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COMPUTER EQUIPMENT AS GENERAL PURPOSE TECHNOLOGIES: THE EFFECTS ON PRODUCTIVITY IN THE ITALIAN CASE, 1995 – 2002

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Computer Equipment as General Purpose Technologies: The Effects on Productivity in the Italian Case, 1995 – 2002[1].

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ABSTRACT. In this paper we investigate the impact of computer investments on productivity, and eventually check for the existence of development dynamics stimulating such investments. While a large number of studies can be found at the firm level, there is a substantial lack of analyses at the macro-level. We focus on 28 Italian manufacturing and service sectors, over the period 1995-2002. Controlling for inter-industry spillovers, ICTs investments proved to positively and significantly affect productivity. Moreover those sectors with lower levels of productivity in 1995 showed up higher average annual growth rates of investments in computer equipment. The case for tailored policy actions is eventually discussed.

JEL CLASSIFICATION: O33, O47

KEYWORDS: Information and Communication Technologies, Innovation, Productivity, Growth.

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1. Introduction

The Italian economy has been facing a very difficult situation for about a decade. The GDP growth rate is positive, but constant on the last part of the 90s, while the Total Factor Productivity (TFP) is affected by negative dynamics. The difference between GDP and TFP growth rate is almost invariantly positive along the period 1983-2001, and with a positive trend along the 90s (Figure 1). This may well be interpreted as the signal of a very limited economic growth, mostly driven by an extensive use of production factors rather than their intensive deployment. The increase in the quantity have substituted for the increase in productivity.

INSERT FIGURE 1 ABOUT HERE

Such a negative dynamics of TFP can be decomposed in two distinct components, one referred to the contribution of radical changes and the other to the contribution of incremental change. It would seem that the introduction of incremental technological change, through a sequence of creative adoptions of technologies created elsewhere, has prevented the Italian economy to collapse (Antonelli and Quatraro, 2006).

It may be argued these marked difficulties are partly due to the changing process that has been affecting the Italian industry. The de-industrialization here is indeed very late, if compared with the analogous experiences of the UK and the US economy. In the early 90s the transition to the service economy was already completed in the US, while it was turning to the end in the UK. In Italy such a mutation would seem to be more complicated, in that it is disturbed by the strong weight manufacturing sectors have always played in the industrial specialization pattern and by the inability of the political and the economic forces to manage the process (Antonelli and Militello, 2000).

The rise of service sectors is in turn characterized by the simultaneous adoption of the information and communication technologies (ICTs), and by the increase in the ratio between skilled and unskilled workers. In particular the progressive diffusion of ICTs within an economy calls for the complementary introduction of specific and dedicated human and fixed capital, as well as the development of intermediate services activities (Antonelli, 2003a).

Such a complementarity between ICTs and intermediate service activities affect in a non-trivial way the impact that the spread of such technologies may have at the macroeconomic level. The full deployment of the potentials offered by the ICTs indeed appears as a factor key to the emergence of virtuous dynamics between structural change and economic growth (Siegel and Griliches, 1991).

The effects of ICTs as general purpose technologies are subject to pretty complicated dynamics. As emphasized by Lypsey et al. (2005), the diffusion of ICTs may have different effects on productivity, depending on several variables. Sometime the introduction of technological change is not captured by productivity measure, because it may take a long time for the technology to be effectively adopted within the system. Insofar as adjustment costs matter, one might also consider the time necessary to develop the complementary physical and human capital, as well as the range of intermediate services. This may also slow the pace at which productivity grows.

The delay in the adoption and the effective implementation of general purpose technologies (GPTs) may also be due to the effects of social learning, i.e. in the process of imitation that prospective adopters engage in, to develop the necessary experience to fully exploit the GPT potentials (Aghion and Howitt, 1998). Moreover, since ICTs are skill-biased, it may also be the case for countries with a locally abundant supply of the most productive factors to be somehow favoured in their quick adoption (Acemoglu, 1998).

