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Impact of Information Technology and Communication on Economic Growth

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ABSTRACT

The paper presents an in depth study of the relationship between Information and Communication Technology (ICT) and economic growth. On the one hand, It highlights the theoretical and empirical insights of the role of the new technology as a mode of economic performance. On the other hand, it presents an empirical study based on different estimation methods recently developed in the context of a dynamic panel for a sample of 43 countries over the period 1995-2011.The overall findings suggest a positive and significant relationship.

Keywords: *Information and Communications Technology (ICT), Economic Growth, Dynamic Panel Data.*

1. INTRODUCTION

The contemporary economic context has helped the emergence of a new economy characterized by the diffusion of ICT. This new technology has had a significant economic impact particularly on productivity and on the pace of growth. Indeed, ICT can bring new opportunities for the acceleration of growth. Thus, some developing countries (DC) consider that the adoption of ICT can overcome the delays encountered by productivity relative to the developed countries.

At this level, a question seems interesting: To what extent has ICT led to the improvement of economic growth?

Far from being a recent phenomenon, ICT remains one of the phenomena of the economic reality which has undergone a tremendous growth since the beginning of the 1980s. One of the first major contributions of theoretical literature dealing with the relationship between the new technology and economic growth is that of Cette, Mairesse and Kocoglu (2000, 2003) and Jorgensen (2001). These authors have analyzed the positive and significant role of ICT in the economic growth using two channels:

Firstly, the substitution effects related to the accumulation of the ICT capital (capital deepening). The latter is the result of the rapid and continuous development in the productive performance of investments in ICT which lead to a sharp drop in the ICT prices compared to other goods, for example, in the UK and in the USA, the price of the computer equipment fell by 15% between 1980 and 2004, while the price deflator of the GDP rose by 3% per year. Secondly, the PTF gains which are mainly the result of the technological progress were achieved in the producing industries of ICT.

This article is structured as follows**:**

In the second section, we suggest a brief literature concerning the relationship between the ICT and economic growth. The impact of the ICT on the overall productivity of the factors is also estimated empirically in a third section, by relying on the stationarity and the Cointegration tests carried out on the different variables of the model. Finally, the last section concludes.

2. ICT AND ECONOMIC GROWTH: A BRIEF LITERATURE

The studies on the assessment of ICT and its impact on economic growth are always of great interest on the part of economists and of many organizations.

Moreover, the first macroeconomic studies, dating back to the late 1980s and the early 1990s, indicated that the contribution of ICT in productivity and economic growth was very low (Roach (1987, 1989, 1991); Oliner and Strioh (1994); Jorgenson and Strioh (1995)). However, further studies showed that investments in ICT have had a significant impact on economic growth (Jorgenson (2001), Oliner and Strioh (2000)).

However, ICT is considered as an engine of economic growth. It affects it in two ways, directly via the ICT producing sectors and indirectly through the sectors called users. All economic sectors are or become users of ICT to the extent that indirect productivity gains related to digitization and the way it is used are often seen as the main vector of growth in the developed economies. (Faucheux, Hue and Nicolai (2010).

According to Drik Pilat of the OECD (2008), the econometric analysis of economic growth and productivity generally distinguishes three types of impacts of the ICT. Firstly, investment in ICT increases the capital stock available to the workers and thus contributes to the improvement of the labor productivity. Secondly, the rapid technological progress in the production of ICT goods and services can contribute to the progress of the capital and labor efficiency, or the multifactor productivity (MFP) in the producing sector of the ICT. Thirdly, a wider use of ICT in the economy can help companies be generally more efficient and therefore increase the multifactor productivity (MFP). The ICT is

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also likely to enhance the network effects, external effects, such as the reduction of the transaction costs and the acceleration of innovation, which can also improve the MFP.

The diffusion of ICT is the main factor of competitiveness gains of the developed economies. In this context, Pohjola (2001) used the data modeling panel to show that the ratio ICT to the GDP was positive and significant in the developed countries, but non-significant in the developing ones.

