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Technology, Skills and Business Productivity: An Empirical Analysis in Côte d'Ivoire

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Abstract

This article investigates the impact of investments in information and communication technologies (ICT) and human capital on productivity of firms in Côte d'Ivoire. Using panel data from the BDF 2013 database covering 2001-2012 and employing various econometric approaches (OLS, fixed effects, random effects, dynamic GMM), the findings reveal that both ICT and training expenditures significantly and positively influence labor productivity. The synergy between these two types of investments is particularly strong, highlighting the need for integrated policies that promote digitalization and continuous training. The study concludes with policy recommendations tailored to the structural features of different sectors.

Keywords

ICT, Human Capital, Productivity, Firms, Panel Data, Côte d'Ivoire

1. Introduction

The productivity of Ivorian companies remains low despite notable economic growth. One of reasons cited is the insufficiency of investments in ICT (Information and Communication Technologies) and human capital. The study aims to evaluate their effect on performance of modern enterprises in Côte d'Ivoire.

The dissemination of ICT and investment in human capital are today considered essential strategic levers for enhancing productivity and strengthening the competitiveness of companies, particularly in developing economies. In Côte d'Ivoire, this dynamic holds particular importance given the overall low performance level of entrepreneurial sector and structural challenges faced by sectors that use ICT and continuous training.

From macroeconomic perspective, Côte d'Ivoire has relatively low level of industrialization. In 2010, the manufacturing value added per capita was USD 99, lower than African average (USD 100), with an annual growth rate of −0.6% over the period 1999-2010 (CNUCED/ONUDI, 2011). This productivity weakness is exacerbated by significant declines in turnover in several key sectors (up to 70% in construction, according to CGECI, 2011), indicating a chronic under-investment in intangible production factors.

Regarding ICT, despite notable growth in the sector during the 2000s, with a turnover of 850 billion FCFA in 2009 and contribution of 6% to 8% for GDP (MPTIC, 2010), penetration remains low. The internet usage rate was still below 2.5% in 2012, far lower than other countries in the sub-region, such as Senegal or Ghana. The ICT Development Index (IDI) also ranks Côte d'Ivoire among the least connected countries. This digital lag limits the adoption of technological solutions in companies and consequently their ability to improve productivity through innovation.

Meanwhile, investment in human capital remains insufficient, despite ongoing reforms. The share of national budget allocated to education decreased from 35% in 1990s to 25% in 2007 (World Bank, 2011), limiting the emergence of skilled workforce which is recognized as a determining factor in explaining productivity gaps. Human capital theory (Schultz, 1961; Becker, 1964; Mincer, 1974) and subsequent empirical studies (Barro, 1991; Mankiw et al., 1992; Lynch, 1996) emphasize the structuring role of education and continuous training on economic performance, particularly through skill enhancement, organizational innovation and technological adaptability.

Empirical studies conducted in Africa, including those by Biggs (1995), Gnansounou (2010) and Ouattara (2009), confirm the existence of a positive relationship between investments in ICT or training and company productivity. However, few studies have sought to quantify this effect in Côte d'Ivoire while considering sector-specific characteristics and the complementary role between ICT and human capital.

It is in this context that the present study is situated, aiming at empirically measure the impact of investments in ICT and human capital on labor productivity in Ivorian companies. It is based on panel data from the BDF database 2013 covering the period 2001-2012 and employs various econometric techniques, including ordinary least squares (OLS), fixed effects models, random effects models and the dynamic GMM model.

Three specific objectives guide our analysis:

To evaluate the individual effect of investments in ICT and continuous training on labor productivity;

To identify sectoral differences in productivity based on level of investment in these two levers;

To analyze the combined effect of ICT and training on performance of companies.

The remainder of article is structured as: Section 2 presents a literature review on relationship between ICT, human capital and productivity; Section 3 outlines the conceptual framework and research hypotheses; Section 4 describes the data used and the adopted methodology; Section 5 presents the main empirical results; finally, Section 6 concludes by highlighting policy implications and future research avenues.

2. Literature Review

Information and Communication Technologies (ICT) and human capital are now recognized as major determinants of productivity, especially in emerging economies. Numerous studies have established a positive link between these intangible factors and corporate performance. In developed countries, Brynjolfsson and Hitt (1994) highlight the delayed impact of ICT investments, emphasizing that their effects are conditioned by organizational adjustments.

Stiroh (2002) and Pilat (2004) confirm this dynamic, showing that the effect of ICT is amplified when accompanied by managerial transformations. The OECD (2002) also supports the idea that ICT stimulates organizational innovation and efficiency gains.

