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Bridging the Digital Divide: the Growth Implications of *e*-Commerce for Small States

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Abstract

The significant growth of the Information & Communication Technology (ICT) sector has created a widening gap in productivity between the leading industrialised and developing economies. The emergence of a digital divide constitutes a critical constraint on the potential for the future growth of many developing economies. This is because they lack of a critical mass of physical infrastructure to support dynamic *e*-commerce and capture some of the growth spillovers from these activities. ICT and the expansion of *e*-commerce is an opportunity for many developing economies to overcome the spatial barriers to international economic interaction that have, in the past, constrained growth because of their economic peripherality and isolation from key regional and global markets. This paper is concerned with potential of ICT to promote economic growth in developing countries. It makes particular reference to the impact of ICT on small states since the empirical literature highlights the critical role of human capital-intensive economic activities in their growth performance. The paper provides a synthesis of the disparate theoretical literatures on the growth implications of ICT and *e*-commerce with that on the growth of small states in order to derive critical growth policy implications with applications to developing countries generally. The paper also proposes an agenda for further research on this important area of investigation.

Key words: small states, growth, *e*-commerce.

Bridging the Digital Divide: the Growth Implications of *e*-Commerce for Small & Developing States *

There has been a significant growth in the Information & Communication Technology (ICT) sector in the last decade or so. Its emergence has stimulated the rapid emergence of *e*-commerce as an economic activity in its own right as well as a critical intermediate activity facilitating the exchange of information and products in traditional business forms. The increasing use of ICT by firms and institutions generates the potential for significant productivity gains in information exchange and business operations by accessing existing markets more effectively and opening-up new untapped markets. Further, *e*-commerce by its very nature eliminates geography as a major barrier to doing business. Given that much of the growth of the ICT sector has been confined to the leading industrialised economies however, they have been able to capture most of the associated gains. This has led to a widening productivity gap with the developing countries, constituting what is generally referred to as a growing global digital divide.

For developing countries, *e*-commerce offers a potential means to overcome some of the spatial barriers that have traditionally impeded their international economic interaction, notably their peripherality and isolation form the major global markets. It is possible to identify several critical factors constraining the assimilation and effective utilisation of *e*-commerce by developing countries and which constitute barriers to their future growth. The three principal constraints are: difficulties in creating a critical mass of domestic physical and technological infrastructure; low levels of income; and a lack of human capital. The first constraint is a result of the limited investment capacity of most developing countries given the need to attain a critical infrastructural threshold. The other two constraints limit the ability of individuals, firms and institutions to harness ICT technology effectively.

This paper outlines the critical role of *e*-commerce in economic growth in the context of formal models of economic growth and insights drawn from the theory of small states. It then undertakes some initial empirical analysis to test the respective roles of the principal constraints identified above on the effective utilisation of *e*-commerce by small and developing states. These initial findings are

then used to advance a research agenda for the further investigation of the impact of the digital divide and possible policy remedies.

1. *e*-Commerce, Growth & Small States: a Theoretical Overview

This section provides a brief theoretical overview of the interaction between economic growth models, technology - including *e*-commerce – and the growth determinants of small states. This permits the development of several initial hypotheses concerning the barriers to ICT take-up in small and developing countries and its potential growth effects.

1.1 ICT, *e*-commerce & Economic Growth

Before the 1980s, explanations of differential growth rates between states focused on their endowments of natural and labour resources and the accumulation of capital. Neo-classical growth theory, such as the Solow-Swann Model (Solow, 1956; Swann, 1956), predicts that the economic growth of states converges in the long run. This convergence did not materialise however, and the models failed to provide a framework to formulate policies that would help the poorer countries to 'catch up' with the richer countries (Thirlwall, 1999).

Endogenous growth models were developed to provide policy-makers with a better framework for explaining divergence in economic growth between countries. Unlike the neo-classical models, the 'new' endogenous growth models are intended to capture the positive externality effects of one firm's capital investments and expenditure on R&D (Romer, 1986, 1990). Similarly, Lucas proposed that the definition of labour resources should be augmented to reflect productivity gains associated with investment in human capital formation (Lucas, 1988). Further, unlike the neo-classical models, the endogenous growth models do not assume strictly constant returns to scale. The endogenous approach provides a natural growth framework that captures explicitly the extent to which economies benefit from externality effects of investments in new technologies and ideas.

According to endogenous models, some countries grow faster than others because they invest more in R&D. This investment leads to the creation of new technologies, new ideas and new ways of conducting business, all of which generate positive externalities. In order for countries to develop,

adopt and, most importantly, fully exploit new technologies and ideas however, they must raise the absorptive capacity of domestic labour through simultaneous investment in human capital formation. The adoption of new technologies in many developing countries is argued to have a small or insignificant impact on growth because their human capital stock lacks sufficient absorptive capacity to maximise the gains from the adoption of new technologies (Pohjola, 2001).

Under the new endogenous growth theory paradigm therefore, 'low growth' states could grow faster and catch up with other 'high growth' states if they are able to benefit from the transfer of ideas and technologies coupled with increased levels of investment in human capital formation. Other things being equal, a high level of growth provides an economy with the resources to invest in both R&D and human capital formation. In turn, these lead to a higher rate of growth and higher levels of income, giving rise to a 'virtuous circle' of economic growth.

The transfer of new technologies and ideas to poorer countries however, is a necessary but insufficient condition for economic growth convergence. 'If technological leap-frogging is to be successful, it must be feasible to bypass stages of capability building or investment that the industrialised countries have had to pass through in the process of economic development' (Mansell, 2001). In other words, the successful absorption and adoption of new technologies and ideas depends upon a critical minimum existing level of capability and capacity, namely:

- A critical threshold level of human capital stock.
- The availability of basic infrastructure.
- An institutional framework encouraging innovation.

A minimum threshold level of human capital is a standard factor in endogenous growth theory, indicating that lagging countries cannot benefit fully from technological advance unless they possess a sufficient quality and volume of human capital capable of absorbing and utilising it. This, in turn, is dependent upon factors such as educational investment and attainment. A basic infrastructure is a necessary but insufficient condition for economic development generally in that it alleviates many potential bottlenecks in effective co-ordination. Infrastructure is often characterised by 'lumpiness' - it requires costly investment and is subject to scale economies – such that it may constitute a barrier to the development of smaller and poorer economies. The existence of an encouraging institutional

framework refers to the role of social capital in providing an appropriate environment for economic growth.

It is evident from this discussion that ICT and *e*-commerce constitute new infrastructural and process technologies with potentially significant positive growth effects, including substantial spillovers, for those economies that are able to take advantage of these opportunities. As such, they are 'instruments of change' in the growth process (Pigato, 2001) rather than an engine of growth *per se*. The new information economy is creating new norms for the conduct of business. In addition, it is also improving both the volume and quality of information that can be exchanged, so improving the efficiency with which markets operate (Madden & Savage, 1998; Forestier et al. (2002). The dynamic growth effects of ICT and *e*-commerce however, are constrained by the need for appropriate human capital and their dependence upon large-scale and costly investment in supporting telecommunications infrastructure. Shortages of key skills along with inadequate and substandard telecommunications infrastructures, such as those in Central and Eastern Europe, may severely hamper regional co-operation and growth (Madden & Savage, 1998). It is also important to note that technology improving the exchange of information represents a major challenge to the continued power of more authoritarian political structures.

1.2 The Determinants of Growth in Small States

There is useful emerging literature on the growth in small states derived from the investigation of the key determinants of economic growth success (see Armstrong et al., 1998). This literature is summarised and reviewed in Armstrong & Read (2003). The concept of small size in these analyses is founded upon population which has important implications for the size of the domestic market, the pattern of sectoral specialisation, comparative advantage, trade policy and macroeconomic policy. The principal empirical findings, based upon large-scale cross-section analysis of a global data set of small states, are that specialisation in resource-based (excluding agriculture) and service activities and broader regional location are key factors in their growth success (see also Armstrong & Read, 1998).

These findings suggest that domestic labour constraints mean that their comparative advantage lies in specialisation in (capital-intensive) natural resources and human capital-intensive service activities. This contrasts with the traditional Lewis-type view of the economic growth and

development process of industrialisation through the expansion of labour-intensive manufacturing based upon low productivity labour drawn from agriculture (Lewis, 1954). Further, proximity to the major markets of the industrialised economies is also found to have a significantly positive impact on growth.

It is useful at this juncture to focus on some important economic similarities between small states generally and many developing countries which may generate possible insights for this study. Although usually defined in terms of their small populations in the theoretical and empirical literature, small states along with many developing countries also have a small absolute magnitude of economic activity (GDP). This suggests that these economies face similar or parallel problems in terms of establishing large-scale infrastructure and production activities in spite of possibly substantial differences in their income levels (Read, 2002).

