The Effect of Mobile Phone Adoption on Economic Output

Completed Research Paper

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ABSTRACT
Mobile phones have had profound economic benefits for people across the globe who may not otherwise have had access to information and communication technologies (ICTs). Surprisingly little research has been done to understand the effect of mobile phones on economic growth, although prior studies have investigated economic impacts of general ICT investments. We examine the extent that mobile phones have led to economic growth through four major industry sectors: Agriculture, financial services, general services, and manufacturing. Using a country-level fixed effects model, we find that mobile phone diffusion has a positive and significant effect on economic output, beyond the effects of general ICT investment classes, mediated by its impact on the four primary industry sectors.

Keywords
Mobile Telephony, Economic Impacts, ICT

INTRODUCTION
In Kerala, a state of India, mobile phones have enabled fishermen to better coordinate with wholesalers and to reduce the spoilage of unsold fish (Jensen 2007). In Niger, mobile phones have enabled farmers to better access regional grain markets, allowing them to negotiate for better prices or search for better deals (Aker 2010). These, among many other examples, illustrate how mobile phones have had profound economic benefits for people who would not otherwise have had access to information and communication technologies (ICTs) such as personal computers (PCs) or broadband connections. Developing countries account for approximately 3.9 billion and developed countries account for 1.4 billion out of the 5.3 billion mobile cellular subscriptions worldwide, according to estimates by the International Telecommunications Union (ITU) (http://www.itu.int). Globally, it appears that the widespread adoption of mobile phone technology may have facilitated the growth of commerce in broad industry sectors such as agriculture, services, and manufacturing.

While it is now understood that investment in general ICTs has contributed to the economic growth of nations (Vu 2011; Colecchia and Schreyer 2002; Jorgenson 2001), surprisingly little research has been done to understand the effect of mobile phones on economic output. In this study, our research contribution is to examine the extent that the adoption of mobile phone technology has led to economic growth through the four primary industry sectors (agriculture, financial services, general services, and manufacturing) over and above the effects of other general ICT investment classes such as PCs, broadband access, and landline telephones. We utilize a panel data set composed of 69 countries from 6 continents over a period of eleven years (2001-2011). In addition to controlling for the use of PCs, broadband, and landline telephones, we also account for country-level fixed effects and examine the effects over multiple years into the future.

LITERATURE REVIEW
Prior research has studied the factors affecting mobile phone diffusion, but there is relatively little research about the effect of mobile phone adoption on economic output. An exception is Vu (2011), who includes mobile phone adoption in a study of the effect of ICT penetration on economic growth, but does not examine the mediating role of specific industry sectors. Hardy (1980) described how fixed-line telephones enabled the spread of information of all kinds that are important in economic development, where “[i]nformation can be considered knowledge, education, or human capital.” Hardy found that GDP growth is faster in countries with advanced telecommunication networks; Norton (1992) confirmed these results after accounting for potential effects of endogeneity. Dewan, Ganley and Kraemer (2010) show that complementarities in the co-diffusion of the installed base of PC’s with internet diffusion contributes to narrowing the digital divide. In a study involving 21 OECD countries over a 20-year period, Roller and Waverman (2001) find a significant positive relationship between telecommunications infrastructure and economic growth. Dewan and Kraemer (2000) study the effects of IT capital and non-
IT capital on GDP for developing and developed countries. Colecchia and Schreyer (2002) examine the effect of general investments in ICT on economic growth, while Czernick et al. (2011) examine the effect of broadband technology on economic growth. Our study differs from prior work in that we focus upon the effect of mobile diffusion on economic output over and above the effects of general ICT. Our contribution is to examine how mobile phone adoption contributes to overall economic growth through its influence on four broad industry sectors (agriculture, financial services, general services, and manufacturing).

HYPOTHESIS

We examine the relationship between mobile phone subscription rate and the economic output of the four primary industry sectors: agriculture, financial services, general services, and manufacturing (Figure 1). These sectors were chosen because, on average, they account for about 82% of total economic output, according to the data used in this study. Among the theoretical mechanisms by which adoption of mobile phones may have contributed to the growth of each sector of economies, we consider four mechanisms which have been studied in prior research: 1) Reduction in price dispersion, which results from market inefficiency (Jensen 2007, Aker 2010), 2) Disintermediation, or elimination of intermediaries (‘middle-men’) (Morawczynski 2009) 3) Provision of information, such as agricultural, scientific, or market information (Hardy 1980; Thompson and Garbacz 2011), and 4) Reduction of transaction costs (Gurbaxani and Whang 1991). We build on prior theory and describe how prior theory manifests in specific examples for each of the sectors.