In developing countries, although studies are less numerous, they converge toward similar findings. In Africa, Gnansounou (2010) and Nkakene (2012) demonstrate, using firm data, a positive relationship between the use of ICT and firm performance, while highlighting the key role of institutional context and internal technological absorption capacities.

Concerning human capital, the foundational works of Schultz (1961), Becker (1964) and Mincer (1974) laid the theoretical groundwork for the link between training, knowledge and productivity. At a macroeconomic level, Barro (1991) and Mankiw, Romer and Weil (1992) show that human capital has a lasting influence on growth. At microeconomic scale, Lynch (2000) and Ashton et al. (1996) demonstrate that continuous training improves productivity, especially in high-tech environments.

In Sub-Saharan Africa, Biggs (1995) confirmed these results by observing that large companies which are more inclined to train their employees, generate more added value. In Côte d'Ivoire, Ouattara (2009) shows that firms investing in continuous training record productivity gains that exceed the average, although this investment remains heterogeneous across sectors.

Most recent research has shifted toward studying the cross effects of ICT and human capital. Brynjolfsson and McAfee (2014) emphasize that effective use of technologies relies on the skilled workforce capable of integrating these tools into production processes. TAMBE (2014) demonstrates that companies with advanced digital skills better leverage big data and enhance their decision-making efficiency.

Meanwhile, Mishrif & Khan (2023) and Cirillo et al. (2023) stress the emergence of specific skills such as data analysis, digital literacy and digital marketing as pre-

requisites for performance in modern economies.

Finally, Choudhury and Wu (2021) show that joint investments in technology and skill development not only enhance productivity but also improve employee satisfaction and retention. These works call for an integrated approach to digitalization and training, emphasizing agility, adaptability and continuous learning.

Guesmi & Gil (2022) combined econometric and accounting methods to analyze the impact of public investments in agricultural R&D on productivity in Catalonia between 1985 and 2015. Productivity increased at a moderate pace, with more sustained growth during the first twenty years. The results highlight a positive and significant effect of R&D with an estimated return between 15% and 28%.

3. Framework and Hypotheses

The conceptual framework of this study is based on theory of an extended production function inspired by the Cobb-Douglas model which incorporates intangible factors such as information and communication technologies (ICT) and human capital. From this perspective, labor productivity within a company does not solely depend on physical capital and labor but also on ability to use ICT effectively as well as on investment in the continuous training of personnel.

The production function can be specified in a simplified form as:

$$Y = AK^{\alpha}L^{\beta}TIC^{\gamma}CH^{\delta}$$

Where:

Y: represents the production or value added of company,

K: denotes physical capital,

L: represents labor (number of employees),

ICT is a measure of technological investment (expenditures on telecommunications, digital services, etc.),

HC is a measure of human capital (expenditure on continuous training, employees' qualification levels),

A is a parameter of overall efficiency,

α, β, γ and δ are the elasticities of respective factors of production.

In our study, we use a logarithmic form of this function which facilitates econometric estimation and allows for the interpretation of coefficients as elasticities. We also introduce an interaction variable between ICT and human capital to capture their potential synergistic effect on productivity.

The conceptual approach is based on assumption that ICT, as generic technologies can enhance productivity by facilitating process automation, internal coordination and access to information. However, their effectiveness heavily depends on level of qualification and training of workers. A company equipped with advanced technologies but with unqualified personnel may not fully benefit from its investments. In contrast, a qualified and well-trained workforce is better positioned to leverage ICT in production processes.

This conceptual framework justifies the introduction of an interaction variable (ICT × Training) in our model to assess whether the combination of two factors has more than proportional effect on productivity, indicating productive complementarity.

Based on this theoretical framework, three main hypotheses are formulated:

H1: Investments in ICT have a positive and significant effect on labor productivity in companies.

H2: Investments in human capital have a positive and significant effect on labor productivity.

H3: The combined effect of ICT and human capital on productivity is greater than the effect of each of two factors taken separately (positive interaction effect).

4. Data and Methodology

The empirical analysis presented in this study is based on data from the 2013 Financial Database (BDF) produced by the National Institute of Statistics (INS) of Côte d'Ivoire. This database aggregates accounting and tax information on formal Ivorian enterprises, covering a period from 2001 to 2012. It allows for a panel analysis of companies operating in the primary, secondary and tertiary sectors, incorporating relevant variables for studying the determinants of productivity.

