

The ICT-Enabled Global Economic Crisis

Kurt DeMaagd

Michigan State University

kdegaard@msu.edu

ABSTRACT

This study examines one of the unintended consequences of ICT investments in developing economies. Although ICT has helped developing countries create links with the global marketplace, which in turn has stimulated economic growth during the good times, it has also synchronized these economies such that the global economic crisis has also affect them. This paper specifically studies the question of whether ICT investments, regardless of their inherent productivity enhancing benefits, also causes a country's economic growth to become more highly correlated with global economic trends. Interestingly, we find that although ICT does cause a country to be more synchronized with the global economy, the country's level of exports does not.

INTRODUCTION

In 2008, World Bank President Robert Zoellick stated, "The global financial crisis, coming so soon after the food and fuel crises, is likely to hurt the poor most in developing countries" (The World Bank, 2008). Because the global economic crisis has a potential effect on the world's poor, it presents a strong incentive to evaluate the causes of the economic collapse. On such potential area is the role of Information and Communication Technology (ICT) spending. What role did ICT infrastructure spending have in spreading the global recession to developing countries?

Although it is common to view ICT as a tool that can directly increase productivity, there is an alternative role for ICT based on a transaction cost perspective. In contrast to the view that

ICT increases an individual or firm's productivity, ICT can also help to provide trade links with the rest of the world. This additional linkage with the broader world economy may expose the individual or business to the highs and lows of global economic trends. Given the generally positive trends of economic growth in recent decades, this would mean that ICT would generally be a positive force for development. Yet the recent downturn shows one of the risks of integration with the global economy: the potential for the global economy to drag the country back down.

This is particularly important when examining the role of ICT in developing countries. The integration of developing countries with the global marketplace has often been credited as one of the primary forces behind the poverty reduction trends and general increases in wellbeing in many emerging markets (Rodrik, 2007a). Yet the risks of economic growth through global integration as opposed to domestic market development have been demonstrated in the recent economic crisis. If ICT adoption is a contributor to this risk factor, then it is an important element in understanding how developing countries manage their technology investments.

To examine the topic, this paper specifically studies the question of whether ICT investments result in an increased correlation between a country's economic growth and global economic growth. Unlike traditional studies that merely look at the potential upside, this also includes whether ICT increases the chances of economic decline when the global economy declines. This is done by examining a data set of both developed and developing countries. The findings indicate that, whether studying developed or developing countries, the effect is the same: an increase in ICT spending results in a closer correlation between the country's economic trends and the global economic trends.

To summarize the findings:

- 1) ICT investment results in a higher correlation with global economic growth.
- 2) Exports do not appear to result in an increased correlation with global economic growth.
- 3) More business-friendly regulatory policies result in an increase correlation with global economic growth.

In addition to the core research questions, this study also makes a methodological contribution to the current literature. The general theory of how ICT investments synchronize domestic economic growth with global economic growth is based on transaction costs. Yet most of the prior literature in this area has focused on production and productivity. (Much of the prior

literature has acknowledged the benefits of ICT for transaction costs, but the actual research models generally do not take advantage of this underlying theory.)

The paper is structured as follows. In the next section, we review the current literature on the link between ICT spending and economic growth. The factors discussed in that literature are used to develop a research model. Third, the source of data and the data analysis are described. Finally, the potential implications for our understanding of the value of these technology investments are described.

LITERATURE

Although recent history has seen a diversity of research on the role of various ICT in economic growth, the telecommunications sector has studied similar questions for several decades. For example, some early research studied whether investments in telecommunications infrastructure increase economic growth (Aschauer, 1989; De Long & Summers, 1991). Of course, the holy grail of research is to show not just correlations but causal links, which has also been shown in the previous studies (Cronin et al., 1991). These studies have established that telecommunications are not merely a luxury for the rich. Instead, the research has developed a general theory that telecommunications infrastructure is a prerequisite for economic growth. The ability to share information helps to coordinate many other types of economic activity (Madden & Savage, 1998). Hence, without a well-developed telecommunications infrastructure, it will not be possible to realize the value of other types of investments.

