Information technologies and economic growth: Do the physical measures tell us something?

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Abstract

This paper explores the impact of different physical measures of information technology (IT) capital on the per capita income of 102 countries. This method not only allows counting on a great number of countries but also to test the great impact other authors have attributed to IT equipments on the basis of such kind of measures.

The estimates carried out in this paper confirm the strong impact of IT on per capita income already found and the difficulty of making it compatible with the real growth of the economies, which point to the presence of grave problems of endogeneity in the estimates. So it seems to be better to rely on monetary measures of capital IT and probably on another method to estimate its effect.

Keywords: Growth, Information technology, Per capita income

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1. Introduction

The relationship between investment in Information Technology (IT) and economic achievement measured in terms of product and productivity has been extensively explored since the beginning of the current century challenged by the famous Solow paradox. Stiroh (2004) surveyed the major results of the estimates that generally support the hypothesis of the strong impact from the investment made in computers and telecom equipment on economic performance. The works developed by Jorgenson stand out as a central reference in this analysis having guided the studies applied to many countries (Jorgenson, 2001, 2004; Jorgenson et al., 2006).

Nevertheless, the exact dimension of such an impact is not yet clear and neither are the differences in the contributions due to computers and telecommunication equipments. On the other side, disparities remain between the analysis based on the econometric estimates of production functions and others driven by calculations of labor and total factor productivity through the rental prices for the inputs.

In addition to that, some analysis using physical measures of the stock of capital seem to offer impacts much higher than the usual measures based on the constant prices values (Röller and Waverman, 2001). The present research is mainly focused on that issue. The advantage of physical capital measures is that they are available for a higher number of countries.

In spite of that, analysis using samples of countries are scarce, as is the separated exploration of developed and developing countries with the outstanding exception of Dewan and Kraemer (2000). One of the reasons is the lack of data referring to long periods. Data on computers for most countries refer to the last decade, which hinders the use of models which require long time series.

This paper studies the IT impact on per capita income through physical measures of the capital stock and a large sample of countries. To do that, it is used a form of the Solow model of economic growth posed by Mankiw et al. (1992) that allows for an approach with limited information. It is used the same sample of countries as they do, with a few exceptions due to the lack of information, with the data from 1980 to 2003 provided by the Penn World Table (2005), for the economic variables, and from the International Telecommunication Union (ITU, 2005 version) for the IT variables. These latter are measured in physical units, which allows to compare the results presented here with those found by Röller and Waverman (2001) showing strong impact of the telephone lines on the income and more recently of mobile phones (Waverman et al., 2008).

2. The model and the data

Assume there is a Cobb Douglas production function with constant returns to scale of this form:

$$Y_t = K_{t,notIT}^{\alpha} \; K_{t,IT}^{\beta} \; (A_t L_t)^{(1-\alpha-\beta)} \qquad (1)$$

Where *Y* is the output, *K* is the stock of physical capital, divided into two categories, with the accumulation of investments in IT equipment separated from the rest, called not IT. *L* is the labor involved in the production process and *A* is a factor of technical progress growing at a constant rate *g*. It is also assumed that the increase in labor matches that of the population in the long run, evolving at the constant rate *n,* and that the physical capital not IT depreciates at the proportional rate of δ.

Given the constant returns to scale, the above function can be expressed in *per capita* terms, using smaller letters to indicate the variables are taken in per capita values.

$$y_t = k_{t,notIT}^{\alpha} \; k_{t,IT}^{\beta}$$

Considering now just the dynamic of accumulation of physical capital not IT, the steady state income is:

$$y^* = \left(\frac{s_{k,notIT} \; k_{IT}^{*\beta}}{\delta + n + g} \right)^{\frac{\alpha}{1-\alpha}} k_{IT}^{*\beta} \qquad (2)$$

Where the * refer to the steady state values, k^*_{IT} is the stock of physical capital IT per capita in the steady state and $s_{k,\ not\ IT}$ is the rate of saving and investment in capital not IT.

In logarithms, expression (2) is transformed into the following:

$$\ln y^* = \frac{\alpha}{1-\alpha}\ln s_{k,notTIC} - \frac{\alpha}{1-\alpha}\ln(\delta + n + g) + \frac{\beta}{1-\alpha}\ln k^*_{IT} \qquad (3)$$

The equation is estimated for the per capita income of 2003, assuming that the countries are in their steady states. The rates of investment and of population growth are introduced as average values for the period 1980-2003. It did not give any value to the depreciation rate assuming that it is equal for every country. So, the second member of this expression became just the population rate of growth. To approach the value of K_{IT} in 2003, four different variables are used, drawn from the ITU data and measured in percentage of 100 inhabitants: number of *personal computers*, number of *main telephone lines*, number of *mobile phones* and *users of the Internet*. Each of them represents one different form of IT.