Mobile Phone Adoption and Agricultural Industries

According to prior research, adoption of mobile phones can help reduce dispersion of prices in agricultural markets. In general, ICT advances such as the Internet can enhance search and market efficiency (Brown and Goolsbee 2002); a similar effect has been demonstrated in mobile phones. Aker (2010) studies the role of mobile phones on price dispersion across grain markets in Niger, and finds that the adoption of mobile phones explains a 10 to 16 percent reduction in grain price dispersion from 2001 to 2006. Such reduction in price dispersion is a result of greater efficiency of agricultural markets that, in turn, should contribute to expansion of agricultural markets. Jensen (2007) shows that the adoption of mobile phones by fishermen and wholesalers in Kerala, India resulted in a reduction in price dispersion from over 60% to under 15% mean coefficient of variation in markets for fish. For example, fishermen used their mobile phones to call agents in various markets to determine where they might obtain the best price for their catch (Jensen 2007).

Mobile phones also enable the reduction of ‘middle-men,’ or market intermediaries (Morawczynski 2009). In India, agricultural products were traditionally purchased in markets called mandis, in which intermediary agents appropriated most of the profits. Intermediaries often concealed information about market prices and did not differentiate between crops of different qualities. These competitive barriers were disrupted by innovations such as e-Choupal, a system that gives farmers access to real-time information about prices in the local markets through mobile phones and Internet kiosks (ITC Limited 2012). This enables farmers to make decisions about where to sell their products without relying on intermediaries.

Mobile phones can be used to provide scientific and agricultural information to farmers to increase crop yields. For example, Mkrishi, a Mobile Agro Advisory System developed by TATA Consultancy Services (TCS) in India, provides information to farmers about soil conditions, fertilizers and weather (Pande, Jagyasi and Jain 2011); M-Farm in Kenya is a similar service that focuses on pricing information (Ogunlesi and Busari 2012). These services allow farmers to send inquiries via text messages and provide responses with relevant information.

H1: Mobile phone diffusion contributes to economic output through its effect on agricultural industries.

Mobile Phone Adoption and Financial Services Industries

Prior evidence suggests that mobile phone adoption can also contribute to growth of the financial services sector. For example, mobile phones can be used to provide financial services to those without traditional bank accounts, and to enable easy transfer of money to individuals. Airtel Money, which was launched by the telecommunications company Bharti Airtel of India, allows its users to load money on their mobile phones that can be used for remittances. The service also allows users to instantly transfer money to other Airtel Money customers and bank accounts across the country (Bharti Airtel Limited 2012). M-PESA, is a similar mobile phone based money-transfer service in Kenya developed by Safaricom (Plyler, Haas and Nagarajan 2010). It was used initially to provide loans from a Kenyan microfinance agency to its clients and collect repayments. Clients could also use the service to deposit and withdraw cash from authorized M-PESA agents, and make person-to-person (P2P) money transfers. M-PESA also provides a banking service enabling users to perform banking transactions without visiting an actual bank or automated teller machine (ATM).
The above examples highlight at least three salient mechanisms for the role of mobile phone technology. First, the examples of M-PESA and Airtel Money illustrate how the use of mobile phones can dramatically reduce the cost of transferring payments. These are highly tangible forms of transaction cost reduction (e.g. Brynjolfsson et al. 1994; Gurbaxani and Whang 1991), which can stimulate greater commerce in economically underdeveloped regions where basic financial services are otherwise scarce. Second, mobile technology helps reduce the costs of search for financial products, just as the Internet has enhanced the visibility of insurance product prices (Brown and Goolsbee 2002), leading to greater efficiency of financial services markets. Third, mobile phones have contributed to the creation of new financial products entirely, such as in the micro-lending industries which rely on the use of mobile phones to communicate with and monitor rural customers (Morawczynski 2009). These technologies represent new forms of financial intermediation, which in turn have been shown to stimulate economic growth (Beck, Demirgüç-Kunt, and Peria 2007; Honohan 2008).