1.3 *e*-Commerce & the Growth of Small States

The small size of the domestic market in small states has important implications for the availability and adoption of new technologies for both supply and demand side reasons. Supply side constraints include the adverse cost effects of increasing returns to scale in critical infrastructural investments. On the demand side, these constraints include the small absolute magnitude of the domestic market which raises problems relating to the availability and distribution of complementary consumer products and services.

With specific reference to the impact on the growth of small states, the adoption of *e*-commerce can be expected to widen and extend the spatial market of export-oriented domestic firms through global trade networks. Increased demand for their products through exports would enable these firms to reap the cost advantages of large-scale production. This is a standard result of Adam Smith's insight that trade increases the extent of the market and is also a critical and consistent feature of the growth strategies of most successful small states. These potential gains however, are subject to the proviso that complete specialisation creates excessive sectoral dependence and greater susceptibility to exogenous shocks and therefore volatility in the long-run growth process (see Armstrong & Read, 1998, 2002). *e*-commerce and associated information technologies may also provide firms with a potential fast and low-cost platform to conduct their marketing activities and exchange trade-related

information (Caves, 2001; Mansell, 2001). In addition, there is also the potential to reap economies of scope through the reduction in costs of external information exchange.

It is clear that, ICT and *e*-commerce constitute 'instruments of change' with respect to the process of economic growth. This is particularly true in the case of small and developing states in that the 'new economy' creates new norms of conducting business. The extremely high degree of structural, as opposed to policy-induced, openness to trade is a critical determinant of growth in small states. In order to maintain their international competitiveness and sustain economic growth, this means that small states have very little alternative but to establish a minimum threshold of domestic infrastructure to access this globally integrated network of rapid information exchange almost irrespective of the initial sunk and subsequent fixed costs. These costs are likely to be well beyond the resource capacity of many poorer small and developing states and therefore may further compound their current peripheralisation and isolation from core growth regions.

1.4 Some Initial Hypotheses

The objective of this paper is to test some basis hypotheses relating to the adoption of *e*-commerce and other information technologies by small states.

- Hypothesis 1: That the adoption of *e*-commerce is positively related to GDP. This is to confirm the existence of the digital divide between developed and developing states.
- Hypothesis 2: That GDP is positively related to the adoption of *e*-commerce, i.e. that there are feedback effects on growth.
- Hypothesis 3: That the adoption of *e*-commerce is positively related to investment in physical capital, particularly in telecommunications infrastructure.
- Hypothesis 4: That the adoption of e-commerce is positively related to investment in human capital.
- Hypothesis 5: That the adoption of e-commerce is positively related to minimum thresholds of investment in both physical and human capital.
- Hypothesis 6: That the adoption of e-commerce is dependent upon large-scale 'lumpy' investment such that small and poorer states lacking in resource capacity face a 'double barrier' to its adoption.

2. Data Sources

This Section provides a brief overview of the sources of data used in this study and a review of some of the critical methodological issues relating to the data analysis. The initial empirical task is to compare and explain the state of *e*- commerce adoption in small and large states respectively. Of particular interest are the differential effects of investments in physical and human capital on *e*-commerce adoption between small and large states. Small states are defined as those economies with less than 3 million inhabitants (following Armstrong et al., 1998).

The number of Internet hosts per 10,000 inhabitants in 2000 (source: International Telecommunications Union, ITU) is used as a measure of *e*-commerce adoption. Although this is a biased measurement of the state of e-commerce diffusion (Chong & Micco, 2003), using alternative available data on the number of Internet users per 10,000 inhabitants instead would grossly overestimate the state of *e*-commerce. Data for the economic variables for 2000 - real GDP, GDP per capita, population, telephone mainlines per 1,000 inhabitants and gross domestic fixed capital formation - are taken from the World Development Indicators 2002, CD-ROM. Data on gross enrolment ratios for 2000, downloaded from the website of the UNESCO Institute for Statistics, are used to proxy the human capital stock of each states included in the analysis. The gross enrolment ratio is defined as 'the number of pupils enrolled in the given level of education regardless of age expressed as a percentage of the population in the relevant official age group' (UNESCO). The variables used in the empirical analysis are defined in Table1.

Table 1: Definition of Variables Used in the Study (all 2000)

Variable	Definition	Source
LHosts	Log of the number of internet hosts per 10,000 inhabitants	ITU, International Telecommunications Union
LogPop	Log of the number of inhabitants	World Development Indicators
LgGDP	Log of real GDP constant $1995	World Development Indicators
LnGDPper	Log of real GDP per capita constant $1995	World Development Indicators
LogTel	Log of the number of telephone lines per 1,000 inhabitants	World Development Indicators
LnEnrol	Log of the gross enrolment ratio (as defined above)	UNESCO statistics website
LogDFCF	Log of gross domestic fixed capital formation	World Development Indicators
CMI	Composite measure of investment	Computed by authors (see explanation in Section 3.2)
Small	Dummy variable, = 1 for small states = 0 otherwise	Computed by authors

3. An Empirical Analysis of *e*-Commerce & Growth in Small States

The empirical analysis is conducted in three separate stages. In the first, the descriptive relationships between the key variables is analysed visually based upon scatter diagrams. In the light of the conclusions concerning the extent of correlation between key variables, this is followed by the development of a simultaneous equation framework and factor analysis to develop a composite measure of investment (CMI). In the third stage, this CMI is utilised as an independent variable in the empirical analysis using the seemingly unrelated regression technique SURE in Limdep 7.0.

3.1 Analysis of Correlation Between Key Variables

This Section analyses the relationships between the key variables identified in Section 2 as being of relevance to this study prior to the application of more sophisticated statistical techniques. The available data provides a data set of 205 states, of which 129 are classified as large (> 3 million population) and 76 as small (< 3 million).

Figure 1 plots the adoption of *e*-commerce, as measured by Internet hosts (LHosts), against the size of economies, as measured by population (LogPop). It is evident from the figure that there is no strong correlation, either positive or negative, between the two variables. The box plots in Figure 2 are used to indicate the variation in the adoption of *e*-commerce within large and small states. The plots provide little evidence of interest in the context of this paper apart from the extent of variation between small states being less than between larger states.

[Figures 1 and 2 here]

Of greater interest and relevance is the already well-established existence of a clear 'digital divide' in the adoption of *e*-commerce between developed and developing states. The box plots in Figure 3 show Internet hosts with respect to countries' income levels, using the World Bank's four income classification groups. It is very apparent from this figure that the extent of the 'digital divide' is greater between income groups than it is between small and large states. This suggests that the critical component of the 'digital divide' is the existence of barriers preventing developing countries from adopting *e*-commerce.

[Figure 3 here]

The positive correlation between income levels and the adoption of *e*-commerce is investigated in greater detail in Figures 4, 4a and 4b which provide scatter diagrams of Internet hosts against per capita income levels in aggregate then disaggregated for small and large states respectively. It is evident from a comparison of Figures 4a and 4b that the relationship between per capita income levels and *e*-commerce adoption is much more strongly positive in the case of large states than in the case of small states. This indicates that small states face additional barriers to the adoption of *e*-commerce over and above simple income levels since it is evident from Figure 4a that at any given level of income the variation in the number of Internet hosts in small states is substantively greater than in large states. This inference tends to support the argument that the adoption of *e*-commerce by small

states is being constrained by additional factors such as the absolute magnitude of their economy, the high sunk costs of the associated infrastructural investment and the possible existence of minimum threshold effects.

[Figures 4, 4a and 4b here]

Turning to the requisite telecommunications infrastructure necessary to support *e*-commerce, as measured by the number of telephone lines per thousand population, Figures 5, 5a and 5b demonstrate a close positive correlation as expected with the number of Internet hosts. Again, this relationship is more pronounced for larger states as opposed to small states in that for there is greater variation in the number of Internet hosts for any given level of telecommunications infrastructure. A robust telecommunications infrastructure is a prerequisite for the effective implementation of information technology and the adoption of *e*-commerce. In the case of small states however, this suggests that *e*-commerce requires additional complementary 'lumpy' investment which appears to be beyond the financial resource capability of some of these states.

[Figures 5, 5a and 5b here]

At a more basic technological level, Figures 6, 6a and 6b investigate the broader factors encouraging and facilitating the adoption of new technologies in terms of the growth of the physical capital stock, measured her in terms of gross domestic fixed capital formation. This is again plotted against the number of Internet hosts to illustrate the respective relationships. In this case, the aggregate relationship as well as those of small and larger states with physical capital is weaker although still clearly positive. For small states, the weak relationship between physical capital stock and the number of Internet hosts reinforces the general inferences derived from the preceding discussion of telecommunications infrastructure and information technology adoption. For small states, the number of Internet hosts is less strongly correlated with high rates of gross physical capital formation.