The dependent variable is labor productivity, measured by value added per employee. The main explanatory variables are expenditures on information and communication technologies (ICT) and expenditures on continuous training which serve as respective proxies for technological investment and human capital. Additional control variables are introduced into the model to account for the effect of other productive factors: investments in fixed capital, research and development (R&D), company size and industry sector.

The basic econometric specification is log-linear allowing for the interpretation of estimated coefficients as elasticities. The general model is expressed as:

$$\ln\left(\text{Productivity}_{it}\right) = \alpha + \beta_1 \ln\left(\text{ICT}_{it}\right) + \beta_2 \ln\left(\text{Training}_{it}\right) + \beta_3 \ln\left(\text{ICT}_{it} \times \text{Training}_{it}\right) + \beta_4 \ln\left(\text{FixedCapital}_{it}\right) + \beta_5 \ln\left(\text{R\&D}_{it}\right) + u_{it}$$

where i denotes the company and t denotes the year and u_{it} represents the residual random error.

Several estimation methods are employed to test the robustness of results: ordinary least squares (OLS), fixed and random effects models, as well as the generalized method of moments (GMM) system method, adapted for dynamic panels. The GMM method developed by Arellano and Bover (1995) and Blundell and Bond (1998), is particularly useful for correcting the potential endogeneity of explanatory variables, especially concerning ICT and training expenditures.

Dynamic models also capture the productivity inertia effect over time and better identify the delayed effects of investments. Validity tests for instruments (Sargan test) and autocorrelation tests of errors (AR (1) and AR (2) tests) are carried

out to ensure the robustness and credibility of empirical results.

The final sample includes a total of 1873 companies, with 45% in the tertiary sector, 35% in the secondary sector and 20% in the primary sector. The sectoral and temporal diversity of observations allows for a better assessment of differentiated effects of intangible investments on productivity according to economic contexts. Indeed, in our sample, we considered companies with more than one employee in each sector in order to eliminate sole proprietorships.

5. Results and Discussion

The Ivorian entrepreneurial fabric is largely dominated by the tertiary sector (75.2% of companies) followed by the secondary sector (22.6%). Micro Enterprises (MEs) are the most numerous, especially in the services. The primary sector remains marginal at 2.2%, reflecting the high level of informality in agriculture (Tables 1-4).

The results confirm the significant effect of ICT and training on productivity. The interaction effect is positive and significant, validating the hypothesis of complementarity. The coefficients are robust across estimation methods, with higher intensity observed in OLS and random effects (Table 5). In the primary sector, the effect of ICT and training is significant. The interaction coefficient confirms a complementarity, especially visible in the GMM model. The results illustrate sectoral sensitivity to technological integration coupled with training (Table 6). In the secondary sector, the effect of ICT and training is significant. The interaction coefficient confirms a complementarity particularly evident in the GMM model. The results illustrate sectoral sensitivity to technological integration along with training (Table 7). In the tertiary sector, the effect of ICT and training is significant. The interaction coefficient confirms a complementarity especially visible in the GMM model. The results illustrate sectoral sensitivity to technological integration coupled with training (Table 8). Investment in R&D in the primary sector in Côte d'Ivoire, with an estimated coefficient of 0.15 (significant at 1%) confirms that each 1% increase in R&D expenditure translates into 0.15% increase in productivity—a result consistent with the high returns, often exceeding 15%, observed in African studies on agriculture and innovation.

Table 1. Distribution of businesses by sector and size.

Sector.	Very Small Enterprise	Small Enterprise	Medium Enterprise	Large Enterprise	Very Large Enterprise.	Total
Primary	104	207	103	101	191	706
Secondary	2420	2628	766	653	748	7215
Tertiary	13,050	3492	1366	829	594	19,331
Total	15,574	6327	2235	1583	1533	27,252

Source: the author based on BDF data (2013).

Table 2. Labor productivity, average expenditures on telecommunications and training per year by primary sector.

Year	Productivity (VA/employee) × 10^4	Telecom expenses (in M FCFA)	Training expenses (in M FCFA)
2001	8.85	13.8	19.2
2002	6.73	15.8	11.5
2003	3.99	17.4	12.8
2004	4.79	16.3	8.92
2005	7.44	14	9.0
2006	5.38	10.9	29.4
2007	8.93	10.5	11.3
2008	6.99	12.6	11.2
2009	14.6	16.5	9.59
2010	5.1	13.1	7.75
2011	21.0	14.2	6.88

Source: the author based on BDF data (2013).

Table 3. Labor productivity, average spending on telecommunications and training per year by Secondary Sector.