**H2: Mobile phone diffusion contributes to economic output through its effect on financial services industries.**

**Mobile Phone Adoption and General Services Industries**

Mobile phones can contribute to the growth of many general service industries other than financial services. General services industries include business-to-business (B2B) services such as management consulting, legal services, marketing, and information systems services. Such industries involve knowledge-intensive activities for which distributed coordination is critical (Mudambi 2008). Service industries also include consumer services such as retail sales, tourism and hospitality, entertainment, and medical services. For instance, taxi drivers can connect with customers via mobile phones rather than searching haphazardly, thereby reducing search and transaction costs. Loop Mobile and Rikshawale.com have collaborated to offer a service in India that allows commuters to reserve auto rickshaws using their mobile phones. Besides enhancing market efficiencies and reducing search and transaction costs, mobile technologies also enable innovations which lead to entirely new categories of consumer services such as in entertainment (e.g. mobile phone gaming), or new retail services through location-based marketing and mobile sales channels.

**H3: Mobile phone diffusion contributes to economic output through its effect on general services industries.**

**Mobile Phone Adoption and Manufacturing Industries**

Mobile phone adoption can also contribute to growth of the manufacturing sector of the economy. Investments in ICT enable greater productivity and innovation in all aspects of the manufacturing process, especially accompanied by practices and investments that enhance human capital (Bartel, Ichniowski, and Shaw 2007; Bresnahan, Brynjolfsson and Hitt 2002). These effects have also been observed at the national level (Casselli and Coleman 2001; Jorgensen 2001).

Building on prior research, we argue that the adoption of mobile phone technologies contributes to the economic output of the manufacturing sector of national economies, over and above the effect of investments in PCs and broadband. In manufacturing plants, mobile phones can enable coordination and rapid transfer of information in situations where workers may not have ready access to landline telephones or computer stations. Mobile phones can also enhance efficiency of manufacturing supply chains. For example, truck drivers carrying raw materials to a factory can use mobile phones to immediately inform the factory when a breakdown or accident occurs. This allows management to make alternate arrangements if necessary, reducing interruptions in the assembly line or production process. These examples, among others, illustrate how mobile phones can reduce coordination costs and transaction costs, and in turn contribute to growth of the manufacturing sectors.

**H4: Mobile phone diffusion contributes to economic output through its effect on manufacturing industries.**

**RESEARCH DESIGN AND METHODOLOGY**

**Data**

Our data source, the Passport GMID database compiled by Euromonitor International, is a panel dataset consisting of 71 countries across 6 continents for 11 years (2001-2011). Two countries (Qatar and Japan) were removed as outliers using a Cook’s distance cut-off of 0.10 and leverage analysis. Of the remaining 69 countries, 28 are developed and 41 are developing countries; 30 are in Europe, 17 in Asia, 7 in Africa, 5 in North America, 8 in South America and 2 in Australia (see Table 1). Passport GMID is a database and analysis tool containing information, data and reports about markets, industries, consumers and countries. Euromonitor conducts comprehensive desk research to collect data from trade surveys and publicly available sources such as government reports and exhaustive field research, including store checks in which analysts retrieve information about products, prices and promotions from firms and businesses in multiple locations. Euromonitor has been used in numerous other research papers such as Day et al. (1988). Further details of the data validation process are provided on its website (http://www.euromonitor.com/research-methodology).
Variables

We use the total number of mobile phone subscriptions per-capita in each country and in each year to measure the adoption of mobile phones. To estimate the effect of mobile phone adoption on economic growth, we use gross value added (GVA) and gross domestic product (GDP) to measure the total size of a national economy as well as its four main industrial sectors. GVA is the difference between the value of output and the value of intermediate consumption. Total GDP is defined as GVA plus taxes on products and services, minus subsidies on these products and services. We estimate the effects of mobile phone adoption on four major sectors of the economy: Agriculture, services, manufacturing and financial services. We use the contribution of manufacturing and services sectors to per-capita GDP as the dependent variables to estimate the effects of mobile phone adoption on these sectors. Due to lack of availability of some GDP data, we use the per-capita GVA from agriculture and from financial intermediation to estimate the effects of mobile phone adoption on the agricultural and financial sectors. Our control variables include use of digital lines, PCs, broadband and dial-up subscriptions, use of digital lines, employment, and public debt; similar controls were used in prior studies on the impact of technology on economic growth, such as Vu (2011) and Thompson and Garbacz (2011). We use per-capita values for all variables in our analysis. Formal definitions of variables can be found in the Appendix: Details Regarding Measures.

