The telecommunications sector and its impact on Cambodia's services export performance

The Telecommunications Sector and its Impact on Cambodia's Services Export Performance[1]

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Abstract

The paper examines the impact of ICT on Cambodia's services export performance. In the econometric estimations, ICT is proxied by fixed telephone subscriptions, mobile cellular subscriptions, fixed broadband subscriptions, and internet users, and is introduced in the augmented gravity model with a panel data set available from 1995 to 2012. Estimations are carried out using the fixed-effects method. It is found that ICT variables are positively associated with Cambodia's total services exports, as well as exports of transport and travel services. Policy implications are provided in order to further develop Cambodia's ICT infrastructure to enhance the country's international trade. Specifically, improvements should be made in the following areas: (i) make available some important legal frameworks including consumer protection law, law on cybersecurity and competition law, which support international trade and electronic commercial activities; (ii) streamline efficient import and export procedures; (iii) upgrade the ICT infrastructure using tax incentives for private sector's participations and encourage foreign investment in ICT-related sectors.

Keywords: Telecommunications; Cambodia; Export Performance

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1. Introduction

The role of the telecommunications sector has recently attracted substantial attention by both academics and policymakers, as it positively impacts upon productivity, trade, economic growth and development, in particular electronic commercial activities. Its impact on international trade takes place through its contribution to building necessary infrastructure that supports trade flows among countries as the result of the cost reduction in sending goods and services to different destinations. The information and communication technologies (ICT) has gained growing popularity among many businesses and the public sector, as they substantially reduce cost and time of business interactions and transactions that can be made round-the-clock and from anywhere, thus increasing economic efficiency and productivity.

The landscape of Cambodia's telecommunications sector has been shaped by the Royal Government of Cambodia (RGC)'s policy to liberalize the sector and the ongoing development of networks and telecommunications services. Thanks to the continued improvements in technology infrastructure in Cambodia, the country's online commercial transactions have increased as the result of the emergence of a middle class in urban areas, a large pool of young people with a strong desire for IT, the availability and adoption of smartphones and other electronic devices, the latest 5G technologies, and low-cost mobile data in prepaid contracts due to increased competition, as well as because of the RGC's policy to promote the ICT sector and its applications.

In the age of increasing digitalization, also the international trade landscape is profoundly affected by ICT as it allows firms to expand their export markets globally at a lower cost. Recent studies have documented the linkages between ICT adoption and international trade. Freund and Weinhold (2002) examined the impact of internet use on bilateral services trade of 13 countries and 14 industries over 1995-1999 and found that the growth of web hosts leads to an increase in exports and imports of services. The positive linkages between trade in goods and internet use is also found by Freund and Weinhold (2004) who examined the role of internet adoption in bilateral trade flows in goods for a sample of 56 countries over 1997-1999. Their results

suggest that internet has a significant positive impact on export growth. Tang (2006) studied the effect of telecommunications on U.S. imports of differentiated goods between 1975 and 2000. He found, using the fixed-effect model, that the adoption of fixed phones, mobile phones, and internet connection in the exporting countries have a significant impact on the U.S. imports of differentiated goods from its trading partners over the period under investigation.

The current study is structured as follows. Section 2 reviews the developments of the telecommunications sector in Cambodia, followed by a discussion of competition issues in the sector in Section 3. Section 4 discusses the role of the telecommunications sector in the Cambodian economy. Section 5 examines empirically the impact of telecommunications on Cambodia's services trade. Section 6 concludes and offers policy implications.

2. Developments of the Telecommunications Sector in Cambodia

The telecommunications sector has played an increasing role in economic development, in particular transforming the traditional economy into the digital one. Countries with more developed ICT tend to enjoy an advantage and achieve higher economic prosperity through cost advantages, faster business communications, and round-the-clock commercial transactions. In Cambodia, several public organizations are responsible for the development of telecommunications infrastructures to promote the digitalization of the Cambodian economy, including e-commerce and online business transactions. These include the Ministry of Post and Telecommunications (MPTC), the Telecommunications Regulator of Cambodia (TRC), and the National ICT Development Agency (NiDA) which was integrated into the MPTC in 2013.

The MPTC is charged with developing and executing policies and strategies related to telecommunications. MPTC responsibilities are to propose legislation to be approved by the legislative body, lead and oversee the telecommunications and ICT sector, formulate relevant policies on networks, communications services and online transactions, as well as promote competition in the telecommunications sector. In its Cambodia Rapid e-Trade Readiness Assessment, UNCTAD (2017) indicated that an

increasing number of Cambodian people acknowledged electronic transactions including e-banking and other related services. The World Bank (2017) reported that 21.67 percent of Cambodians had bank accounts in 2017, up from 3.66 percent in 2011. ICT technology has also been introduced in the tourism sector in Cambodia.

NiDA was established in 2000 to develop and promote ICT technology. Originally under the Office of the Council of Ministers, it was integrated into the MPTC in 2013 to improve public service delivery, efficiency, and effectiveness as its ICT policy responsibilities overlapped with those of MPTC. TRC, officially established in late 2012 to formulate telecommunications policy and regulations, monitors telecommunications services; proposes legal instruments; sets standards for the use of telecommunications infrastructure and networks; promotes competition; grants, suspends, transfers, and withdraws permits, certificates, or licenses; and acts as a regulatory body and resolves disputes relating to the telecommunications sector.

Since the 1993 election, Cambodia has adopted an open policy towards foreign direct investment (FDI) and trade with the rest of the world. The investment law, drafted and approved in 1994, was amended in 2003 to simplify investment application procedures and make approved investment projects eligible for generous fiscal incentives on a non-discriminatory basis. Cambodia received about $1.58 billion of total FDI in 2000. This amount increased to $6.16 billion in 2010 and $21.20 billion by the second quarter of 2018.[4] The distribution of FDI in Cambodia was uneven during 1994–2018. Based on data up to the second quarter of 2018, the financial sector attracted 23 percent of total FDI stocks, followed by labour-intensive manufacturing. Over the same period, FDI in telecommunications remained small, about 3 percent of total FDI stocks. This may pose some challenges for the development of ICT and other ICT-related sectors in Cambodia.