Similarly, A Dewan and Kraemer (2000, 2001) followed the same approach of Pohjola (2001) for 36 countries. They confirm that the lack of complementary assets and infrastructure, such as the knowledge-based structure to support the use of ICT may be the reason why the effect of the ICT in the developing countries was weak in the 1980.

Beside this, Collecchia and Schreyer (2001) have developed international comparisons of some OECD countries on the contribution of ICT to economic growth over the period 1980-2000. Hence, these two authors have calculated the hedonic harmonized index for each country on the basis of the prices of the national U.S. accounts. The construction of the price index of computer equipment is based on the assumption that the differential of the price evolution outside the ICT investment and the investment in the computer equipment is the same for each country as well as for the United States.

Over the period 1995-2000, France recorded 0.35% per annum for the contribution of ICT and 0.52% per year for the equipment and buildings.

The results generated by Collecchia and Schreyer (2001), for the case of France, are very similar to those of Germany, Italy and Japan. Thus, the contribution of ICT to economic growth in these three countries is about 0.20% to 0.40% per year over the four periods from 1980 to 2000. (See Appendix 1)

The United States recorded the strongest effect, twice as high as that in France; it is in the range of 0.45% per annum until 1995 and even 0.90% per year from 1995 to 2000. Australia, Canada, Finland and the United Kingdom have followed the United States at some distance. These countries have an intermediary position between the first group of countries (Germany, France, Japan and Italy) and the United States. Indeed, the evaluation of the study results of Collecchia and Schreyer (2001) powerfully outlined that the gap between these countries is mainly explained by the degree of the dissemination of new technology in these economies.

Furthermore, the analysis of the work of Oliner and Sickel (2000, 2002), for the case of the United States and that of Cette, Mairesse and Kocoglu (2002, 2004), for the case of France, show that the contribution of the ICT sector to the TFP, which was approximately 0.3% per year in the U.S. until the mid-95, has recently gone up to 0.8%. Over the same period in France, it went up from 0, 4 0% to 6% per year. (See Appendix 2)

Thus, these results lead to a finding of great importance of the ICT-using industries across the economies. The importance of the ICT use seems stronger in the United States. In this regard, these authors agree that ICT increased in the late 90s and afterwards accelerated the contribution of economic growth.

In the same study framework, Khuong (2011) examines the positive effects of ICT on economic growth in the long run. He relied, in a first step, on the traditional regression method in order to identify the role of the ICT in the economic growth during the period 1996-2005. In a second step, he uses the Generalized Method of Moments (GMM) to show the causal link between ICT and economic growth.

This study pays a particular attention to the important contribution of the ICT sector to the economic growth cycle.

On his part, Gorden (2000) points out that the acceleration of productivity and growth in the U.S. is mainly due to the lower prices of Information Technology which led the U.S. firms to over-invest in the ICT sector.

Along this line, Aghion et al (2008) attempt to empirically characterize the impact of the ICT diffusion on the market rigidity and subsequently on economic growth. Indeed, this analysis is performed using data from 17 OECD countries over the period 1985-2003. These authors carried out estimates using the method of instrumental variables since the estimates produced by the method of least squares (OLS) may be subject to biases, for example, the measurement or simultaneity errors which explain some counter-intuitive or unstable results according to the specifications. To achieve this, these five authors have carried out two tests in order to assess the quality of the adjustments the first of which is that of Davidson and C. Kinnon (1993) to ensure the importance of using the method of the instrumental variables, and the second is that of Sargan (1958) which indicates the quality of the adjustment and the relevance of the instruments.

The main estimation results are:

- The ICT diffusion influences the labor productivity and subsequently the factor overall productivity .
- Tensions on the use of the capital apprehended by the use of the production capacity significantly and positively influence the diffusion of ICT. Thus, the tensions raise the level of ICT investment, which corresponds to a standard accelerator effect, but also the contribution of the ICT to investment.