[Figures 6, 6a and 6b here]

The discussion of the growth impact of information technologies (Section 1.1) and of the determinants of growth in small states reviewed in Section 1.2 both indicate that human capital is expected to play a critical role in the adoption of *e*-commerce and its consequent growth impact. The relationship between the adoption of *e*-commerce and human capital stock, measured by gross

enrolment ratios, is shown in Tables 7, 7a and 7b. Again, there is a clearly positive general relationship between these variables as well as for larger states. For small states however, this relationship is much weaker, primarily because of the generally consistently high enrolment rates independent of the number of Internet hosts. This would tend to support theoretical inferences concerning the critical need for a high human capital stock in small states but this is not in itself a sufficient condition for their adoption of *e*-commerce. Again, this suggests that the critical focus relates to the magnitude of requisite information technology infrastructural investments and the extent to which they are 'lumpy, i.e. whether there are significant minimum thresholds necessary for the adoption of *e*-commerce.

[Figures 7, 7a and 7b here]

A summary scatter matrix diagram of the correlation between the key variables used in this study is provided in Figure 8.

[Figure 8 here]

3.2 Simultaneous Equations Framework Results & Factor Analysis

The introductory descriptive correlation statistics presented in Section 3.1 strongly suggest that the adoption of *e*-commerce depends upon economic growth success measured in terms of income levels. Income levels are also a useful measure of market size and therefore also capture the effects of constraints imposed by the low absolute magnitude of local demand in small states. The adoption and absorption of *e*-commerce is also dependent upon critical stocks of physical capital, particularly telecommunications infrastructure, and human capital. The evidence in Section 3.1 indicates that physical and human capital stocks are necessarily complementary and that both may have critical minimum thresholds that must be satisfied simultaneously.

The theory of economic growth in all of its forms highlights the key contribution of a country's stock of physical and human capital influence. Further, the adoption of *e*-commerce and other information technologies is both strongly influenced by the accumulation of physical and human capital and, in turn, also enhances economic growth. Any empirical analysis of the adoption of *e*-commerce must therefore acknowledge explicitly the endogenous relationship between e-commerce adoption and economic growth.

This can be represented in a basic simultaneous equation framework as follows:

$$LHosts = f(LogDGFC, LnEnrol, LogTel, LgGDP, \text{other factors} + \text{error term}) \quad (1)$$

$$LgGDP = f(LogDFCF, LnEnrol, LogTel, Lhosts, \text{other factors} + \text{error term}) \quad (2)$$

As anticipated, the variables LogDFCF, LnEnrol and LogTel are all highly correlated as is shown in the component matrix in Table 2. Factor analysis (a data reduction technique) is then used to compute a composite measure of investment (CMI). This new variable measures each state's combined levels of physical, telecommunications infrastructure and human capital stock. The factor loadings indicate that the three variables are highly positively correlated with the composite measure of investment

Table 2: Component Matrix

Component Matrix [a]

	Component
	1
LOGTEL	.934
LNENROL	.927
LOGDFCF	.750

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

The regression analysis is undertaken using the new composite measure of investment (CMI) in place of the three previously highly correlated independent variables. The CMI variable is therefore substituted into the original simultaneous equation framework, Equations (1) and (2) respectively, to give:

$$LHosts = f(CMI, LgGDP, \text{other factors} + \text{error term}) \quad (3)$$

$$LgGDP = f(CMI, LHosts, \text{other factors} + \text{error term}) \quad (4)$$

In order to capture the effect of an economy's size on the adoption of *e*-commerce within this statistical framework, a dummy variable (Small) is used to indicate whether a state is small (= 1) or large (= 0). This dummy is included in both Equations 3 and 4, giving two further equations to be tested:

$$\text{LHosts} = f(\text{CMI, LgGDP, Small, other factors + error term}) \quad (5)$$

$$\text{LgGDP} = f(\text{CMI, LHosts, Small, other factors + error term}) \quad (6)$$

The regression technique employed in the empirical analysis is seemingly unrelated regression (SURE) in LIMDEP 7.0 and this is used to estimate both specifications of the simultaneous equations, Equations (3) (4) and (5) (6) respectively. The SURE regression technique captures the degree of simultaneity between dependent variables from two or more structural equations. More importantly in this case, SURE provides a means to include explicitly in the models other unobservable factors that affect both economic growth and *e*-commerce adoption.

3.3 Regressions Analysis of *e*-Commerce & Small States

Four empirical simulations using the SURE estimation technique are undertaken for the simultaneous equations developed in Section 3.2, the first two using the first specification (Equations (3) and (4)) followed by two using the second specification (Equations (5) and (6)). The available data for the principal independent variables reduces the size of the data set to 126, of which 93 are large states (> 3 million population) and 33 are small (< 3 million). The empirical results of these simulations for both specifications of the model are presented in Table 3.

[Table 3 here]

Simulation 1

The first simulation of the model tests Equations (3) and (4), i.e. specified without the small states dummy, with the number of Internet hosts (LHosts) and LgGDP as the respective dependent variables. GDP is found to be a positive and significant determinant of Internet hosts while the composite CMI variable is found to be a positive and significant determinant of GDP. These results confirm the simultaneity of the independent variables LHosts, LgGDP and CMI and that investment in physical and human capital affect *e*-commerce adoption both directly and indirectly via their impact upon GDP. Further, the results support the hypothesis that the adoption of *e*-commerce and GDP are endogenously related.

Simulation 2

The second simulation of the model again tests Equations (3) and (4), again specified without the dummy variable, but regresses the composite investment variable (CMI) on the number of Internet hosts (LHosts) and then CMI and LHosts on GDP (LgGDP) respectively. The CMI variable is found to be a positive and significant determinant of the number of Internet hosts while both CMI and LHosts are also found to be positive and significant determinants of GDP (LgGDP). These results provide strong evidence to support the view that CMI has critical simultaneous impact on both GDP and the number of Internet hosts via investment in physical and human capital. Further, the number of Internet hosts is also found to be a good predictor of GDP.

Simulation 3

The third simulation of the model has an identical specification to that of Simulation 1 except that it includes the small states dummy. In the first regression, GDP is found to continue to have a positive and significant impact on the number of Internet hosts but the small states dummy is found to be positive but insignificant. This suggests that the small size of an economy does not directly affect its adoption of *e*-commerce adversely contrary to a priori expectations. In the second regression, both investment (CMI) and the small states dummy are found to be significant determinants of GDP, the former positively and the later negatively. The first conforms to expectations and replicates the result

of the first simulation. The negative and significant size dummy indicates that the GDP of small states is affected indirectly by their size and its growth effect on the adoption of *e*-commerce.

In the context of the theoretical and empirical literature on small states, this is a notable finding. Although a priori expectations are that small size adversely affects growth and levels of GDP, the results of most empirical analyses are generally statistically insignificant (see Armstrong et al., 1998). The strongly negative and significant coefficient on the size dummy found here may result from the use of a simultaneous equations framework but may also be affected by data specification and other statistical problems. A fuller discussion of this finding must await another paper.

Simulation 4

The fourth simulation has an identical specification to Simulation 2 except that it incorporates the size dummy for small states. As in Simulation 2, investment (CMI) is found to be a positive and significant determinant of the number of Internet hosts in the first regression. The size dummy is negative in accord with a priori expectations but only very weakly significant. This suggests that small size does have some adverse on the number of Internet hosts. In the second regression, all three variables are found to be significant. As in the second regression in Simulation 2, investment and the number of Internet hosts are positive and significant. The size dummy however, is again strongly negative and significant and suggests that small size has a strongly adverse impact on the number of Internet hosts but only indirectly through its negative effect on GDP. The fact that the dummy size variables in Simulation 3 and 4 are both negative and significant suggests that further investigation of this relationship is merited.

4. Bridging the Digital Divide: Conclusions & Policy Issues

The emergence of the information technology sector and the rapid expansion of the Internet and *e*-commerce is creating new businesses as well as offering new ways of doing traditional business. It is evident however, that access to the potentially substantial gains from the *e*-revolution is far from equal, most noticeably with respect to the growing 'digital divide' between the developed and developing countries. The principal explanations for this growing divide revolve around the growing

resource gap between these groups of countries. This resource constraint limits the capacity of many developing to put in place appropriate basic and specialist infrastructure capable of supporting telecommunications and information technology as well as generating the necessary and complementary human capital stock. In the absence of a minimum threshold of both human and physical capital, developing countries cannot be expected to be able to capture the full benefits associated with *e*-commerce, including many potential positive externalities and spillover effects.

