Information Technology and the European Productivity Revival

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Abstract

We analyze the data of 8 European countries using regression and compare the result of our model to Stiroh's. We find mainly four results as follows. First, different from the result in Stiroh (2002), we found only slightly more than half of the industries' labor productivity increased around 1993. Second, to some extent, similar to the result in Stiroh (2002), we found it is true that the increase in labor productivity growth was related to ICT in the sense that the most significant increase in labor productivity growth is related to ICT-intensive industries, especially IT producing and FIRE industries. Fourth, the Chow test and chart analysis show that 1993 is not a breakpoint with significant level of 5%.

Keywords: Information technology, Productivity revival, Regression, Breakpoint test

1. Introduction

Our task was to verify, if conclusions from given paper "Information Technology and the U.S. Productivity Revival: What Do the Industry Data Say?" hold true for European economies. We considered 8 developed European countries. Data were collected with year frequency for period from 1970 to 2005. For testing and modeling we used programs Matlab and Eviews. Our model is closely related to the works like Alpar and Kim (1991) (Alpar, P. and Kim, M. 1991), Ahituv and Giladi (1993) (Ahituv, N. and Giladi, N. 1993), Bresnahan, Brynjolfsson, and Hitt (2002) (Bresnahan, T., Brynjolfsson, E. and Hitt, L. 2002) and O'Mahony and Van (2003) (O'Mahony, M. and Van Ark, B. 2003).

2. Data

We first consider the breakpoint in Data. In order to have an intuitive view of the possible breakpoint, we divide the period from 1970 to 2005 into two parts and plot a picture, Figure 1. The X label is the breakpoint; the Y label is the difference of the average growth rate of latest period minus the average growth rate of the former period. From the plot in Figure1 we can see, 1974-1981, 1993, 2001 can be the most possible breakpoints, in1974-1981 and 2001 we can see, after those years, the growth rate significantly drop, on contrast, after 1993 the grow rate have a comparatively significant increase. Notice that in 1993 is the possible breakpoint start to increase, but other two points start to decrease. So this is more rational to say those data have more than one breakpoint, and have several periods and need to use more than one model to depict them. If we just have the null hypothesis that 1993 as the only breakpoint the whole period from 1970 to 2005, we may find this hypothesis is very insignificant. But if we only consider part of the period, for instance, period 1980-1994, then 1992 may consider being breakpoint.

Figure 2 is an aggregate growth chart of all the industries from 8 countries. We can see it change a lot around year 1974, 1993, and 2001. The pink line indicates the average growth change for 1974, the green line for 2001 and red line for 1993.

Anyway, first, we will test the null hypothesis that 1993 is a not breakpoint for the whole period 1970-2005, and examine the some topics about productivity revival.

3. Models

A: Is the Productivity Revival Widespread?

By examining the industry productivity data directly, Figure3 suggest a not so significant productivity revival after 1993. Figure 3 plots the 1993-2005 growth rates versus the 1970-1993 growth rates for 8 countries, totally 240 countries. The points about the line show accelerating productivity, while those below the line show decelerating productivity. The slightly more than half industries-126 out of 240 industries- shows productivity acceleration.

The 13 green points is the outlier industries. They are 23 in AUT, 64 in DNK, 30t33 in FIN, 64 in FIN, 23 in GER, 64 in GER, 64 in ITA, 70 in ITA, 64 in NLD, H in UK, 51 in UK, 64 in UK, J in UK, 8 out of those 13 industries is IT-producing or FIRE industries. We can see IT-producing or FIRE industries show gins largely due to the fundamental technological advances in the production of IT.

We estimate model (1) to examine the change in the mean growth rate across industries

$$d \ln A_{i,t}^{Y} = \alpha + \beta D + \varepsilon_{i,t} \tag{1}$$

Where $D = 1$ if $t >$ breakpoint, else $D = 0$

β Gives the mean change. Results of estimation are show in Table1

Table 1 presents results for various estimates of equation (1) the first column is the OLS and, we can see, it is very small and not significant.   And the unweighted regressions allow small industries to have a considerable impact on the results. As in the paper of Stiroh (2002)(Kevin J. Stiroh. 2002), we take weight, the square root of Logarithm of outputs, which is related to industries size. Why Logarithm of outputs? Because this kind of data is available in all countries and years, we want to make use of all the data. Including industry level fixed effects to control for heterogeneity in productivity growth across industries (column 3) leads to a slightly larger acceleration and 5% significant estimates. In column four, we drop the IT-producing and FIRE industries. The acceleration coefficient fall a lot in size because those industries show large productivity accelerations. So it can be seen, the total growth rate have a slight increase, but the growth rate for IT-producing and FIRE industries have a very significant increase.

B Is the Slight Productivity Revival Linked to IT Use?

This section examines the link between productivity acceleration and IT intensity across the 8 European countries.

We estimate the model of *Difference-in-Difference Estimates* with an additional constant and interaction term for IT-intensive industries in equation (2)

$$d \ln A_{i,t}^{Y} = \alpha + \beta D + \gamma C + \delta D \cdot C + \varepsilon_{i,t}$$

  Where $D = 1$ if $t >$ breakpoint, else $D = 0$ (2)

$C = 1$ If IT intensive, else $C = 0$

Here $\alpha, \beta, \gamma, \delta$ have the same meanings in Stiroh(2002)[4]. We define the IT-intensive industry as one with an above median IT share of capital services in 1993.