Empirical Models

To test the hypotheses, we build a set of country level fixed-effects panel models. By using fixed-effects panel regression, we can remove the influence of any country specific omitted factors that do not vary much over time. This resolves the most obvious potential source of endogeneity—the notion that larger and more economically developed nations are likely to also have greater adoption of all ICTs including mobile phones. The independent variable of interest is mobile phone subscription rate (Mobile). We examine the mediating role of four major industry sectors—agriculture, financial services, manufacturing, and services—in the contribution of mobile phone technology to economic growth. First, we estimate the effect of mobile phone adoption on the economic output of each of the four major industry sectors. The dependent variable (Industry Sector Output per-capita) in the following equation represents the per-capita economic output of the agricultural (Agriculture), financial services (FinancialServices), general services (GeneralServices), and manufacturing (Manufacturing) sectors. We also control for per-capita values of PCs, broadband and dial-up subscriptions, use of digital lines, employment, and public debt.

\[ \text{Industry Sector Output per-capita}_{it} = \alpha_i + \beta_1 \text{Mobile}_{it} + \beta_2 \text{Internet}_{it} + \beta_3 \text{Broadband}_{it} + \beta_4 \text{PC}_{it} + \beta_5 \text{DialUp}_{it} + \beta_6 \text{DigitalLines}_{it} + \beta_7 \text{Employment}_{it} + \beta_8 \text{PublicDebt}_{it} + \Sigma \beta_t \text{year}_t + e_{it} \]  

Equation (1)

from which we obtain four equations by setting Industry Sector Output per-capita to one of the following variables: [Agriculture, FinancialServices, GeneralServices, Manufacturing]. Equation (1) also includes indicator variables for each year.

Next, we estimate the contribution of each industry sector to the total national economic output (Total GDP per-capita), as well as any additional effect of mobile telephony.

\[ \text{Total GDP per-capita}_{it} = \alpha_i + \beta_1 \text{Mobile}_{it} + \beta_2 \text{Internet}_{it} + \beta_3 \text{Broadband}_{it} + \beta_4 \text{PC}_{it} + \beta_5 \text{DialUp}_{it} + \beta_6 \text{DigitalLines}_{it} + \beta_7 \text{Employment}_{it} + \beta_8 \text{PublicDebt}_{it} + \beta_9 \text{Agriculture}_{it} + \beta_{10} \text{FinancialServices}_{it} + \beta_{11} \text{GeneralServices}_{it} + \beta_{12} \text{Manufacturing}_{it} + \Sigma \beta_t \text{year}_t + e_{it} \]  

Equation (2)

where subscript \(i\) indicates the country and \(t\) indicates time, \(\alpha_i\) is the unobserved time-invariant individual effect for each country. Total GDP per-capita\(_{it}\) is the per-capita GDP for country \(i\) at time \(t\). Equation (2) also includes indicator variables for each year.

To test our hypotheses H1 through H4, we use the conjunction of results from each of the four industry-sector specific versions of equation (1), as well as the total economic output model represented in equation (2), which includes each of the four major industry sectors as well as each major class of ICT adoption.

RESULTS

Hypothesis 1 suggests that mobile phone diffusion contributes to economic output through its effect on the agricultural sector. Consistent with H1, the coefficient estimate for Mobile in Table 2 (column 1) is positive and statistically significant (\(\beta_1 = 0.073, p < 0.05\)). In supplementary analysis, we also estimated the fixed effects model two and three years into the future.\(^1\) The coefficient \(\beta_1\) for Mobile remains positive and significant two years ahead (\(p < 0.05\), but becomes weaker in the third

\(^1\) We are happy to send any supplementary results upon request.
year. These results suggest a positive and statistically significant relationship between mobile phone adoption and economic output of the agriculture sectors of nations. In Table 3, we observe a positive and statistically significant relationship between the economic output of the agriculture sectors \((\beta_a = 5.280, p < 0.01)\) and the per-capita economic output \((\text{Total GDP per-capita})\). Together, these results suggest that H1 is supported. Similar analyses show that hypotheses H2 and H4 are also supported, as seen in empirical results in Table 2 (columns 2 and 4). Supplementary analysis (not reported) showed that H3 is supported two and three years into the future. Preacher & Hayes test confirms the mediating role of each of the four industry sectors in the effect of mobile phone adoption on total per-capita economic output.