Consistently with Helpman and Trajtenberg (1994), GPTs have striking enhancing effects on productivity. Differently from their framework, the potentials are not inherent to the technologies themselves, and hence the impacts on the economy are not immediate at all. If it were so, the producers might want to engage in efforts to retain the benefits stemming from the technology. No effects on productivity could be devised. On the contrary, a large part of the adoption process consists of adaptation, which incidentally may also require the carrying out of complementary R&D and/or the imitation of the success stories. These delaying factors may well be sources of temporary productivity slow-down, unless the system reacts by creating the conditions fostering the effective implementation of ICTs.

This paper aims at analyzing the impacts of the diffusion of ICTs understood as GPTs on productivity growth, across manufacturing and non-manufacturing sectors in Italy. In particular we expect that, after controlling for cross-industrial spillovers, the diffusion of ICTs positively affect TFP as an effect of the benefits stemming from their effective integration within the specific and idiosyncratic production conditions. We eventually investigate the existence of inducement dynamics in the adoption of ICTs, i.e. we ask whether the adoption choice is somehow connected to productivity levels at the first period we observed.

The main results can be summarized as follows. 1) the growth of TFP is positively related to the growth in the share investments in computer equipment, at the sectoral level (and controlling for cross-sectional heteroskedasticity). 2) the diffusion pattern of ICTs across sectors is such that sectors with lower levels of productivity in 1995 show up faster rates of diffusion over the time span we consider.

In the next Section we provide a brief outline of the empirical works already carried out on this subject. In Section 3 we describe the methodology and the data used in the analysis. Section 4 presents the results of the econometric test of the hypotheses. Finally, the discussion and the main conclusions follow in Section 5.

2. Framework

The impact of ICTs diffusion on productivity growth is in its own right a relevant issue, and as such it has received great attention, since the famous contribution by Robert Solow about the so-called productivity paradox appeared. Several works investigated such a relationship both from a micro and a macro perspective, using different indicators as proxies of ICTs, and deriving opposite conclusions from their analysis.

Siegel and Griliches (1991) carry out an analysis ad the industry and the establishment level, *within* the manufacturing sector, aimed at estimating the extent to which the outsourcing to services sectors or to foreign industries, and the investments in computers, may have caused an upward bias in the estimates of productivity growth. Among their main findings is the *positive* and statistically significant relationship between productivity growth and investment in computers.

Lehr and Lichtenberg (1999), put together different data sources to analyze the impact of information technology on productivity. Their data show a dramatic increase in the use of computers in all type of firms and industries, in the period 1977-1983. They found that that ICT capital yields excess returns, relative to other kinds of fixed capital, and that the type of computer matters, and the way they are used. They also show how difficult it is to build proper measures of ICT capital. Comparing the analyses carried out by using the ratio of investments and ratio of capital, they draw similar results, even if the former underestimates the magnitude of the impact on productivity. Lichtenberg (1995), obtains very similar results, investigating the returns from computers and from information systems labour.

Brynjolfsson and Hitt (1995) use survey data relative to firms with within both manufacturing and non-manufacturing sectors. They found that even when controlling for firms' fixed effect, ICT capital has a positive and significant effect on productivity. They also compared a standard Cobb-Douglas production function approach with the less restricted framework of a translog specification, yielding similar results. The same authors elsewhere (Brynjolfsson and Hitt, 2002) investigate the time span it takes for computers to trigger the enhancing productivity effect. They found that both in the short and in the long run computerization has a positive effect on productivity, but it is greater the larger the lag considered.

As far as the macro-level analysis is concerned, Berndt and Morrison (1995) focus on the U.S. manufacturing sectors in the period 1968-1986. They investigate how the change in the share of investments in "high tech" office and information technology capital affect some measures of profitability or multi-factor productivity. Their estimations provide evidence of a *negative* correlation between high-tech capital and productivity.

Antonelli (1997) focuses on the Italian evidence, using input-output tables in the period 1985-1988. He concludes that the rates of growth in the use in communication and business services co-evolve. Moreover the *enhancing effects* of such a co-evolution on productivity clearly emerge from the econometric evidence. This draws the attention to the complex chain of feedbacks between structural change, economic growth and diffusion of information technologies.