These studies have shown that telecommunications should create economic growth around the world, but some studies have indicated that developing countries may not obtain the same level of benefits from their investments. For example, studies by Dewan and Kraemer (1998, 2000) test if IT investments had an effect on economic growth. They find that IT—defined using metrics such as computers and enterprise software—has a positive effect on productivity in developed economies, but their results for developing economies are not statistically significant. They speculate that IT did not have any detectable effect in developing regions because of the limited infrastructure, a view shared in other research (DeMaagd & Moore, 2007; Mansell, 2001).

Although Dewan and Kraemer primarily focused on infrastructure in the narrower sense in a relatively narrow sense of computers and software, a broader interpretation may also affect the value of ICT investments. For example, the rule of law is an important factor in understanding the value of ICT investments. Zhang identified several legal prerequisites for successful implementation of ICT projects (Zhang, 2001). These included the implementation safeguards to ensure a competitive environment, mandatory interconnection with competing service providers, universal service rules to ensure access in even rural regions, transparent licensing procedures, an independent regulatory body, and pro-competitive allocation of scarce resources (e.g., frequencies for wireless communication). Work such as Zhang's has become part of the commonly accepted view that ICT works best in a deregulated environment.

Shifting the models from the country-level to lower levels, some of the previous research has identified the potential value of ICT investments, but has also called into question the link between ICT and profitability. Hitt et al. (1996) is one of the classic examples, argues that competition will transfer any surplus to the consumer (Porter, 1980). In other words, ICT becomes a strategic necessity, not a source of competitive advantage (Celmons, 1991). Although this paper does not attempt to address the question of profitability in countries that invest in ICT, these studies on profitability do emphasize the need for a more nuanced understanding of the value of ICT.

Several other factors affect the ability of developing in realizing profitability in ICT projects: barriers to entry and the limited market size. First, consider the role of barriers to entry. Traditionally, we would expect that any firm earning premium profits from IT would attract competitors, thereby driving profits back down. But, if there are sufficient barriers to entry, then the firm can enjoy a competitive advantage from their IT investment (Bain, 1956). In the developing world, high fixed costs due to poor infrastructure present a strong barrier to entry. More specific to the IT question, developing nations often lack even the most rudimentary telecommunications infrastructure. As a result, a firm must make substantial investments to build their own IT infrastructure. This presents obstacles to copycat firms that would like to also use IT to enter these markets. Hence, the firm may be able to increase its profitability to the point where it can rationally enter the market.

Of course, if the firm can use IT to break down some of the barriers, then so could a competitor. This is where the limited market size comes into the picture. If another firm already satisfies most of the market's demand, a new entrant could be blocked due to a lack of demand (MacMillan, 1983). In our developing world scenario, smaller potential markets make it easier for a firm to capture a large portion of the demand in a particular market. As a result, when one firm chooses to invest in IT to break open the market, they may satisfy a large enough portion of the demand that it is no longer profitable for another firm to make the necessary investments to attempt to enter the market. These different factors show the ability to realize the benefits of an ICT investment are dependent on the underlying economic environment in addition to the basic production functions.

TRADE LINKAGES AND ECONOMIC GROWTH

The theoretical basis for this paper begins with prior work primarily studied under the topic of information technology and firm size. Although this literature looks at ICT affects the size of a business, it is fundamentally an analysis of the make versus buy decision. In theory, ICT should reduce both internal and external transaction costs. Yet, the relative effects may not be proportional. If ICT has a bias towards reducing internal transaction costs, then firms should increase in size. If ICT has a bias towards reducing external transaction costs, then firms should decrease in size (Malone, 1987). This research found that ICT did in fact result in smaller firms, supporting the hypothesis that it helped external coordination more than internal coordination (Brynjolfsson, Malone, Gurubaxani & Kambil, 1994).

The same make versus buy comparison relates to countries. In this case, the question is whether to meet all of the country's demand from internal production or to specialize and turn to external markets to fulfill the remainder of demand. In the same way that ICT helps firms coordinate with other firms, ICT can help countries coordinate and trade with other countries. In this way, ICT should help countries integrate with the global supply chain (Feenstra, 1998).

Yet this also provides new sources of risk. Historically, the focus on the risks of global integration fall into three areas: product complexities, manufacturing process complexity, and supply chain complexities (Ritchie & Brindley, 2000). Yet at the country level, a risk emerges. By integrating more fully with other countries, it bears additional risks based on the economic fluctuations of its trading partners. Economic shocks in countries that supply goods can disrupt

internal supply chains. Economic declines in trading partners will threaten demand for locally produced goods and services. Granted, similar domestic economic fluctuations would present similar risks if the country were not globally integrated. Yet this risk is outside the country's control and hence represents a source of risk that is particularly difficult to manage.