Besides the hypothesis tests, we mention some additional results of interest. We observe that adoption of broadband has positive and statistically significant effects on economic output of each of the four major sectors we consider. Consistent with the findings of Czernizki et al. (2011), we see that broadband has a positive effect on overall economic growth. We also observe that the coefficient estimate for broadband is considerably larger in the services sector than in the other sectors. One possible explanation for this is the growing role of outsourcing services in developing nations such as India; such services rely heavily on broadband technology.

We also conducted supplementary analyses with separate regression estimates for developing and developed nations (regression tables available upon request). Overall, the empirical results appear to be even stronger when we consider only developing nations. As expected, in developing countries, mobile phone adoption has a positive and statistically significant effect on economic output in the agricultural, services and manufacturing sectors.

**CONCLUSION**

This study provides insights into the effects of mobile phone adoption on the overall economic growth of 69 countries through its effects on the agricultural, financial services, services and manufacturing sectors. These effects are positive and significant across three of the four sectors, in support of the hypotheses. For the general services sector, the effects are only significant two and three years in the future. We also analyzed the effect of mobile phone adoption on the total GDP per-capita. Our analysis shows that adoption of mobile phones has a positive and significant effect on overall economic growth.

Prior research has studied the effects of ICT on economic growth of nations. Our contribution was to investigate how the adoption of mobile phone technology has influenced economic output in four major industry sectors. Controlling for the effects of adoption of other communication technologies such as PC’s, broadband and landline telephones, we find that mobile phone adoption has a positive effect on economic output of the agricultural, financial services, general services and manufacturing sectors. We also find that mobile phones have a significant effect on economic output over and above the other major ICT categories. Finally, the effect of mobile phones on economic output is mediated through the agriculture, financial services, general services, and manufacturing industries; and there is a separate direct effect of mobile phone adoption on total economic output that may be mediated by other smaller industry sectors. These results have policy implications, as they might encourage developing nations to invest resources to prioritize the telecommunications sector of their economies and to encourage widespread adoption of mobile phones, particularly among segments of the populace lacking access to other forms of ICT. Dewan and Kraemer (2000) show that the returns from IT capital are positive and significant in developed countries, whereas in developing countries the returns from non-IT capital investments are positive and significant. We conclude that developing countries might benefit from making capital investments in mobile phone communications, as this would lead to increased productivity and economic growth in the agricultural, financial services, services and manufacturing sectors.
Figure 1. Intermediate pathways by which mobile phone adoption affects economic growth. Mediating effects are confirmed using the Preacher & Hayes test.

### Developing Countries
- Algeria
- Argentina
- Bahrain
- Bolivia
- Bosnia-Herzegovina
- Brazil
- Bulgaria
- Cameroon
- Chile
- China
- Colombia
- Costa Rica
- Croatia
- Guatemala
- Hungary
- India
- Indonesia
- Iran
- Jordan
- Kenya
- Kuwait
- Latvia
- Macedonia
- Malaysia
- Mexico
- Morocco
- Nigeria
- Peru
- Philippines
- Poland
- Russia
- Saudi Arabia
- South Africa
- Tunisia
- Ukraine
- UAE
- Uruguay
- Venezuela

### Developed Countries
- Australia
- Austria
- Belgium
- Canada
- Czech Republic
- Denmark
- Estonia
- Finland
- Germany
- Greece
- Ireland
- Israel
- Italy
- Luxembourg
- Netherlands
- New Zealand
- Norway
- Portugal
- Singapore
- Slovak Republic
- Slovenia
- Sweden
- Switzerland
- Spain
- Taiwan
- UK
- USA