This paper is concerned with the constraints and likely impact of the adoption of *e*-commerce by small states. The primary reason for this focus is that small states are, by their very nature, highly open (structural openness), regardless of endogenously determined (functional) openness. Further, the analytical literature on the growth determinants of small states highlights the critical contribution of human capital to the comparative advantage and the international competitiveness of small states. The advent of *e*-commerce therefore constitutes a critical growth opportunity for small states given that the successful exploitation of the new information technologies depends upon the availability of complementary human capital. This suggests that many small states are well placed to benefit substantially from the adoption of *e*-commerce. In addition, *e*-commerce offers the potential for many remote and peripheral states, including many small and developing states, to eliminate or substantially reduce the adverse impact of their geography by reducing their 'distance' from key markets and growth poles. The economic growth potential offered by the effective adoption and harnessing of *e*-commerce however, is also dependent upon a pre-requisite of costly and possibly 'lumpy' investment in appropriate telecommunications and information technology infrastructure. The magnitude of such investment immediately places small and developing states at a distinct disadvantage with respect to resource capacity and the existence of increasing returns to scale. This paper is therefore concerned with the rate of adoption of e-commerce and the differences between states based upon interaction between their income levels, size and investment in physical and human capital.

The first stage of the empirical analysis provides a descriptive survey of the inter-relationships between the key variables for the full data set of 205 states (129 large and 76 small – i.e., less than 3 million). These provide some indication of the extent to which the key variables in the analysis - GDP, investment and Internet hosts - are related and also reveal some important differences between the sub-sets of small and large states (see Figures 1 to 8). Using a simultaneous equations framework

and factor analysis provides a means to produce a new composite investment variable which combines the stock of physical and human capital. This is then substituted into the empirical analysis in Section 3.3 using seemingly unrelated regression (SURE) techniques in LIMDEP 7.0 for a reduced sample of 126 states (93 large and 33 small), given the limited availability of data for key variables. The principal findings generally confirm a priori expectations regarding the significance of and simultaneity between the key variables being analysed. Investment in both physical and human capital are significant determinants of *e*-commerce adoption both directly and indirectly through their impact upon growth. The introduction of a size dummy into the simulation reveals that small size doe not in itself adversely affect the adoption of *e*-commerce but it has a significantly negative impact on GDP which, in turn, feeds through into *e*-commerce. The key findings of this paper therefore confirm that there is a strongly significant relationship between growth and the adoption of e-commerce, determined by the level of investment in physical and human capital. This fits with a priori expectations concerning the digital divide between relatively wealthy developed states and developing states. The significance of most of the size dummies however, reveals a more subtle and critical relationship that suggests that the magnitude of the requisite initial investment in appropriate infrastructure is acting as a constraint to the adoption of e-commerce by smaller and poorer states. This is likely to constitute a formidable barrier for even for the wealthier small states which have the requisite complementary stocks of human capital. For poorer developing states generally however, including poor small states, this physical capital constraint is likely to be exacerbated by problems relating to complementary investment in human capital – representing a 'double barrier' to the adoption of *e*-commerce.

This paper provides only an initial survey and analysis of the digital divide and the role of size in the adoption of *e*-commerce. Nevertheless, its results tend to confirm the general view that the gains from the adoption of new information technologies are likely to be confined to wealthier, and generally larger, states. In addition, it highlights the potential barriers to their adoption by smaller and poorer states owing to the magnitude of the investments required in both infrastructure and human capital. These issues need to be investigated further, particularly with respect to the precise costs of technological investment or upgrading required and the nature of the required human capital.

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Table 3: Simulation Results

Model specification 1 (Excluding the Small state dummy variable)								
Regression model					Regression model			
Dependent Variable LHOSTS					Dependent Variable LGGDP			
Variable	***Coefficient***	***Standard Error***	***T-Ratio***		***Variable***	***Coefficient***	***Standard E***	***T-Ratio***
Constant	-41.106	40.093	-1.025		Constant	23.982	45.355	0.529
CMI	0.061	0.049	1.248		CMI	0.211	0.054	3.925
LGGDP	0.396	0.062	6.425					
LogLikelihood			-1463.878		LogLikelihood			-1489.802
Restricted Log Likelihood			-1488.011		Restricted Log Likelihood			-1498.255
Akaike Info Criteria			14.311		Akaike Info Criteria			14.554
Model specification 1 (Excluding the Small state dummy variable)								
Regression model					Regression model			
Dependent Variable LHOSTS					Dependent Variable LGGDP			
Variable	***Coefficient***	***Standard Error***	***T-Ratio***		***Variable***	***Coefficient***	***Standard E***	***T-Ratio***
Constant	-31.599	43.915	-0.720		Constant	37.343	41.432	0.901
CMI	0.145	0.052	2.790		CMI	0.150	0.050	3.000
					LHOSTS	0.423	0.066	6.425
LogLikelihood			-1483.187		LogLikelihood			-1470.493
Restricted Log Likelihood			-1488.011		Restricted Log Likelihood			-1498.226
Akaike Info Criteria			14.490		Akaike Info Criteria			14.376
Model specification 2 (Including the Small state dummy variable)								
Regression model					Regression model			
Dependent Variable LHOSTS					Dependent Variable LGGDP			
Variable	***Coefficient***	***Standard Error***	***T-Ratio***		***Variable***	***Coefficient***	***Standard E***	***T-Ratio***
Constant	-42.901	41.962	-1.022		Constant	77.224	45.187	1.709
CMI	0.062	0.049	1.262		CMI	0.177	0.052	3.396
LGGDP	0.399	0.064	6.196		SMALL	-209.499	48.835	-4.290
SMALL	6.814	47.011	0.145					
LogLikelihood			-1463.356		LogLikelihood			-1480.484
Restricted Log Likelihood			-1488.011		Restricted Log Likelihood			-1498.255
Akaike Info Criteria			14.316		Akaike Info Criteria			14.473
Model specification 2 (Including the Small state dummy variable)								
Regression model					Regression model			
Dependent Variable LHOSTS					Dependent Variable LGGDP			
Variable	***Coefficient***	***Standard Error***	***T-Ratio***		***Variable***	***Coefficient***	***Standard E***	***T-Ratio***
Constant	-12.084	45.401	-0.266		Constant	82.000	41.475	1.977
CMI	0.133	0.052	2.533		CMI	0.125	0.049	2.565
SMALL	-76.790	49.069	-1.565		LHOSTS	0.395	0.064	6.196
					SMALL	-179.145	45.085	-3.973
LogLikelihood			-1481.464		LogLikelihood			-1462.379
Restricted Log Likelihood			-1488.011		Restricted Log Likelihood			-1498.255
Akaike Info Criteria			14.483		Akaike Info Criteria			14.306

Figure 1: Scatter Diagram of Population & Number of Internet Hosts per 10,000 Inhabitants, 2000

