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The Role of Information and Communications Technology (ICT) in Enhancing Service Sector Productivity in Palestine:
An International Perspective

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ABSTRACT

This article discusses the productivity of the Information and Communication Technology (ICT) sector using cross-sectional data from 793 service firms in Palestine. The authors have examined the impact of ICT growth on service sector productivity in Palestine using a set of indicators for ICT including internet usage, e-commerce, networks, websites, and use of "smart" phones. They find that using ICT (mainly Internet) in commerce (e-commerce) is one of the most important levers of labor productivity among service firms. Service firms that are less ICT-intensive are less productive than more ICT-intensive firms; moreover, the use of mobile phones for services other than send-and-receive calls, highly improves the labor productivity of service firms. Conversely, using a website and computer network does not positively affect the labor productivity. Regarding geographical differences in labor productivity, the analysis shows that firms in Jerusalem are characterized by higher productivity than firms in the West Bank, while firms in Gaza have a lower productivity compared to firms in the West Bank.

KEYWORDS

E-Commerce, ICT, Internet Usage, Productivity, Service Sector

1. INTRODUCTION

Information and Communication Technology (ICT) is a vital engine for economic growth in developed economies. ICT supports economic development through productivity enhancement, innovation and trade development through new delivery processes. Moreover, ICT is expected to contribute to economic recovery by providing relevant solutions to the current world economic crisis.

In most developing countries, ICT as a stand-alone economic sector is still under-developed compared to that in countries that are part of the knowledge economy. Both the public and private sectors in developing economies are still consumers of technologies developed abroad, and not ICT producers and innovators. However, over the past 20 years some developing countries such as India,

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China, Malaysia and Turkey have improved their capacity to use the ICT sector as an important tool for economic development in a way that sometimes exceeded the capacity of developed countries. The impact of ICT in developing countries depends on the synergy between ICT investment and long-term economic growth and stability. Moreover, ICT productivity depends on the human capital development related to ICT usage skills. The adequacy of ICT investment and the efficiency of human capital were behind the significant improvement in the quality of life for large segments of people in countries like Vietnam and India.

Studies at the firm level provide circumstantial evidence that ICT implementation has positively affected growth in productivity (Strassmann, 1985, 1990; Bender, 1986; Franke, 1987; Gargallo-Castel and Galve-Gorriz, 2012). Despite the fact that the service sector is more ICT-intensive than the manufacturing sector (OECD, 2004), evidence of ICT productivity from the service sector of developing countries is rare (UNCTAD, 2008). Although increasing over the last few years, the limited number of studies on this issue mainly addresses countries characterized by rapid ICT growth, like China, India, Malaysia and Turkey. Regarding other underdeveloped countries, the relationship between ICT on the one hand, and productivity and economic growth on the other, need more attention by researchers and policy makers.

This paper addresses the relationship between ICT productivity and economic growth in the case of an under-developed economy – Palestine - where the economy is heavily affected by the colonial measures of a military occupation. Palestine was forced to split into three distinct areas: namely, West Bank, Gaza, and Jerusalem. Despite the relative autonomy in economic decisions Palestine gained in 1993, this autonomy is very limited when it comes to trade between the three areas. Other restrictive measures apply to foreign trade and to the use of third and fourth generations of mobile services, to mention a few.

In the course of the past 20 years, Palestine has experienced high growth in its service sector in comparison with manufacturing and agriculture sectors. The contribution of the service sector to GDP grew steadily, shifting from 50% in 1995 to 60% in 2009, and it now employs more than 65% of the labor force. However, the Palestinian economy has experienced weak growth in productivity in the service sector compared to the manufacturing sector, which negatively influences the overall productivity growth of the Palestinian economy (see Figure 1, below).

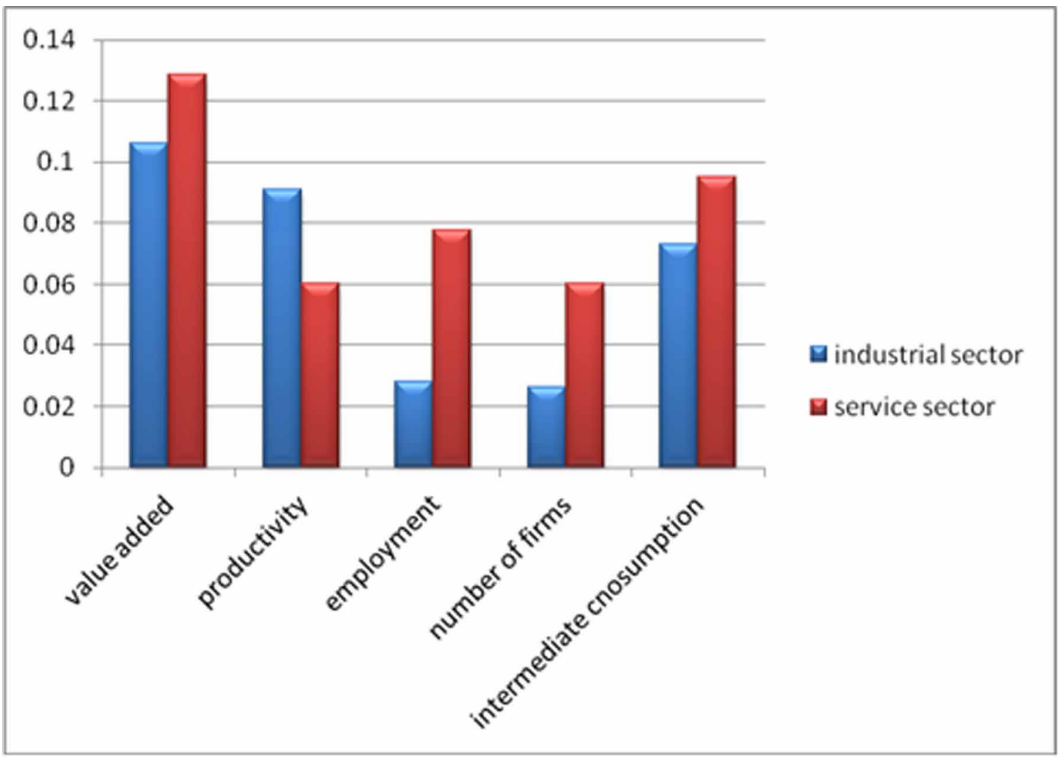
In the last decade, Palestine has experienced a particular and continuing increase in the utilization of ICT at the firm level, especially in terms of computers, cellular subscriptions, Internet Wi-Fi, and networks. This is mainly due to the fast growth of the ICT sector in Palestine during these years. The productivity of the service sectors, which use more ICT, is likely to grow higher compared to sectors which are low ICT-intensive (Morrar and Gallouj, 2016).