HYPOTHESES AND MODEL

The goal of this research paper is to study if ICT spending results in a greater correlation between the country's economic growth and global economic growth. We perform an empirical investigation to test this relationship. Although the primary focus of the study is the ICT link, we also control for several additional factors: the country's exports and its regulatory environment. In addition to controlling for their effects, the addition of these factors will help identify the relative role of ICT versus other factors.

Hypothesis 1: An increase in a country's ICT investment will result in a higher correlation between the country's GDP growth and global GDP changes.

The literature review has already outlined some of the previous literature that studied the impacts of telecommunications and information technology investments as it related to GDP. The prior research found a positive link. This paper examines the problem from a slightly different perspective. Whereas the prior literature assumed that ICT had a direct link to increased productivity, there is an alternative hypothesis that may have at least partially contributed to the benefits of ICT investments. The general argument is as follows:

- 1) ICT investments help coordinate with other global economic activities
- 2) The general trend in recent decades has been towards robust economic growth
- 3) Hence, ICT investment results in economic growth

In times of economic growth, according to the above formulation, ICT will have a positive impact. But during times of global economic decline, ICT will have a negative impact. It should be noted, however, that the goal of this alternative hypothesis is *not* to contradict the previous

studies on the value of the value of ICT but merely to provide a nuance that may explain a portion of the previously detected economic impacts.

In Step 1 of the above argument, the rationale basically takes a transaction cost perspective on the value of ICT. This transaction cost perspective assumes that ICT does not directly make the production process more productive. Instead, it will streamline the search and information costs necessary to participate in the global marketplace. Because these costs are reduced, it will make it easier for the country to transact business with other countries, thereby tying its economic fate with that of the rest of the globe. When the global marketplace does well, the country's reduced transaction costs will allow it to share in the increased wealth. When the global marketplace declines, those previously realized benefits decline too. In other words, the country's economy becomes more closely tied to the fate of the global economy.

Hypothesis 2: An increase in a country's exports will result in a higher correlation between the country's GDP growth and global GDP changes.

This hypothesis is related to the first. The first hypothesis argues that ICT investments help the country integrate with the global marketplace. A symptom of this integration should be an increase in exports as the new ICT investments help the country identify and transact with new global trading partners. As these exports become a more important part of the country's economic position, then the global marketplace will have a greater affect on the country's total output. Hence, the country's GDP will be more highly correlated with global GDP.

Hypothesis 3: A decrease in the value a country's Ease of Business ranking will result in a higher correlation between the country's GDP growth and global GDP changes.

It should first be noted that the Ease of Business value used in this study is a rank value. (E.g., 1st for the country with the best ease of business.) Hence low values are good. This hypothesis claims that the more friendly the business environment, the more closely the country's GDP

growth will be correlated with the global growth trend. The role of public policy and the regulatory environment has been previously recognized as a driver of economic growth (e.g., King & Rebelo, 1990; Nelson & Romer, 1996; Rebelo, 1991). According to these theories, the regulatory environment affects the incentives to produce and accumulate capital. It is often concluded that free market reforms will increase these incentives, thereby increasing economic growth. Though it should be noted that the one-size-fits-all approach to deregulation has also been questioned by some recent literature (Rodrik, 2007b).

Yet regulatory policies can also exacerbate economic decline or at least do little to cushion the decline. For example, monetary policy can affect how recessions affect a given country or spread between countries (Hamada & Sakurai, 1978). Yet of more interest to this particular paper is that certain very non-free market policies can cushion the market during a downturn. For example, food stamps can serve as a monetary stabilizer during recessions (Hamermesh & Johannes, 1985).

Because of this, free market economies allow for free growth when the economy is increasing but will also allow the market to fall when the trend is towards a decline. Hence, we hypothesize that the pro-business economies will be more highly correlated with global economic trends.

