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Chapter · November 2023

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Editors

Azzam Hannon 
American University in the Emirates
Dubai, United Arab Emirates

Abdullah Mahmood
Integrated Development Academy for
Training and Consultations
Amman, Jordan

ISSN 1860-949X ISSN 1860-9503 (electronic)
Studies in Computational Intelligence
ISBN 978-3-031-43299-6 ISBN 978-3-031-43300-9 (eBook)
<https://doi.org/10.1007/978-3-031-43300-9>

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Impact of Information and Communication Technology (ICT) on Labor Productivity of Palestinian Manufacturing Firms



Islam Abdeljawad , Abdunaser I. Nour , and Assi Sobhi Utt

Abstract This study sought to determine the impact of ICT on the labor productivity of Palestinian businesses. This research incorporated all of the industrial sector data from Palestine published between 2013 and 2018, for a total of 9972 observations. Using ICT indicators such as the availability of computer consulting services and computer software as independent variables, the variability of labor productivity were captured. According to the findings, increasing expenditures on software and computer consulting services enhances labor productivity. It was demonstrated that the West Bank work force is more productive than its counterpart in the Gaza Strip. The results recommend that businesses utilize ICT to improve efficiency. Finally, some intriguing policy implications for the growth of the Palestinian manufacturing sector are proposed, while the limitations are acknowledged.

Keywords Information and communication technology · Labor productivity · Palestine

1 Introduction

Unquestionably, information and communication technology (ICT) is a crucial mechanism for economic evolution in industrialized countries. It promotes growth through innovation and productivity improvement. It was discovered that ICT facilitates capital deepening, improves the productivity of capital and labor, reduces transaction costs, speed up innovation, and facilitates access to data and knowledge [1].

The relationship between information and communication technologies (ICT) and economic performance has been widely explored in past studies [2–6]. Recent data shows a favorable influence of ICT on economic performance [7–10], notwithstanding inconsistent results.

I. Abdeljawad (✉) · A. I. Nour · A. S. Utt
Faculty of Economics and Social Sciences, An-Najah National University, Nablus, Palestine
e-mail: islamjawad@najah.edu

The impact of ICT on economic progress in underdeveloped nations is contingent on the appropriateness of ICT investments for long-term growth and the skills and productivity of human capital associated to ICT usage. Rare evidence comes from developing nations, with the majority coming from countries with significant ICT growth, such as China, India, Malaysia, and Turkey. In addition, the majority of research focuses on the ICT-productivity relationship in the manufacturing sector. Although the service sector is more ICT-concentrated [11], it is rarely studied in developing nations [12].

This article examines the connection between ICT utilization and labor productivity in Palestine's underdeveloped economy. Long-term colonial measures imposed by a military occupation have a significant impact on the Palestinian economy. As a result, Palestine was compelled to split into several separate regions, namely the West Bank, Gaza, and Al-Quds, each of which has its unique political and economic conditions. Notwithstanding the qualified autonomy in economic choices achieved by Palestine in 1993, this independence is severely constrained in terms of inter-trade between the three zones and international trade with the rest of the globe. By connecting different regions of Palestine to the rest of the globe, it is believed that ICT can assist circumvent many of the constraints, particularly in the service industry. The Palestinian manufacturing industry has witnessed substantial growth in the use of information and communication technologies (ICT) at the enterprise level [13]. An important study question is whether the productivity of the manufacturing sector, which employ more ICT, will increase relative to the less ICT-intensive sectors.

The remaining sections of this document are as follows: Sect. 2 introduces the study background. Methodology is discussed in Sect. 3. Section 4 contains the results and outcomes are discussed. Section 5 concluded the study.

2 Theoretical Background

Theoretically, ICT promotes economic development by fostering a “knowledge-based economy” in which information is an indispensable contribution for corporate developments. This is accomplished by the application of ICT tools, such as hardware, software, office automation, Internet service, and communications.