In this work, the relationship between ICT and productivity growth of service firms is investigated in an original context. Palestine is a country where data are lacking. The three areas of the country (West Bank, Gaza, and Jerusalem) have their own political and economic conditions, and have to comply with colonial and military restrictions. ICT can help to connect the different areas and bypass many of these restrictions, especially for service businesses. The remainder of this paper contains the following sections: Section two reviews the literature devoted to the relationship between ICT and economic performance at different levels of analysis: the macroeconomic level, industrial level, and firm level. In section three, we present statistics about the ICT sector in Palestine and its applications in the service sector. Section four discusses the methodology used and the data. In section five, results are presented and discussed. The last section concludes the study.

2. RESEARCH OBJECTIVE AND HYPOTHESES

Table 1 below summarises the research objective, questions and hypotheses. The main objective of this research is to measure the impact of ICT tools on the productivity of service firms. To answer this question, we introduce a set of hypotheses that we will test using quantitative methods. Some of these hypotheses are related with ICT usage while the others are control variables.

Figure 1. Annual growth rate in value added, productivity, employment, number of firms, and intermediate consumption between 1995 and 2010 (Resource: Author calculation based on PCBS data)



3. LITERATURE REVIEW

Theoretically, the mechanism by which ICT affects economic development is through building a "knowledge-based economy" and an "information society" in which information is an essential input for business processes and economic development. In practice, this occurs through the employment of ICT tools, which include hardware, software, office automation, internet service, and telecommunications.

The relationship between ICT and economic performance has been extensively analyzed (Brynjolfsson & Yang, 1996; Motohashi, 1997; Kraemer & Dedrick, 2001; Jalava & Pohjola, 2002; Farhadi et al., 2012). While the results are mixed, the evidence after the mid-1990s suggests a positive impact of ICT on economic performance. Most of the early studies focused on measuring the impact of using computers on labor productivity, ignoring the effect of non-computer ICT. One of the limitations to the realization of such studies was the availability of data. Nevertheless, there is now a growing consensus about the positive relationship between ICT and labor productivity (Koellinger, 2008). This positive impact comes mainly from three sources (Pilat, 2005). First, it is due to the impact of ICT on capital deepening, which enhances labor productivity. Second, more production of ICT products is likely to increase the efficiency of labor and capital, or multifactor productivity in the ICT-producing sector. And third, greater use of ICT helps firms to increase their overall efficiency; for example, through lowering transaction costs, speeding innovation, and by increasing access to information and knowledge.

Empirical studies on the relationship between economic growth and the use of ICT can be classifed into three levels of analysis: macro, industrial, and firm level. At the macro level, several studies (Nasab and Aghaei, 2009; Schreyer et al., 2003; Van Ark et al., 2003; Jorgenson, 2003) found that

Table 1. Research objective, questions, and hypothesizes

Research objective	Research questions	Research hypotheses
To estimate the relationship between ICT usage and the productivity/ growth of service firms in Palestine, using different ICT indicators (internet, computers, networks, website, etc.)	What is the estimated impact of ICT on the economic performance of service firms in Palestine, measured by labor productivity?	H0: There is no relationship between the ICT labor and labor productivity of service firms (H0: B1 = 0). H0: There is no difference between labor-intensive services and capital-intensive services in regard to service productivity (H0: B2 = 0). H0: There is no relationship between the use of mobile phones in business activities, including internet access, emails, banking services, and governmental services, and the labor productivity of service firms (H0: B3 = 0). H0: There is no relationship between use of computer networks and the labor productivity of service firms (H0: B4 = 0). H0: There is no relationship between use of the internet for selling and purchasing (E-commerce) and labor productivity of service firms (H0: B5 = 0). H0: Firms with more R&D activities have no advantage regarding service productivity (H0: B6 = 0). H0: There is no complementarity effect between ICT labor and R&D (H0: B7 = 0). H0: There is no relationship between the use of computers and labor productivity of service firms (H0: B8 = 0). H0: There is no relationship between the use of websites and labor productivity of service firms (H0: B9 = 0). H0: Exports will not improve labor productivity of service firms (H0: B10 = 0). H0: There is no difference in labor productivity in terms of firm size (H0: B11 = 0). H0: There is no difference between West Bank, Jerusalem and Gaza in terms of labor productivity (H0: B12 = B13 = 0).