In addition, the study of Eid (2008) identifies the impact of the IT investments on three macroeconomic variables: the growth in the labor productivity, the added value of enterprises, and inflation in the U.S., by dealing with quarterly data from 1959 to 2008 and using the error correction model vector to demonstrate the importance of the period of the informatics revolution (1994-2008) which emphasizes a significant change in these three variables.

Kharti Lee (2003), on their part, studied the ICT influence on the growth of the Asian countries. To achieve this, they used a production function type Cobb-Douglas with the non-ICT capital, the ICT capital (including hardware, software and communication) and the workforce as an independent variable during the periods 1990-1994 and 1995 to 1999.

They suggest that the contribution of the ICT to the economic growth is the result of the effect of the capital of the ICT sector in the 1990s and particularly the effect of capital intensity in the ICT sector in 1995-2000 play an important role in improving the labor productivity.

Sotiris and Papaoannou (2004), Lequieller (2001), Oulton (2001), Cette, and Naoul Lopez (2004) also came to a similar conclusion where the productivity speed up is explained primarily by the level of the capital stock in the ICT.

3. EMPIRICAL VALIDATION: AN ANALYSIS BY THE DYNAMIC PANEL MODELS

The purpose of our analysis is to examine, in an equation structure on dynamic panel data, the role of Information and Communication Technology (ICT) in economic growth. To achieve this, we use a sample of 43 countries over a 17-year-period (1995-2011). Due to insufficient timely and comparable data, it is very difficult to analyze the link between ICT and economic growth. In this perspective, our analysis focuses on the impact of this new technology beside other factors, including open trade, investment, government spending, labor and the rate of the population growth on the overall productivity.

3.1 Presentation of the Model

The models which primarily focus on the influence of ICT on productivity can often be subject to problems of measurement of the ICT variable because of the lack of a standard definition of the "ICT" concept. To deal with this problem, most economists or research institutions have proposed fundamental indicators of the ICT variable, which are part of the computer or telecommunication indicators (such as the case of the ITU, OECD...) or they are just merely the indicator "number of Internet users" to denote the variable ICT (such as the study of Gretton et al (2004), (Atrostic and Nguyen (2004)...).

To avoid these limitations, we selected four indicators: Fixed-telephone subscriptions.

Fixed (wired)-broadband subscriptions; Individuals using the Internet; Mobile-cellular subscriptions; Households with a computer; Internet subscribers fixed cables; Internet subscribers to fixed broadband are collected over the period 1995-2011 for 43 countries in order to construct the variable "new technology". This restriction is based on using the PCR (Principal Component Analysis) technique which can be defined as a set of methods XQpermitting to perform linear transformations of a large number of inter connected variables in order to obtain a relatively small number of uncorrelated components. This approach facilitates the analysis by grouping the data into smaller sets and eliminating the problems of multi collinearity between the variables. The principal component analysis is similar to the factorial analysis, but it is an independent technique often used as a first step in the factorial analysis. (Vogt, 1993, page 177).

Indeed, the construction of the variable "new technology" using the PCA method allows us to obtain a set of values .

In the context of our study, we consider the following transformed function Cobb-Douglas log-linear production:

$$\text{Log } PIB_{it} = \alpha_0+\alpha_1 \text{Log } PIB_{it-1}+ \alpha_2 NT_{it}+ \alpha_3 \text{Log } LL_{it}+ \alpha_4 dep_{it}+ \alpha_5 ouv_{it} + \alpha_6 Q_{it}+ \alpha_7 GR_{it}+\varepsilon$$

Thus, we define:

PIB_{it}: Gross domestic product in logarithm at time t ;
α_0: The individual specific effect (country) ;
NT_{it}: New technology for country (i) in year t ;
LL_{it}: The work factor for country (i) in year t ;
Dep_{it}: public spending for country (i) in year t ;
Ouv_{it}: trade openness for country (i) in year t ;
Q_{it}: Investment for country (i) in year t ;
GR_{it}: Rate of population for country (i) in year t ;
ξ_{it} : The error term

We have to check if there is a unit root and if all the series are non-stationary so that we can study Cointegration. The tests adopted by Im, Pesaran and Shin "IPS" and others, such as Levin Lin, are used for unit root tests as well as the recent tests of Kao (1999) and Pedrouni (2004) are developed to check the existence of a Cointegrating relationship. The method developed by "IPS" consists in conducting unit root tests on each series using the Augmented Dickey-Fuller method, "ADF".