Table 1 describes the value of these variables and the geometric average for several geographical areas in the world. As expected, North America and Europe show the highest values of IT penetration; the first due to a greater dissemination of computers and Internet accessibility, while the second is because of the great number of mobile phones.

Table 1
IT in the world in 2003[a]

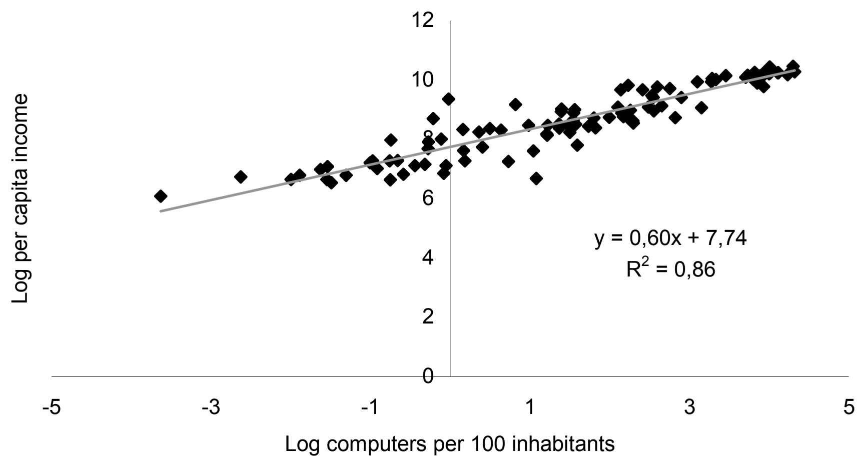
	Computers	Main telephone lines	Mobile phones	Users of internet	Geometrical average
Africa	2.3	3.8	8.4	2.3	3.6
Central America	8.0	17.4	28.2	13.1	15.1
South America	5.9	10.4	21.5	15.1	11.9
North America	56.1	55.5	48.1	63.9	55.6
Asia	16.8	20.2	38.4	22.4	23.2
Europe	37.9	37.3	81.7	51.5	49.4
Oceania	29.3	29.5	37.7	37.5	33.2
OECD	43.7	43.0	79.5	53.6	53.2

(a) Units per 100 inhabitants.
Source: International Telecommunication Union (ITU, 2005).

One of the problems with any estimate of expression (3) stems from the fact that the investment rate includes IT equipment, but this only represents about 10% of the total investment in the US and Finland.

Another problem of much more importance derives from the presence of endogeneity as stock of capital IT also depends on per capita income. Figure 1 depicts the strong relationship between per capita income and IT physical capital which supports this problem.

Figure 1. Computers and income per capita in 2003 (*source*: ITU and Penn World Table, 2005).



To control for endogeneity, a term is introduced in the second term representing the per capita income of the first year, 1980. This term is supposed to capture the part of the IT demand for investment depending on the previous per capita income. This is almost equivalent to the estimate of a conditioned convergence equation of this form:

$$\ln y_t - \ln y_t = \frac{\alpha}{1-\alpha}\ln s_{k,notIT} - \frac{\alpha}{1-\alpha}\ln(\delta + n + g) + \frac{\beta}{1-\alpha}\ln k^*_{IT} - \lambda \ln y_{t-1} \qquad (4)$$

However, here the dependent variable is the rate of growth between 1980 and 2003, so it is estimated the impact of IT on the long run rate of growth. In this new expression λ is the coefficient of conditioned convergence.

3. Results

Table 2 shows the results for the equation (3) and for the 102 selected countries. It is presented only an estimation of the restricted equation which imposes the same coefficient on the rate of physical capital investment and the rate of population growth. This restriction slightly changes the results and better fits the theoretical model.

The IT variables chosen are gradually introduced. After some estimates, it was decided to exclude the “users of Internet” as it seemed to be strongly correlated with the others, particularly with the number of personal computers. Problems of multicolineality in the estimates are detected, altering the signs of the coefficients for the rest of the variables.

The estimated coefficients always have the expected sign. The first column in Table 2 shows the basic original model, without the IT capital. The implicit elasticity of per capita income to physical not IT capital (α in the model) is 0.6, a very common outcome in the reference literature. In the second column, the number of computers are added showing a very high impact on the output: its implicit elasticity calculated [β (1) implicit] reaches 0.34. However, it becomes smaller to the value of 0.15 when the per capita income of 1980 is included, as shown in column [3]. This new variable seems to work in avoiding some of circularity problems, and also re-establishes the original value of the constant of the estimate, leading to an acceptable value of the elasticity for the investment in not IT physical capital which otherwise would decline gradually as new IT variables are incorporated. In short, it gives more stability to the estimates and seems partially to avoid the problems of endogeneity.