ICT investments increased capital and improved growth in most OECD countries, taking into account the variation between countries. Oliner and Sichel (2000), using computer hardware, software and telecommunication equipment as indicators for ICT, found a high impact of ICT on economic growth, starting from the mid-1990. In a similar study, Javala and Pohjola (2002) found that ICT was one of the most important factors in U.S. economic growth in the 1990s. There is a gap between developed countries themeleves. For instance, Daveri (2000) and Schreyer (2000) found that the contribution of ICT to economic growth is higher in US than in the EU.

At the industrial level, several studies showed that growth in the ICT sector contributed significantly to labor productivity and multifactor productivity (MFP) in many developed countries. Thus, in the US, France, and Australia, ICT-based services grew rapidly, which substantially enhanced the growth of labour productivity and MFP (O'Mahony & Van Ark, 2003; Pilat et al., 2002; Pilat & Wölfl, 2004).

Compared to the two other levels, firm-level analysis is likely to be more rigorous in measuring the relationship between productivity and ICT usage. Firm-level data can reveal the factors influencing the effect of ICT that cannot be captured at the macro or aggregate level, e.g. skills, organizational competences, and entrepreneurship. Also, firm-level analyses consider the competitive impact of ICT, e.g. the entry and exit of new firms and market share.

For instance, Atrostic and Nguyen (2002) found that using computers led to a 5% increase in manufacturing firms' labor productivity in the US. Arvanitis (2004) found a high correlation between labor productivity and ICT investment at the firm level in Switzerland. Atrostic and Nguyen (2005), using two different computer-related measures -- computer capital and computer networks (how computers are used) -- to measure the relationship between ICT and labor productivity in US

manufacturing firms, found that computer networks added 5% to labor productivity in comparison to 12% in the case of investment in computers (computer capital). Criscuolo and Waldron (2003), using a panel of manufacturing firms in the UK, found that using E-commerce enhanced labour productivity between 7 to 9%. Gretton et al. (2004), using firm-level data from Australia, found that ICT raised the annual growth of MFP by nearly two-tenths of a percent. Maliranta and Rouvinen (2004) found that the productivity of ICT-equipped labor increased 8-18% in Finland after controlling for specific firm and industry characteristics and the effect of time. This effect was clear in ICT-producing services.

The influence of ICT investment on productivity growth varies greatly between sectors (e.g. industrial versus service sector) and countries (e.g. developing versus developed countries). Despite consensus on the positive impact of ICT on productivity in developed countries, there is no consensus on its effect in developing countries. Dewan and Kraemer (2000), using panel data for 36 developed and developing countries between 1985-1993, found that investment in IT capital positively affected the output growth in developed countries, but this was not the case for developing countries. They attributed this gap to the low rate of IT capital in developing countries as well as the lack of complementary assets such as human capital, infrastructure, and knowledge-based structures. Edquist (2005) attributed this gap to the late introduction of ICT in developing countries. For example, until the late 1990s, Internet services were not available in many developing countries. Some studies revealed a negative impact of ICT on productivity. Lehr and Lichtemberg (1999) explained this negative impact by the limitations of using simple bivariate relationships, while Becchetti et al. (2003) attributed it to the lagged effect of ICT investments and their association with labor network externalities.

Thailand is one of the developing countries where ICT was a core function of governemnt policies. It considered ICT a vehicle for social and economic development, playing a vital role in improving the competitiveness of domestic businesses (UNCTAD, 2008). Thailand established the National Information Technology Committee in 1992 to promote ICT, including members from both public and private sectors (Thuvasethakul and Koanantakool, 2002). Results of productivity analysis for Thai firms show that using computers and Internet as well as web presence are associated with high growth in labor productivity, represented by sales per employee (UNCTAD, 2008). They also show that the effect of computers on productivity is higher than that of Internet and web. Computers' influence on productivity comes from their intrinsic characteristics such as storage capacity and processing and from their use as means of acquiring other complex ICT services such as Internet access and web presence.

Many studies confirm the importance of complementarity between ICT investment and other investments. The impact of ICT is apparent when ICT investment is accompanied by other investments and changes, i.e. "ICT primarily affects firms where skills have been improved and organizational changes have been introduced" (OECD, 2004).

In Canada, Baldwin et al. (1995) found that employment of advanced technology requires a higher level of skills. Gretton et al. (2004) also found that human skills, new innovation processes, advanced business practices and the application of new organizational changes were crucial for Australian firms to generate a positive influence of ICT investment on productivity growth. In France, Entorf and Kramarz (1998) showed that higher labor productivity is associated with more experience in using computer-based technologies. Charlo (2011) found that innovation has no significant impact on productivity growth in manufacturing firms in Uruguay, but this was reversed when innovation interacts with investment in ICT. In a similar study, Koellinger (2008) suggested that innovative firms that invest in ICT are more likely to exhibit an increase in labor productivity, which confirms the importance of complementarity between ICT investment and other investments in innovation and human capital.

ICT is likely to be more employed in the service sector than in manufacturing (OECD, 2004). Moreover, there is a high intra-sectoral heterogeneity in terms of ICT intensity within the service sector. For example, financial services in many countries are among the service sectors that intensively

employ ICT (OECD, 2004). Evidence from the UK shows that financial intermediation is highly dependent on network technologies, much more than other service sectors (OECD, 2004).