Using the above hypotheses, the research model used is:

$$CORR_{t,i} = \beta_{ICT} ICT_{t,i} + \beta_{EX} EX_{t,i} + \beta_{REG} REG_{t,i} + \alpha_t + \lambda_i + \varepsilon_{t,i}$$

where *CORR* is the correlation between the country's GDP and the global GDP, *ICT* is the amount of investment in the ICT sector, *EX* is the amount of exports for the country, *REG* is the ranking of the business friendliness of the country's regulation. The β terms are the regression coefficients, α is the time-specific error term, λ is the country-specific error term, and the *i* and *t* subscripts correspond to the country and time, respectively. This model assumes a random effects regression. This assumption is statistically tested in the Analysis section.

DATA

The data set used is based on 31 countries in the period from 2005 to 2008. This data set includes 18 developed countries and 13 developing countries. The selection of data was constrained by the ability to find data on all of the desired variables over a reasonable length of time. The time frame chosen was particularly limited because of a lack of the Ease of Business ranking for countries before 2005. The list of countries is shown in Table 1. The classification of developed versus developing used in Table 1 is based on the International Monetary Fund's (IMF) classification advanced economies.

For the dependent variable, the correlation between the country's GDP and the global GDP is computed using a 5-year sliding window. For example, to compute the correlation in 2005, the correlation is computed between the country and global GDP growth from 2001 to 2005. Similar, the 2006 correlation is computed from 2002 to 2006. GDP data is taken from the IMF using their World Economic Outlook database and the International Financial Statistics database. All GDP data is converted to purchase power parity terms.

To measure ICT spending, the total spending in the telecommunications sector it used. The data comes from the International Telecommunication Union (ITU). The ITU's statistics specifically measure the capital investment in telecommunications measured at the country level. The ITU data is reported in the local currency, so the data used in this study is adjusted to be in purchase power parity terms to make the investment level comparable.

The second independent variable is the level of exports. This data is taken from statistics provided by the IMF in their International Financial Statistics Databases. As before, the value of the country's exports is reported in the local currency by the IMF but is converted to purchase power parity for purposes of this study.

Table 1: Countries in Data Set

Developed Countries	Developing Countries
Australia	Argentina

Austria	Brazil
Belgium	Chile
Canada	China
France	Hungary
Germany	India
Greece	Malaysia
Italy	Mexico
Japan	Poland
Netherlands	Romania
Portugal	Russia
Singapore	South Africa
South Korea	Turkey
Spain	
Sweden	
Taiwan	
United Kingdom	
United States	

Finally, the ease of doing business ranking variable use is the World Bank's metric (2009). This ranking is derived from a country's rank on 10 metrics on the regulatory environment surrounding a business. These metrics are: the ease of starting a business, dealing with permits, employing workers, registering property, getting credit, protecting investors, paying taxes, trading across borders, enforcing contracts, and closing a business. Countries are rating according to each of these sub-metrics, then the ranking is averaged to compute the final ranking. Perhaps not surprisingly, the top 10 ranked countries in the ease of business category are all developed countries.

ANALYSIS

Using the model and data described in the previous two sections, the link between ICT spending and the synchronization with global economic output is examined. This is done using a random effects regression, with the results reported in Table 2. The data is a cross-sectional time-series set of data examining the hypotheses at the country level.

The Breusch-Pagan test indicated the presence of unobserved effects, supporting the use of a random effects model (Woolridge 2001; Breusch & Pagan 1980). The Durbin-Watson test for serial correlation indicated a potential problem (Durbin & Watson, 1971), so the error terms have been computed with Arellano's method (Arellano, 1987). All p-values are computed using a one-tailed T-test.

Table 2: Regression results for factors that influence the correlation between a country's GDP and global GDP

Variable	Coefficient	P
Intercept	0.0109	0.004
ICT spending	0.0045	0.003
Exports	0.0033	0.239
Ease of business	-0.0001	0.042
N	124	
F(3, 120)	4.2727	0.007

Although the primary discussion of the implications of the results is covered in the conclusion section, several factors stand out. First, the ICT spending variable is positive and statistically significant. This supports Hypothesis 1. Second, exports is also positive, but it is not statistically significant. Hence, Hypothesis 2 is not supported. Third, the coefficient for ease of business is negative and statistically significant. Recall that this variable is a rank variable and hence low values are considered good. Hypothesis 3 is supported.