Since ICT is often viewed as a driving force for many aspects of the national economy, through promoting competitiveness, sustainable economic growth, and development in the age of digitalization, in 2016 the Royal Government of Cambodia implemented its Telecommunications and ICT Development Policy 2020 (Royal Government of

[4] The amounts are FDI stocks in Cambodia, based on the data made available by the National Bank of Cambodia (2018).

Cambodia, 2016) to serve as a roadmap and mechanism for a successful development of the ICT sector. With this policy, Cambodia could continue to sustain high economic growth and equitable economic development in the digital age.

Based on its ICT policy, Cambodia envisages to become a competitive information-based society that can provide ICT-based solutions for transforming the country into a knowledge-based economy to enhance economic growth and development. To achieve this, the government is committed to achieving the following targets by 2020. First, it is improving and expanding the telecommunications infrastructure and use of sector services by expanding broadband service coverage in urban and rural areas, as well as increasing the internet penetration rate. By 2020, the government targets increasing broadband service coverage in urban areas to 100 percent, broadband service coverage in rural areas to 70 percent, the mobile penetration rate to 100 percent, the internet penetration rate to 80 percent, the broadband internet penetration rate to 70 percent, the percentage of households with internet access to 30 percent, and the percentage of households with a computer to 30 percent.

Second, the government is developing human resources and capacity in ICT skills by setting a target for 2020 to increase the percentage of government officials with basic ICT skills to 95 percent, the percentage of subnational government officials with basic ICT skills to 75 percent, and the percentage of high school graduates with basic ICT skills to 100 percent. Third, the government is committed to encouraging expansion of the ICT industry and promoting ICT applications in all public institutions. It welcomes more investment in ICT and telecommunications as well as ICT-related companies. It encourages the intensive use of emails and the development of websites in all public institutions.

To achieve the 2020 targets, the government formulated three broad strategies: (i) strengthening of telecommunications and ICT development, (ii) enhancement of ICT security and development of the ICT industry, and (iii) promotion of the use of ICT applications.

- *Strengthening the development of the telecommunications and ICT-related sector*. The government will develop legal and regulatory frameworks; and formulate policies on broadband, the ICT-related strategic plan, and other ICT-

related issues. A sub-decree on digital signatures was issued in late 2017, cybercrime legislation is being prepared, and e-commerce legislation is in final draft form. In addition, telecommunications and ICT infrastructure investment has to be intensified, including the promotion of investment in submarine cable, satellite, and broadband network infrastructure; building and expanding internet exchange points and the national data centre; and encouraging digital broadcasting. The digital divide is to be narrowed through ICT content and applications in the national language (Khmer), promoting ICT for community development, making available assistive technology for people with disabilities, and equipping women with ICT skills to provide them with greater opportunities for employment. ICT literacy and research and development (R&D) are to be enhanced by improving telecommunications and ICT curricula, establishing an ICT literacy plan, raising public awareness on the benefits of ICT, and promoting public-private partnerships for ICT innovations. A sub-decree on the management of capacity building and telecommunications and ICT R&D was issued on 21 July 2017 to implement the capacity building and telecommunications and ICT R&D plan in an efficient, effective, and transparent manner.

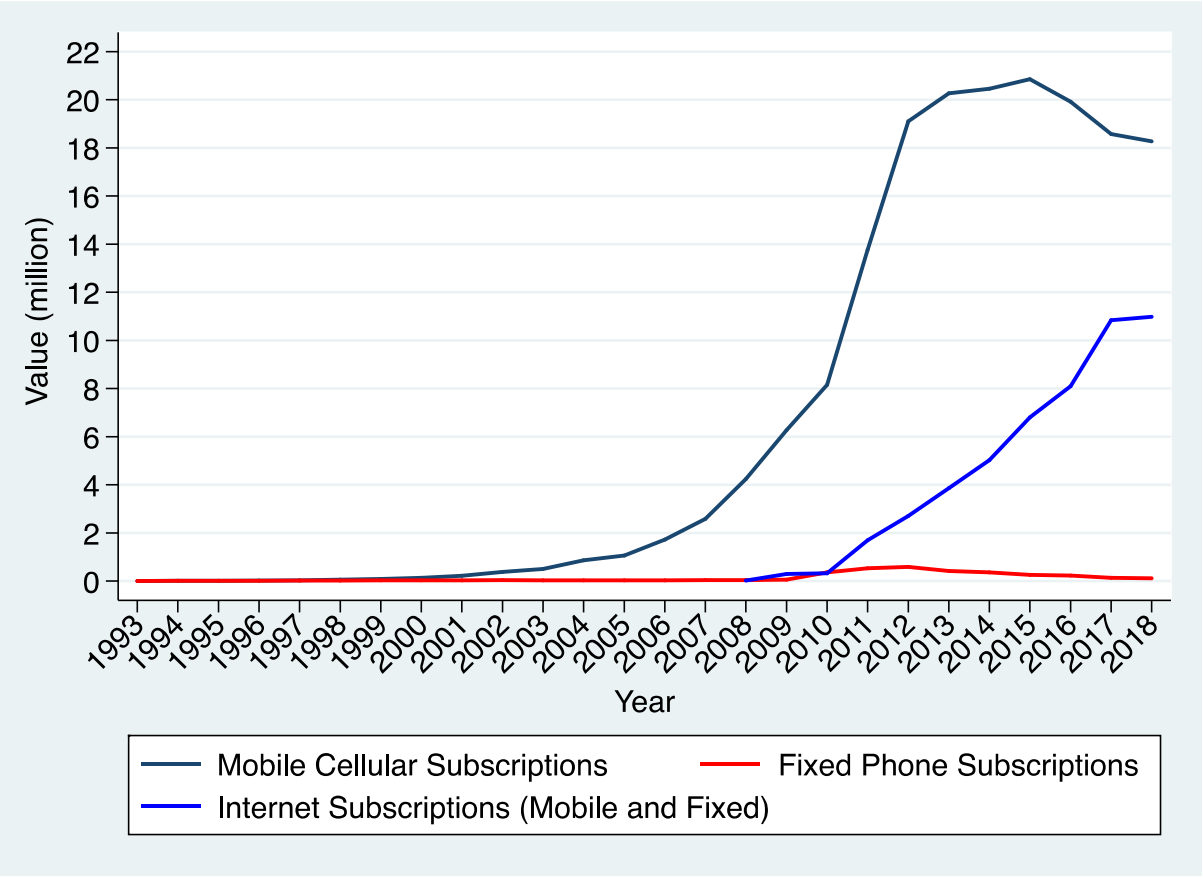
- *Enhancing ICT security*. Security is a serious concern among online users, as they are worried that their information and data provided online may leak out to others, due to online data risks of being hacked. To address these issues, the government has made efforts to develop and implement ICT security standards, national technical frameworks on ICT security, and best practices; establish the digital forensic laboratory and mechanism to protect information; enhance the security of websites; and increase international cooperation on ICT security.
- *Promoting ICT applications*. ICT applications, including e-commerce and e-government, play an important role in enhancing work efficiency and productivity. Because of these benefits, the government has made efforts to introduce, among others, e-government, e-commerce, e-education, e-tourism, and the use of ICT applications for environment-related issues such as environmental protection, climate change adoption and mitigation, and disaster management.