More evidence related to services includes Gretton et al. (2004), who found a positive impact for ICT on MFP growth in many service sectors in Australia and the United States. Also, in the USA, Doms et al. (2004) found that the replacement of traditional retailers by sophisticated services in the U.S. retail sector during the 1990s was contingent on introducing new technologies and processes, and especially ICT. Maliranta and Rouvinen (2004) found that the impact of ICT on labor productivity in Finland was higher in the service sector than in manufacturing. A similar result was found in Switzerland by Arvanitis (2004), who found that the employment of the Internet in the service sector was more important for service firms' performance than for the manufacturing firms. This is explained by the unavailability of a desk job equipped by PC and Internet connection for many of the employees in the manufacturing sector. Farooqui (2005), using a sample of service and manufacturing firms, found that the impact of e-selling on labour productivity revealed positive signs in service firms (i.e., boosting labor productivity by 4%) and negative signs in manufacturing firms. Hempell et al. (2004) confirmed the importance of complementarity between ICT investment and innovation to obtain a positive impact of ICT on labor productivity in the service sector in both Germany and the Netherlands.

4.THE ICT SECTOR IN PALESTINE

The Information and Communication Technology sector is gaining increasing recognition in Palestine. Economic experts commend the ICT sector in Palestine for its viability and ability to promote economic development and sustainable growth (USAID, 2006). The ICT sector in Palestine gains its advantage from the specificities of Palestine economy: small, with a young and well-educated population.

In recent years the ICT sector has significantly expanded in the number of firms and foreign investments. The output of the ICT sector was estimated at $588.9 million in 2010 (PCBS, 2011). The contribution of ICT to Palestinian GDP increased from 0.8% in 2008 to 6.4% in 2011 (PCBS, 2011). A recent study (Wihaidi, 2009) confirms the view of international experts that outsourcing ICT services from Palestine is evaluated positively in terms of quality, timeliness and customer satisfaction.

The growth of the ICT sector is due to changes in the trend of many sectors towards modernization and novelty. ICT is employed in most of the productive sectors and along the supply chain of most companies. Meanwhile, national organizations such as the United States Agency for International Development (USAID) and the German Society for International Cooperation (GIZ) have started supporting the ICT sector in Palestine, which will give new impetus for growth and development.

4.1. History of the ICT Sector in Palestine

The USAID (2006) assessment provides a brief background and history about the ICT sector in Palestine. During the 1980s the ICT sector was represented by a handful of companies which mainly distributed the services provided by Israeli dealers and had limited experience in ICT services. Some software companies were involved in developing accounting-related packages to replace the Israeli accounting software programs used by local companies and hospitals.

In the 1990s and after the Oslo agreements, the ICT sector started to grow in response to the demand coming from the private sector (financial and insurance sector, telecommunication, etc.), local government, public administrations, universities and NGOs. The launch of the first telecommunication company (PALTEL) in 1997 strongly contributed to the development of the ICT sector in Palestine. The Palestinian Internet service provider was also created and the Internet became accessible to different stakeholders. By 2012, PALTEL had around 382,700 subscribers to fixed line and 165,000 to ADSL lines.

ICT activities and the market demand are mainly concentrated in three areas: Ramallah, Gaza and Jerusalem. The main products of ICT firms are hardware (direct agents or PC assemblers), software development, enterprise consultancy, Internet services and office automation equipment.

During the 2000s there was a sharp decline in ICT companies' revenue, from US$120 million in 2000 to US$87 million in 2003, because of political instability resulting from the second Intifada in 2001. Moreover, International companies such as HP, Timex and IDS shut down their sales operations in Palestine.

According to Wihaidi (2009), 29% of ICT firms are mainly developing software, 28% are engaged in hardware sales, and 5% are manufacturing ICT products. By the end of 2005, there were around 100 ICT companies, 150 Internet cafes, and 150 computer stores in the Palestinian areas. Wihaidi (2009) also shows that, at the end of 2007, the ICT sector contributed about 10-12% of GDP, with a $500 million market size. There were around 250 ICT firms, and over 5,300 individuals working in the ICT sector. According to the World Bank database, exports of ICT services increased from 5.4% of total Palestinian service export in 2008 to 6.0% in 2009. In 2010, growth in software development firms represented 36% of ICT firms, whereas hardware firms, telecommunication firms and training firms represented 35%, 18% and 11%, respectively (Paltrade, 2014). The number of employees increased to 6,400 in 2011 (PCBS, 2012).

4.2. Structure of the ICT Sector in Palestine

Goods and services introduced by ICT companies in Palestine extend from telecommunications (fixed and mobile phone lines, Internet services, etc.) through computer developers, equipment manufacturers and resellers, storage, audio-visual systems, production of software for solutions and packages (projects and sales management, finance and accounting programs, education-related solutions, children's education and entertainment, etc.) to web products (e.g., web development, e-businesses, web portals development, ICT consultancy, etc).

4.3. Local Demand for ICT

The demand for ICT goods and services has significantly increased in Palestine over the last few years (Table 2). In 2012, the PCBS conducted the ICT Business survey, which aims to provide a comprehensive statistical profile of the main features of ICT means, access and usages in Palestinian firms across different economic activities; it also provides statistical information for decision-makers either in the public or private sector.

4.3.1. Use of Computers

Table 3 shows that 47.0% of the total number of firms in Palestine used computers in 2011. The West Bank has an advantage in the use of computers compared to the Gaza Strip (49.6% versus 40.8%). There are 22.3 computers per 100 employees in Palestine.

There is also high heterogeneity between economic sectors regarding computer use. Financial intermediary firms and information and communication sectors are the main users of computers, with 97.1% and 92.6% respectively, using this tool (Table 4). These percentages are consistent with the basically informational nature of these sectors.

The percentage of firms that use computer in the overall services is 50%, which is explained by the inclusion of service activities which are less ICT intensive, like hotels and restaurants, sales and repair of motor vehicles, wholesale trade, and public services. The industrial sector has the lowest score in terms of Internet use, due to to the nature of the industrial sector in Palestine, which comprises mostly traditional industries employing chiefly non-skilled labor.