Table 2
Estimates of the steady state per capita income in 2003 for all the countries

Dependent variable (y): per capita income in 2003
Equation estimated : $\ln y_{2003} = \alpha_1 + \alpha_2 \; [\ln (I/Y) - \ln n\,] + \alpha_3 \ln k_{TIC} + \ln y_{1980} + u_i$

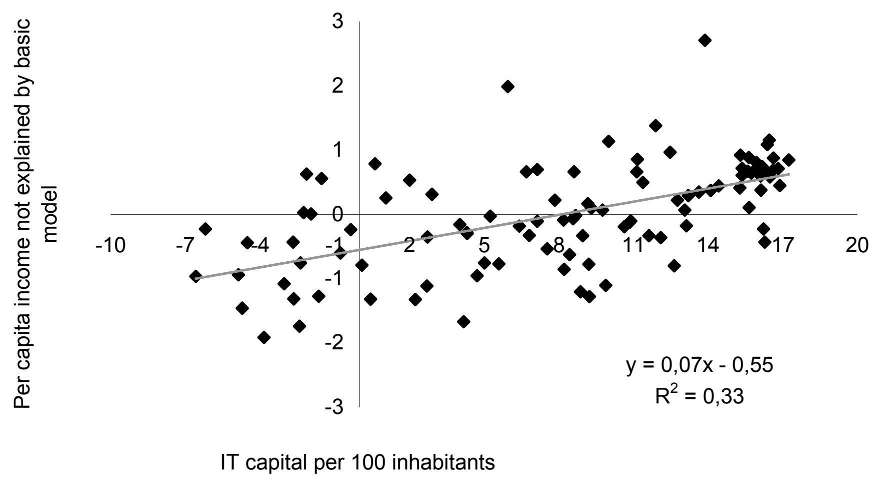
	[1]	[2]	[3]	[4]	[5]
Constant	4.640 (0.000)	7.162 (0.000)	3.041 (0.000)	3.329 (0.000)	3.588 (0.000)
Rate of physical capital not IT investment - Rate of population growth	1.629 (0.000)	0.269 (0.024)	0.304 (0.001)	0.276 (0.003)	0.219 (0.023)
Computers		0.539 (0.000)	0.266 (0.000)	0.216 (0.000)	0. 147 (0.012)
Mobile phones				0.112 (0.016)	0.086 (0.070)
Main telephone lines					0.123 (0.042)
1980 per capita income			0.533 (0.000)	0.480 (0.000)	0.456 (0.000)
α Implicit	0.619	0.212	0.233	0.216	0.179
β (1) Implicit		0.425	0.204	0.169	0.120
β (2) Implicit				0.088	0.070
β (3) Implicit					0.101
Adjusted R^2	0.535	0. 867	0. 916	0.920	0.923
Number of observations	102	102	102	102	102

The number of mobile phones and main telephone lines are also found to be powerful variables as shown by their elasticities [β (2) and β (3) implicit]. When the three variables are included together (column [5]), the elasticity of per capita income to investment in not IT physical is 0.18, an acceptable result. The increase in the number of personal computers affects the per capita income by 0.12 meaning that any increase of 10% in the number of computer gets 1.2% more of per capita income, a huge impact. Taking everything into account gives a greater one, as an increase in IT capital by 10% would add around 2.9 points to per capita income.

It is important to stress the striking role apparently played by the main telephone lines, in accordance with the results by Röller and Waverman (2001).

Figure 2 shows the relationship between the per capita income not explained by the basic model and the IT variables taken together through its geometric average to illustrate the findings in a better way.

Figure 2. Not explained per capita income and IT capital (*source*: ITU and Penn World Table, 2005).



To go deeper into this issue, the differences between developed and developing countries are also explored (Table 3). While the first do not show any sensitivity to the physical capital investment, probably because all of them share the same steady state defined by this variable, per capita income is clearly dependent of its value in developing countries.

Differences in per capita income between developed countries are only related to the most characteristic kind of IT equipment, the computers which have a large influence on production achievements. Neither mobile phones nor main telephone lines seem to provoke perceptible differences in the sample of developed countries.