Such an evidence would hence suggest that the positive effects of ICT diffusion on productivity growth are in some sense enabled by the rise of the service sectors. Indeed ICTs are general purpose technology which are characterized by a strong bias effect, in that they are high-skilled-labour and capital intensive, and low-skilled-labour saving. The interaction between relative prices and technology features is of particular relevance in this case, as the powerful effects of ICTs aren't likely to show themselves unless the factor endowment of the system is such that the most productive inputs are also the locally abundant ones (Antonelli, 2003a).

Moreover, both the U.S. and the German evidence have made fairly clear how much ICTs as innovations, exhibit a strong bias not only in favour of university-based human capital and specific forms of fixed capital, but also an array of intermediary products and especially services (Kaiser, 2001; Bresnhan et al., 2002; Antonelli, 2003a). Looking at the diffusion of ICTs also across non-manufacturing sectors thus seems to be a necessary step forward a better understanding of their impact.

In conclusion, with the exception of the contribution by Berndt and Morrison (1995) and Antonelli (1997), it seems that no particular attention has been paid to the macro-analysis of the relationships between productivity growth and the diffusion of ICTs. Moreover, both of these studies has some limitations. The first actually focus just on the dynamics occurring *within* the manufacturing sector, neglecting the growing relevance of the service sectors. The second focus on the time span 1985-1988, while it can be argued at that time the diffusion process was still at the very early stages, at least as far as Italy is concerned.

In this paper we look at the actual change in productivity and in the use of computers, mainly focusing on the time span ranging from 1995 to 2002, and considering both manufacturing and non-manufacturing sectors. Such a period seems to be appropriated as far as the Italian case is concerned, as for the reasons we outlined in Section 1 the adoption of ICTs and the subsequent development of a new service-based economy is considerably delayed. The effective implementation is still far to be completed, and the positive feedbacks due to spillovers from upward to downstream industries are unevenly distributed across user sectors.
In the next Section we describe the dataset we used for the analysis.

3. Research Design

3.1 The data

The main source for this work are the economic time-series ad the Input-Output tables provided by the National Bureau of Census (ISTAT), respectively for the period 1970 – 2002 and 1995 – 2003. Data are here disaggregated at a very good level, and indeed one can distinguish 29 micro-sectors. Unfortunately they are aggregated at the national level, so that we can only deploy the sectoral dimension.

In Table 1 we report the data about the dynamics of computer investments, and Employment at the micro-sector level. It is quite impressive to note that most of manufacturing sectors are characterized by negative employment dynamics. The only exceptions are the manufacturing of mechanical equipment and of rubber, chemical and metal products. The worst performance can be found in the *Production and Distribution of Electricity* and the *Manufacturing of Transportation Equipment*. As far as services are concerned, the only sector with negative growth rates is the *Financial and Monetary Intermediation*, while the one growing more (than any other sector) is the *Real Estate, Informatics and R&D*.

The data about the investments in computer equipment provide evidence of the relevance of service sectors in the diffusion of ICTs. They actually reveal that all the sectors we consider, have increased their expenditure in the period 1995-2003. But even in this case on average service sectors use ICT more than manufacturing sectors. The *Real Estate, Informatics and R&D* is the service sector with the highest growth rate, together with *Hotels and Restaurants*.

INSERT TABLE 1 ABOUT HERE

In table 2 we compare the rates of growth of TFP and labour productivity. Labour productivity would seem to grow in all the industrial sectors, in the period 1995-2002. Moreover on average manufacturing sectors have higher productivity growth rates than non-manufacturing sectors. This may well be due to a mere statistical effect. Actually it is known that valued added is the result of the contribution of basically two factors, i.e. capital and labour. It's straightforward for any economist[2] that manufacturing sectors, having a higher capital endowment, show up systematically higher labour productivity than non-manufacturing sectors. It is hence necessary to somehow deflate cross-sectors differences in capital endowments.

If one looks at the data relative to the TFP, the situation changes dramatically, and we maintain it takes sharper contours. All of manufacturing sectors actually have negative growth rates, as well as some service sectors. This is consistent with the Figure 1, as it is another way to argue that GDP growth has been fed through investments in fixed capital. The only relevant case is once again the *Real Estate, Informatics and R&D* service sectors, whose productivity grows at a rate of 2,8%.