4.3.2. Use of the Internet

As noted, Table 3 shows that 39.2% of firms accessed Internet services in 2011, 41.3% in West Bank compared with 34.0% in the Gaza Strip. The lower rate of internet access is explained by the difficult

Table 2. Percentage of households with IT goods and services

	2004	2011
Computer	26.4	50.9
Internet connection	9.2	30.4
Fixed phone line	40.8	44
Mobile phone	72.8	95

Source: PCBS (2006, 2012)

Table 3. Percentage of firms with IT goods and services

Indicator	Region		
	Palestine	West bank	Gaza
Percentage of firms using computers	47	49.6	40.8
Percentage of firms using Internet	39.2	41.3	34
Percentage of firms using electronic transactions	11.2	10.8	12
Percentage of firms have Website	4.8	5.2	3.7
Percentage of firms engaged in R&D in ICT	2.5	1.5	5
Number of computers per 100 employees	22.3	21.5	25
Number of telephones per 100 employees	25.9	26.4	24.1
Number of mobile phones per 100 employees	40.2	37.3	50.3

Source: PCBS (2012)

Table 4. Percentage of firms that use computers by economic sector (activity) in 2011

Economic sector	Percentage
Industrial	26.3
Constructions	90.1
Internal trade	49.9
Services	50
Transportation and storage	32.3
Information and communication	92.6
Financial intermediation	97.1

Source: PCBS (2012)

political situation in Gaza, which adversely affects most economic sectors and impedes the ability of many firms to develop and employ ICT.

Regarding differences between industrial and service sectors in use of the Internet, Table 5 shows that the gap between industrial and service sectors is lower in comparison with the gap in the use of computers. Information and communication and financial intermediation sectors are also the highest among other sectors in using the Internet in 2011, with 99.3% and 97.8%, respectively; only 65.3% of industrial firms employed the Internet in 2011. According to PCBS, in 2011, 86.5% of the firms did not use the Internet because it is not employed in their production processes, while 18.4% do not use it because of cost (PCBS, 2012).

Table 5. Percentage of firms that use computers by economic sector (activity) in 2011

Economic sector	Percentage
Industrial	65.3
Constructions	92.1
Internal trade	85.8
Services	81.5
Transportation and storage	75.8
Information and communication	99.3
Financial intermediation	97.8

Source: PCBS (2012)

4.3.3. Electronic Commerce

Table 3 shows that 11.2% of firms in 2011 carried out e-commerce transactions, with minor differences between the West Bank and Gaza Strip (12% in Gaza vs. 10.8% in West Bank). According to PCBS (2012), in 2011, information and communication technologies and financial intermediation were the main users of electronic transactions, with 55.9% and 36.7 of the firms, respectively. Thirty-one percent of industrial firms used electronic transactions, which is considered a good ratio regarding the low implementation of E-commerce in Palestine. Only 4.8% of firms had a website (5.2% in the West Bank and 3.7% in the Gaza Strip).

4.3.4. Telecommunications

Table 3 reveals that the number of mobile phones in firms was 40.2 per 100 employees in Palestine in 2011 (37.3 in West Bank and 50.3 in the Gaza Strip). The number of fixed telephones per 100 employees was 25.9 in Palestinian firms at the same period. The PCBS (2012) shows that in 2011 around 70% of firms in Palestine used mobile phones to obtain information about goods and services, 46.5% to provide customer services, 31.2% to access banking or other financial services, and 23.3% to interact with general government organizations. Only 9.2% of firms used mobile phones to access the Internet and 10.1% to send and receive E-mails.

4.3.5. Research and Development (R&D)

The data from PCBS (2012) shows that only 2.5% of firms in Palestine performed R&D activities related to ICT in 2011. This might be explained by the low concern for R&D either from the private or public sector and by the fact that most R&D related to ICT in Palestinian firms is developed outside Palestine. The R&D sector is the smallest sector in the Palestinian economy and it mobilizes less than adequate financial resources (Morrar & Gallouj, 2016).

Sectoral differences also manifest in R&D activities related to ICT. About 32% of firms in the information and communication sector implemented R&D related to ICT, 21% in financial intermediation. Only 1.6% of industrial firms engage in R&D related to ICT. This confirms what we already outlined, i.e., that the industrial sector in Palestine is a traditional sector with low employment of technology and of skilled labor. Israeli restrictions against the Palestinian economy also make the investment in R&D a non-profitable activity.

5. METHODOLOGY AND EMPIRICAL APPROACH

In this section, we develop an econometric approach to analyze the relationship between ICT use and labor productivity in the Palestinian service sector. The model for estimating the complex relationship between ICT and economic performance should take into account the fact that the relationship between ICT and economic development is a multi-dimensional process which must be discussed in several perspectives (e.g., economic, social and human development). Moreover, it must be based on a robust blend of both qualitative and quantitative data.