Table 3
Estimates of the steady state in 2003: developed and developing countries

Dependent variable (y): per capita income in 2003
Estimated equation: $\ln y_{2003} = \alpha_1 + \alpha_2 \; [\ln (I/Y) - \ln n\,] + \alpha_3 \; \ln k_{T/C} + \ln y_{1980} + u_i$

	Developed countries	Developing countries
Constant	6.317 (0.000)	3.900 (0.000)
Rate of physical capital investment - Rate of population growth	-0.048 (0.702)	0.189 (0.083)
Computers	0.257 (0.000)	0.090 (0.211)
Mobile phones	0.044 (0.619)	0.088 (0.106)
Main telephone lines	-0.051 (0.744)	0.150 (0.031)
Per capita income in 1980	0.311 (0.000)	0.418 (0.000)
α Implicit		0.158
β (1) Implicit		0.076
β (2) Implicit		0.074
β (3) Implicit		0.127
Adjusted R^2	0.747	0.843
Number of observations	28	74

For developing countries, computers are less relevant than main telephone lines. But the mobile phone also plays an important role. It obtains here the same result as Dewan and Kraemer (2000).

The above results can be also reached with the model of convergence given by the expression (4). Now the dependent variable is the rate of growth of per capita income between 1980 and 2003 while the explanatory variables are the same as in the previous estimates. However, the expected sign for the per capita income of 1980 will be negative if a convergence process is registered.

Table 4 shows the result of this estimate for the whole sample. In the column [1], the per capita income in the initial year, 1980, shows the expected negative impact, indicating the presence of a convergence process. The investment in physical capital not IT has a positive effect on the income. IT variables are not significant, with the only exception being the number of personal computers which has a big coefficient, 0.006, implying a very similar implicit elasticity (0.007), as its value depends on α and that is very low. This elasticity is quite big as it refers to the increase in the average rate of growth in the period 1980-2003 (permanent or long run rate).

Table 4
Estimates of convergence equations

Dependent variable (log of change in y): Accumulated rate of growth since 1980 to 2003
Estimated equation. Convergence equation:
$\ln y_{2003} - \ln y_{1980} = \alpha_1 + \alpha_2 [\ln (I/Y) - \ln n] + \alpha_3 \ln k_{TIC} - \alpha_4 \ln y_{1980} + u_i$

	[1]	[2]
Constant	0.156 (0.000)	2 (0.000)
Rate of physical capital not IT investment - Rate of population growth	0.009 (0.023)	0.013 (0.001)
Per capita income in 1980	-0.024 (0.000)	-0.020 (0.000)
Computers	0.006 (0.013)	0.012 (0.000)
Mobile phones	0.004 (0.070)	
Main telephone lines	0.005 (0.042)	
Adjusted R^2	0.496	0. 453
Number of observations	102	102

As the introduction of non significant IT variables tends to reduce the value of α, the second column in Table 4 includes only the number of personal computers. Then, the coefficient for that variable almost doubles, reaching 0.011 implying an elasticity of 0.012, an enormous value as an increase in the rate of growth for a long period. Apparently it is similar to that obtained by Jorgenson

(2001) but it is really much higher, as the latter refers to a direct and punctual effect on per capita income, not to a permanent increase in the rate of growth[1].

Those results can not be accepted just taking in account that the stock of IT capital in the US multiplied by 5 from 1990 to 2003 and that of computers by 26 (Jorgenson, 2004). With the estimates carried out in this paper these increases would have more than doubled the per capita income. But the direct effect of them in the output only totals 14% after adding the impact in total factor productivity (Jorgenson, 2001; Jorgenson and Vu, 2005, 2007)[2].

On the other hand, so high impact would indicate a clear excess of return of the investment in IT compared to those in other physical capital, meaning that most of the countries, particularly the developed ones would have lost great opportunities for growth as they have not reallocated their resources to the IT investments. For the most backward countries in the EU-10, such as Portugal, Greece or Spain these losses would have been over 10% of the per capita income.

All those considerations mean that apparently it is already facing a big problem of endogeneity. In trying to avoid in, a version of the convergence equation has been estimated, where the IT variables are taken in variations (approaching for the rate of investment in them)[3]. The first period considered is 1995-2003, but in order to be able to do it has been necessary to complete the available data of IT capital for 1995, particularly that for personal computers and mobile phones. To that end, own calculations are used, taking into account the rate from 2000 to 2003 and the level reached in the first of these years and comparing countries in the same stages of development. These calculations were only accepted after checking out that they match very well the data for around half of the countries in 1995. The other period chosen is 2000-2003, a short one but even

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[1] When this last estimate is compared to another including only the investment in physical capital (once discounted for population growth) it is observed that the value of α declines but the coefficient of convergence multiplies by four from -0.006 to -0.020. This result means that the countries converge faster when the number of computers is taken into account. This accelerates the process of reaching the steady state defined by investment and population growth rates.

[2] For the last years of the period examined in this research see also Jorgenson et al. (2006).

[3] Now a steady state value is calculated for all the forms of physical capital and they depend on the portion of the income invested in them. In this version of the model the implicit elasticities do not depend on α.

more crucial than the previously selected in the accumulation of IT capital, mainly in developing countries. This last period offers the advantage that all the required data are available.