Table 1. List of Countries
Table 2. Fixed-Effects Panel Model
Effect of Mobile phone diffusion on Economic Output from Agriculture, Financial Services, General Services and Manufacturing per-capita

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Year t+1</th>
<th>Year t+1</th>
<th>Year t+1</th>
<th>Year t+1</th>
</tr>
</thead>
<tbody>
<tr>
<td>β₁:Mobile</td>
<td>0.073(0.030)**</td>
<td>0.202(0.110)*</td>
<td>0.774(0.558)</td>
<td>0.569(0.147)***</td>
</tr>
<tr>
<td>β₂:PC</td>
<td>0.002(0.068)</td>
<td>0.631(0.247)**</td>
<td>2.018(1.256)</td>
<td>-0.785(0.331)**</td>
</tr>
<tr>
<td>β₃:Broadband</td>
<td>0.246(0.143)*</td>
<td>2.069(0.517)***</td>
<td>27.651(2.625)***</td>
<td>5.539(0.693)***</td>
</tr>
<tr>
<td>β₄:DialUp</td>
<td>-0.181(0.126)</td>
<td>-2.286(0.458)***</td>
<td>-13.248(2.326)***</td>
<td>-2.791(0.614)***</td>
</tr>
<tr>
<td>β₅:DigitalLines</td>
<td>5.465(1.075)***</td>
<td>-20.768(3.895)***</td>
<td>-9.496(19.790)</td>
<td>-4.868(5.222)</td>
</tr>
<tr>
<td>β₆:Employment</td>
<td>-0.002(0.002)</td>
<td>0.016(0.006)**</td>
<td>0.085(0.032)***</td>
<td>-0.010(0.008)</td>
</tr>
<tr>
<td>β₇:PublicDebt</td>
<td>-0.006(0.001)***</td>
<td>0.005(0.005)</td>
<td>0.084(0.026)***</td>
<td>0.004(0.007)</td>
</tr>
</tbody>
</table>

Observations 690 690 690 690
Number of countries 69 69 69 69

* significant at 10%; ** significant at 5%; ***significant at 1%; standard errors are in parentheses. The models include an intercept and indicator variables for each year.
Table 3. Fixed-Effects Panel Model Effect of Mobile phone diffusion on Total GDP per-capita

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total GDP per-capita</td>
<td>Total GDP per-capita</td>
<td>Total GDP per-capita</td>
</tr>
<tr>
<td>β₁: Mobile</td>
<td>2.014(0.724)***</td>
<td>3.704(1.062)***</td>
<td>3.867(1.164)***</td>
</tr>
<tr>
<td>β₂: PC</td>
<td>-1.208(1.629)</td>
<td>-2.636(2.269)</td>
<td>-6.940(2.472)***</td>
</tr>
<tr>
<td>β₃: Broadband</td>
<td>1.211 (3.884)</td>
<td>11.288(5.643)**</td>
<td>3.743(6.445)</td>
</tr>
<tr>
<td>β₅: DigitalLines</td>
<td>-10.916(27.453)</td>
<td>9.753(38.604)</td>
<td>43.4658(42.930)</td>
</tr>
<tr>
<td>β₆: Employment</td>
<td>0.039(0.041)</td>
<td>-0.080(0.056)</td>
<td>-0.1913(0.058)***</td>
</tr>
<tr>
<td>β₇: PublicDebt</td>
<td>-0.061(0.037)*</td>
<td>-0.082(0.056)</td>
<td>0.018(0.064)</td>
</tr>
<tr>
<td>β₈: Agriculture</td>
<td>5.280(1.190)***</td>
<td>5.792(1.729)***</td>
<td>8.962(1.813)***</td>
</tr>
<tr>
<td>β₉: FinancialServices</td>
<td>1.604(0.373)***</td>
<td>1.020(0.502)**</td>
<td>1.021(0.520)*</td>
</tr>
<tr>
<td>β₁₀: GeneralServices</td>
<td>0.965(0.095)***</td>
<td>0.517(0.138)***</td>
<td>0.271(0.152)*</td>
</tr>
<tr>
<td>β₁₂: Manufacturing</td>
<td>0.846(0.253)***</td>
<td>0.324(0.359)</td>
<td>0.905(0.383)**</td>
</tr>
<tr>
<td>Observations</td>
<td>690</td>
<td>621</td>
<td>552</td>
</tr>
<tr>
<td>Number of countries</td>
<td>69</td>
<td>69</td>
<td>69</td>
</tr>
</tbody>
</table>

* significant at 10%; ** significant at 5%; ***significant at 1%; standard errors are in parentheses. The models include an intercept and indicator variables for each year.