There are three levels of analysis for empirical research on the association between economic growth and ICT usage: macro, sectoral, and firm. Due to the absence of data on ICT investment and utilization, macroeconomic studies are uncommon [14]. The majority of this research demonstrates a positive effect on productivity [7, 8]. The majority of macroeconomic and industrial research is based on the growth accounting concept, which accounts for each output. Typically, research undertaken at the firm level is more rigorous. Firm-level data can reveal aspects of ICT impact that cannot be captured at the industry or macro levels, such as skills, organizational competences, and entrepreneurship [15]. A variety of approaches and data are applied for analysis at the corporate level. The majority of this research has been conducted in wealthy nations. Using complementary factors, for instance, the availability of talent,

organizational variables, and creativity, Skorupinska and Sellens [14] examined the relationship between ICT and productivity. These factors are difficult to measure in macroeconomics. For instance, if we invest the same amount in ICT in two firms in the same industry, but they manage organizational changes differently, there will be a variation in production between the two firms at the sector level.

The impact of computers on productivity is the result of both their inherent features, such as their storage capacity and processing power, and their use as the means for acquiring other complex ICT facilities, such as internet connection and web presence. The use of computers increased the labor efficiency of U.S. industrial enterprises by five percent, according to a study [16]. In Switzerland, Arvanitis [17] observed a substantial correlation between enterprise-level ICT investment and labor productivity. Atrostic and Nguyen [18] investigated the relationship between ICT and worker productivity in U.S. industrial firms by utilizing two unique computer-related variables: computer capital and computer networks (how computers are utilized). They discovered that computer networks enhanced labor productivity by 5%, whereas computer investment raised it by 12%. Criscuolo and Waldron [19], utilizing data of British industrial enterprises, discovered that e-commerce increased labor productivity by 7–9%. Gretton [20] discovered, using Australian firm-level data, that ICT was positively related with the annual rise of multifactor productivity (MFP) by nearly two-tenths of a percentage point. After correcting for firm- and industry-specific factors as well as the effect of time, Maliranta and Rouvinen [21] estimated that the productivity of ICT-equipped labor in Finland improved by 8–18%. Using computers and the Internet, as well as having a strong web presence, is associated with significant increases in worker performance, as measured by revenue per employee [12], according to an analysis of the productivity of Thai businesses. Thuvasethakul and Koanantakool [22] shown that the impact of computers on Thai enterprises' productivity was greater than that of the internet and web presence.

Gretton [20], who demonstrated a beneficial influence of ICT on MFP development in several Australian and American service sector enterprises. Moreover, Doms [23] found that the replacement of conventional retailers with modern services in the retail segment of the United States throughout the 1990s was reliant on the adoption of new technologies and processes that integrated ICT. Maliranta and Rouvinen [21] found that the impact of ICT on worker productivity in Finland's service sector was significant. In Switzerland, Arvanitis [17] discovered that Internet use in the service sector was crucial. Using a sample of service and manufacturing organizations, Farooqui [24] discovered that e-commerce had a beneficial influence on worker productivity in service organizations but a negative one in manufacturing firms.

When ICT investment is combined with other investments and reforms, its impact becomes evident, i.e. "ICT predominantly affects enterprises when skills have been developed and organizational changes have been implemented" [11]. In Canada, the use of new technology needs a higher level of ability [25]. Gretton [20] also found that human skills, new innovation methods, sophisticated business practices, and the adoption of fresh organizational changes are crucial for Australian enterprises to generate a positive im-pact of ICT investment on productivity. In France, Entorf and Kramarz [26] indicate that greater experience with computer-based technology

correlates with greater labor productivity. Charlo [27] discovered that the idea had no significant effect on the Uruguayan manufacturing sector's productivity growth. However, this relationship is flipped when creativity combines with ICT investment. In a similar study, Koellinger [9] reported that innovative companies that invest in ICT are more likely to see an improvement in labor productivity, underscoring the importance of the synergy among ICT investment and other inputs in innovation and human capital. Hempell [28] demonstrates the importance of combining ICT investment with innovation in order to realize a positive impact of ICT on productivity growth in the German and Dutch services industries.