Table 5 shows the result of these last estimates. For the longer period, 1995-2003, the physical not IT capital and even the number of mobile phones one revealed as significant variables, apart from the initial level of per capita income which plays a great role indicating a strong convergence process. But the computer is not significant perhaps indicating that the estimates of the levels reached in 1995 for every country, approaching the missing values through extrapolations from the data of similar countries or interpolations based in the short number of data provided for every single country, are not enough good.

Table 5
Estimates of convergence equations for recent periods

Dependent variable (change in log y): Accumulated rate of growth for the quoted period
Estimated equation. Convergence equation:
$\ln y_{2003} - \ln y_{1980} = \alpha_1 + \alpha_2 [\ln (I/Y) - \ln n] + \alpha_3 \ln k_{TIC} - \alpha_4 \ln y_{1980} + u_i$

	[1] 1995-2003	[2] 1995-2003	[3] 2000-2003	[4] 2000-2003
Constant	-0.105 (0.746)	-0.073 (0.817)	-0.208 (0.051)	-0.136 (0.206)
Rate of physical capital not IT investment - Rate of population growth	0.264 (0.000)	0.261 (0.000)	0.062 (0.011)	0.047 (0.051)
Per capita income in 1980	-0.070 (0.057)	-0.071 (0.053)	0.002 (0.898)	-0.000
Computers	0.0324 (0.361)		0.055 (0.030)	
Mobile phones	0.0421 (0.066)		0.048 (0.001)	
Main telephone lines	0.015 (0.057)		-0.071 (0.078)	
IT geometric average		0.107 (0.039)		0.095 (0.006)
α Implicit	0.209	0.207	0.058	0.047
β (1) Implicit	0.031		0.052	
β (2) Implicit	0.030		0.045	
β (3) Implicit	0.015			
β (4) Implicit		0.097		0.086
Adjusted R^2	0.152		0.118	0.071
Number of observations	102	102	102	102

But going now to the shorter period spanning from 2000 to 2003, the results are much better (column [3], Table 5). The impact of computer becomes statistically significant and the coefficient for the mobile phones reveals as more robust. Computers and mobile phones show elasticities closer to the rank of the values obtained by other authors. Nevertheless, the computers elasticity is more than three times higher than that calculated by Jorgenson (2001) which could hardly be due to the fact that the estimates carried out also capture the effects on Total Factor Productivity. The main telephone lines show a negative impact which must be caused by a negative correlation with the mobile phones. The coefficient for that correlation is 0.35 and it is significant with a 99% of confidence.

Therefore with such results, an increase in 10% in the number of computers would increase the per capita income slightly more than 0.5%, while the same increase in mobile phones would do so far around 0.48%. As in the period 1995-2003 the endowments of both kinds of devices grow at very high average rates, by 142 and 398% respectively, the impact on the average per capita income should have been huge, around 4 points due to personal computers and 18 due to mobile phones. While the first seems reasonable the second is not assumable. In fact the average increase in per capita income was just 16%. Nevertheless, these outcomes depend partially on the fact that the starting point of the endowment of mobile phones in 1995 was almost zero for every country experiencing an enormous rise since then. But even if it is taken just the period of 2000-2003 with more reliable data the average increase has been of 127%, which should have lead to an increase in the per capita income in that period of almost 5%, again higher than the real figures of 3.8%.

Perhaps some of the difficulties with this calculation arise from the fact that the mobile phone is a very specific device facing a very fast growing demand in the period analyzed and not belonging properly to the set of IT equipments of companies and institutions, so it should be relied more on one unique measurement for IT capital. Columns 2 and 4 of Table 5 show the estimate for the geometric average of the three partial measures used here. For the first period, it is found a more significant value for the elasticity but it is around 0.096 three times the value obtained by

Jorgenson (2001) and almost twice the average value of the available estimates evaluated by Stiroh (2004). The results are similar for the second period, with even a higher value for the elasticity although less significant.

Anyway, the big impact on growth of the mobile phones seems to justify perfectly the speed of their expansion and the fact that in all the advanced countries they have spread very widely among the population, as Table 6 shows just with reference to the European countries. The same result would have expected for the personal computer but in fact some of the developed countries show low levels even in 2003.