ICT and its applications have great potential (UNCTAD, 2017). This is mainly because of the emergence of a middle class in urban areas, a large pool of young people with a strong desire for IT, the availability and adoption of smartphones and other electronic devices, the latest G5 technologies, and low-cost mobile data in prepaid contracts. Mobile internet can be easily accessed at an affordable cost through smartphones, tablets, and other devices. Measures to promote ICT are included in Cambodia's National Strategic Development Plan 2014–2018 (Royal Government of Cambodia, 2014) and the Rectangular Strategy Phase III (Royal Government of Cambodia, 2013).

According to the Ministry of Posts and Telecommunications (MPTC, 2019) and World Bank (2019), Cambodia had 20,402 internet subscribers in 2008, increasing exponentially to 320,190 in 2010, 6.80 million in 2015, and 10.98 million in 2018 (Figure 1)[5]. This sharp increase in internet use correlates with the rise in mobile cellular subscriptions from 4,810 in 1993 to 8.15 million in 2010 and 20.85 million in 2015, although this dropped to 19.92 million in 2016, to 18.57 million in 2017, and to 18.27 million in 2018 (MPTC, 2018; World Bank, 2018). Cambodians are using mobile internet on their smartphones. Cambodia's Telecommunications and ICT Development Policy 2020 estimates that 70 percent of the population will have regular internet access by 2020.

Figure 1: Subscriptions by Service, 1993–2018

[5] Figure for 2018 is based on data of April 2018.



Source: MPTC (2019) and World Bank (2019)

Cambodia has 37 internet service providers and 19 other internet-related voice over internet protocols (VoIPs) in operation (MPTC, 2018). Three large operators—Cambodia Fiber Optic Communication Network (CFOCN), Viettel Cambodia, and Telecom Cambodia—have established fibre optic backbone routes with a combined total length of 29,800 kilometres. In addition, submarine cables have been granted to Telcotech, Chuan Wei Cambodia, and CFOCN. Telcotech's submarine cable has been in operation since March 2017, connecting Cambodia, Malaysia, and Thailand. CFOCN's cable has been operated since late 2017 and connects Cambodia to the Asia–Africa–Europe 1 submarine networks. This could help transform Cambodia into a digital economy, although the level of digitization lags other advanced Association of Southeast Asian Nations (ASEAN) member states.

3 Competition in the Telecommunications Sector

Despite successfully moving towards a market-oriented economy, Cambodia is the only ASEAN member state that has not yet adopted formal competition law (Table 1).

This may not be surprising as, at the initial stages of economic development, Cambodia had to first focus on establishing basic legal building blocks of economic infrastructures, including property law, contract law, a civil code, corporate law, and other necessary legal instruments (Hammer, 2004). Equally important, competition policy is critically useful in effectively shaping economic agents' behaviors, promoting competitive markets, and facilitating the optimal allocations of economic resources to their most productive uses.

Table 1: Competition Law in ASEAN Member States

Country	Year Implemented	Details
Brunei Darussalam	2015	Brunei Competition Order Agency: Brunei Competition Commission
Cambodia	No	2018 draft competition law under reviews by the Office of Council of Ministers in 2019
Indonesia	1999	Law No. 5 of 1999 Agency: Commission for the Supervision of Business Competition or Komisi Pengawas Persaingan Usaha
Lao PDR	2015	Lao Competition Law Agency – Trade Competition Commission (Ministry of Industry and Commerce)
Malaysia	2010	Competition Act 2010, which came into effect in January 2012 Agency: Malaysia Competition Commission
Myanmar	2015/2017	Myanmar Competition Law, which came into force in February 2017 Agency: Myanmar Competition Commission (to be established)
Philippines	2015	Philippine Competition Act Agency: Philippine Competition Commission
Singapore	2004	Competition Act Agency: Competition Commission of Singapore (CCS)
Thailand	1999	Competition Act B.E.2542 (1999), which was amended in October 2016 Agency: Trade Competition Commission

Vietnam	2005	Vietnam Competition Law No. 27/2004/QH11 Agencies: Vietnam Competition Authority (investigation) and Vietnam Competition Council (adjudication)

Sources: Lee et al. (2014) and ASEAN (2017)

Competition policy which encompasses competition law and economic policies (Sivalingam, 2006) aims at creating and promoting market competition by establishing and enforcing rules that prohibit anti-competitive behaviors and practices. It is viewed as an important tool for enhancing economic growth and development via macroeconomic effects of competition on productivity growth which in turn boosts economic growth and development. Romano (2015) found a positive relationship between competition policy effectiveness and the change in real GDP per capita, thus providing evidence of a positive effect of competition policy enforcement on economic performance. A significant positive economic effect of competition policy was also reported by Clougherty (2010) and Buccirossi et al. (2013).

Competition policy contributes to cross-border connectivity through its positive effect on international trade. With competition law and policy, if effectively implemented, prices of goods and services produced domestically tend to fall while their quality tends to increase, thus increasing domestic and global demand for the goods and services. Higher demand, in turn, translates into higher domestic production, employment, and income for countries with the stringent enforcement of competition policy.