INSERT TABLE 2 ABOUT HERE

Summing up, a diffusion process of ICTs across industrial sectors appears to be at stake in the period we consider, and above all within some service sectors, which in turn show up comparatively high growth rates of TFP. This provides an earlier support to the main hypothesis underlying this study, i.e. the existence of positive feedbacks between the use of ICTs and productivity growth. Moreover the evidence of higher growth rates of productivity in service sectors paralleled by higher utilization of ICTs, may be considered a further clue of the fact that such technologies exhibit a strong bias in favour of an array of intermediary products, especially services (Antonelli, 2003a and 2003b). In the next section we provide an outline of the econometric strategy.

3.2 Method

The aim of this paper is to check for the existence of positive feedbacks between the diffusion of ICTs and the dynamics of productivity. As noted above, we use here data disaggregated at the micro-sector level. We have 29 sectors on 8 years. The very simple model we are going to estimate is the following:

$$\mathrm{dlog}TFP_{it}/\mathrm{dt} = \alpha + \beta_1[\mathrm{dlog}(ICT_{it}/\ GFI_{it})\mathrm{dt}] \qquad (3)$$

[2] With the possible exception of those economists in the Robinson-Sraffa tradition, who deny the measurability of capital.

Where i in refers to the different industries. What we are looking at, is hence the relationship between the growth in the share of investments (*GFI*) devoted to the purchase of ICTs and the growth of TFP. According to the theoretical framework and the data analyzed so far, we expect this relationship to be positive.

Since this analysis is conducted by considering the sector dimension, it must be noted that serious problems of heteroskedasticity due to cross-sectional correlation may arise. It is actually reasonable to argue that increases in productivity in some sectors may have spill-over effects on the productivity of other sectors, for example due to vertical relationships, outsourcing, and so on and so forth. This is even more crucial when the impact of ICTs is at stake. We need to control for the positive effects that productivity in service sectors, as array of complementary activities, may have on other sectors performance.

Once you control for the impact of cross-sectors productivity spill-overs, what you are supposed to get is the effect of the spill-overs due to the adoption of ICTs, i.e. the benefits accruing from their adoption. We expect to find evidence of a positive relationship between ICTs investments and TFP, but unevenly distributed across sectors. This because the macroeconomic effects of ICTs as GPTs are far from being both immediate and automatic. A sequence of intermediate steps are to be undertaken, in order to effectively integrate such technologies within the production system. Of course, not all sectors may be equally successful in going through these steps.

Finally, we also wonder whether some development dynamics are at stake or not. In particular it seems of some interest to investigate the prospective relationship between the level of ICT investments share and the level of TFP at the first observed period. This might well be interpreted as the proxy of induced innovation engendered by worst performance, pursued through the adoption of new technologies (Antonelli, 2003b). The evidence of a radically changing environment in Italy strongly supports this hypothesis. Firms are coping with the emergence of novelties, and it is reasonable to expect them to try and adapt to the new situation. The rise of service sectors in particular determines a strong bias in the utilization of ICTs. The idea is thus that the sectors characterized by lower levels of productivity in 1995 are those investing more in ICTs, to fully deploy their potentials of general purpose technologies (Lypsey et al., 2005). This amounts to propose the following specification:

$$\frac{1}{T}\Delta\log(ICT/GFI)_{1995}^{2002}=\alpha+\beta\log TFP_{1995} \qquad (4)$$

Where T is the number of periods observed. This equation looks like those used in convergence analysis, in that we relate an average annual growth rate to an initial level datum. Of course it is very different from that framework because we are not assuming any convergence to any equilibrium growth rate. We are just wondering whether bad economic performances may stimulate the undertaking of a reaction strategy based on ICTs. Accordingly, the negative sign from the regression would provide support to the idea of induced technological change in lagging-behind sectors.