Table 6
Growth, investment and IT capital in European countries

Countries	Growth of per capita income 1995-2003 in %	Average rate of investment 1995-2003 % of GDP	Personal computers per 100 inhabitants in 2003	Mobile phones per 100 inhabitants in 2003
Austria	1.94	23.86	55.21	87.15
Belgium	1.76	22.78	31.79	82.78
Cyprus	3.20	13.02	28.05	76.82
Denmark	1.64	23.00	61.40	88.32
Finland	3.34	22.60	46.06	90.06
France	1.91	22.60	41.66	69.59
Germany	1.16	22.10	48.43	78.52
Greece	3.24	22.59	8.50	78.00
Hungary	3.93	20.92	12.55	78.53
Iceland	2.88	22.70	46.31	96.77
Ireland	6.76	21.89	45.52	87.96
Italy	1.37	21.30	26.70	98.07
Netherlands	1.92	21.60	51.25	81.06
Norway	2.29	22.55	54.96	90.89
Poland	3.84	19.67	14.20	45.09
Portugal	2.09	24.11	13.46	95.76
Romania	1.80	11.00	9.38	32.47
Spain	2.95	24.80	22.17	87.19
Sweden	2.35	19.90	68.82	98.05
Switzerland	0.87	27.70	75.14	84.58
Turkey	1.28	17.35	4.67	39.44
United Kingdom	2.54	18.90	44.06	91.43

This paradox could be explained at least by three factors. First, perhaps the personal computer is not representative enough of the development of the computerization of the economy, more dependent on the big equipment inside firms. So, it could be assumed that the differences between countries in the computer equipment of the companies are not so large as are the differences in the endowment of personal computers. Unfortunately the data to prove that assumption are not available.

A second factor that would explain why backward countries in per capita income have not increased the investment in personal computers more is that the benefit coming from this capital requires of additional investment in other forms of capital and a reform of the companies and the institutions, following the ideas by Brynjolfsson and Hitt (2000).

A third reason perhaps would lie in the fact that some of the countries referred exhibited high rates of investment so increasing the computer equipment would have required the reallocation of some resources invested in other forms of capital almost as profitable as computers. This would give support to the implicit idea in the calculation of rental prices by Jorgenson (2001) that all forms of capital have the same net rate of profit. But this would lead directly to the conclusion that physical measures of IT capital are misleading in the empirical work.

Anyway, the main conclusion is that estimates of IT impact using physical measures of IT equipment in order to have a wider data base referring to many countries tend to overestimate the contribution of IT to development. The reason has to be found in the rapid growth of this equipment that tends to amplify the endogeneity problems. Probably this is something that also happens to some extent with other kinds of measures but not to such a high degree.

4. Conclusions

This paper explores the impact of physical measures of IT capital on the per capita income of 102 countries on the basis of the model formulated by Mankiw et al. (1992) that allows for the use of data with a small time span. IT capital is measured through three variables expressed in terms of

100 inhabitants, the number of personal computers, the number of mobile phones and the number of main telephone lines. This method not only has allowed to count on a great number of countries but to test the huge impact other authors have attributed to such kinds of measures.

The estimates carried out in this paper confirm that these classes of measures have an impact on per capita income so strong that it can not be seen as compatible with the real growth of the economies, which must be due to the presence of endogeneity problems in the estimates. So probably it is better to rely on the estimated based on monetary measures of IT stock of capital and on their rental prices, following the Jorgenson's (2001) approach.