In the real world, markets, however, are not automatically efficient. In many cases, they need government intervention. Anticompetitive practices, unfair competition, legislative provisions and interventions with anticompetitive effects are factors that adversely affect the competitive market, technology transfers and innovations, thus generating a negative impact upon the markets (Romano, 2015). These practices are often found in developing and transition economies where competition is relatively limited and weak. In this regard, competition policy and its effective implementation should play an important role in ensuring an efficient functioning of the markets and in achieving the highest social welfare gains.

Despite the absence of formal competition law, Cambodia has its Law on Telecommunications which was enacted in 2015 to promote competition in the sector. The purpose of the telecommunications law is twofold. First, it is to ensure that the utilization and provision of telecommunications infrastructure, networks, and services are made in an effective, reliable, and affordable manner, to support the country's sustainable socio-economic development needs. Second, it encourages active participation from the private sector in the development of the telecommunications industry to achieve fair competition in the industry.

The Law on Telecommunications covers many issues related to telecommunications and the development of the sector, including infrastructure and networks; quality of telecommunications services; service obligations; capacity building, research, and development; competition in the telecommunications sector; depute settlement; telecommunications inspection; and universal service obligation and penalty. The sub-decree on the implementation of universal service obligation was issued on 21 July 2017 to establish a mechanism to execute it effectively. Under the legislation, the MPTC is tasked with formulating the legal framework and policy, strategic plan development, telecommunications infrastructure, inspection, and capacity building, research and development. The law also provides detailed procedures for resolving deputes that may arise among telecommunications operators and/or subscribers, with the TRC playing a mediation role. In addition, it details provisions on penalties for violating the communications practices and law, ranging from monetary fines to heavy prison sentences.

Despite the lack of formal competition legislation, Cambodia's telecommunications sector has experienced fierce competition, due largely to the relatively easy entry into the sector. In the mobile phone industry, prior to 2008, there were only four companies competing in Cambodia's telecom market (Vong, Lee, and Zo, 2012). Thanks to the continued expansion of market demand for telecommunications services, the number of phone operators doubled, reaching eight companies in 2010. Phong, Srou, and Solá (2016) reported almost half of the population (48%) has access to the internet or Facebook, and five out of every six respondents have their own Facebook account. Some 85 percent of Facebook users accessed their Facebook

through smartphones. In 2016, internet or Facebook became the most important information source. Almost one third of Cambodians did their reading on the internet.

MPTC (2018) reported that as of February 2018, it had issued telecommunications licenses to 82 ICT operators, of which 37 (more than 45%,) are internet service providers and 19 (23%) are VoIPs. VoIP service covers the 24 provinces and major cities of Cambodia. Nine mobile phone operators and eight fixed telephone operators are active in the Cambodian telecommunications market. In November 2016, Viettel (Cambodia) enjoyed a market share of almost 46 percent in the mobile cellular market, followed by Smart Axiata at 40 percent and CamGSM at 13 percent. Similarly, in the fixed telephone market, Viettel (Cambodia) captured a market share of 73 percent, leaving the remainder to be shared by Telecom Cambodia at 14 percent and others at 13 percent. In the internet market, Smart Axiata had a mobile cellular internet market share of about 60 percent, while Viettel (Cambodia) had 30 percent and CamGSM captured about 10 percent. For the fixed internet market, Viettel was in the lead, enjoying a market share of more than 60 percent, followed by Cogetel (ONLINE) at 10.31 percent, Telecom Cambodia at 7.60 percent, and Xinwei (Cambodia) Telecom at 6.18 percent. Based on these market share figures, the market structure in the telecommunications sector seems to be rather concentrated. Viettel enjoyed 46% and 73% in the mobile cellular and fixed phone markets respectively, while Smart Axiata captured 60% in cellular internet market share in 2016.

4 The Contribution of the Telecommunications Sector to the Cambodian Economy

In its efforts to diversify Cambodia's narrow-based economy and sustain economic growth and development, the Royal Government of Cambodia has been committed to develop the telecommunications sector to promote commercial activities and online business activities. Electronic commerce in Cambodia is at a nascent stage of development but developing rapidly, although the country is still facing a lack of ICT infrastructures; legal tools, including e-commerce law and consumer protection legislation; and necessary policies to support secure functioning of these online activities. Electronic commerce offers both consumers and businesses selling goods and services many benefits, including round-the-clock transactions, ease of delivery, and product information at their fingertips.

Online commercial transactions have become very popular, thanks to the availability of affordable smartphones, reduced prices of electronic devices, as well as shopping portals. Phong et al. (2016) conducted a survey on the use of mobile phones and the internet in Cambodia. Their results showed that the phone market in Cambodia is saturated, with over 96 percent of Cambodians owning a phone and almost 100 percent being reachable through some sort of phone. The proportion of people with more than one phone remains 13%, while one in four phone owners used more than one mobile operator, mainly because of more expensive off-net calls.[6] The survey also suggested that 48 percent of Cambodians had at least one smartphone.

The rapid growth of e-commerce in Cambodia is attributed to the rising internet penetration rate and the prevalence of cheaper and seamless internet connectivity options. Better internet infrastructures, increasing uses of credit cards made available by banks, and affordable mobile internet on smartphones and other electronic devices are also facilitating factors explaining the growing e-commerce activities. The introduction of compatible mobile apps makes it easy for buyers to shop online, make electronic payments at a reduced price, and even get a ride in three-wheeled vehicles or a taxi.

In the banking sector, the National Bank of Cambodia, Cambodia's central bank, reported in 2017 electronic payments have grown rapidly. The increase in e-payments is greatly facilitated by new payment systems introduced to enhance trading activities fast and effectively. Fast and Secure Transfer (FAST), launched in mid-July 2016, is a retail payment system to provide funds to customers on a real-time basis. The National Bank of Cambodia is also developing a central shared switch system to facilitate interbank settlement transactions using debit cards with ATMs and POS machines. Cambodia had 1,260 ATMs and 11,761 POS machines in December 2016, but this is undoubtedly higher because of Cambodians' preferences towards electronic transactions, switching from cash-based to cashless transactions, and the rapid increase in the use of banking services. A total of 1.55 million debit cards and 55,402

[6] In Cambodia, it is more expensive when a call is made from one network to another. To avoid this, an increasing number of Cambodians owns more than one cellular phone.

credit cards were issued by commercial and specialized banks that operated in Cambodia in 2016.