4. The Econometric Results

The Equation 3 specifies the relationship between the TFP and the share of computer investments growth rates. As in this step we use data disaggregated at the sector level, the serious problem of cross-sectional autocorrelation arises. To cope with it, we fit the data with a cross-sectional time-series linear model, by using feasible GLS. In the Figure 2 we report the scatter plot with the regression line. It is fairly evident that the panel is heteroskedastic. The GLS estimation accounting for heteroskedasticity due to cross-sectional correlation yielded the following result:

$$d\log TFP_{i,t}/dt=-.016+.109^{***}\,d\log\left(\frac{ICT_{it}}{GFI_{it}}\right)/dt \qquad (5)$$

N = 29, T = 8, n = 232; Wald Chi-sq = 8.74***. The regression behaves very well statistically. The share of computer investments have a positive impact on productivity, when intersectoral spillovers are accounted for. As we considered the logarithm of both of the variables, their coefficient can be directly read as elasticity of TFP to the increase of computer investment.

Of course this result is complementary to the descriptive analysis we have presented above. In a system characterized by higher growth rates of employment in service sectors, the adoption of ICTs is likely to exhibit positive effects on productivity. The introduction of ICTs indeed represents a technological change with a strong bias towards skilled labour in the business-related service sectors. A mismatch between the features of the technology and the local endowment of production factors (and hence relative prices) has negative effects on its productivity and competitive advantage.

The positive impact of ICTs on productivity is the proof that some of the sectors we considered, are able to deploy their potentials of general purpose technologies. The evidence about informatics and R&D service sectors is very relevant, in that they are likely to include the array of service sectors which is complementary to the effective adoption of ICTs within the economy.

What remains now to investigate is whether ICT diffusion can be actually thought as a reaction to the evolving environment, and hence whether it really assumes the features of an induced technological change. According to this hypothesis, sectors doing bad at the first period observed, are supposed to show higher rates of investment in ICTs. The following results are obtained through the OLS estimation of Equation (4):

$$\frac{1}{T}\Delta \log(ICT/GFI)_{1995}^{2002} = .118 - .039**TFP_{1995}$$

N = 29, R-sq = 0.16, F = 5.10. Even in this case the regression is well behaved. The result is clearly supportive to the idea that sectors characterized by lower levels of TFP in 1995 are those on average investing more in computers in the period 1995-2002. In Figure 3 the scatter plot is reported, with the regression line. The sectors list can be found in Table 1. The interpretation is straightforward. First of all it must be noted that the *real estate*, *informatics and R&D* as well as the *financial and monetary intermediation* service sectors show up pretty high average growth rates of computer expenditures. However, the former is also characterized by a low level of TFP in 1995, fitting the regression model, while the latter represents on outlier in that the TFP level in 1995 is the highest in the whole sample. In general one can note a dense group of sectors, mostly manufacturing, in the middle of the diagram. A further important element is that within the manufacturing sectors, the energy-related activities seem to show up a higher propensity to adopt ICTs.

Summing up, the results of the econometric estimations provide support to the main hypothesis underlying this study, i.e. that the increasing cross-sector adoption of ICTs leads to an increase in productivity, which turns out to be unevenly distributed across manufacturing and non-manufacturing sectors. Such disparities can be interpreted as the effect of the complex set of complementary activities which are required to effectively implement ICTs within the production system.

Hence, even if firm are induced to innovate by negative economic performances, the result of the adoption choice is by no means easy to predict. Some sectors are successful, while other sectors are not. Beside this argument, our results also suggest that in some sectors either the difficult situation is not perceived, and hence they are not pushed to invest in ICTs, or they don't regard ICTs as key technologies to react.

5. Conclusions

The impact of computers utilization on productivity has received great attention in literature, since the famous Solow's contribution about the productivity paradox appeared. Several empirical accounts have been carried out. Most of them provide analyses at the firm level, concluding that the effect of ICTs on productivity is positive. Very few studies have carried out analyses at the macro-economic level, and only one out of them considered both manufacturing and service sectors. The stream of literature analyzing the macroeconomic effects of GPTs suggests that ICTs are likely to produce important shifts in productivity, but their adoption is a complex process which requires a strong efforts on the user side, aimed at creating the right enabling conditions conducive to productivity gains. The emergence of such complementary intermediate products and services may take a long time, and hence the enhancing effects on productivity may be considerably delayed, or may also not appear at all.