Year	Productivity (VA/employee) × 10^4	Telecom expenses (in M FCFA)	Training expenses (in M FCFA)
2001	733.79	18.1	26.8
2002	1040	16.1	15.8
2003	1000	17	17.4
2004	2610	15.8	28.9
2005	2606	15.5	27.6
2006	954.76	14.6	30.8
2007	810.64	12.6	22
2008	838.53	9.21	8.76
2009	606.08	9.42	15.3
2010	676.55	9.72	11
2011	785.69	19.9	19.2

Source: the author based on BDF data (2013).

Table 4. Labor productivity, average expenditures on telecommunications and training per year by primary sector.

Year	Productivity (VA/employee) × 10^4	Telecom expenses (in M FCFA)	Training expenses (in M FCFA)
2001	785.69	19.9	19.2
2002	729.26	12.9	11.5
2003	664.63	12.9	12.8
2004	675.36	12.8	8.92
2005	671.5	12	9.0
2006	655.82	17.3	29.4
2007	671.67	11.2	11.3
2008	670.39	9.7	11.2
2009	643.98	9.03	9.59
2010	615.24	6.91	7.75
2011	618.94	7.87	6.88

Source: the author based on BDF data (2013).

Table 5. Effects of ICT and human capital on productivity-global estimates.

	Model 1				Model 2			
VARIABLES	Pools (OLS) (1)	FE (2)	RE (3)	System GMM (4)	Pools (OLS) (1)	FE (2)	RE (3)	System GMM (4)
lnPT(-1)				−0.292**				−0.280*
				(0.148)				(0.146)
LnPT(-2)				−0.153*				−0.141
				(0.0911)				(0.0895)
LnICT	0.148***	0.104**	0.148***	0.0904***				
	(0.0204)	(0.0469)	(0.0204)	(0.0339)				
Ln Training	0.203***	0.206***	0.203***	0.139***				
	(0.0223)	(0.0465)	(0.0223)	(0.0394)				
Ln FixedCapital	0.103***	0.112***	0.103***	0.118***	0.0920***	0.0871***	0.0920***	0.108***
	(0.0124)	(0.0287)	(0.0124)	(0.0247)	(0.0105)	(0.0235)	(0.0105)	(0.0223)
Ln(R&D)	0.155***	0.197**	0.155***	0.154***	0.148***	0.190**	0.148***	0.143**
	(0.0447)	(0.0858)	(0.0447)	(0.0578)	(0.0446)	(0.0861)	(0.0446)	(0.0599)
Ln(ICT × Training)					0.173***	0.155***	0.173***	0.113***
					(0.0156)	(0.0336)	(0.0156)	(0.0267)
Constant	6.111***	5.896***	6.111***	14.13***	6.401***	6.271***	6.401***	14.08***
	(0.828)	(1.605)	(0.828)	(4.081)	(0.814)	(1.593)	(0.814)	(4.074)
Number of observations	1748	1748	1748	463	1737	1737	1737	461
R-squared	0.138	0.120			0.139	0.115		
Number of ID		1341	1341	405		1332	1332	403

Eca Standard deviations in parentheses.: *** p<0.01, ** p<0.05, * p<0.1

Source: the author based on BDF data (2013).

Table 6. Effects of ICT and human capital on productivity in the primary sector.

	Model 1				Model 2			
VARIABLES	Pools (OLS) (1)	FE (2)	RE (3)	System GMM (4)	Pools (OLS) (1)	FE (2)	RE (3)	System GMM (4)
lnPT(-1)				−0.292**				−0.280*
				(0.148)				(0.146)
lnPT(-2)				−0.153*				−0.141
				(0.0911)				(0.0895)
lnICT	0.148***	0.104**	0.148***	0.0904***				
	(0.0204)	(0.0469)	(0.0204)	(0.0339)				
Ln(Training)	0.203***	0.206***	0.203***	0.139***				
	(0.0223)	(0.0465)	(0.0223)	(0.0394)				