Although formal training in ICT and online business is lacking, an increasing number of local online shopping portals is available. With the growing e-payment methods and portals, consumers, especially young people, shop more online (UNCTAD, 2017). These young people look for information about products and services via the internet on their smartphones and other electronic devices. This leads to a rising share of the telecommunications sector in aggregate GDP in Cambodia. Hang (2009) reported that the telecommunications sector had become an engine of economic growth and development. The added value of the telecommunications sector more than quadrupled, rising from US$15.6 million in 1994, to US$65.5 million in 2006.

5 Impacts of Telecommunications on Cambodia's Services Export Performance

5.1 Econometric specification

In today's increasingly digitalizing world, trade flows are profoundly changed and reshaped by the Information and Communications Technology (ICT) based innovations that give firms wider access to global markets, allowing them to expand their customer base, increase the scale of production and raise profits. It also forces firms to compete with other competitors, exposes them to new ideas and expertise, and encourages them to stay abreast of market trends (Xing, 2018). A country's technology infrastructure plays a critical role in creating an environment inducive for ICT development and its adoption. This establishes the basis for developing and promoting the digital economy.

In recent empirical studies, the impact of ICT on international trade has been investigated and documented. Freund and Weinhold (2002) looked at the impact of the internet use on bilateral trade in services over the period of 1995-1999 and found a significant positive association between the growth of web hosts and exports and imports of services. Freund and Weinhold (2004) further examined the role of internet adoption in bilateral trade flows in goods. They found that a 10-percentage point increase in the adoption of internet leads to a 0.2 percentage point increase in trade in

goods in a panel of 56 countries over the period 1997-1999. Tang (2006) investigated how the use of different means of telecommunications affects US imports of differentiated goods from 1975 to 2000. Using the fixed-effects model, it was found that the adoption of fixed line telephones, mobile phones, and internet connections in the exporting countries have a significant positive impact on the US imports of differentiated goods. Similarly, Clarke and Wallsten (2006) found that greater internet penetration promotes trade flows from developing countries to developed countries, but no significant effect was detected for the trade flows from developed countries to developing countries. In turn, Vemuri and Siddiqi (2009) found that internet use is positively associated with bilateral trade for a panel of 64 countries between 1985 and 2005. Using a data set from more than 150 countries over 1990-2006, Choi (2010) indicated that a doubling of internet usage would increase a country's export of services by between 2% and 4%. Likewise, Liu and Nath (2013) found that internet subscriptions and internet hosts were positively and significantly related to trade performance. Yushkova (2014) used the business Internet usage index to estimate the effect of the internet on exports of goods for 40 countries and found that the internet usage by business communities in both exporting and importing country is positively related to the export flows between these countries. More recently, Xing (2018) examined the impact of internet on bilateral trade, using a panel data set of 51 countries and found that better access to ICT boosted the bilateral trade flows among the countries under investigation.

To examine the role that telecommunications have played in influencing Cambodia's services exports, a panel data analysis is carried out. Based on the discussion above, the relationship between services export and information and communications technology in Cambodia is modelled as follows:

$$lnEXPORT_{ijt} = \beta_0 + \beta_1 lnPOP_{jt} + \beta_2 lnGDPCAP_{jt} + \beta_3 lnEXCH_{ijt} + \beta_4 Financial\ Depth_{it} + \beta_4 lnICT_{i,t-1} + \sum_{j=1995}^{2012} \gamma_{j-1994} yeardummy_j + \alpha_i + \varepsilon_{ijt} \quad (1)$$

4jjuyuiu (1)

$where\ i = 1, 2, 3, \dots, N\ and\ t = 1, 2, 3, \dots, T\ (1995\ to\ 2012, inclusive)$

Ln stands for a natural logarithm. The subscripts i, j and *t* refer to Cambodia, trading partners and time, respectively. α_i is individual country-specific, accounting for the unobserved heterogeneity among trading partners, and ε_{it} is the error term assumed to be well behaved. Specification (1) suggests that services exports of Cambodia are influenced by the population of the trading partners; per-capita income of the trading partners; financial depth (the ratio of broad money to GDP) of Cambodia; and information and communications technology (ICT) of both Cambodia and trading partners. Following Freund and Weinhold (2002), the financial depth ratio is used as a proxy for overall comparative advantage in services across countries. It is intuitive that a country with a deeper financial system is more likely to have a skilled labor force suitable for the production of electronic services. A yearly dummy variable is included to account for the global business cycle, the extent of globalization, oil shocks and so on (Rose, 2004; Eichengreen et al., 2007). ICT is proxied by fixed telephone subscriptions per 100 people; mobile cellular subscriptions per 100 people; fixed broadband subscriptions per 100 people; and internet users as percentage of population (see Appendix A).

The specification (1) is estimated by using a panel data set covering twenty trading partners during 1995-2012 (see Appendix B). Data for the dependent variable (services export) are from the Organization for Economic Cooperation and Development (OECD), while data on population and GDP per capita are retrieved from the World Bank's World Development Indicators. Likewise, country data on ICT and the financial depth ratio are taken from the World Bank's World Development Indicators.

5.2 Estimation Strategy

Due to the inappropriateness and inefficiency of estimation with time series and cross-sectional estimation, it was decided to opt for a panel data set, i.e. the data containing time series of a number of individuals, in the estimation of specification (1). Panel data have several advantages over the usual cross-sectional or time series data (Hsiao, 2003, 2005; Plasmans, 2006). Plasmans (2006) has shown that panel data are more efficient with respect to random sampling and ease of identification, present less multicollinearity, and are better for aggregation as the aggregation may vary over time. Similarly, Hsiao (2005) has indicated that an important advantage of panel data is that

it allows to control for the impact of omitted variables, and contain information on the intertemporal dynamics, and, moreover, that the individuality of the entities allows the effects of missing or omitted variables to be controlled for. The use of panel data takes into account the diversity and the specificity of the unobservables, which are not shown in the above specification.