This paper adopts the productivity approach used in many previous studies (Gurbaxani et al., 1998; Ramirez & Nembhard, 2004). A Cobb-Douglas production function is used as the basic analytical framework as it is simple and has empirical robustness in estimating firm performance. The logarithmic transformation of the Cobb-Douglas function provides a log-linear form of the production model as follows:

$$\text{Ln}(Q/L) = B_0 + B_1.\ln(\text{ICTlabor}) + B_2*\ln(\text{Capitaintensity}) + B_3*\text{lnTelecom} + B_4*\text{CompNet} + B_5*\text{E-commerce} + B_6*\text{R\&D} + B_7*\text{ICTlab*R\&D} + B_8*\text{Computer} + B_9*\text{Website} + B_{10}*\ln(\text{Exports}) + B_{11}*\ln(\text{Size}) + B_{12}.\text{Gaza} + B_{13}.\text{Jerusalem} + \text{Ui}$$

The dependent variable is productivity, which is proxied by labor productivity. There is no consensus as regards the most relevant index for measuring labor productivity. It has been commonly measured in the literature using value-added per employee or sales per employee. Value added is considered a more accurate measure of labor productivity because it subtracts the cost of intermediate consumption from the value of the sales. Therefore, we have used the logarithm of value added per employee to proxy for the labor productivity. ICT labor is the logarithm of the ratio of labor using ICT to total number of employees. The labor using ICT is proxied by the number of employees using computers during their work. Capital intensity is measured by the logarithm of the ratio of book value of assets to the total number of employees. Telecom is a dummy variable which equals 1 if the firm uses smart mobiles for activities other than sending and receiving calls. These activities include Internet access, emails, banking services, governmental services, offering goods and services and other activities that can be performed using smartphones. Compute is the natural logarithm of the number of computers used by the firm. Network is a dummy variable that equals 1 if the firm has computer network of any type. E-commerce is a dummy variable that equals 1 if the firm uses the Internet to acquire information about goods and services, provides information about goods and services, buys goods or services online, or uses Internet banking services. R&D is a dummy variable that equals 1 if the firm implements a research and development project, and 0 otherwise. ICTlab*R&D is an interaction variable that measures the complementarity between R&D and the number of employees using ICT. Website is a dummy variable which equals 1 if the firm has a website. Exports is the natural logarithm of the export sales of the firm. Size is the logarithm of the number of employees; Gaza is a dummy variable which equals 1 if the firm works in the Gaza Strip. Jerusalem is a dummy variable which equals 1 if the firm works in Jerusalem.

5.1. Data and Sample

We will use firm-level data to investigate the relationship between ICT and labor productivity in the Palestinian service sector. Using firm-level data is advantageous over macroeconomic and industry level data (OECD, 2004) because it helps to understand why high ICT investment may not lead to high growth in labor productivity (Solow paradox); that is, it can highlight the factors (skills, organisational factors, etc.) which influence the relationship between ICT and productivity and cannot be observed at the aggregate level.

Secondary data about both the dependent and independent variables were obtained from the raw data of the PCBS ICT survey. In 2012, PCBS implemented the ICT business survey for the first

Table 6. Percentage of firms, employees in service sector in 2011

Percentage number of firms	Percentage number of employees	Sector
8.98	9.20	Sale and repair of motor vehicles
2.36	3.65	Wholesale trade
59.45	43.89	Retail trade, repair of personal goods
0.562	6.39	Hotels and restaurant
0.52	1.57	Land transport
0.44	0.55	Supporting & auxiliary transport
0.38	2.22	Postal services and telecommunication
0.21	0.17	Real estate activities
0.43	0.40	Renting of machinery without operator
0.62	0.48	Computer and related activities
0.05	0.19	R&D
3.59	3.61	Other business activity
2.57	8.75	Education
4.66	6.62	Health and social work
00	0.01	Sewage and refuse disposal
2.00	5.54	Membership organization activities
2.08	2.50	Recreational culture and sporting activities
6.02	4.25	Other service activity

Source: Author calculation based on PCBS data 2011

time to provide statistical information about the use of ICT at both household and business levels in 2011. After data cleaning, a total of 793 service firms was available to measure the relationship between ICT and labor productivity in the Palestinian service sector. Table 6 (below) introduces the segmentation of the service sector in Palestine and the percentage of firms and employees in each segment. The data show that retail trade, repair and personal goods employ about 44% of all employees in the service sector; this includes around 59.5% of service firms, followed by sale and repair of motor vehicles and public services. This pattern illustrates the traditional nature of the service sector in Palestine. Knowledge-intensive business services and capital-intensive services such as postal and telecommunication, financial sector, computer, and real estate are still very small, which might be explained by the modernity of these sectors and the long period of political instability and occupation for the Palestinian territories which has lasted for over 40 years.

6. RESULTS AND DISCUSSION

Table 7 below summarizes the results of testing the 12 hypotheses. We find that we reject the null hypothesis (H0) in 11 of the 12 hypotheses, and accept the null hypothesis for hypothesis number 4, which is related to the use of computer networks.

Table 8 summarizes the results of the regression equation estimates. Four models are estimated using OLS based on the specifications presented in the last section. Standard errors for the regression coefficients are robust for heteroscedasticity using White's method. The adjusted R-square for the four models varied between 0.15 and 0.259, which means that they explain around 15% to 26% of