Appendix: Details Regarding Measures

**Mobile phone subscription rate (Mobile)** - We measure the mobile phone subscription rate as the number mobile phone subscriptions/population. Mobile phone subscriptions are portable telephone subscriptions (personal and business, post-paid and pre-paid) to a mobile telephone service.

**PCs in Use per-capita (PC)** – We measure the PCs in use per-capita as the number of PCs in use/population. PCs in use are medium-range and high-end portable and non-portable personal computer systems, designed to be operated by a single user (business and residential) at a time.

**Broadband per-capita (Broadband)** – We measure the broadband per-capita as the number of broadband subscribers/population. Broadband Internet subscriber refers to someone who pays for high-speed access to the public Internet.

**Dial Up per-capita (DialUp)** - We measure Dial-up per-capita as the number of dial-up subscribers /population. Dial-up is a connection to the Internet via a modem and fixed telephone line.

**Availability of digital main Lines (Digital Lines)** - Refers to the percentage of main lines connected to digital exchanges. This percentage is obtained by dividing the number of main lines connected to digital telephone exchanges by the total number of main lines.

**Employment Rate (Employment)** - Employed population aged 15-64 as a percentage of working age (15-64) population.
Public debt rate (PublicDebt) – We measure public debt rate as the public debt/population. Public debt is defined as total gross debt owed by any level of government (central government, local government, social security funds). Debt is reported at values outstanding at the end of the year.

Total GDP per-capita (Total GDP per-capita) - We measure the per-capita value of GDP as Total GDP/population. Gross domestic product is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.

GVA from Agriculture, Hunting, Forestry and Fishing per-capita (Agriculture) - We measure the per-capita value for Agriculture as GVA from Agriculture, Hunting, Forestry and Fishing/population. This is the per-capita value of GVA from agriculture. The sector comprises the activities of growing crops, raising animals and fishing, harvesting timber, and harvesting other plants and animals from a farm or their natural habitats.

GVA from Financial Intermediation per-capita (Financial Services) - We measure the per-capita value of Financial Services as GVA from Financial Intermediation/population. This sector comprises units primarily engaged in financial transactions, i.e. transactions involving the creation, liquidation or change of ownership of financial assets. Also included are insurance and pension funding and activities facilitating financial transactions. Units charged with monetary control, the monetary authorities, are included here.

GDP from Manufacturing per-capita (Manufacturing) - This sector includes manufacture of food, beverages and tobacco; textile, wearing apparel and leather industries; manufacture of wood and wood products; manufacture of paper and paper products, printing and publishing; manufacture of chemicals and chemical petroleum, coal, rubber and plastic products; manufacture of non-metallic mineral products, except products of petroleum and coal; basic metal industries; manufacture of fabricated metal products; other manufacturing industries.

GDP from Services per-capita (GeneralServices) - This includes services from wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods, hotels and restaurants, transport, storage and communications, financial intermediation, real estate, renting and business activities, public administration and defense, education, health and social work, other community, social and personal service activities and activities of private households.

We measure the per-capita contribution of manufacturing to GDP using the following equation.

\[
\text{Manufacturing} = \frac{\text{Manufacturing as a % of GDP} \times \text{per-capita GDP}}{100}
\]

We measure the per-capita contribution of services to GDP using the following equation.

\[
\text{GeneralServices} = \frac{\text{Services as a % of GDP} \times \text{per-capita GDP}}{100}
\]

REFERENCES


\[\text{(1)}\] This category corresponds to Sections A and B of the International Standard Industrial Classification (ISIC Rev. 3.1), and covers the exploitation of vegetal, animal and fish natural resources.

\[\text{(2)}\] This category corresponds to Section J of the International Standard Industrial Classification (ISIC Rev. 3.1)

\[\text{(3)}\] This category corresponds to Section D of the International Standard Industrial Classification (ISIC Rev. 3.1)