Engelstätter [29] examined a variety of ICT applications to enterprise systems, including enterprise resource planning (ERP), supply chain management (SCM), customer relationship management (CRM), and labor productivity. The analysis is predicated on a production function and focuses on the impact of concurrent deployment of numerous business systems on productivity. The data pertain to manufacturers and service providers. Results supported the anticipated positive impact of enterprise systems on worker productivity and underlined the complementarity between CRM and SCM, especially if the ERP system offers the required IT infrastructure. Kalwar et al. [7] compared the performance before and after implementing an ERP case study for a manufacturing company. As a result of the industrial and financial system implementation in 2021, the company saved about 50 thousand hours in 2021 compared with the manual approach. It reduces the average cost of a unit of production and increases economies of scale within firms. Taştan and Gönel [3] evaluated the influence of ICT information on firm-level productivity in Turkey using samples that varied by business size and industry. ICT adds more to labor productivity in enterprises that use specialist software; ICT is more elastic in small and medium-sized businesses; and larger businesses have higher marginal productivity than smaller businesses. The service sector adds more ICT to worker productivity than manufacturing. Skorupinska and Sellens [14] employed structural equation modeling and ordinary least squares in their research. They evaluated direct and indirect worker productivity variables in 444 Eastern European manufacturing enterprises. The primary direct predictor of labor productivity was wages. Indirectly, a connection has been demonstrated between ICT and its complementarities and productivity. Brynjolfsson and Hitt [30] examined the link between computer expenditures and growth in production and MFP at 527 large U.S. firms using traditional growth accounting and performance assessment approaches. In the short term (one year), computerization's impact on production and output growth was roughly comparable to its cost. However, the impact of ICT was approximately five times stronger over longer periods of time (5–7 years). Conclusion: Long-term investments in complementary resources, such as organizational capital, are essential for ICTs to produce productivity gains. Reenen's [8] study examines the influence of ICT capital on worker productivity in 13 European nations from 1998 to 2008. The data is collected at the business level and spans the years 1998–2008. It was discovered that a 10% increase in ICT capital might result in a 0.9–0.23% rise in output, underlining the relevance of ICT for economic growth.

This study's objective is to examine the hypothesis that there is a positive relationship between ICT and worker productivity in the Palestinian industrial sector.

3 Methodology

3.1 Data and Sample

The data of this study was extracted from the economic survey series conducted by PCBS for the years 2013 through 2018, the last year available for the establishment survey. In the sample, all manufacturing firms in Palestine for the years 2013–2018 was utilized except firms that did not have data needed. The total observations of the study were 9972 detailed in Table 2.

3.2 Variables and Model

The model of labor productivity has been developed for empirical analysis based on main papers in the literature [3, 5, 14, 15] as follows:

$$\begin{aligned} \ln(Q/L) = & B_0 + B_1 * (\text{Computer consulting services}) + B_2 * (\text{Databases}) \\ & + B_3 * (\text{R\&D}) + B_4 * (\text{Computer program}) + B_5 * (\text{Advertising}) \\ & + B_6 * \ln(\text{Capital intensity}) + B_7 * \ln(\text{labor wage}) \\ & + B_8 \ln(\text{Size}) + B_9 * (\text{Gaza}) + U_i \end{aligned} \quad (1)$$

The variables of the study presented in Table 1 were based on previous literature [3, 5, 14, 15].

4 Results and Discussion

The descriptive statistics of the variables in this paper are presented in Table 2. The mean, median, maximum, minimum, and standard deviation are all values. were presented for continuous variables, while the dummy variables include the number of firms and the percentage of firms having the characteristics for each year and for both the West Bank and Gaza.