Appendix 1
Selected countries

Countries and Geographical areas	Per capita income dollars of 2000 1980	2003	Avr. rate investment 1980-2003	Avr. growth population 1980-2003	IT per 100 inhabitants in 2003 computers	mobile phones	main telephone lines	internet
Africa								
Algeria	5095.21	5993.34	14.96	2.44	0.81	4.56	6.90	2.20
Benin	1129.93	1345.39	8.60	3.16	0.37	3.36	0.90	1.00
Botswana	2771.04	8055.74	17.24	2.39	4.77	29.71	7.50	3.41
Burkina Faso	751.76	1070.84	10.39	2.84	0.20	1.85	0.50	0.39
Burundi	894.07	763.31	4.77	1.70	0.21	0.89	0.30	0.19
Cameroon	2370.32	2712.55	4.90	2.59	0.76	6.62	0.60	0.62
Cape Verde	1931.42	5116.88	15.10	1.45	9.95	11.63	15.60	4.36
Cent. Africa Rep.	1065.41	887.50	7.26	2.18	0.27	0.97	0.20	0.14
Chad	627.31	883.75	10.08	3.14	0.15	0.8	0.20	0.37
Comoros	1903.74	1277.62	11.36	2.82	0.73	0.25	1.70	0.63
Congo Rep. Dem.	1164.14	438.02	8.61	3.09	0.03	9.43	0.20	0.43
Ivory Cost	2093.77	2018.77	5.50	3.18	1.18	7.7	1.40	1.44
Egypt	2577.17	4759.36	7.46	2.47	2.68	8.45	12.70	4.37
Equatorial Guinea	1939.64	11 586.89	14.67	3.05	0.98	7.64	1.80	0.55
Ethiopia	505.34	687.52	3.89	2.66	0.23	0.14	0.60	0.11
Gabon	15 774.35	9558.85	5.10	2.72	2.27	22.44	2.90	2.62
Ghana	3562.27	1439.67	4.58	2.73	0.47	3.74	1.40	1.17
Guinea	2542.40	2887.47	8.31	3.07	0.48	1.44	0.30	0.52
Kenya	1273.74	1218.27	9.93	2.82	0.95	5.02	1,00	3.15
Madagascar	1174.01	758.95	3.57	2.96	0.47	1.74	0.40	0.43
Malawi	719.79	770.65	7.24	2.83	0.14	1.29	0.80	0.34
Mali	822.06	1183.81	7.74	2.40	0.22	2.25	0.60	0.32
Mauritania	1269.19	1429.80	12.61	2.78	1.20	12.75	1.40	0.44
Mauritius	6245.60	16 464.44	10.67	1.00	15.70	26.7	28.50	12.29
Morocco	3099.81	4060.78	11.83	2.14	1.89	24.43	40,00	3.32
Mozambique	1132.51	1452.20	3.81	1.88	0.52	2.35	0.40	0.45
Namibia	5089.67	5556.49	11.17	3.01	9.91	11.63	6.60	3.38
Niger	1236.39	834.42	7.08	2.98	0.07	0.62	0.20	0.15
Nigeria	1002.47	1223.28	5.67	2.88	0.64	2.55	0.70	0.61
Senegal	1411.87	1406.54	6.38	2.77	2.08	7.55	2.20	2.17
South Africa	7578.97	8836.35	8.37	1.67	8.21	36.36	10.40	7.17
Tanzania	570.48	912.30	5.94	2.83	0.56	2.95	0.40	0.71
Togo	1327.24	789.04	10.71	3.26	2.95	4.4	1.20	4.20
Tunisia	4249.83	7601.05	15.90	1.90	4.03	19.41	11.80	6.38
Uganda	746.61	1113.36	3.07	3.24	0.40	3.03	0.20	0.49
Zambia	1327.72	946.27	9.64	2.61	0.92	2.15	0.80	0.98
Zimbabwe	3229.23	2438.67	12.43	2.47	4.93	3.09	2.60	6.80

Countries and Geographical areas	Per capita income dollars of 2000		Avr. rate investment	Avr. growth population	IT per 100 inhabitants in 2003			
	1980	2003	1980-2003	1980-2003	computers	mobile phones	main telephone lines	internet
Central America								
Barbados	13 541.50	15 706.65	4.41	0.42	11.18	51.91	49.70	37.08
Costa Rica	6989.82	8585.65	9.15	2.32	23.36	18.66	27.80	21.58
El Salvador	3986.97	4751.22	7.61	1.53	3.40	17.32	11.30	8.29
Grenada	3491.38	6136.33	22.88	-0.04	16.81	37.63	29.00	16.90
Guatemala	4080.15	3805.09	6.60	2.88	1.44	16.52	7.70	4.47
Honduras	2306.08	2291.20	13.45	2.67	1.50	5.58	4.90	2.73
Jamaica	3705.18	4585.12	14.32	0.83	5.68	60.57	17.40	30.28
Mexico	7271.98	7938.15	17.25	1.88	9.58	29.47	16.00	11.96
Nicaragua	5290.62	3409.28	9.57	2.66	3.37	8.45	3.70	1.81
Panama	5775.91	8243.80	15.58	1.82	4.05	26.76	12.20	8.34
Saint Vicent and the Grenad.	2854.42	7741.07	9.20	0.76	12.84	52.87	17.80	5.88
Trinidad and Tobago.	13 560.31	18 416.61	18.14	0.05	9.33	25.81	24.50	11.74
South America								
Brasil	6777.70	7204.94	16.51	1.72	8.60	26.29	22.20	10.20
Chile	6674.84	12 140.69	18.45	1.51	12.77	49.38	21.40	26.26
Colombia	4828.82	6094.30	12.27	1.97	6.07	14.13	17.90	6.24
Ecuador	5023.73	4329.60	18.99	2.41	3.94	18.31	11.80	4.35
Paraguay	4891.96	4716.23	12.39	2.81	4.42	29.85	4.70	2.02
Peru	4985.63	4350.81	16.44	2.18	6.19	10.69	6.70	10.39
Uruguay	8621.86	8855.10	12.61	0.68	12.01	15.40	29.00	16.40
Venezuela	8925.12	6253.34	13.27	2.25	7.36	27.31	11.50	7.53
North America								
Canada	18 634.28	27 844.94	23.39	1.11	52.11	41.65	64.90	55.41
USA	21 606.13	34 875.37	19.93	1.03	55.00	54.58	62.90	55.58