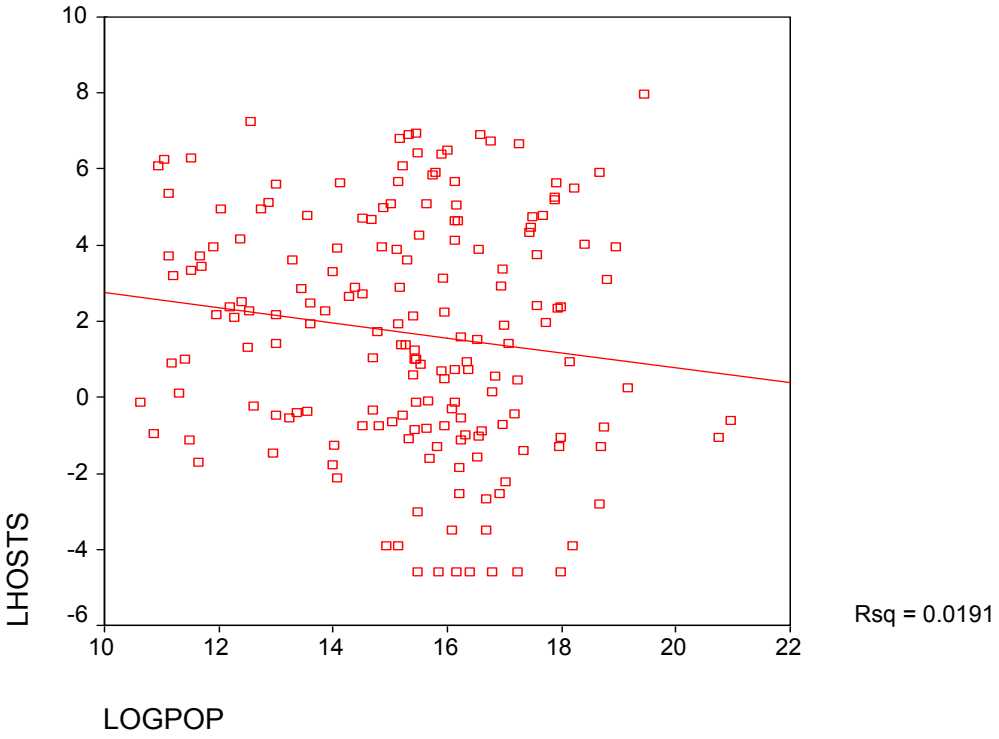

Figure 2: Box Plots of *e*-Commerce Adoption in Large & Small States

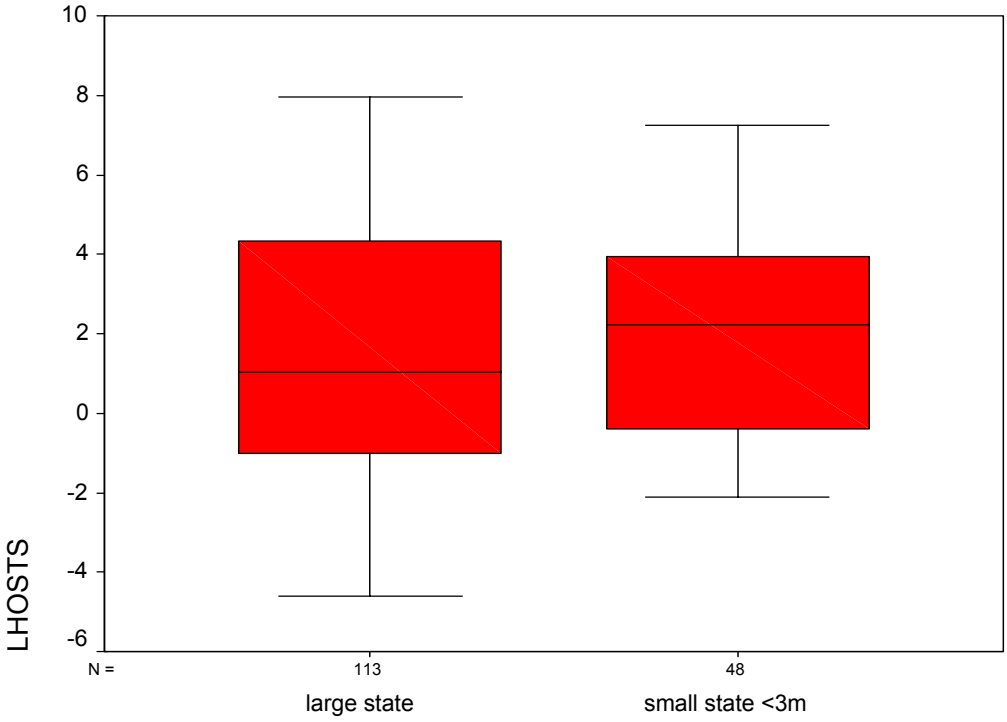

Figure 3: Box Plots of *e*-Commerce Adoption by Income Group, World Bank Definitions

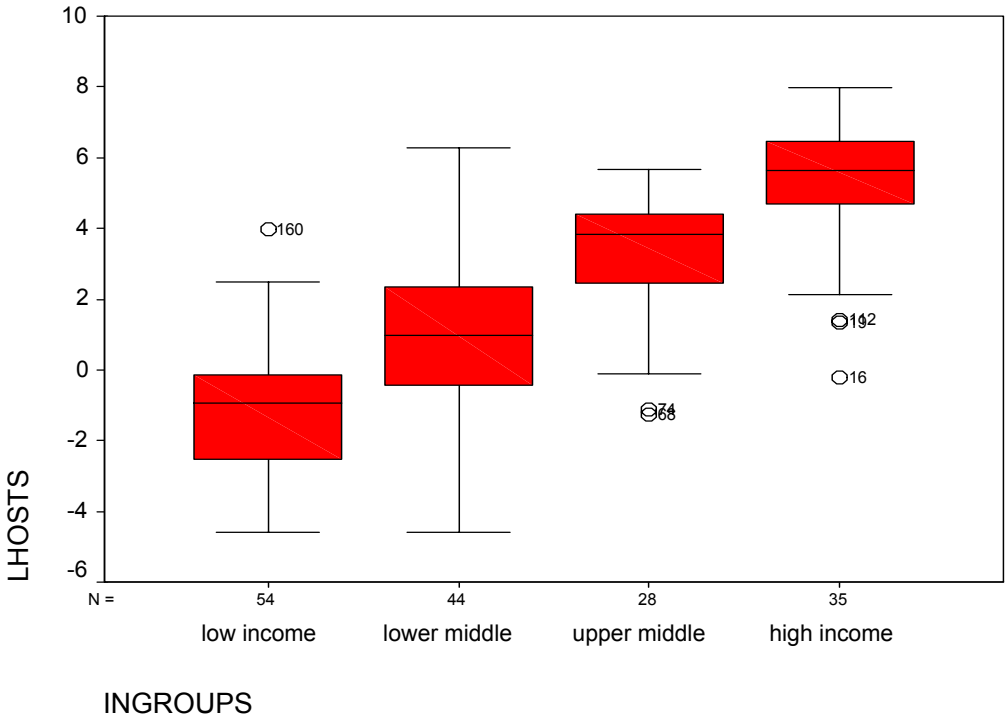

Figure 4: Scatter Diagram of *e*-Commerce Adoption & Real GDP Per Capita, Small & Large States

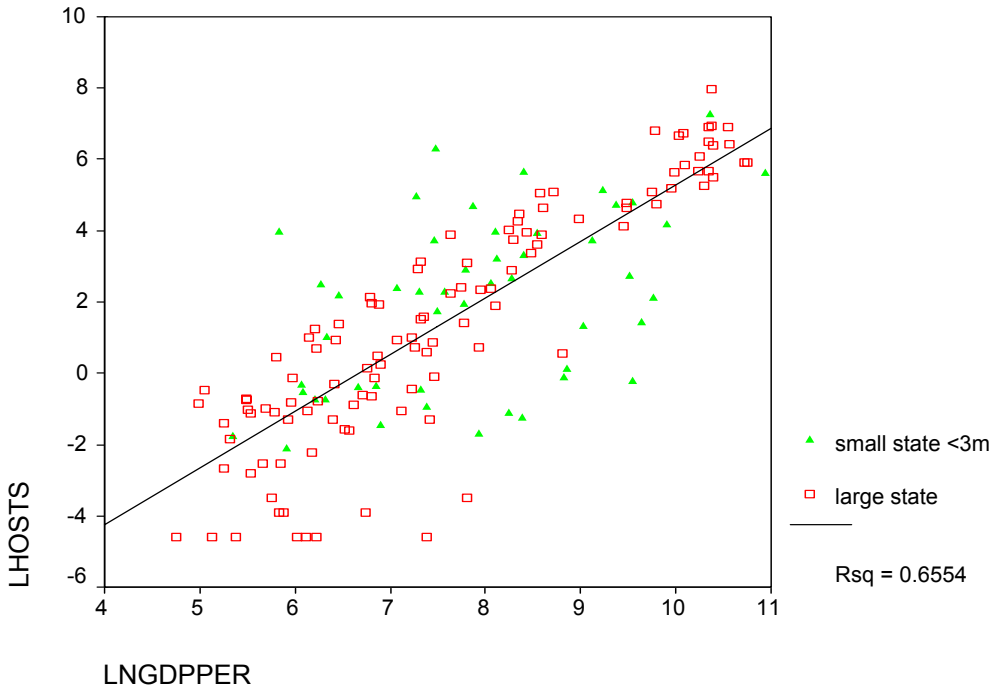

Figure 4a: Scatter Diagram of *e*-Commerce Adoption & Real GDP Per Capita in Small States