3.2 Study of the Stationarity and the Data Cointegration

In such cases, we firstly seek to study the properties of non-stationarity so that afterwards we will study the relationship Cointegration.

3.2.1 Stationarity Analysis

The tests of Levin and Lin IPS and others are used to verify the results studying the non-stationarity. Generally, these tests have the following specification:

$$\Delta y_{it} = \alpha_i + \theta_i t + \beta y_{it-1} + \sum_{j=1}^{p} \gamma_j \Delta y_{it-j} + e_{it}$$

Where e_{it} the random term which is considered white noise, the number of lags p is chosen so as to eliminate the autocorrelation of the residuals and minimize the Akaike information criterion. The regressions used to test the stationarity of the level variables can include a constant and a linear trend. Failure to reject the null hypothesis of the unit root indicates that the series is characterized by a random walk representation. Moreover, only the constant is included in the regressions used to test the stationarity of the variables in first difference.

To check the stationarity of the group and reduce the inadequate power of the LL tests in a small sample, we used the IPS method which proposed a unit root test in the context of a panel data model using the statistical average of the individual ADF regressions. Our longitudinal cross-sectional data should ideally meet the assumptions necessary for the application of the alternative statistical t-bar to test the null hypothesis of the unit root for all the i (βi= 0):

$$\bar{t}_{NT}(p_i) = \frac{1}{N}\sum_{i=1}^{N} t_{iT}(p_i)$$

Where: t_{iT} (Pi) is the ADF tests estimated with lagged differences pi ;

N, the number of groups N = 1.2, ... 43 .

T, the total number of observations T = 1.2, ... 17 .

IPS suggests using the following standardized statistics:

$$Z_i = \frac{\sqrt{N}\left(\bar{t}_{NT} - E\left(\bar{t}_{NT}\right)\right)}{\sqrt{\mathrm{var}\left(\bar{t}_{NT}\right)}}$$

Where E(t-barNT) and Var (t-barNT) are respectively the arithmetic averages and variances of the ADF individual statistics given that βi = 0. The study of the IPS shows that this standardized statistics converges weakly toward the reduced standard normal distribution, which allows comparing the critical values of the distribution N (0, 1).

The application of the unit root tests LL and IPS shows that all the statistical series are assigned a unit root (see Table 1). It should be noted that the maximum number of lags is set to 3 and the selection of the number of lags for each individual is programmed by Pedroni for both tests.

Table 1: Unit root tests of the different model variables

Statistique	Log PIB	NT	LL	DEP	OUV	Q	GR
Levin-Lin ADF-stat	5.498	8.635	6.199	-0.337	2.169	-0 .507	0.561
IPS ADF-stat	6.829	12.752	8.2101	-2.806	1.310	-2.38	-0.759

The synthesis of all the results of the unit root tests is represented by the above table. However, we try in what follows to present a summary of the results for the unity of the unit root test.

Table 2: Summary of the results of the unit root tests

Variable	Levin-Lin rho Stat	Levin-Lin rho Stat	Levin-Lin ADF Stat	IPS ADF Stat
Lpib	3.67705	6.12645	5.49870	6.82911
NT	3.98751	6.32081	8.63564	12.75221
LL	1.89036	3.06829	6.19902	8.21019
Dep	-2.99193	-0.29136	-0.33786	-2.80644
Ouv	-0.41495	2.18342	2.16937	1.31040
Q	-2.69756	0.08264	-0.50780	-2.38147
GR	-2.62053	1.01080	0.56179	-0.75960

In general, the checking of the non-stationarity properties for all the variables of the panel leads us to study the existence of a long-term relationship between these variables, that is to say, to study the existence of a Cointegrating relationship by applying the Cointegration tests of Pedroni 2003, 2007 based on the unit root tests on estimated residuals.

