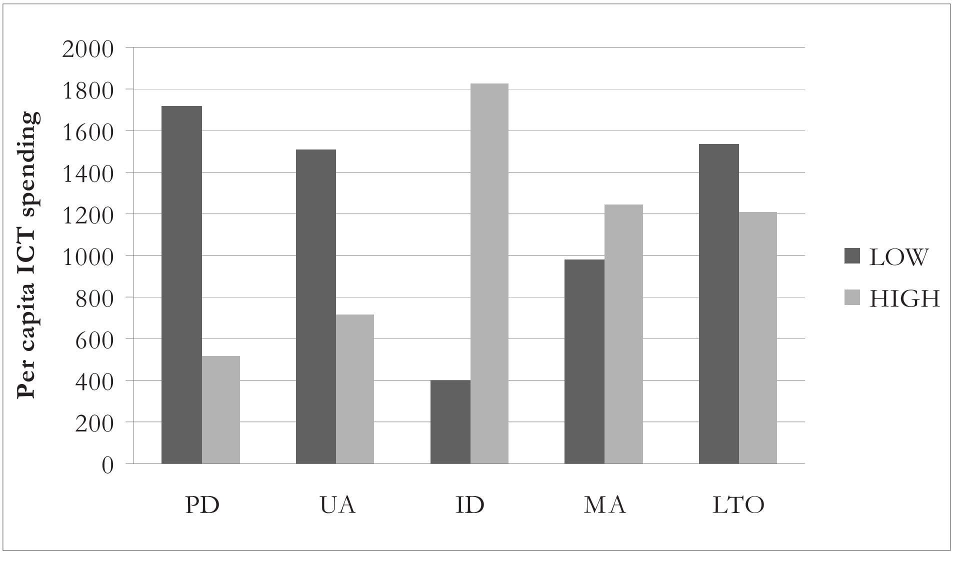
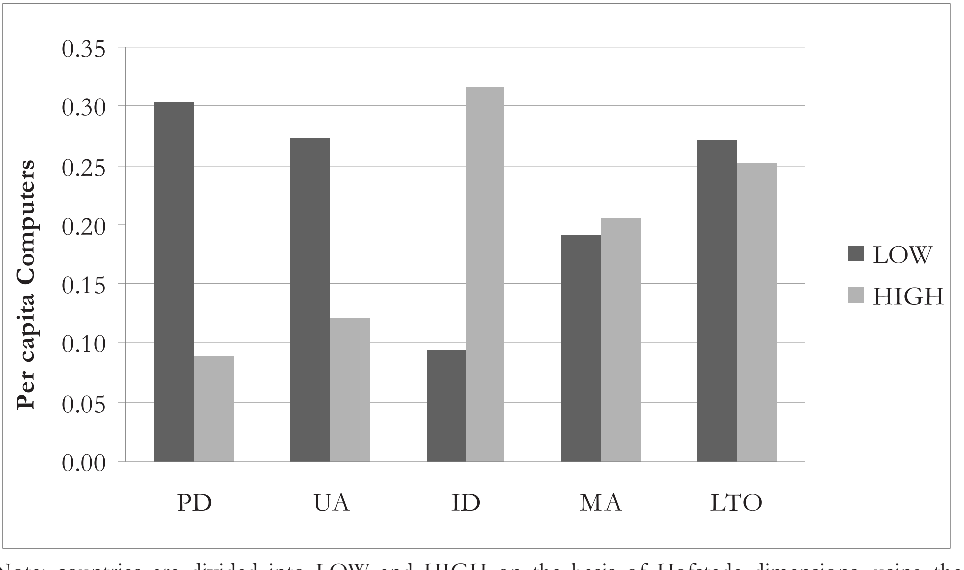


Figure 6.2b: Per capita computers (average 1998-2002) and Hofstede dimensions



Note: countries are divided into LOW and HIGH on the basis of Hofstede dimensions, using the median as a split point.

[18] The relationship remains the same for all the years for which the data is available, hence we opted to present the latest year for which the data is available.