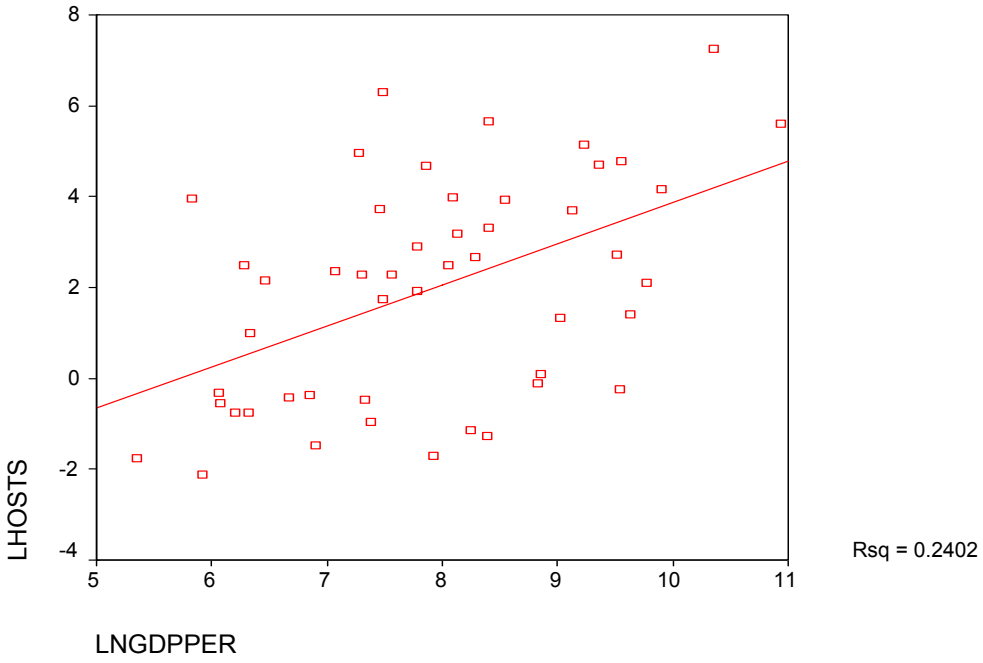

Figure 4b: Scatter Diagram of *e*-Commerce Adoption & Real GDP Per Capita in Large States

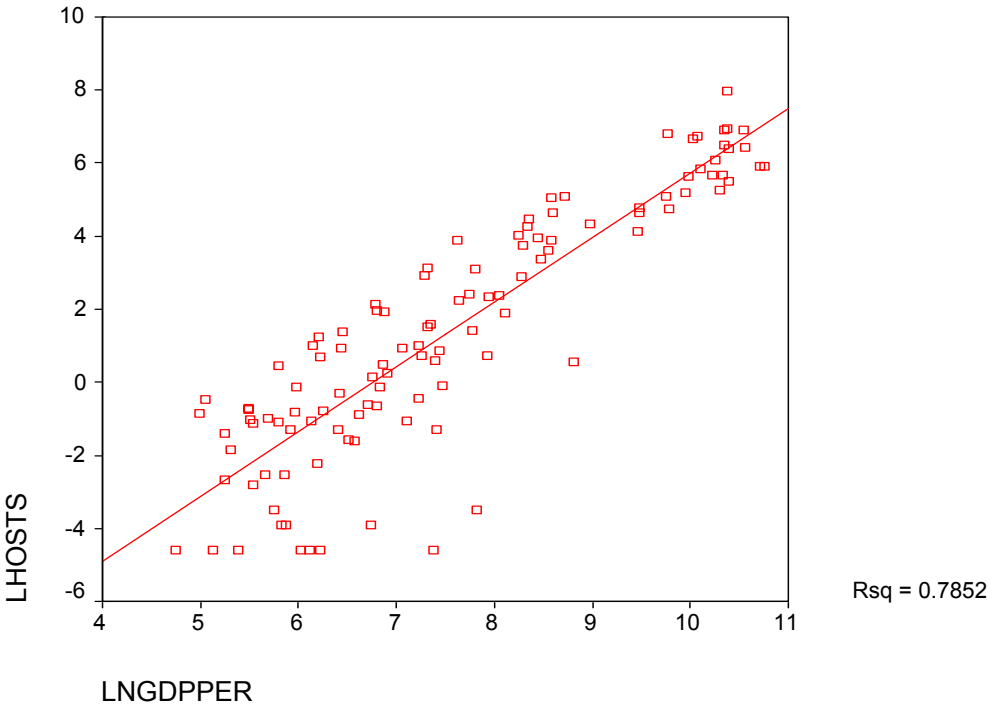

Figure 5: Scatter Diagram of *e*-Commerce Adoption & Telecommunication Infrastructure, Small & Large States

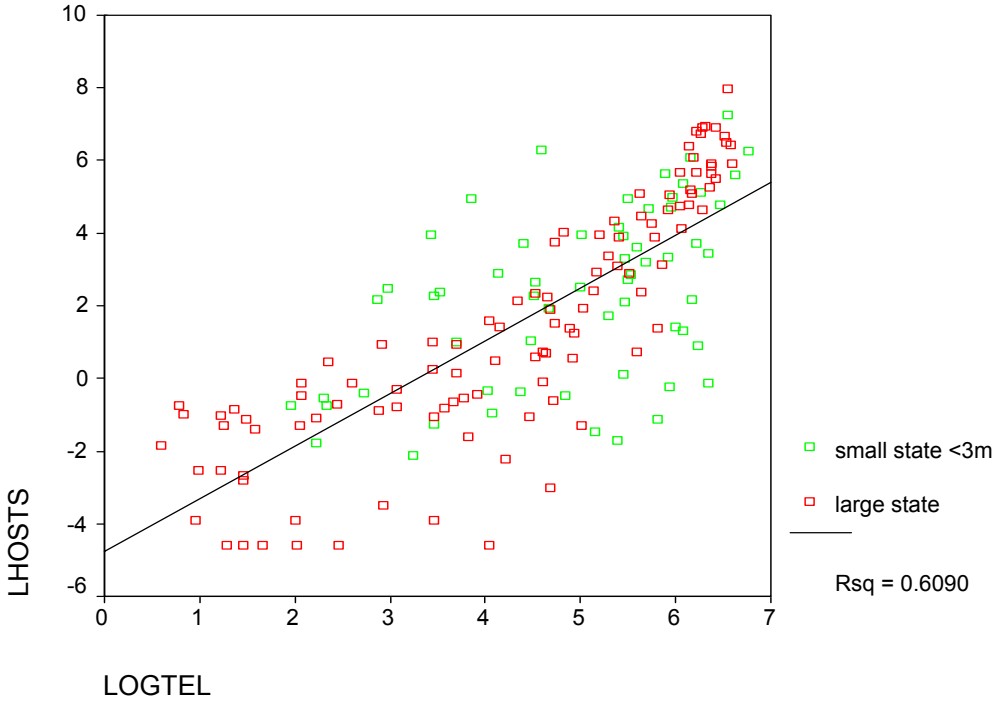

Figure 5a: Scatter Diagram of *e*-Commerce Adoption & Telecommunication Infrastructure in Small States

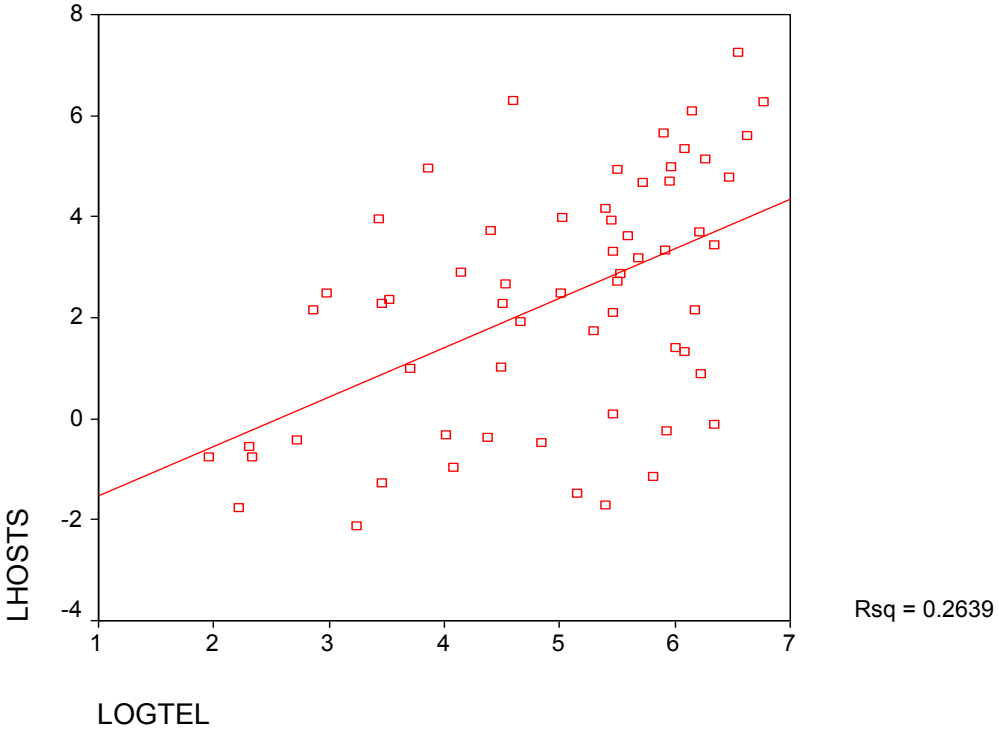

Figure 5b: Scatter Diagram of *e*-Commerce Adoption & Telecommunication Infrastructure in Large States