In this paper we have analyzed the impact of ICTs diffusion on productivity for 29 sectors, over the period 1995-2002. We used a GLS estimation technique to control for cross-sector spill-overs affecting productivity, and we found a *positive* relationship between computer investments and productivity. The scatterplot suggests that such positive effects are unevenly distributed across sectors, providing support to the idea that the implementation of ICTs is a complex and time-consuming process, in which users are supposed to play a very crucial role. As a result, not all sectors may be equally successful in this process.

We have eventually investigated the existence of development dynamics occurring across sectors, by analyzing the relationship between initial levels of productivity and the annual average growth rate of ICT expenditure for each sector. Sectors with lower initial levels of TFP turned out to be the ones spending more on ICTs in the period considered. In particular the *real estate, informatics and R&D*, as well as the energy related manufacturing sectors appeared especially sensible to such a dynamics.

These results have important policy implications, as far as the Italian case is concerned. Actually, the Italian economic structure is facing process of gradual change, featured by the transition from a manufacturing to a service-based economy. The strong complementarity between ICT and service sectors hence requires that such a process should be fostered through incentives to the adoption of ICT. Of course, the bias in favour of high-skilled labour and specific fixed capital also suggests that the economic system should also provided with the necessary levels of Academic trained workers and telecommunication infrastructures for ICTs to fully express their productivity-enhancing potentials.

6. Appendix

In the construction of multi-factor productivity we followed Solow (1957). We derived a Hicks-neutral measure of technological change, by accounting for the shifts in the production function. Differently from that framework, we didn't apply the Divisia-Tornquist methodology. We obtained the output elasticity of labour starting from the production function:

$$Y = AK^{1-\alpha}L^{\alpha} \tag{A1}$$

Which implies a constant-returns-to-scale framework. Under the assumption of perfect competition, production factors are paid their marginal productivity, and hence one can write down the following relationship:

$$P'_L = w$$

Which can be written as follows:

$$\alpha\frac{Y}{L} = w \qquad \rightarrow \qquad \alpha_{it} = \frac{w_t L_{it}}{Y_{it}} \tag{A2}$$

This expression allows us to calculate the output elasticity of labour, assuming a Cobb-Douglas production function. The multifactor productivity is then obtained through the following relation:

$$A_{it} = \frac{Y_{it}}{K_{it}^{1-\alpha}L_{it}^{\alpha}} \tag{A3}$$

Where the stock of fixed capital is obtained by applying a lag operator to gross fixed investments (*GFI*) as follows:

$$K_t = GFI_t + 0.8GFI_{t-1} + 0.4GFI_{t-2} \tag{A3a}$$

The index we obtained in such a way is a measure of multifactor productivity which is consistent with the Solowian TFP, although we allow output elasticities to vary over time. Some basic questions of course remain as to what interpretations to give to differences in levels and rates of change of TFP. While Solow (1957) associated TFP growth with technological advances, Abramovitz (1956) defined the residual as some sort of measure of ignorance. Nonetheless it remains a useful signalling device, in that it provides useful hints on where the attention of the analysts should focus (Maddison, 1987).

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Table 1 – ICT Expenditure and Employment Growth Rates at the national level, by Sector (1995-2002)

ID	Sectors	ICT	Employment
1	Agricolture	0.044	-0.038
2	Fisheries	0.011	0.006
3	Mining and quarrying of energy producing materials	0.089	-0.001
4	Mining and quarrying, except of energy producing materials	0.066	-0.014
5	Food Products and Beverages	0.055	-0.015
6	Manufacturing of Textiles and Apparel	0.023	-0.027
7	Manufacturing of Leather, Leather products, and Footwear	0.013	-0.024
8	Manufacturing of Wood and products of Wood and Coke	0.050	-0.007
9	Manufacturing of pulp, paper and paper products; Printing and Publishing	0.026	-0.011
10	Manufacturing of coke, refined petroleum products and nuclear fuel	0.098	-0.016
11	Chemicals and Manufacturing of chemical products	0.039	-0.012
12	Manufacturing of Rubber and Plastics products	0.053	0.006
13	Manufacturing of Other non-metallic products	0.037	-0.008
14	Fabricated metal products	0.044	0.008
15	Manufacturing of mechanical equipment	0.042	0.007
16	Manufacturing of electric, electronic and optical equipment	0.028	-0.006
17	Manufacturing of transportation equipment	0.030	-0.026
18	Other manufacturing sectors	0.039	-0.009
19	Production and distribution of electricity, gas and water	0.135	-0.030
20	Constructions	0.022	0.011
21	Trade	0.055	0.004
22	Hotels and Restaurants	0.105	0.026
23	Logistic and Communication	0.087	0.009
24	Financial and Monetary intermediation	0.101	-0.012
25	Real Estate activities, Informatics and R&D	0.105	0.051
26	General Public services and Social Security	0.060	-0.015
27	Education	-0.097	-0.010
28	Health-care	0.078	0.008
29	Other Services	0.057	0.012