Table 3 displays the model's regression findings. This model explains 20.70% of the overall variability in labor productivity, as measured by R-squared. At a 1% level of significance, a high F-statistic indicates that the null hypothesis that the model was inadequate should be rejected, suggesting that the model was well-fitted.

Table 1 Measurement and definitions of variables

Variable	Definition
(Q/L) Labor productivity	Value-added per employee. It is measured by the total production of the firm divided by the number of employees
Computer consulting services	A dummy variable will equal 1 if the company invests in computer consulting services and zero otherwise
Database	A dummy variable will equal 1 if the company invests in a database and zero otherwise
R&D	If the company invests in R&D, the dummy variable is 1, otherwise it is 0
Computer program	If the company invests in computer programs, the dummy variable equals 1, otherwise it equals 0
Advertising	If the company invests in advertising, the dummy variable is 1, otherwise it is 0
Capital intensity	Measured by the logarithm of the market value of total assets at the end of the year
Labor wages	Measured by the logarithm of total wage/number of employees
Size	Logarithm of the number of workers
Gaza	If the company is located in Gaza, the dummy variable equals one, otherwise it equals 0

The regression results in Table 3 show a significant positive relationship between computer consulting services and labor productivity. However, the complementarity hypothesis states that using ICTs can only lead to productivity gains if a complementary factor of production is in place. A firm may invest in industrial machinery to help with production. This industrial machinery needs programming specialists to operate and maintain it to become more efficient and productive. This can be done by either outsourcing specialists or hiring experts within the organization. It depends on the firm's size and the cost–benefit analysis. In general, hiring them remains the best option if a large company wishes to hire experts. Considering that most institutions in Palestine are small to medium-sized, external consulting is the best solution. Computer consulting services, as complementary investments in software and hardware, are consistent with this study's result.

The results show a significant positive relationship between computer programs and labor productivity. Therefore, this result means firms that have invested in computer programs have leveraged the benefits of ICT, including improving business operations, facilitating coordination, communication, and information processing, matching buyers and suppliers in the same field, and saving time. All these together improve productivity. This result was consistent with many previous research findings [4, 7, 29].

Table 2 The descriptive statistics

Variable	Mean	Median	Maximum	Minimum	Std. Dev	
Labor productivity	13.03	13.03	17.88	7.20	1.03	
Size	1.78	1.61	7.60	0.00	1.22	
Capital intensity	12.10	12.19	19.12	0.65	1.42	
Labor wage	12.83	11.42	22.71	6.62	3.61	
Year	2018		2017		2016	
Area	West Bank	Gaza	West Bank	Gaza	West Bank	Gaza
Number of firms	1135	571	1228	595	1108	553
Computer consulting services	10.49%	3.75%	16.04%	9.41%	13.54%	7.59%
Databases	1.11%	0.41%	0.33%	0.34%	0.09%	0.00%
R&D	0.88%	0.29%	0.16%	0.34%	0.36%	0.00%
Computer programs	7.62%	6.98%	13.76%	24.20%	11.10%	20.07%
Advertising	17.23%	10.90%	22.88%	29.92%	27.44%	32.19%
Year	2015		2014		2013	
Area	West Bank	Gaza	West Bank	Gaza	West Bank	Gaza
Number of firms	1066	555	1061	505	1238	357
Computer consulting services	15.76%	6.13%	13.57%	6.73%	11.07%	8.12%
Databases	0.19%	0.18%	0.19%	0.20%	0.24%	0.00%
R&D	0.00%	0.72%	0.28%	0.20%	0.24%	0.56%
Computer programs	13.32%	19.46%	12.35%	11.49%	12.52%	12.61%
Advertising	29.92%	39.64%	34.59%	35.05%	32.31%	26.89%

As a result of colonial actions dividing Palestinian lands into distinct regions, we examined whether the geographical location influences labor productivity. The idea of splitting Palestine into three distinct regions for research reasons is also used by official sources of statistics [13]. Jerusalem, the West Bank, and Gaza are the three territories. According to Table 3, the labor productivity of West Bank and Jerusalem enterprises is greater than that of Gaza-based firms. This is due to the business activity gap between the West Bank and Gaza, which has a favorable effect on worker productivity in the industrial sector.