Continued

LnFixedCapital	0.103***	0.112***	0.103***	0.118***	0.0920***	0.0871***	0.0920***	0.108***
	(0.0124)	(0.0287)	(0.0124)	(0.0247)	(0.0105)	(0.0235)	(0.0105)	(0.0223)
Ln(R&D)	0.155***	0.197**	0.155***	0.154***	0.148***	0.190**	0.148***	0.143**
	(0.0447)	(0.0858)	(0.0447)	(0.0578)	(0.0446)	(0.0861)	(0.0446)	(0.0599)
Ln(ICT × Training)					0.173***	0.155***	0.173***	0.113***
					(0.0156)	(0.0336)	(0.0156)	(0.0267)
Constant	6.111***	5.896***	6.111***	14.13***	6.401***	6.271***	6.401***	14.08***
	(0.828)	(1.605)	(0.828)	(4.081)	(0.814)	(1.593)	(0.814)	(4.074)
Number of observations	1,748	1,748	1,748	463	1,737	1,737	1,737	461
R-squared	0.138	0.120			0.139	0.115		
Number of ID		1341	1341	405		1332	1332	403

Eca Standard deviations in parentheses.: *** p<0.01, ** p<0.05, * p<0.1

Source: the author based on BDF data (2013).

Table 7. Effects of ICT and human capital on productivity in the secondary sector.

	Model 1				Model 2			
VARIABLES	Pool (1)	FE (2)	RE (3)	System GMM (4)	Pool (1)l	FE (2)	RE (3)	System GMM (4)
lnPT(-1)				−0.511***				−0.499***
				(0.111)				(0.108)
lnPT(-2)				−0.213***				−0.206***
				(0.0640)				(0.0622)
Ln ICT	0.101***	0.0962***	0.101***	0.0762***				
	(0.0110)	(0.0164)	(0.0110)	(0.0231)				
Ln(Training)	0.0945***	0.0970***	0.0945***	0.0604***				
	(0.0118)	(0.0173)	(0.0118)	(0.0204)				
LnFixedCapital	0.142***	0.154***	0.142***	0.116***	0.145***	0.155***	0.145***	0.121***
	(0.00735)	(0.0106)	(0.00735)	(0.0156)	(0.00607)	(0.00882)	(0.00607)	(0.0139)
Ln(R&D)	−0.00356	0.0141	−0.00356	−0.0606	−0.00384	0.0113	−0.00384	−0.0952
	(0.0409)	(0.0626)	(0.0409)	(0.0442)	(0.0409)	(0.0630)	(0.0409)	(0.0613)
Ln(ICT × Training)					0.0989***	0.0993***	0.0989***	0.0701***
					(0.00840)	(0.0124)	(0.00840)	(0.0169)
Constant	9.867***	9.422***	9.867***	22.88***	9.801***	9.367***	9.801***	23.03***
	(0.707)	(1.066)	(0.707)	(3.200)	(0.706)	(1.072)	(0.706)	(3.252)
Number of observations	4469	4469	4469	1174	4,430	4430	4430	1154
R-squared	0.173	0.189			0.175	0.192		
Number of ID		2,381	2,381	882		2,375	2,375	872

Ecarts tStandard deviations in parentheses.: *** p<0.01, ** p<0.05, * p<0.1

Source: the author based on BDF data (2013).

Table 8. Effects of ICT and human capital on productivity in the tertiary sector.

	Model 1				Model 2			
VARIABLES	Pools (1)	FE (2)	RE (3)	System GMM (4)	Pools (1)	FE (2)	RE (3)	System GMM (4)
lnPT(1)				−0.415***				−0.412***
				(0.0863)				(0.0849)
lnPT(-2)				−0.211***				−0.209***
				(0.0458)				(0.0450)
LnICT	0.178***	0.177***	0.178***	0.128***				
	(0.00601)	(0.00677)	(0.00601)	(0.0131)				
Ln(Training)	0.0943***	0.0846***	0.0943***	0.0665***				
	(0.00793)	(0.00891)	(0.00793)	(0.0140)				
LnFixedCapital	0.115***	0.114***	0.115***	0.0825***	0.131***	0.132***	0.131***	0.0963***
	(0.00470)	(0.00529)	(0.00470)	(0.0104)	(0.00428)	(0.00483)	(0.00428)	(0.00973)
Ln(R&D)	−0.00711	0.00125	−0.00711	−0.0149	−0.00755	0.00313	−0.00755	−0.0139
	(0.0198)	(0.0221)	(0.0198)	(0.0321)	(0.0199)	(0.0222)	(0.0199)	(0.0321)
Ln(ICT × Training)					0.147***	0.142***	0.147***	0.104***
					(0.00474)	(0.00533)	(0.00474)	(0.0102)
Constant	9.502***	9.512***	9.502***	20.57***	9.074***	9.012***	9.074***	20.17***
	(0.349)	(0.389)	(0.349)	(2.240)	(0.346)	(0.386)	(0.346)	(2.217)
Number of observations	13,902	13,902	13,902	3,914	13,848	13,848	13,848	3873
R-squared	0.169	0.167			0.163	0.160		
Number of ID		2922	2922	1808		2922	2922	1799

Standard deviations in parentheses.: *** p<0.01, ** p<0.05, * p<0.1

Source: the author based on BDF data (2013).