Panel data sets allow the use of three estimation procedures, namely pooled OLS, fixed-effects (FE) or random effects (RE) estimations. If the assumption holds that the unobservable individual country-specific effects are not very different, pooled OLS estimations are the most efficient and simplest method. To choose pooled OLS against the RE model, the Breusch and Pagan (1980) test is carried out. A large value of the LM test statistic will reject the null hypothesis in favor of the RE model. The FE estimator allows for the unobservable country heterogeneity, and is always less efficient than the RE estimator, but the latter may suffer from endogeneity bias (Hausman test) so that the FE estimator is preferred in that case. Like the FE model, RE estimations take into account the unobservable country heterogeneity effects, but incorporate these effects into the error terms, which are assumed to be uncorrelated with the explanatory variables. To choose the appropriate model for the panel data set from these two competing models, the Hausman test based on Hausman (1978) is performed. The Hausman test is for testing the appropriateness of the FE model against the RE model. The Hausman test statistic is computed as follows (Verbeek, 2017):

$$\psi_H = \left(\hat{\beta}_{FE} - \hat{\beta}_{RE}\right)' \left[\hat{V}\{\hat{\beta}_{FE}\} - \hat{V}\{\hat{\beta}_{RE}\}\right]^{-1} \left(\hat{\beta}_{FE} - \hat{\beta}_{RE}\right) \qquad (2)$$

where $\hat{V}_s$ denote estimates of the true covariance matrices. Under the null hypothesis that the explanatory variables and α_i are uncorrelated, the Hausman test statistic ψ_H is asymptotically χ^2 distributed with *K* degrees of freedom, where *K* is the number of slope coefficients in the random-effects model. A large value of ψ_H leads to the rejection of the null in favor of the fixed-effects model.

Additional tests such as collinearity and heteroskedasticity tests are carried out. The collinearity check is based on the variance inflation factor (*VIF*), which has been shown

to be equal to $1/(1-R_i^2)$, where R_i^2 is obtained from the multiple correlation coefficient of an explanatory variable X_i regressed on the remaining explanatory variables. Evidently, a higher VIF_i indicates R_i^2 to be near unity and therefore points to collinearity. The commonly-used rule of thumb states that if *VIF* < 10, there is no evidence of damaging multicollinearity (Baum, 2006).[7] Greene (2012) proposes a test for groupwise heteroskedasticity, which is based on the Wald statistic. Under the null hypothesis of common variance, the Wald test statistic is shown to be of the following form: $W = \sum_{i=1}^{N} \frac{(\hat{\sigma}_i^2 - \sigma^2)^2}{var(\hat{\sigma}_i^2)}$, where W is χ^2 distributed with N degrees of freedom. Failure to reject the null indicates the absence of groupwise heteroskedasticity.

5.3 Empirical Results

Table 2 presents the correlation matrix for the ICT variables and the results of collinearity checks for these variables. The correlation coefficients and the variance inflation factor (VIF) values for most of the ICT variables are relatively high, indicating that there is a high multicollinearity among the ICT variables. These high inter-correlations affect the estimation results as they pose difficulty in identifying statistically the influence of specific ICT factors on services exports. To circumvent these high correlation problems, we include the ICT variables, namely fixed telephone subscriptions, mobile cellular subscriptions, fixed broadband subscriptions per 100 people, and internet users as percentage of population, one by one in the estimations of specification (1). Table 3 presents the unit-root test results for time variant variables. The IPS test statistics for all the time variant variables are highly statistically significant at 1 per cent, except LnGDPCAP which is statistically insignificant.[8] These results show that these variables are stationary.

We carried out the Breusch-Pagan test to choose between pooled OLS vs. RE methods. The LM statistics are highly significant at the 1% level, suggesting that the random-effects model is statistically superior to the pooled OLS approach. We also carried out the Hausman test to choose between fixed-effects vs. random-effects models. The

[7] Baum (2006) argues that we can safely ignore near-collinearity that does not affect key parameters.
[8] We re-estimated our econometric specification (1), by excluding the non-stationary variable, lnGDPCAP. The results do not change, which can be obtained from the authors. Our variable of interest, ICT, returns to have much higher statistical significance for all specifications.

Hausman statistics are highly significant at the 1% significance level, providing evidence that there is correlation between the explanatory variables and the error terms. The fixed-effects technique, therefore, is statistically more appropriate, thus the estimation results are provided by the fixed-effects method.

Table 2: Correlation Matrix and VIF values for ICT Variables

Variable Name	VIF	Telephone	Mobile	Broadband	Internet User
Ln(Telephone)	9.15	1.00			
Ln(Mobile)	59.80	0.78	1.00		
Ln(Broadband)	23.16	0.61	0.93	1.00	
Ln(Internet)	23.08	0.74	0.97	0.73	1.00

Notes: *ln(Telephone)* refers to log of fixed telephone subscriptions per 100 people; *ln(Mobile)* is log of mobile cellular subscriptions per 100 people; ln(*Broadband)* is log of fixed broadband subscriptions per 100 people; and ln(*Internet)* refers log of individuals using the internet as percentage of population.

Table 3: Unit-Root Test Results

Variable	IPS Test
LnEX	-7.40***
LnPOP	-5.74***
LnGDPCAP	-0.29
LnEXCH	-2.60***

Notes:

- *LnEX* is logarithm of service exports; *lnPOP* is logarithm of population of trading partners; *lnGDPCAP* is logarithm of GDP per capita of trading partners; *lnEXCH* is logarithm of the ratio of the US dollar to trading partner's national currency per US$ exchange rate.
- *** *denotes statistical signfiance at the 1% level.*

Since the impact of the ICT variables on exports may not be instantaneous, we carried the estimation with one-year lagged ICT variables. Table 4 shows the estimation results for Cambodia's total services exports over the period under investigation. As expected, the coefficient on population, which is a proxy for market size for importing countries, is positive and highly significant at the 1% significance level. This finding is in line with the gravity model hypothesis, which predicts that bilateral trade flows increase as market size becomes larger. Similarly, the coefficient on GDP per capita, a proxy for purchasing power of importing countries, is also statistically significant for all columns (Table 4). The estimated coefficient of 0.41-0.56 suggests that a one percent increase in per-capita income of the trading partners leads to an increase of

0.41-0.56% in their services imports from Cambodia. This provides evidence that an increase in per-capita incomes of the importing countries translates into higher demand of the trading partners for imports from Cambodia. This finding is consistent with recent empirical studies (Nath and Liu, 2017; Xing, 2018). Financial depth is positive and significant in most columns.