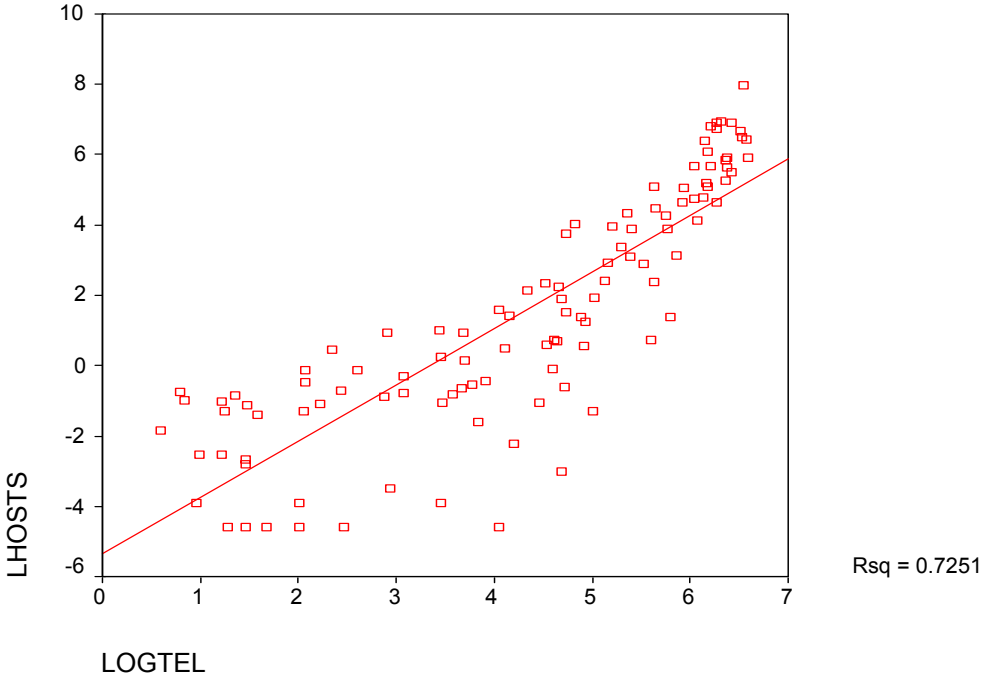

Figure 6: Scatter Diagram of *e*-Commerce Adoption & Physical Capital Stock, Small & Large States

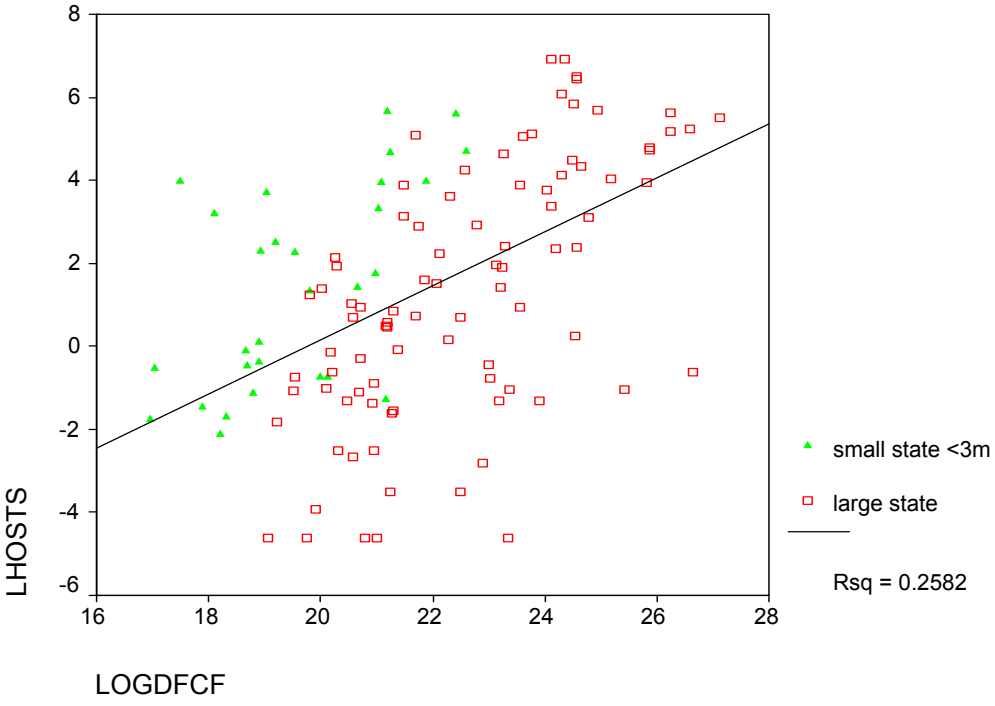

Figure 6a: Scatter Diagram of *e*-Commerce Adoption & Physical Capital Stock, Small States

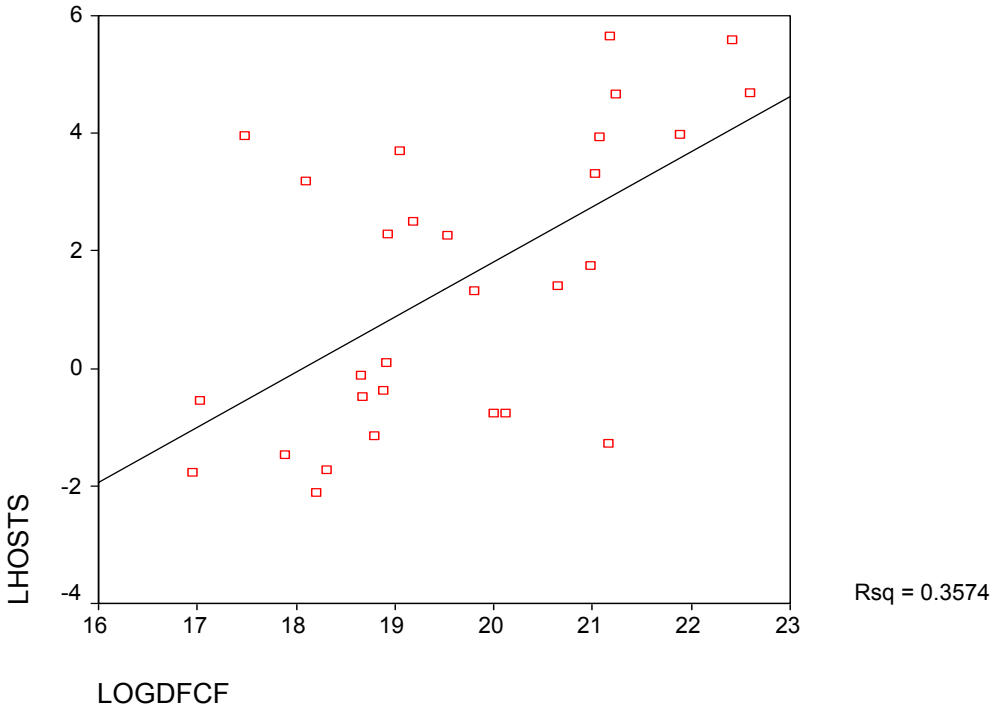

Figure 6b: Scatter Diagram of *e*-Commerce Adoption & Physical Capital Stock, Large States