3.2.2 Cointegration Analysis

The massive development of the unit root tests on panel data has simultaneously allowed the development of the Cointegration tests.

In other words, Cointegration tests on panel data consist in testing for the presence of a unit root in the estimated residuals. However, the problem of misleading regressions, well known in econometrics as time series, also arises in the case of the panel data. Pedroni tests are of the null hypothesis of no Cointegration based on unit root tests on the estimated residuals. Pedroni has developed seven homogeneous and heterogeneous Cointegration tests on panel data. These tests take into account the heterogeneity in the Cointegrating relationship which means that for every individual there is one or more Cointegration relationships not necessarily identical for every individual panel.

The implementation of Pedroni's tests firstly requires the estimation of the long-term relationship for each person and described by:

$$y_{it} = \alpha_i + \delta_i t + \beta_{1i} x_{1it} + ... + \beta_{Mi} x_{Mit} + \varepsilon_{it}$$

With : i = 1……N, t = 1……T and m = 1……M

Within Pedroni's seven tests, four are based on the "Within" dimension (intra) and three on the "Between" dimension (inter). These two categories are based on the null hypothesis of no Cointegration (non-stationarity of the estimated residuals), the distinction between the two categories is at the level of the alternative hypothesis:

$$H_1 = \begin{cases} \rho_i = \rho < 1 \forall i : within \\ \rho_i < 1 \forall i : between \end{cases}$$

Pedroni has shown that inappropriate normalizations based on functions of the Brownian motion, each of the seven estimations follows a standard normal distribution for N and T which are considered large enough:

$$\frac{z_{NT} - \mu\sqrt{N}}{\sqrt{v}} \rightarrow N(0,1)$$

Where Z_{NT} designates one of the seven statistics, Pedroni has tabulated the values of moments μ and v required for such standardization according to the number of explanatory variables and the presence or absence of a constant and of a trend in the Cointegrating relations. The results are shown below.

Table 3: Cointegration Tests of Pedroni

Stat	v-stat	Rho-stat	pp-stat	Adf-stat	Rho_stat[1]	Pp_stat[1]	Adf_stat[1]
Log PIB,.NT, LL, Dep, ouv , Q, GR	**-3.539**	**7.587**	**-3.969**	**-3.487**	**10.277**	**-5.368**	**-3.563**

These are the tests based on the size BETWEEN[1]

Based on the results of the Cointegration tests of Pedroni, we can see that all the statistics are inferior to the critical value of the normal rule at the threshold of 5% level (-1.64). Therefore, all these tests require the existence of a Cointegrating relationship. In order to carry out Cointegration tests on panel data and estimate the Cointegrating vectors, it is necessary to apply an efficient estimation method.

In this context, we can distinguish several techniques namely, the FMOLS method used by Pedroni, the DOLS method, the GMM and ML method (generalized method of moments and maximum likelihood). Phillips and Moon (1999) showed that in the context of panel data, the FMOLS and DOLS techniques lead to asymptotically distributed estimations according to a standard normal distribution. Similarly, Pedroni (1996) argues that the OLS estimators are super-convergent, while their asymptotic distributions are skewed and depend on nuisance parameters. According to Pedroni, these problems may be more noticeable in the presence of heterogeneity. In our model, the estimation of the Cointegrating vectors with the FMOLS method for the whole panel is given by (t-student in brackets):

$$\beta\begin{pmatrix} 1 & 0.11 & 4.35 & -0,01 & -0.01 & 0.01 & 0.32 \\ \_ & 19.43 & 26.31 & -11.33 & -22.49 & 12.88 & -0.52 \end{pmatrix}$$

4. RESULT INTERPRETATION AND CONCLUSION

The results of the unit root tests (IPS) indicate that all the series contain a unit root. Similarly, the Cointegration test results show a Cointegrating relationship between ICT and economic growth. Our results provide a very strong support to the idea that ICT affects economic growth.