Estimation Results are show in Table2

Table 2 presents results for various estimates of equation (2). The first column is the OLS and, we can see, IT-intensive industries experienced an economically large and statistically significant increase in productivity growth relative to other industries. Other industries even have a decreasing productivity growth it is very small and not significant.   When the LnY weights account for the relative size of industries (column 2), also give an evidence that IT-intensive industries experienced an economically large and statistically significant increase in productivity growth relative to other industries. When including both the weight and the industry level fixed effects (column 3), IT intensive dummy is 0.1218 very significant. When we drop the 3 IT-producing and FIRE industries, α drop from 0.1218 to 0.0178, this show those industries have significant growth increase.

4. Breakpoint Test

Figure 4 shows that the difference in productivity acceleration for IT-intensive industries robust in most all the years, but there is no significant increasing or decreasing around 1993, so it is almost the same structure, especially according to the whole period from 1970s to 2000s. This is evidence, that we do not accept 1993 as breakpoint. For the same reason, we also do not accept other years as breakpoint with respect to the whole period from 1970s to 2000s.

Base on model 1 with weight and without fixed effect, we do the Chow break test. The null hypothesis is that 1993 is not a break point. The error sum of squares under the null hypothesis $S_0 = 129.1408$, two subset regressions' SSR are $S_1 = 93.7341, S_2 = 35.3628$. F-value is 2.8565, and the critical value of $F(1,8400) = 3.8426$, at the significant level of 95%. So we cannot reject the null hypothesis.

If test each year as break point, we can get the Figure 5, where the y label is the difference of the F-statistic and Critical value. The year where the value of difference is positive will be accepted as break point.   It is easy to see, this result match the result and analysis very well.

The reason why the breakpoint is not significant in 1993 is that we have 30 industries in each country, of those only 3 IT-producing or FIRE industries. So the impact of ICT-producing or FIRE industries in the whole data is limited, even IT-producing or FIRE industries have a very significant increasing growth rate. Because the breakpoint is related to all the industries.

5. Conclusions

According to the data of European 8 countries, we found IT producing and FIRE industries have very significant growth acceleration, other IT intensive also have growth acceleration, but not so significant. We use Chow test to test the structure breakpoints in model 2 with weight, find out that 1985-1997 will accept as structure stable, if we test the model with only one possible breakpoint.

References

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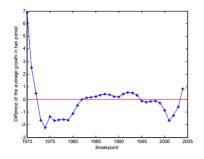
Table 1. Dummy Variables Tests of Post-1993 Acceleration of Industry Labor Productivity

Eight Countries	t-test	1970-1993 vs. 1970-2005		weight: sqrt (LnY)
Constant	0.0292***	0.0601***	---	---
Post-1993 dummy	0.0006(t=0.44)	0.0024(t=0.46)	0.0023**	-4.6314e-004 (t=-0.45)
Weights		yes	yes	yes
Industry fixed effects			yes	yes
Drop IT-producing industries				yes
Drop FIRE outliers				yes

* Significant at the 10-percent level ** Significant at the 5-percent level   *** Significant at the 1-percent level

Table 2. Dummy Variables Tests of Post-1993 Acceleration of Industry Labor Productivity For IT-intensive Industries

Eight Countries	t-test	1970-1993 vs.	1970-2005	
Constant	0.0288***	0.0598***	---	---
IT-intensive dummy	0.0008	0.0003	0.1218***	0.0178***
Post-1993 dummy	-0.0022	-0.0010	-0.0009	-0.0013
Post-1993 dummy* IT-intensive dummy	0.0056**	0.0032***	-0.0000	0.0004(t=0.37)
Weights		yes	yes	yes
Industry fixed effects			yes	yes
Drop IT-producing industries				yes
Drop FIRE outliers				yes

* Significant at the 10-percent level   ** Significant at the 5-percent level   *** Significant at the 1-percent level
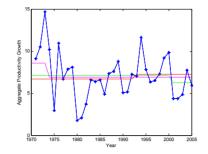
Figure 1. Difference of average growth

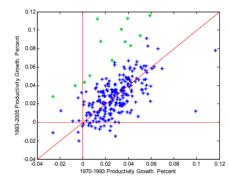Figure 2. Aggregate Productivity Growth

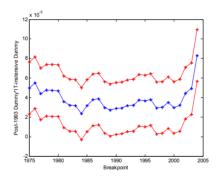Figure 3. Changes in Industry Productivity Growth 1970-1993 vs.1993-2005

Figure 4. Relative Labor Productivity Acceleration for IT-intensive industries

Notes: Figure plots estimated coefficient on the interaction of them dummy and IT-intensive industry dummy (blue line) and its 95-percent confidence interval (red line), the regression is based on model 2. (column2)
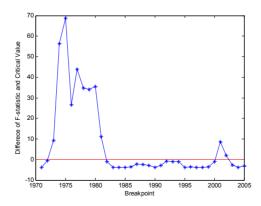

Figure 5. Chow Break Test: Difference of F-Statistic and Critical Value