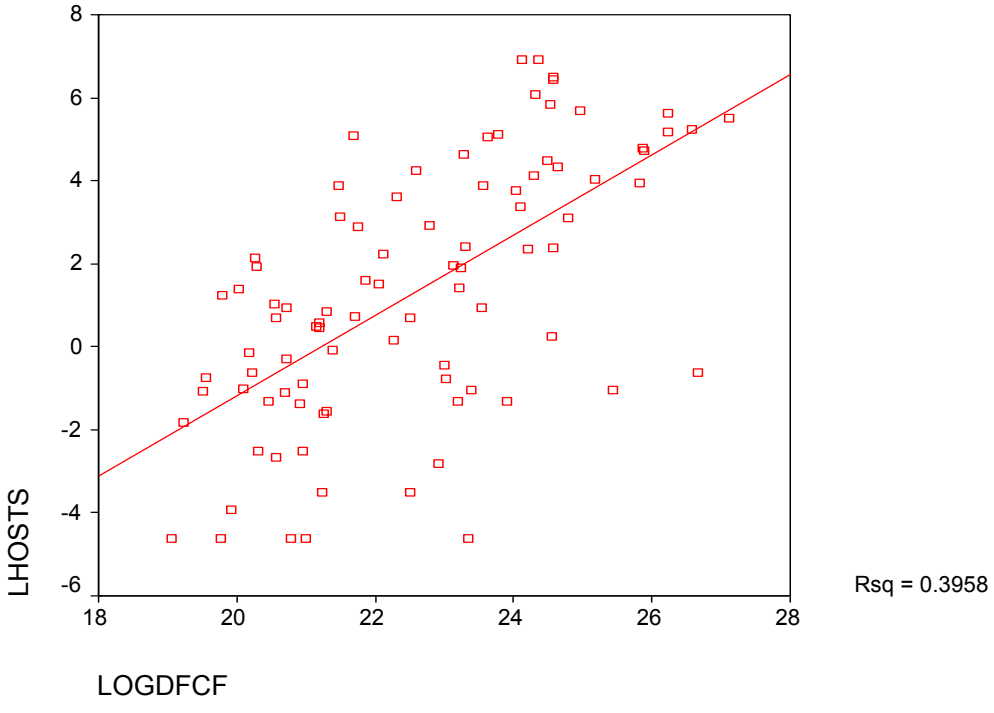

Figure 7: Scatter Diagram of *e*-Commerce Adoption & Human Capital Stock, Small & Large States

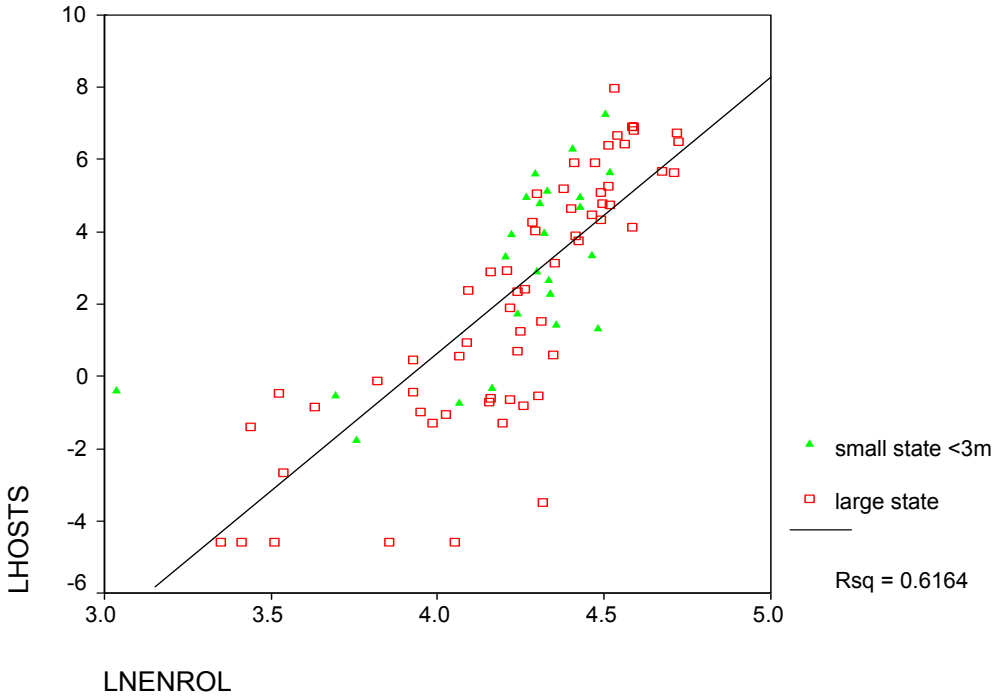

Figure 7a: Scatter Diagram of *e*-Commerce Adoption & Human Capital Stock, Small States

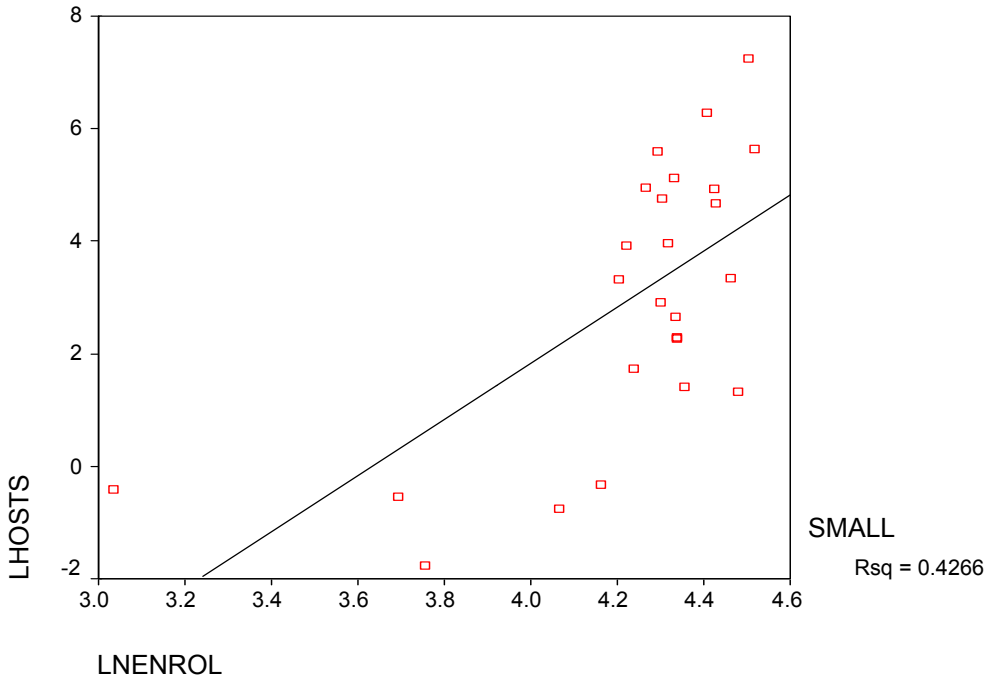

Figure 7b: Scatter Diagram of *e*-Commerce Adoption & Human Capital Stock, Large States

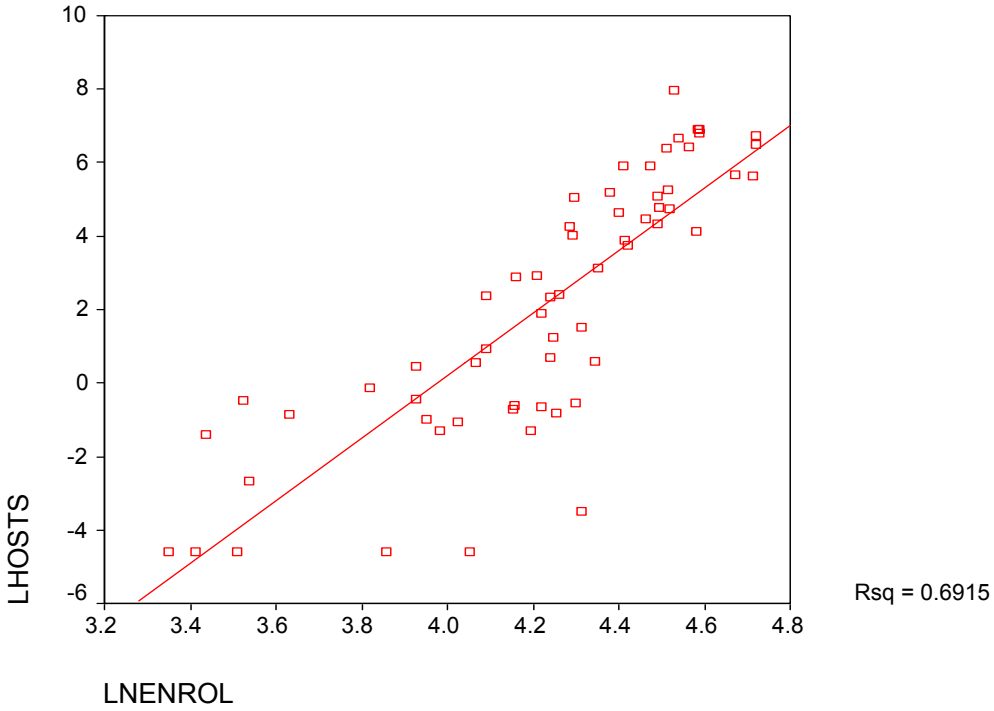

Figure 8: Summary Scatter Matrix Diagram of Correlation Between Variables