Countries and Geographical areas	Per capita income dollars of 2000 1980	2003	Avr. rate investment 1980-2003	Avr. growth population 1980-2003	IT per 100 inhabitants in 2003 computers	mobile phones	main telephone lines	internet
Asia								
Bangladesh	1347.79	2154.04	9.22	1.99	0.76	1.01	0.50	0.18
China	749.23	4969.64	27.20	1.17	3.92	20.89	20.30	6.15
Hong Kong	13 410.12	27 657.51	24.82	1.66	51.08	107.92	55.90	47.18
India	1348.63	2990.07	10.82	1.86	0.89	2.47	4.00	1.75
Indonesia	2083.34	4122.08	17.26	1.84	1.17	8.74	3.90	3.76
Iran	5555.76	6396.92	30.53	2.40	8.79	5.09	22.00	7.24
Israel	13 932.29	20 712.97	23.01	2.16	26.49	96.07	45.80	36.95
Japan	15 520.56	24 036.74	30.73	0.39	40.72	67.9	47.20	48.30
Jordan	4458.46	3743.13	16.42	4.11	4.49	24.19	11.40	8.11
Korea Republic	4496.06	17 596.91	35.50	0.96	51.09	70.2	53.90	61.07
Malaysia	4950.85	12 133.25	23.78	2.28	18.19	44.41	18.20	34.50
Nepal	869.42	1441.21	16.53	2.50	0.38	0.35	1.60	0.42
Philippines	3313.21	3575.10	13.69	2.23	3.36	27.77	4.10	4.93
Singapore	13 033.43	26 999.24	41.06	2.85	44.00	82.86	45.20	54.81
Sri Lanka	1872.50	4271.94	13.17	1.23	1.65	7.24	4.90	1.30
Syria	1898.95	2015.98	8.28	3.07	2.84	6.75	13.80	3.48
Taiwan	5962.50	19 885.08	18.77	1.03	47.14	114.14	59.10	51.94
Thailand	2708.32	7274.02	31.04	1.37	4.71	40.15	10.70	9.74
Europe								
Austria	17 906.90	27 566.73	23.53	0.33	55.22	87.15	47.70	45.82
Belgium	17 137.03	25 263.96	21.47	0.22	31.80	82.78	46.90	38.47
Cyprus	8423.61	22378.36	17.42	1.07	28.05	76.82	59.00	34.81
Denmark	18 970.18	27 969.73	20.66	0.23	61.40	88.32	67.00	45.96
Finland	15 898.82	23 784.07	25.69	0.38	46.07	90.96	49.20	49.05
France	17 438.46	25 663.67	22.33	0.47	41.66	69.59	56.40	36.56
Germany	17 613.76	25 188.15	23.11	0.23	48.44	78.52	65.70	39.98
Greece	11 875.24	15 785.16	20.86	0.60	8.51	78.00	55.00	15.00
Hungary	8541.89	13 013.73	17.77	-0.23	12.55	78.53	35.60	23.72
Iceland	18 728.42	26 347.29	22.12	1.04	46.31	96.77	66.60	67.47
Ireland	10 563.90	28 248.04	20.72	0.72	45.52	87.96	49.10	31.67
Italy	15 828.74	22 924.75	21.64	0.12	26.71	98.07	45.90	39.52
Netherlands	18 172.10	26 156.73	21.54	0.58	51.26	81.06	48.20	52.19
Norway	19 615.50	34 010.96	24.55	0.49	54.97	90.89	48.70	34.57
Poland	6245.19	9215.51	17.02	0.35	14.20	45.09	31.90	23.24
Portugal	9980.57	17 333.93	21.03	0.27	13.46	95.76	40.90	25.53
Romania	5745.10	6056.94	16.81	0.05	9.38	32.47	20.00	18.45
Spain	12 050.03	20 644.31	22.53	0.50	22.18	87.19	41.60	22.93
Sweden	18 192.20	26 136.43	20.18	0.33	68.83	98.05	72.90	63.00
Switzerland	24 049.14	28 791.67	27.79	0.58	75.15	84.58	72.70	46.46
Turkey	3527.99	5633.33	14.68	1.89	4.68	39.44	26.80	8.49
United Kingdom	15 393.02	26 045.56	17.30	0.28	44.06	91.43	56.40	57.82
Oceania								
Australia	17 464.73	27 871.90	23.99	1.31	60.83	72.17	55.20	56.84
Fiji	4550.62	4919.71	12.43	1.37	4.84	13.31	12.40	6.66
New Zealand	15 443.17	22 195.45	20.71	1.04	44.88	64.83	44.80	52.63

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