This supports the general theme of the paper. Increased ICT spending results in a greater correlation with global economic growth. This supports the view that ICT helps integrate the

country's economy with the global economy. It is important to note that this includes a control for the level of exports. Merely exporting more does not result in greater integration with the global economy. Instead, ICT spending is a better determinant of this link. In addition, the analysis also controls for the ease of doing business. This controls for the argument that deregulated and open economies are more likely to invest in both IT and to integrate with the global economy, hence confounding the analysis. Yet controlling for the ease of business operation, ICT still has a positive effect.

CONCLUSION

As hypothesized, this study found a link between the level of ICT investment and the country's correlation with global economic growth. This demonstrates an additional reason why investments in information systems might yield benefits for developing countries. Assuming that the global trends are towards growth, then ICT helps countries tap into those global markets. Of course, it also has its corresponding costs, which are discussed in greater detail below.

Curiously, we did not find that exports affected the correlation with global economic output. In theory, exports should be a proxy for the economic activity that follows the reduction in transaction costs. The combination of ICT and export activity should have resulted in a country with a higher correlation with global economic output. Yet the effect was not significant. The most likely explanation is that exports are a relatively limited proxy for globally linked economic activity. The obvious extension would be the combination of imports and exports. Yet this would still look at only a fraction of all international economic activity. For example, foreign direct investments, income from foreign assets, and other types of transfers are also supported by ICT. A proxy such as the country's Current Account may be a better measure of global economic integration.

The results of this study could also have broader implications for our understanding of the value of ICT investments. Historically, research on the value of ICT has focused on the inherent value of ICT investments. Instead, the results of this study imply that some of the economic potential of ICT are derived when businesses tap into other global trends of economic growth. Of course, this is not to claim that there are ICT has no inherent productivity enhancing benefits. Yet this presents a potential nuance to the existing literature.

This nuance comes from taking a transaction cost perspective on the value of ICT. Instead of assuming that ICT will have a direct production benefit, as is captured in many of the models used in the previous literature, this paper assumes that ICT's role is to reduce the search and information costs of conducting business in the global marketplace. As these costs decrease, the country will look outside of its borders for a greater portion of its economic activity. Although this will be a positive factor when the world economy is growing, during a period of global recession, the country will also see an economic contraction.

From the perspective of a developing country, this may influence the country's ICT policies and regulations. Globalization is cited by many as a key driving force in poverty reduction and rapid growth of many emerging markets. ICT is the platform on which globalization is built. Without ICT, the transaction costs of operating such a marketplace would be prohibitive. Hence, any firm that wishes to participate in the benefits of globalization also needs to build a sound ICT infrastructure.

Yet linking with this global marketplace also has its risks. Global economic downturns can trigger domestic recessions. Because ICT investments are often used to transact on a global scale, this risk from globalization is also a risk from ICT. Hence ICT investments must also be made such that they can enhance the domestic economy. For example, in many developing countries, the lack of supporting institutions and pro-business laws would logically lead local entrepreneurs to focus their ICT use on accessing the global marketplace. These types of ICT investments will increase the risks associated with exposure to the global marketplace.

To reduce this risk, entrepreneurs and policy makers can focus their efforts on using ICT to also support the domestic marketplace. For example, local ICT policy makers could focus on using ICT to for e-government purposes to streamline the regulatory processes, thereby increasing the efficiency of local businesses. In addition, although there has been much entrepreneurial work on using ICT at the retail level of the supply chain, some statistics indicate that to date the overall supply chains in developing countries are still lacking in the use of ICT. An increased emphasis on using technology to create more efficient supply chains would increase the overall efficiency of the domestic economy.

Furthermore, in spite of the recent economic challenges, global declines are still relatively rare. To the extent that a country chooses to use ICT to integrate with other countries,

diversification is still important. One potential area for future research would be to study whether—instead of focusing on the raw amount of exports—it may be more practical to study the number of export partners. Though more diversified trading partners should limit the potential downside of global trade.

Of course, an overemphasis on the domestic use of ICT has its risks. To properly manage these risks, a country needs to ensure that it has a diversified portfolio of investments that support both the domestic and international market. By doing so, developing countries can continue to benefit from the general trends toward global economic growth while limiting excess exposure to global economic risks.