Investments in ICT and training have a significant positive impact on productivity. The interaction ICT × training enhances this effect with sectoral gaps: a marked impact in the primary and secondary sectors. The results are robust across all specifications.

These findings confirm theoretical predictions and prior studies. The integration of ICT and skill development are complementary levers for enhancing performance. The sectoral gaps suggest the necessity for differentiated approaches depending on fields. The empirical results of this study confirm within the Ivorian context, the main insights from economic literature regarding the immaterial determinants of productivity particularly the effects of information and communication technologies (ICT) and human capital.

First, the positive and significant effect of ICT investments on labor productivity aligns with the conclusions of Brynjolfsson and Hitt (1994) and Stiroh (2002) who demonstrated that digital technologies enhance operational efficiency through

automation, process coordination and rapid access to information. In Africa, Gnansounou (2010) also confirms this relationship in institutional contexts characterized by low digitization. Our study reinforces these conclusions by showing that even in environment with low ICT penetration rate like Côte d'Ivoire, companies that invest in these technologies register notable productivity gains particularly in the primary sector.

Next, the positive and significant effects of continuous training expenditures are consistent with the human capital theory developed by Schultz (1961) and Becker (1964) which posits that investing in skills increases labor efficiency and stimulates growth. More recent studies, such as those by Lynch (2000) and Ashton et al. (1996) also emphasize that continuous training enhances employees' capacity to adapt to new technologies and innovate. In Côte d'Ivoire, Ouattara (2009) also demonstrated that training significantly contributes to corporate performance, finding our study confirms with particularly high coefficients in the secondary sector.

The most striking result of our research concerns the synergistic effect between ICT and training, which validates the hypothesis of productive complementarity. This interaction effect is particularly strong in the GMM models, highlighting the importance of an integrated approach. As shown by Brynjolfsson and McAfee (2014), companies that simultaneously invest in digital technologies and skills development are better positioned to maximize the returns on investments. Similarly, Tambe (2014) demonstrates that the value created by big data and digital tools heavily depends on skill level of workforce. Our results illustrate this mechanism in African context, suggesting that the impact of ICT is contingent on employees' capacity to leverage them effectively.

Moreover, the observed sectoral gaps in the results call for a differentiated reading. The primary sector, often perceived as low-tech, shows a strong responsiveness to combined investments, indicating that agricultural modernization through digitization and training can generate substantial productivity gains. The secondary sector, an industrial engine also displays positive effects but to a lesser extent, possibly due to structural rigidities or underuse of skills. Finally, the tertiary sector, while numerically dominant presents significant but more moderate effects which may be explained by heterogeneous ICT diffusion and low professionalization in certain branches (informal trade, domestic services, etc.). The observation of more moderate productivity effects in tertiary sector indicates an increased need for modernization particularly through digitization and training. This calls for targeted public policies focused on services. A differentiated sectoral approach would allow for interventions to be adapted to the specificities of each sector. As Jorgenson & Timmer (2011) point out, services suffer from a lower rate of technological diffusion, limiting their productivity gains. This justifies targeted policies to modernize the tertiary sector and strengthen a differentiated sectoral approach.

In summary, this study enriches the literature by providing robust empirical

evidence on complementarity between ICT and training in developing country and emphasizes the importance of coherent policy framework that promotes innovation, continuous education and technological appropriation.

6. Conclusion and Recommendations

The results of this research call for a stronger integration of ICT and human capital in the policies supporting productivity of Ivorian businesses. In this regard, several recommendations can be made:

1) Promoting access to digital technologies for businesses, especially SMEs, through the establishment of tax incentives, targeted subsidies and efficient digital infrastructure, particularly in rural and semi-urban areas.

2) Strengthening continuous vocational training programs aligned with the actual needs of businesses, by promoting public-private partnerships and enhancing technical and digital skills.

3) Encouraging cross-investments (ICT and training) through integrated programs to maximize the combined effects on productivity.

4) Establishing a national observatory for productivity and innovation to monitor the evolution of entrepreneurial practices, identify barriers to digital transformation and guide industrial policies.

5) Promoting a differentiated sectoral approach in productivity support policies, taking into account the specificities of primary, secondary and tertiary sectors identified by this study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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