The observed differences in the two-way division are statistically tested by using an independent t-test and appear to be significant in power-distance, uncertainty-avoidance and individualism dimensions (Table 6.2). Both masculinity and long-term orientation dimensions are not statistically significant. Apparently the adoption rates are not affected by a country's characteristics in terms of masculinity/femininity. It should be noted that the LTO dimensions were only available for less than half of the countries in our sample and therefore, this observed insignificant relationship may possibly be attributed to the small sample size.

We next estimated a regression by using the two ICT adoption measures, with and without control variables. The results of the regression analysis are presented in Tables 6.3 and 6.4. Table 6.3 provides the results for per capita ICT spending and table 6.4 presents the results for per capita computer. The results are largely in conformity with our observations based on the two sets of graphs in the preceding discussion. In the basic model (column 1) three dimensions have significant coefficients, namely the power-distance (-), uncertainty-avoidance (-) and individualism (+) dimensions. The signs of all these dimensions are as expected, strengthening our earlier observations. As was the case in our earlier analyses, the regression analysis shows no evidence of any significant impact of the masculinity dimension on ICT adoption. The story remains the same for both computer per capita and per capita ICT spending measures. In terms of the relative magnitudes and level of significance of coefficients, power-distance and individualism seems to show dominance over uncertainty, in both indicators.

Even after controlling for the education component (column 2), the results for cultural dimensions remained largely the same. The education variable shows a positive and significant effect on both ICT spending as well as per capita computers. In the case of per capita computers, though the individualism dimension remained positive and significant, the magnitude of the coefficient as well as the level of significance has come down. The masculinity dimension showed no significant effect.

Table 6.3: Regression results for per capita ICT spending

Parameter	Model 1 Without Control Variables	Model 2 Including Education	Model 3 Including Education & Income Dummy	Model 4 Without Power Distance	Model 5 Without Individualism
Constant	1734.2 ***	1500.0 **	1523.5 ***	603.2	2169.0 ***
	(620)	(563.3)	(506.2)	(440.1)	(383.3)
PD	-15.2 ***	-14.3 ***	-13.0 ***	-	-18.8 ***
	(4.6)	(4.8)	(4.8)	-	(3.9)
UA	-9.0 *	-12.1 **	-14.5 ***	-14.8 ***	-16.5 ***
	(5.3)	(4.9)	(3.8)	(3.7)	(3.3)
ID	23.0 ***	16.7 ***	10.9 *	18.1 ***	-
	(4.9)	(5.3)	(5.5)	(4.3)	-
MA	-3.9	-3.6	-3.8	-7.4	-1.5
	(5.9)	(5.5)	(5.1)	(5.3)	(5)
Education	-	65.2 ***	46.9 ***	48.8 ***	57.9 ***
	-	(16.7)	(13.8)	(14.8)	(13.3)
Dummy	-	-	780.2 ***	816.9 ***	920.5 ***
	-	-	(181.6)	(200.1)	(155.7)
Adj. R^2	0.59	0.65	0.72	0.69	0.70

Notes: N=56. Results are corrected for heteroskedasticity. Dummy takes the value 1 for high-income countries and 0 for low-income countries. *** =significant at 1 %, ** =significant at 5 % and *=significant at 10 %. Figures in parentheses are standard errors

Table 6.4: Regression results for per capita computer

Parameter	Model 1 Without Control Variables	Model 2 Including Education	Model 3 Including Education & Income Dummy	Model 4 Without Power Distance	Model 5 Without Individualism
Constant	0.434 ***	0.373 ***	0.381 ***	0.165 **	0.433 ***
	(0.1108)	(0.0989)	(0.0835)	(0.0678)	(0.0594)
PD	-0.003 ***	-0.003 ***	-0.003 ***	-	-0.003 ***
	(0.0008)	(0.0009)	(0.0009)	-	(0.0008)
UA	-0.002 **	-0.002 ***	-0.003 ***	-0.003 ***	-0.003 ***
	(0.0009)	(0.0009)	(0.0007)	(0.0007)	(0.0006)
ID	0.003 ***	0.002 *	0.001	0.002 ***	-
	(0.0009)	(0.0009)	(0.0008)	(0.0009)	-
MA	-0.001	-0.001	-0.001 *	-0.002 **	-0.001 *
	(0.0008)	(0.0008)	(0.0007)	(0.0007)	(0.0007)
Education	-	0.013 ***	0.009 ***	0.010 ***	0.009 ***
	-	(0.0033)	(0.0028)	(0.003)	(0.0027)
Dummy	-	-	0.1343 ***	0.1332 ***	0.1440 ***
	-	-	(0.0324)	(0.037)	(0.0272)
Adj. R^2	0.59	0.67	0.74	0.70	0.74

Notes: N=49. Other notes as in Table 6.3.