We examined the results of the unit root and potential Cointegration of new technology tests and economic growth using panel data from 43 countries over 17 years from 1995 to 2011. The results per country and the tests based on IPS as well as the panel Cointegration tests developed by Kao and Pedrouni confirm the existence of a positive and significant relationship between ICT and economic growth for most countries of the sample, although for some countries, the coefficients are low. Therefore, some countries should strengthen the dissemination of technology in their activities.

The aim of our study is to compare the results of the theoretical and empirical literature related to the contribution of ICT to economic growth. This field of research has received little attention in literature. Although a model including a set of customary variables is tested with the generally accepted estimators, the emphasis is on the dynamic analysis of the panel data. This approach helps to study a model closer to the theoretical courses on ICT. Based on the estimator of Arenallo and Bond 1991, the econometric specification of this dynamic model combines the use of the instrumental variables and the generalized method of moments (GMM). The use of the instrumental variables provides consistent estimates since it solves the problems of correlations between the lagged variable, the constant, and the error terms provided that the error terms are uncorrelated over time (Anderson Hsiao 1982). The estimation by the GMM can, in turn, help obtain efficient estimators (Arenallo and Bond 1991). Generally, we can say that the tests we have used made it possible to highlight, for the studied countries, the important role of ICT in economic growth. Moreover, the diffusion of the new technology has accelerated the pace of economic growth.

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APPENDICES

Appendix 1: Contributions of capital to growth for 9 OECD countries

		1980-1985	1985-1990	1990-1995	1995-2000	
	GDP	1.5	3.5	1.0	2.8	
	Total ICT including	0.18	0.22	0.18	0.35	
	Mat.Inf and Communication	0.13	0.17	0.16	0.25	
	software	0.05	0.05	0.02	0.10	
	Equipment and buildings	0.54	0.70	0.60	0.52	
Germany	GDP	1.1	3.6	2.2	2.1	
	Total ICT including	0.20	0.27	0.30	0.38	
	Mat.Inf and Communication	0.18	0.23	0.24	0.30	
	software	0.03	0.04	0.06	0.07	
	Equipment and buildings	0.49	0.64	0.78	0.60	
Italy	GDP	1.5	3.0	1.4	1.9	
	Total ICT including	0.23	0.31	0.21	0.36	
	Mat.Inf and Communication	0.21	0.23	0.18	0.29	
	software	0.02	0.08	0.02	0.07	
	Equipment and buildings	0.59	0.66	0.52	0.65	
United Kingdom	GDP	2.6	3.9	2.1	3.5	
	Total ICT including	0.18	0.29	0.27	0.48	
	Mat.Inf and Communication	0.16	0.25	0.23	0.43	
	software	0.02	0.02	0.04	0.04	0.58
	Equipment and buildings	0.85	0.58	0.77		
USA	GDP	3.3	3.3	2.6	4.4	
	Total ICT including	0.44	0.43	0.43	0.87	
	Mat.Inf and Communication	0.36	0.32	0.29	0.62	
	software	0.07	0.11	0.14	0.25	
	Equipment and buildings	0.81	0.67	0.54	0.84	
Canada	GDP	2.7	2.9	1.8	4.2	
	Total ICT including	0.30	0.33	0.30	0.57	
	Mat.Inf and Communication	0.25	0.24	0.21	0.43	
	software	0.04	0.09	0.09	0.13	
	Equipment and buildings	0.81	0.80	0.35	0.46	
Japan	GDP	3.3	5.1	1.3	1.1	
	Total ICT including	0.18	0.30	0.31	0.38	
	Mat.Inf and Communication	0.16	0.23	0.25	0.36	
	software	0.02	0.07	0.06	0.02	
	Equipment and buildings	0.92	1.20	1.18	0.69	
Australia	GDP	3.4	3.8	3.4	4.6	
	Total ICT including	0.29	0.46	0.48	0.68	
	Mat.Inf and Communication	0.24	0.34	0.37	0.53	
	software	0.05	0.12	0.12	0.15	
	Equipment and buildings	1.37	1.47	0.89	0.97	
Finland	GDP	2.8	3.4	-0.7	5.6	
	Total ICT including	0.28	0.42	0.24	0.62	0.21
	Mat.Inf and Communication	0.30	0.17	0.46		
	software	0.07	0.12	0.07	0.16	
	Equipment and buildings	0.49	0.58	0.02	-0.05	