Table 7. Results of hypothesis testing

Research hypotheses	Decision	Conclusion
H0: There is no relationship between the ICT labor and labor productivity in service .	1. Reject H0	1. The increase in ICT labor improves labor productivity.
H0: There is no difference between labor-intensive services and capital-intensive services in regard to service productivity	2. Reject H0	2. Capital-intensive services are more productive than labor-intensive services.
H0: . There is no relationship between the use of mobile phones in business activities, including internet access, emails, banking services, governmental services and the labor productivity of service firms	3. Reject H0	3. There is a positive relationship between the use of mobile phones in business activities, including internet access, emails, banking services, government services and the labor productivity of service firms.
H0: There is no relationship between the use of computer networks and labor productivity of service firms	4. Accept H0	4. The use of computer networks does not improve the labor productivity in service firms.
H0: There is no relationship between use of the internet for selling and purchasing (E-commerce) and labor productivity of service firms	5. Reject H0	5. E-commerce improves the labor productivity of service firms.
H0: Firms with more R&D activities have no advantage regarding service productivity	6. Accept H0	6. More R&D worsens the labor productivity of service firms.
H0: The is no complementarity effect between ICT labor and R&D	7. Reject H0	7. The impact of ICT labor on labor productivity improves it if complemented by investment in R&D.
H0: There is no relationship between the use of computers and labor productivity of service firms	8. Reject H0	8. The use of computers negatively influences the labor productivity of service firms.
H0: There is no relationship between the use of websites and labor productivity of service firms.	9. Reject H0	9. The use of electronic websites worsens the labor productivity in service firms.
H0: Exports will not improve labor productivity of service firms	10. Reject H0	10. Service firms with more exports are more productive than firms with low exports.
H0: There is no association between labor productivity and firm size	11. Reject H0	11. Large firms are more productive than small firms.
H0: There is no difference between West Bank, Jerusalem and Gaza in terms of labor productivity (.	12. Reject H0	12. Service firms located in Jerusalem are characterized by a higher labor productivity than those in the West Bank and Gaza. Also, service firms located in West Bank are more productive that those in Gaza.

change in the growth of productivity. Model 4 has the highest value of adjusted R^2 compared to other models. In model 4, most of the ICT indicators have a positive impact on labor productivity for the Palestinian service sector. This is consistent with previous findings, which suggested that, in order to increase their contribution to productivity, service sectors should invest far more heavily in new technologies, mainly ICT (Morrar & Gallouj, 2016), for the case of Palestine; see also x and y for the case of other developing countries like Thailand and India).

Table 8 shows that firms which use the Internet for selling and purchasing services (E-commerce) achieved larger productivity scores than firms which do not use E-commerce. Possible explanations for this result may include the following:

Table 8. Regression analysis for the ICT determinants of labor productivity

Variable	Model 1	Model 2	Model 3	Model 4
Size	0.353***	0.331***	0.332***	0.550***
	(6.64)	(6.09)	(6.13)	(9.164)
Exports	0.084***	0.064***	0.054***	0.050***
	(6.23)	(4.53)	(3.67)	(3.327)
E-commerce	0.386***	0.393***	0.428***	0.557***
	(3.41)	(3.50)	(3.85)	(4.757)
Capital intensity	0.084***	0.081***	0.079***	0.120***
	(3.49)	(3.37)	(3.38)	(5.359)
ICT labor	0.338***	0.295***	0.204***	0.380***
	(5.50)	(4.84)	(3.01)	(5.567)
R&D	-0.923***	-0.819***	-0.468***	-0.058***
	(-7.15)	(-6.31)	(-2.66)	(-3.338)
Telecom	0.350***	0.387***	0.374***	0.307***
	(2.86)	(3.17)	(3.11)	(2.680)
Gaza		-0.524***	-0.505***	-0.536***
		(-4.41)	(-4.26)	(-4.596)
Jerusalem		0.424*	0.480*	0.703***
		(1.66)	(1.81)	(2.892)
ICT labor*R&D			0.487***	0.554***
			(3.55)	(3.967)
COMPUT				-0.389***
				(-8.014)
NETWORK				0.031
				(0.239)
WEBSITE				-0.167*
				(-1.875)
C	1.873***	1.967***	1.853***	1.706***
	(9.34)	(9.61)	(8.95)	(8.354)
Number of observations	793	793	793	793
R-squared	0.157	0.182	0.193	0.272
Adjusted R-squared	0.150	0.173	0.183	0.259
F-statistic	20.964***	19.399***	18.737***	21.915***

All regressions are estimated using OLS regression. The numbers in parenthesis are robust t-statistic calculated based on White standard errors. ***, **, * indicate significance at 1%, 5%, and 10% respectively

- Increased use of the Internet by financial services and information-communication services
- E-commerce influences on the business process, by enabling firms to access wider markets and new customers
- Increased efficiency of business processes by allowing less expensive and more efficient sourcing of materials

The increase in ICT labor variable was found to improve labor productivity. This is consistent with what Entorf and Kramarz (1998) emphasized regarding French workers, i.e., that they are more productive when they have gained greater experience in using computer-based technologies.

The use of mobile phones in business activities, including internet access, emails, banking services, governmental services, offering goods and services, and other activities that can be performed using smart-phones.

Telecom was found to be highly important in improving the labor productivity of service firms. This can be understood in terms of the high percentage of employees who use mobile phones to obtain information about goods and services (70%), to provide customer services (46.5%), and to access banking or other financial services (32%) (PCBS, 2012).

Despite the fact that 47% of service firms in Palestine use computers (Table 3), this paradoxically does not seem to have a positive impact on labor productivity. The regression coefficient for Comput variable is negative. This expression of the Solow Paradox might be explained by the lack of complementary assets like human capital, and knowledge-based structures. Employees in many serivce sectors like trade, hotels and restaurants, and personal services are nonskilled labor with very limited knowledge of computers and software.

R&D has a negative influence on labor productivity in the Palestinian service sector. This might be explained by the obstacles that limit the private sector in Palestine from benefiting from the results of R&D (El-Jafari et al., 2008). These obstacles are 1) the outcome of prepared research does not match the needs and requirements of the private sector, 2) the inability of research institutions to publish results of their research and studies, 3) research activity is restricted to universities in purely academic fields, 4) many R&D activities in universities and research centres are not applicable, 5) lack of data and information, 6) the use of inappropriate research methods to solve the problems faced by the private sector, and 7) the high costs of patents for many research studies.