Table 2 – TFP and Labour Productivity Growth Rates at the national level, by Sector (1995-2002)

ID	Sectors	TFP	Labour Productivity
1	Agricolture	-0.046	0.133
2	Fisheries	0.004	0.110
3	Mining and quarrying of energy producing materials	0.005	0.121
4	Mining and quarrying, except of energy producing materials	-0.025	0.133
5	Food Products and Beverages	-0.028	0.126
6	Manufacturing of Textiles and Apparel	-0.005	0.126
7	Manufacturing of Leather, Leather products, and Footwear	-0.008	0.123
8	Manufacturing of Wood and products of Wood and Coke	-0.018	0.129
9	Manufacturing of pulp, paper and paper products; Printing and Publishing	-0.040	0.126
10	Manufacturing of coke, refined petroleum products and nuclear fuel	0.004	0.112
11	Chemicals and Manufacturing of chemical products	-0.001	0.126
12	Manufacturing of Rubber and Plastics products	0.015	0.125
13	Manufacturing of Other non-metallic products	-0.024	0.130
14	Fabricated metal products	-0.008	0.125
15	Manufacturing of mechanical equipment	0.000	0.121
16	Manufacturing of electric, electronic and optical equipment	-0.020	0.125
17	Manufacturing of transportation equipment	-0.011	0.126
18	Other manufacturing sectors	-0.005	0.123
19	Production and distribution of electricity, gas and water	-0.046	0.130
20	Constructions	-0.035	0.125
21	Trade	-0.034	0.123
22	Hotels and Restaurants	-0.005	0.121
23	Logistic and Communication	-0.037	0.130
24	Financial and Monetary intermediation	-0.018	0.122
25	Real Estate activities, Informatics and R&D	0.028	0.119
26	General Public services and Social Security	0.007	0.129
27	Education	0.002	0.128
28	Health-care	-0.003	0.127
29	Other Services	-0.050	0.121