The coefficient on the ICT variables, namely fixed phone, mobile phone, broadband and internet use, is positive and significant at the 10% significance level, except broadband which is significant at 5%. This suggests that ICT is an important determinant of Cambodia's services trade. It implies that better ICT infrastructure enhances Cambodia's trade performance with its trading partners and that the higher penetrations of fixed phone, mobile phone, broadband and the internet uses are important ingredients for exporters and producers as well as firms, to overcome traditional impediments associated with restricted access to information on potential markets for their goods and services. This finding confirms the important role played by the high level of ICT infrastructure development in boosting export growth via cost reduction in the presence of ICT.

Table 4: Estimation Results for Services Export

Variable Name	(1)	(2)	(3)	(4)	(5)
Constant	-31.44***	-33.60***	-34.42***	-39.40***	-36.67***
lnPOP	1.81*** (0.30)	1.91*** (0.28)	1.91*** (0.28)	2.04*** (0.29)	2.10*** (0.27)
lnGDPCAP	0.41* (0.20)	0.42** (0.20)	0.42** (0.20)	0.56*** (0.19)	0.45** (0.17)
lnEXCH	0.68*** (0.22)	0.56** (0.24)	0.56** (0.24)	0.07 (0.37)	0.66* (0.35)
Financial Depth	0.01** (4×10^{-3})	0.01* (5×10^{-3})	-0.01 (0.10)	0.15** (0.60)	1.4×10^{-3} (7×10^{-3})
lnTelephone(-1)		0.07* (0.03)			
lnMobile(-1)			0.36* (0.19)		
lnBroadband(-1)				3.09** (1.32)	
lnInternet(-1)					0.11* (0.06)
Time Dummy	Estimated	Estimated	Estimated	Estimated	Estimated

No. of Obs.	360	340	340	200	300
Overall R^2	0.2657	0.2520	0.2520	0.0736	0.2484
Wald Test for Heteroskedasticity	1002***	623***	1025***	927***	495***
Breusch-Pagan test	1728.30***	1621.60***	1781.99***	686.42***	1467.82***
Hausman Test	40.31***	40.02***	40.02***	27.31***	48.87***

Notes:

1. *ln* denotes values in natural logarithm.
2. *, **, and *** denote that the slope parameter estimates are statistically significant at the levels of 10%, 5%, and 1%, respectively.
3. Standard errors are heteroskedasticity robust standard errors in parentheses.
4. *POP* is population of trading partners; *GDPCAP* is GDP per capita of trading partners; *EXCH* is ratio of US dollar to trading partner's national currency per US$ exchange rate; *Financial Depth* is the ratio of *M2 to GDP*; *Telephone* refers to fixed telephone subscriptions per 100 people in Cambodia; *Mobile* is mobile cellular subscriptions per 100 people in Cambodia; *Broadband* is fixed broadband subscriptions per 100 people in Cambodia; and *Internet* refers individuals using the internet as percentage of population in Cambodia.

We disaggregated services trade into transport services exports and travel services exports. The results are provided in Tables 4 and 5, respectively. According to Table 5, ICT variables retain both statistical and economic significance. The results confirm that ICT, namely penetrations of fixed telephone, mobile cellular phone, broadband, and internet, is positively associated with Cambodia's exports of transport services. However, travel services exports do not seem to be affected by ICT, except broadband which is significant at 10% level (Table 6).

Table 5: Estimation Results for Transport Exports

Variable Name	(1)	(2)	(3)	(4)	(5)
Constant	-33.64***	-35.29***	-36.13***	-39.26***	-38.62***
	(7.10)	(6.77)	(6.51)	(7.33)	(6.75)
lnPOP	1.81***	1.90***	1.90***	2.01***	2.10***
	(0.31)	(0.29)	(0.29)	(0.36)	(0.30)
lnGDPCAP	0.50**	0.49**	0.49**	0.46**	0.51**
	(0.23)	(0.21)	(0.21)	(0.19)	(0.19)
lnEXCH	0.44*	0.34	0.34	-0.13	0.33
	(0.22)	(0.21)	(0.21)	(0.38)	(0.35)
Financial Depth	0.01**	0.01	-0.01	0.17**	5×10^{-4}
	(4×10^{-3})	(4×10^{-3})	(0.01)	(0.06)	(0.01)
$\ln Telephone_{(-1)}$		0.07*			
		(0.03)			
$\ln Mobile_{(-1)}$			0.36*		
			(0.19)		

lnBroadband$_{(-1)}$				3.58** (1.44)	
lnInternet$_{(-1)}$					0.12* (0.06)
Time Dummy	Estimated	Estimated	Estimated	Estimated	Estimated
No. of Obs.	360	340	340	200	300
Overall R^2	0.2154	0.1845	0.1845	0.0174	0.1602
Wald Test for Heteroskedasticity	3495***	1209***	1117***	974***	1156***
Breusch-Pagan test	1923.57***	1783.67***	1900.49***	686.98***	1517.62***
Hausman Test	35.05***	37.13***	37.13***	25.62***	44.87***

Notes:

1. *ln* denotes values in natural logarithm.
2. *, **, and *** denote that the slope parameter estimates are statistically significant at the levels of 10%, 5%, and 1%, respectively.
3. Standard errors are heteroskedasticity robust standard errors in parentheses.
4. *POP* is population of trading partners; *GDPCAP* is GDP per capita of trading partners; *EXCH* is ratio of US dollar to trading partner's national currency per US$ exchange rate; *Financial Depth* is the ratio of *M2 to GDP*; *Telephone* refers to fixed telephone subscriptions per 100 people in Cambodia; *Mobile* is mobile cellular subscriptions per 100 people in Cambodia; *Broadband* is fixed broadband subscriptions per 100 people in Cambodia; and *Internet* refers individuals using the internet as percentage of population in Cambodia.