REFERENCES

1. Arellano, M. (1987). Computing robust standard errors for within group estimators. *Oxford Bulletin of Economics and Statistics*, 49, 431–434.
2. Aschauer, D. (1989). Is public expenditure productive? *Journal of Monetary Economics*, 23, 177–200.
3. Bain, J. (1956). *Barriers to New Competition*. Cambridge, MA: Harvard University Press.
4. Breusch, T. S., & A.R. Pagan. (1980). The Lagrange multiplier test and its applications to model specification in econometrics. *Review of Economic Studies*, 47, 239–253.
5. Brynjolfsson, E., Malone, T. W., Gurbaxani, V. & Kambil, A. (1994). Does information technology lead to smaller firms? *Management Science*, 40, 1628-1644.
6. Clemons, E. (1991). Evaluation of strategic investments in information technology. *Communications of the ACM*, 34, 22–36.
7. Cronin, F., Parker, E., Colleran, E., & Gold, M. (1991). Telecommunications infrastructure and economic growth. *Telecommunications Policy*, 15, 529–535.
8. De Long, J., Summers, L. (1991). Equipment investment and economic growth. *Quarterly Journal of Economics*, 106, 445–502.
9. DeMaagd, K., Moore, S., (2007). *Comparing models of IT and economic growth: An empirical investigation*. In: International Conference on Information and Communication Technologies and Development.
10. Dewan, S., Kraemer, K. (1998). International dimensions of the productivity paradox. *Communications of the ACM*, 41, 56–62.
11. Dewan, S., Kraemer, K. (2000). Information technology and productivity: Evidence from country level data. *Management Science*, 46, 548–562.
12. Feenstra, R. (1998). Integration of Trade and Disintegration of Production in the Global Economy. *Journal of Economic Perspectives*, 12, 31-50.
13. Durbin, J., & Watson, G. S. (1971). Testing for serial correlation in least squares regression III. *Biometrika*, 58, 1–19.

14. Hamada, K., & Sakurai, M. (1978). International transmission of stagflation under fixed and flexible exchange rates. *Journal of Political Economy*, 86, 877-895.
15. Hamermesh, D., & Johannes, J. (1985). Food stamps as money: The macroeconomics of a transfer program. *The Journal of Political Economy*, 93, 205-213.
16. Hitt, L., & Brynjolfsson, E. (1996) Productivity, business profitability, and consumer surplus: Three different measures of information technology value. *MIS Quarterly*, 20, 121–142.
17. King, R. G., Rebelo, S. (1990). Public Policy and Economic Growth: Developing Neoclassical Implications. *The Journal of Political Economy*, 98, S126-S150.
18. MacMillan, I. (1983). Preemptive strategies. *Journal of Business Strategy*, 4, 16–26.
19. Madden, G., & Savage, S. (1998). CEE telecommunications investment and economic growth. *Information Economics and Policy*, 10, 173–195.
20. Malone, T.W. (1987). Modelling Coordination in Organizations and Markets. *Management Science*, 33, 1317-1332.
21. Mansell, R. (2001). Digital opportunities and the missing link for developing countries. *Oxford Review of Economic Policy*, 17, 282–295.
22. Nelson, R. & Romer, P. (1996). Science, economic growth, and public policy. *Challenge*, 39, 9-21.
23. Porter, M. (1980). *Competitive Strategy*. New York, NY: Free Press.
24. Ritchie, B & Brindley, C. (2000). Disintermediation, disintegration, and risk in the SME global supply chain. *Management Decision*, 38, 575.
25. Rebelo, S. (1991). Long-run policy analysis and long-run growth. *Journal of Political Economy*, 99, 500-521.
26. Rodrik, D. (2007a). Globalization and Economic Development. Smart Economist.com. <http://www.smarteconomist.com/interview/18>. Retrieved September 30, 2009.
27. Rodrik, D. (2007b). One economics, many recipes: Globalization, institutions, and economic growth. Princeton, NJ: Princeton University Press.

28. Woolridge, J. (2001). *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.
29. World Bank, The. (2008). The financial crisis: Implications for developing countries. <http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/0,,contentMDK:21974412~pagePK:64165401~piPK:64165026~theSitePK:469372,00.html>. Retrieved September 30, 2009.
30. World Bank, The. (2009). Doing Business: Measuring Business Regulations. <http://www.doingbusiness.org/economyrankings/> . Retrieved September 30, 2009.
31. Zhang, B. (2001). Assessing the WTO agreements on China's telecommunications regulatory reform and industrial regulation. *Telecommunications Policy*, 25, 461–483.