However, once we included the dummy to capture the effects of income levels and those of education together, the masculinity dimension showed a mild negative impact and the positive effect of individualism disappeared in the case of per capita computers while all other dimensions generally remained the same (column 3, Table 6.4). Also in the case of per capita ICT spending, the observed positive effect of the individualism dimension has declined. This might be attributed to the high correlation observed between power-distance and individualism (see Table 6.1). Therefore, we have dropped these two variables alternatively from the equation. The results are reported in the last two columns of Tables 6.3 and 6.4. In both model 4 and 5 all coefficients are significant and their signs are as expected, with masculinity as exception. The sign of the masculinity dimension is different than expected, but is significant only in the model of per capita computers, not in per capita ICT spending. One possible reason for the inconsistency regarding masculinity may be the highly diverse nature of this technology. As is evident from the name itself, ICT can be used to improve communication. If this is the major purpose for which the technology is being adopted, then adoption rates might be higher in feminine cultures. On the other hand, ICT can also be used to compete with others. After all, information is power. In that case, the masculine countries might show a higher adoption rate. For instance, a recent study by Niederle and Vesterlund (2007) shows that men are more competitive than women. However, since we have made no distinction between the user aspects of the dependent variable, it is hard to make a judgement of this kind. Also the individualism dimension has gained a positive and significant coefficient in Model 4, when power-distance is excluded. More interestingly the magnitude of individualism coefficient that has declined significantly in model 3, has regained somewhat same value as in models 1 and 2 when the power-distance is omitted (Table 6.4, column 5). This may be indicative of the severity of the impact of multicollinearity. In all cases, both education and income variables show up positively and significantly indicating the importance of economic variables in addition to the cultural variables.

6.6 Concluding Remarks

Within the field of behavioural economics, attempts to establish a more realistic view of human nature with respect to economic decision making have significantly expanded over the last few decades. In line with this development, this chapter has attempted to look at specific cultural dimensions that are expected to affect rates of ICT adoption across countries. Such an attempt is expected to enrich our understanding of the sources on some of the deeper sources of cross-country differences in economic growth, which is partly fostered by the differences in technology.

The central hypothesis was that a nation's culture has an influence on the adoption of ICT. Our results derived using Hofstede's cultural dimensions confirm this. Our analysis indicates that economies with higher power-distance tend to show lower ICT adoption. The results for the countries with high uncertainty-avoidance scores are similar; these countries have shown lower adoption rates than countries with low uncertainty-avoidance scores. The results remained the same even after controlling for education and income. With respect to the individualism dimension, as was expected, a significant positive relationship has been observed, however, only when corrected for the possible correlation with the power-distance. Therefore it can be concluded that there is at least partial evidence on the effect of individualism. The results show no strong support for the relation between the masculinity dimension and ICT adoption. The two control variables, income and education are found to influence cross country ICT diffusion positively and significantly.

The results obtained in this study complement the existing evidence on the determinants of technology adoption by highlighting the role of cultural factors in economic decision making. These results stress the fact, which Abramovitz (1993) pointed out, that it would be unfair to "…reduce the actual advance of technology, its direction as well as its pace, to a stable function of savings and the costs of finance alone" (Abramovitz, 1993, p.237). Technology spillover is not something that automatically takes place depending only upon country's economic capacity or education level but also its cultural ambience is important. Our results suggest that in some countries certain cultural traits can act as a barrier to ICT adoption, and it is therefore imperative to consider the cultural settings of these countries while devising strategies for the ICT proliferation. This may also indicate that the cultural constraints against the adoption of better technologies may partly explain the high and increasing gaps in productivity across countries which we found in chapter 2.