Source : Collecchia-Schreyer (2001)

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Appendix 2: Comparative study between the U.S. and France

	Etats- Unis Oliner and Sichel (2002)			France Cette, Mairesse and Kocoglu (2002)		
	1974-1990	**1990-1995**	**1995-2001**	**1980-1990**	**1990-1995**	**1995-2002**
1. Per capital productivity (1a) .ICT capital growth (1b).Part ICT capital	1,4 % 15% 0 ,033	15% 11% 0,046	2 ,4% 16% 0 ,063	2 ,7% 8 ,7% 0 ,018	1,5% 6 ,3% 0 ,024	0 ,9% 15 ,2% 0,026
2. Effect capital ICT	0 ,4%	0,5%	1 ,0%	0 ,15%	0 ,15%	0 ,4%
3 .Effect out capital ICT	0 ,4%	0 , 1%	0,2%	1 ,2%	1 ,5%	0 ,2%
4 a. Quality of work	0,2%	0 ,45%	0 ,2%	_	_	_
4b. Duration of work	-	-	-	-0 ,4%	-0 ,2%	-0,6%
5. PGF effect ICT sector	0 ,3%	0 ,4%	0 ,8%	0 ,4%	0,1%	0 ,6%
6. PGF effect sector out ICT	0,1%	0,2%	0 ,1%	1 ,3%	-0 ,1%	0,4%
7. Total ICT effect (2+5)	0,7%	0,9%	1,8%	0,6%	0,3%	1,0%

Notes: The decomposition is 1 = 2 +3 +4 +5 +6 / 7 = 2 +5

The effect of ICT capital deepening (2) is the product of the growth of ICT capital per head by the share of ICT capital in total cost.

Sources: Hourly productivity in Oliner and Sichel (2002) and Jorgenson Ho and Stiroh (2002), productivity per employee in this, and Kocoglu Mairesse (2002 and 2004)

LIST OF COUNTRIES

Country	**Name**	**Country**	**Name**
01. Algeria	**ALG**	**23.**Ireland	**IRL**
02. Argentina	**ARG**	**24.**Isreal	**ISR**
03. Australia	**AUS**	**25.**Italy	**ITA**
04. Austria	**AST**	**26.** Japon	**JAP**
05. Belguim	**BEL**	**27.** Korea of	**COR**
06. Bolivia	**BOL**	**28.** Malaysia	**MAL**
07. Brazil	**BRA**	**29.**Mexico	**MEX**
08. Canada	**CAN**	**30.**Netherland	**NET**
09. China	**CHI**	**31.**Peru	**PER**
10. Colombia	**COL**	**32.**Portogal	**POR**
11. Croatia	**CRO**	**33.**Senegal	**SIN**
12. Cypus	**CYP**	**34.**SouthAfrica	**SOA**
13. Denmark	**DEN**	**35.**Spain	**SPA**
14. France	**FRA**	**36.**Sweden	**SWE**
15 . Gabon	**GAB**	**37.**Switherland	**SUE**
16. Germany	**GER**	**38.**Tunisia	**TUN**
17. Greece	**GRE**	**39.**Turkey	**TUR**
18. Hong kong	**HON**	**40.**UnitedKingdom	**UKG**
19. Hungary	**HEN**	**41.** United States	**USA**
20. Iceland	**ISL**	**42.** Uruguay	**URA**
21. India	**IND**	**43.** Zambia	**ZAM**
22. Indonsia	**INS**		