The impact of ICT labor on labor productivity will improve if it is complemented by investment in R&D, which means that the R&D impact on firm productivity will be positive if it is complemented by labor with high intensity use of ICT. This confirms the results of Koellinger (2008) and Hempell et al. (2004), that innovative firms investing in ICT are more likely to show increases in labor productivity.

Our analysis shows that the use of websites by firms does not improve their labor productivity. This might be related to the very low percentage of firms that have a website (only 4.8% in 2011, as appears in Table 3).

We also found no significant relationship between using computer networks and labor productivity. This is inconsistent with work in many other countries, which confirm a positive relationship (Atrostic and Nguyen, 2002; Atrostic et al., 2004). In Palestine, this result might be explained by the fact that most service firms are micro firms (from 1 to 4 employees) or medium-size firms (from 5 to 9 employees) which are unable to employ computer networks, or which are not in need of such networks.

For control variables, there is a strong positive relationship between Exports and labor productivity, which means that service firms which export are more productive than others. This positive impact of exports on productivity is highlighted by most of the literature, whether it concerns developed or developing countries (Grazzi & Vergara, 2011; Calza & Rovira, 2011). In the last 20 years in Palestine the ratio of services to industrial exports strongly increased. According to PCBS statistics, it increased from 11.5% in 1997 to 46% in 2010 (PCBS, 2012).

As colonial measures divide Palestinian territories into three distinct areas, we determined whether the geographical region has an effect on labor productivity. The convention of dividing Palestine

into three separate areas is adopted by official statistical sources (PCBS 2012). The three areas are West Bank, Gaza and Jerusalem. Results in Table 8 show that service firms located in Jerusalem are characterized by a higher labor productivity than those in the West Bank and Gaza. This is explained by the special political situation of Jerusalem, which the Israeli government considers a part of Israel, while the international community classifies it as occupied territory. Jerusalem is a tourist area where millions of tourists visit yearly. Some service sub-sectors, like hotels, restaurants, and transportation, are more developed in Jerusalem than in the West Bank and Gaza due to the flourishing tourism trade, free mobility of people, and other trade. This creates a gap in demand between Jerusalem and the West Bank, which positively impacts labor productivity in the service sector of Jerusalem.

The low productivity of the service sector in the Gaza Strip compared to the West Bank is related to the difficult political situation due to the blockade imposed by Israel and Egypt since 2006, which negatively affects all economic sectors. Service sectors like financial services, wholesale trade, transportation, tourism and real estate have been harmed by long years of blockade. Three Israeli wars against Gaza in 2008, 2012 and 2014 have also destroyed the infrastructure necessary for economic development.

Finally, our analysis identifies a positive link between the size of firms and their labor productivity. Large service firms in Palestine are characterized by higher labor productivity than smaller ones. These large service firms include firms in telecommunications, financial and whole-trade sectors.

6. CONCLUSION

In this work we have addressed the question of the relationship between the use of ICT and the labor productivity in the Palestinian service sector. The results show that many ICT indicators have a positive impact on labor productivity. Using ICT (mainly Internet) in commerce (E-commerce) is one of the most important levers of labor productivity in service firms. The increased volume of ICT labor positively impacts firm labor productivity in general. This means that service firms which are less ICT-intensive (e.g., in retail trade, hotels and restaurant, as well as the sale and repair of motor vehicles), are less productive than more ICT-intensive firms (e.g., in telecommunications, real-estate, R&D and financial services). The use of mobile phones for services other than send-and-receive calls is strongly associated with increased labor productivity in service firms. This is related to the high percentage of employees using mobile phones for various purposes: to obtain information about goods and services, to provide customer services, and to access banking or other financial services. Conversely, using websites and computer networks is not associated with labor productivity.

Regarding other control variables, our analysis shows that large service firms are more productive than small ones, and exports positively impact the labor productivity of service firms. Finally, regarding geographical differences in labor productivity, firms in Jerusalem are characterized by higher productivity scores than those in the West Bank, while firms in Gaza have a lower productivity than those in the West Bank. This result is explained by the higher level of demand in Jerusalem and the difficult political situation and blockade in the Gaza Strip.

New policies are needed to enable the ICT sector to develop Palestinian services. Applicable recommendations are also needed for policy makers to maintain the relationship between ICT institutions and governing bodies in a long-term economic strategy. First, financial and strategic commitments in governing institutions are crucial to support a knowledge-based economy. Second, government should improve the fiscal and regulatory environment in ICT through reforms in ICT legislation (i.e., intellectual property rights, patents, etc.), increased market competition, and through tax breaks and domestic credit for ICT-intensive firms. Third, specific long-term plans should be developed for the service sector based on knowledge and ICT employment, mainly in traditional services. Fourth, a closer link is needed between public institutions represented by the Ministry of Telecommunications and Information Technology, and the ICT sector, to develop ICT infrastructure, mainly in the Gaza Strip, which was destroyed by the Israeli occupation. This requires help from the

international community to encourage Israel to allow Palestinian ICT firms to import the necessary equipment. Until now, Israel has not permitted Palestinian telecommunications firms to provide G3 Internet service for customers. Fifth, service firms need to build their future plans on ICT usage, and their employment strategy on ICT-based workers. This needs the development of ICT infrastructure, more expenditure on R&D activities related with ICT, and increased ICT training for present and prospected employees to offer more experience in using computer-based technologies. Sixth, it is important to emphasize the role of academics and research centres in delivering the vital role of ICT development in Palestine to policy-makers, in order to transform ICT strategies into real economic growth.

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