Figure 1

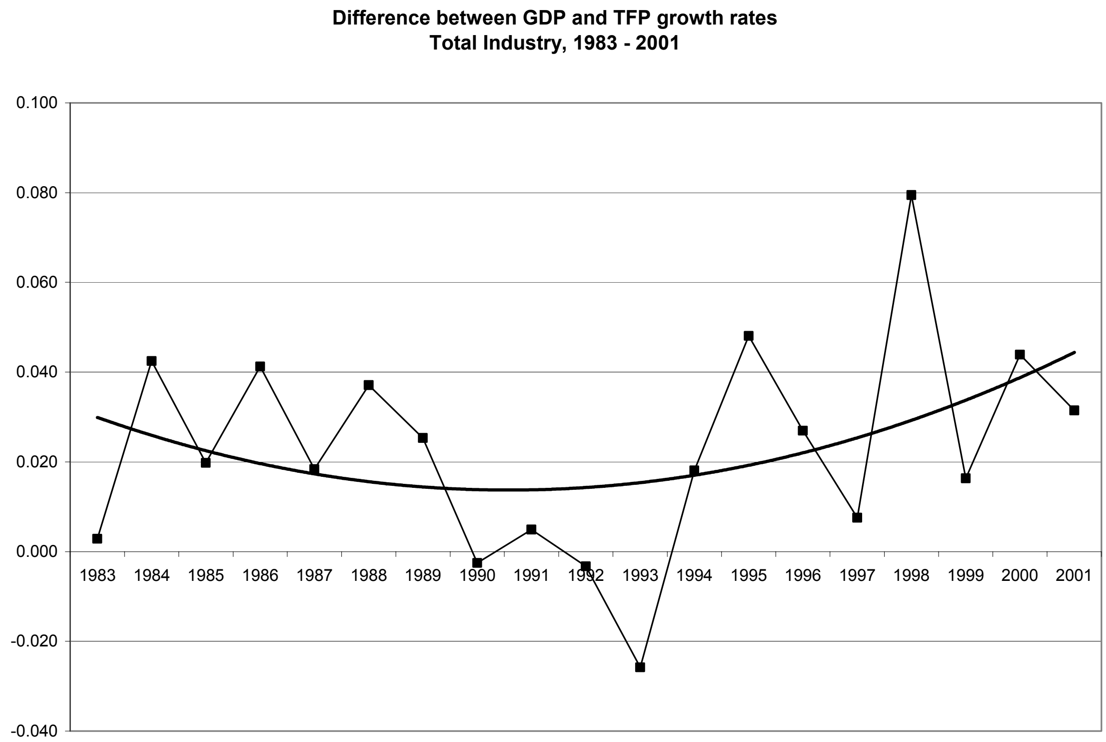

Figure 2 – Relationship between the ICT investments share and the TFP growth

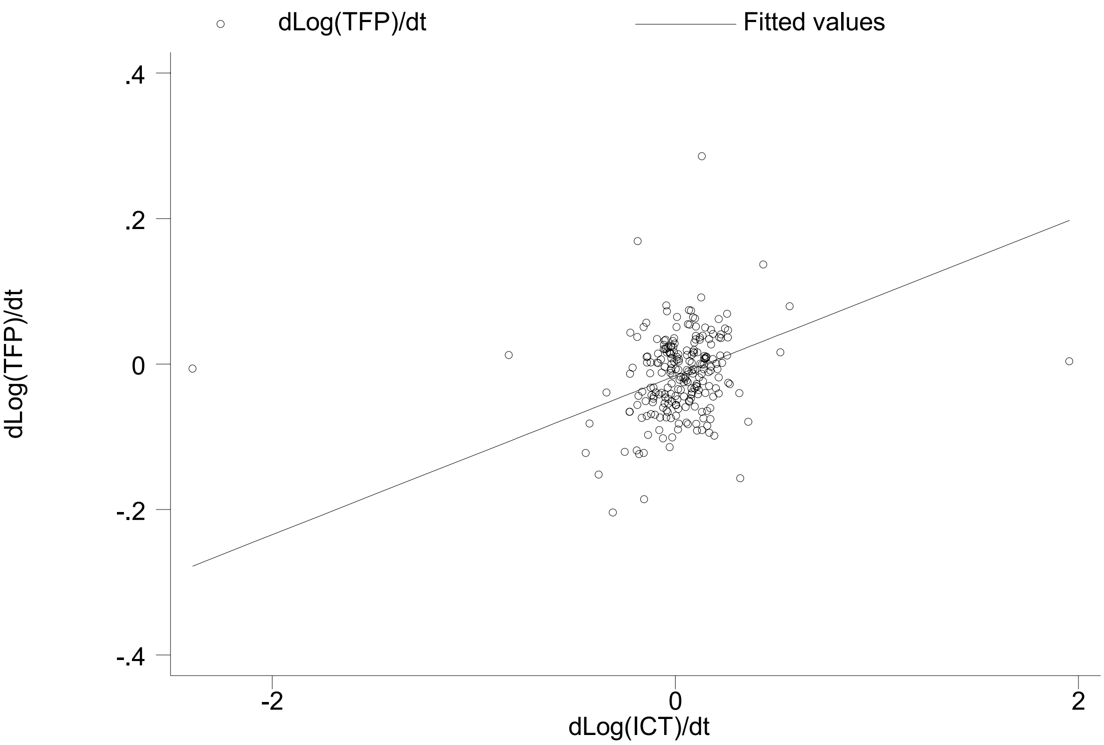

Figure 3 – Relationship between the growth of ICT investments share and the level of TFP at 1995