This study's findings are significant for Palestinian businesses seeking productivity in a challenging economic and political context. Other investigations prepared the way for this objective [31–35]. However, this study has taken a novel way to achieving this objective, namely by employing ICT, and has discovered strong evidence of the success of such a strategy.

Table 3 Estimation results

Variable	Coefficient	t-Statistic	Prob
Computer consulting services	0.119	3.364	0.001
Databases	0.165	1.051	0.293
R&D	− 0.190	− 1.294	0.196
Computer programs	0.206	6.320	0.000
Advertising	0.126	5.494	0.000
Capital	0.276	34.405	0.000
Labor wages	0.014	3.722	0.000
Number of laborers	− 0.010	− 1.030	0.303
Gaza strip	− 0.298	− 11.556	0.000
C	9.531	85.974	0.000
R-squared	0.207		
Adjusted R-squared	0.206		
F-statistic	289.883		
Prob(F-statistic)	0.000		

HAC standard errors & covariance (Bartlett Kernel, Newey-West fixed)

Significant results are in bold

5 Conclusion

This study explored the empirical connection between ICT utilization and labor productivity in the Palestinian industrial sector. Using multi-year cross-sectional data from 2013 to 2018, the results demonstrate that ICT factors have a positive impact on labor productivity. This shows that firms with a lower ICT intensity are less efficient than those with a higher ICT intensity.

In terms of geographical disparities in worker productivity, our data reveal that West Bank-based enterprises had higher scores than Gaza-based businesses. This result can be explained by Gaza's challenging political climate and siege. In view of Israel's embargo, which has had a negative impact on all economic sectors since 2006, the low productivity of the service industry in the Gaza Strip compared to the West Bank might be justified. In addition, many Israeli attacks against Gaza devastated the essential infrastructure for economic growth.

As part of a long-term economic strategy, certain policies must be implemented in order for the ICT sector to be used as a tool for the growth of the Palestinian industrial sector, and policymakers must be offered with guidelines to retain the relationship between ICT entities and governing bodies.

Initially, the support of a knowledge-based economy is contingent upon the financial and strategic commitments of government bodies. Second, the government should boost the regulatory and fiscal environment in ICT by updating ICT

regulations (intellectual property rights, patents, etc.), promoting market competition, granting tax exemptions, and subsidizing ICT-intensive firms domestically. Thirdly, it should describe clear long-term strategies for the growth of the manufacturing sector and ICT employment, mostly based on conventional sector knowledge. Fourthly, it is crucial to improve relations between the public bodies headed by the Ministry of Telecommunications and Information Technology and the ICT industry in order to reconstruct the Gaza Strip's demolished ICT infrastructure. The international community must help exert pressure on Israel to permit Palestinian ICT firms to import essential equipment. Fifthly, service firms must incorporate ICT-based labor into their planning and personnel strategies. This involves the extension of ICT infrastructure, an increase in ICT-related R&D spending, and the expansion of ICT training programs for present and future employees in order to boost their proficiency with computer-based technologies. Sixth, in order to convert ICT policies into actual growth in the economy, it is critical to recognize the role of academia and research institutes in explaining to policymakers the importance of ICT development in Palestine.

The limitations of this study stem from the data source. The only available data source was the PCBS, which does not guarantee all ICT-related variables, such as internet usage, and only provides data until 2018. Due to the COVID-19 pandemic, no data was available for 2019 or 2020. The researcher proposed future research into the impact of ICTs on labor in relation to other variables, including creativity and innovation, internet usage, labor skill, and organizational transformation. It is recommended that additional research be conducted to investigate the impact of ICTs on various West Bank and Gaza Strip industries. Also supported is the research of ICT management policies in Palestinian businesses.

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