Table 6: Estimation Results for Travel Exports

Variable Name	(1)	(2)	(3)	(4)	(5)
Constant	-32.11*** (7.74)	-34.45*** (7.31)	-35.19*** (7.06)	-40.42*** (6.01)	-36.76*** (6.53)
lnPOP	1.84*** (0.33)	1.95*** (0.31)	1.95*** (0.31)	2.00*** (0.27)	2.09*** (0.28)
lnGDPCAP	0.38* (0.20)	0.39* (0.20)	0.39* (0.20)	0.68*** (0.22)	0.43** (0.17)
lnEXCH	0.85*** (0.28)	0.71** (0.30)	0.71** (0.30)	0.10 (0.44)	0.81** (0.37)
Financial Depth	0.01** (3×10^{-3})	0.01* (3×10^{-3})	(0.01)	0.12* (0.06)	(0.01)
lnTelephone$_{(-1)}$		0.06 (0.04)			
lnMobile$_{(-1)}$			0.32 (0.19)		
lnBroadband$_{(-1)}$				2.49* (1.32)	
lnInternet$_{(-1)}$					0.10 (0.06)
Time Dummy	Estimated	Estimated	Estimated	Estimated	Estimated
No. of Obs.	360	340	340	200	300

Overall R^2	0.2860	0.2860	0.2860	0.1103	0.2894
Wald Test for Heteroskedasticity	440***	500***	682***	1175***	693***
Breusch-Pagan test	1483.49***	1429.28***	1631.86***	677.55***	1396.89***
Hausman Test	41.16***	38.33***	38.33***	23.88**	43.64***

Notes:

1. *ln* denotes values in natural logarithm.
2. *, **, and *** denote that the slope parameter estimates are statistically significant at the levels of 10%, 5%, and 1%, respectively.
3. Standard errors are heteroskedasticity robust standard errors in parentheses.
4. *POP* is population of trading partners; *GDPCAP* is GDP per capita of trading partners; *EXCH* is ratio of US dollar to trading partner's national currency per US$ exchange rate; *Financial Depth* is the ratio of *M2 to GDP*; *Telephone* refers to fixed telephone subscriptions per 100 people in Cambodia; *Mobile* is mobile cellular subscriptions per 100 people in Cambodia; *Broadband* is fixed broadband subscriptions per 100 people in Cambodia; and *Internet* refers individuals using the internet as percentage of population in Cambodia.

6 Concluding Remarks

The present paper started with stock taking of the development of ICT, which is an important infrastructure to further support online business communications, promote trade, as well as to transform Cambodia's narrow-based economy into a knowledge-based or digital one, in order to sustain its high economic growth and an equitable national economic development. ICT, although currently at the infancy stage, has been introduced in many sectors including public sector, education, tourism, health, transport, administration, and commercial activities.

To support the ICT sector and ICT applications, the Royal Government of Cambodia has made great efforts to build both ICT infrastructure and ICT-related legal frameworks to promote ICT investments, provide protection for consumers, data and privacy, and bolster users' confidence in adopting and using the innovative technology system. Concurrently, access to information has been streamlined through the RGC's policy to promote the ICT sector and fair competition in the ICT sector. Investment in telecommunications has been particularly encouraged. As a result, Cambodia has attracted more than 80 ICT operators. The country is currently home to 9 mobile cellular operators and 8 fixed telephone operators who also provide mobile and fixed internet services across all Cambodia's provinces and major cities.

The impact of information and communications technology on Cambodia's services export performance was investigated empirically, using the augmented gravity model with a panel data set from 20 trading partners over 1995-2012. We controlled for the widely-used gravity masses, such as population, income per capita, financial depth, and a time dummy, which are believed to affect Cambodia's exports to its trading partners. To report the best possible results, several diagnostic tests were carried out. It was found that the fixed-effects model is statistically better. Additional tests were also undertaken including multicollinearity checks based on the variance inflation factor (VIF), and groupwide heteroskedasticity test to avoid presenting spurious estimation results.

The estimation results provide some support for the role of ICTs in promoting Cambodia's total services export performance, as well as exports of transport and travel services. Since ICT is found to be an important determinant of Cambodia's services exports, further development of the country's ICT infrastructure is encouraged. The need to overcome infrastructural bottlenecks in the telecommunications and transport system should be addressed prior to promote trade flows both within the country and internationally. Improvements should be made in the following areas: (i) make available some important legal frameworks including consumer protection law, law on cybersecurity and competition law, which support international trade and electronic commercial activities; (ii) streamline efficient import and export procedures; (iii) upgrade the ICT infrastructure using tax incentives for private sector's participations and encourage foreign investment in ICT-related sectors.

Access to technology and ICTs should be also combined with relevant skills, opportunities and capacities. It is vital to promote ICT education and provide capability training in ICTs and new technology so that citizens can use these technologies in their work and businesses. While Cambodia has an abundant young low-cost labor force, there remain challenges of developing IT literacy and education to ensure the quality and size of the IT workforce. Support should be given on aligning curricula with computer science and IT-related courses throughout schools, vocational training centers, and higher educational institutions.

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Appendix B: Definitions of Variables and Their sources

Variable	***Definition/Measurement***	***Source***
LnExport	Logarithm of Services Export of Cambodia to trading partners	Organization for Economic Cooperation and Development (OECD)
LnPOP	Logarithm of population of trading partners	World Bank's World Development Indicators
LnGDPCAP	Logarithm of per-capita income of trading partners	World Bank's World Development Indicators
LnEXCH	Logarithm of the ratio of US dollar to trading partner's national currency per US$ exchange rate	World Bank's World Development Indicators
Financial Depth	Cambodia's ratio of M2 to GDP	World Bank's World Development Indicators

$LnTelephone_{(-1)}$	Logarithm of fixed Phone Subscriptions per 100 people in Cambodia	World Bank's World Development Indicators
$LnMobile_{(-1)}$	Logarithm of mobile cellular subscriptions per 100 people in Cambodia	World Bank's World Development Indicators
$LnBroadband_{(-1)}$	Logarithm of fixed broadband subscriptions per 100 people in Cambodia	World Bank's World Development Indicators
$LnInternet_{(-1)}$	Logarithm of individuals using the Internet as percentage of population in Cambodia	World Bank's World Development Indicators
Time Dummy	A yearly dummy variable is included to account for the global business cycle, the extent of globalization, oil shocks and so on	Rose (2004) and Eichengreen et al. (2007)

Appendix B: Cambodia's Trading Partners in the Sample

Australia	Canada	China	Denmark	France
Germany	Hong Kong	Indonesia	Italy	Japan
South Korea	Malaysia	Singapore	Spain	Switzerland
Thailand	United Arab Emirates	United Kingdom	United States	Viet Nam