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"Shocks and Institutions, assessing the role of ICT on Unemployment"

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To Patrizia, Giuseppe,

Michele and Blaine

I would like to say some "thanks" at the end of my work and my bachelor experience. I would like to start from my professor and supervisor Giovanna Vallanti; she has been not only a guide for my path, but above all a reference point, always there to give me advices and in particular the practical example that the hard work is the only way for the success. Thanks also to my university, which gave me the chance to grow up and appreciate the academic's world in all its facets.

I feel obliged to say thanks to my university colleagues, Francesco, Giorgio, Luca and Giulio, and to my friends Alberto, Francesco, Gianclaudio, Giulio and Pasquale; I would not be there without their help.

Finally, there's no way how I could express how grateful I am to my whole family, who has always supported me in every single day of my life.

ABSTRACT

In the last 30 years we have observed interesting trends among unemployment rate of European countries. Namely we found a common increasing trend for almost all of the countries, but also a strong degree of heterogeneity among European individual unemployment rates. Conversely, in United States we have not been faced with a massive increase in the unemployment rate. While it is widely accept the idea that the increase and the heterogeneity of unemployment in Europe could be explained by unfavourable shocks, iterated with specific institutional variables, the so-called "rigidities (Blanchard and Wolfers, 2000), there is no clear explanation for the different American trend, which, according to Nickell (2005) could be explained by the specific technological path followed by the U.S. government. In this paper we investigate the basic relationship between technologies, in particular those of communication and integration of telecommunication (ICT), and unemployment, as well as the combined effect of technologies and institutional settings on unemployment. Our analysis suggests a significant impact of the level of ICT on unemployment, which could be amplified if considered with respect to income taxes.

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INTRODUCTION

The topic of unemployment rate has been central into the economics debate since the late 1970. What we have observed, in fact, was a strict increase in the unemployment rate, and in a country like Italy, we have had an increase of almost 7%.

This unexpected European trend goes against what was the common idea, and relationship between wage, inflation and unemployment, thus making more and more social scientists to analyse it and try to come up with a firm believe on what was the dynamic of unemployment and, probably more important, which were the proximate causes of this phenomenon. The main research about the argument tried to explain this dynamic in terms of shocks of the aggregate demand and institutional characteristics. As we will see later in the chapters this view found reasonably consent among economists, mainly because it was able to explain past economics' trends. In particular the slowdown in TFP observed in late '80, and the downturn trend in real interest rate have been sees as unfavourable shocks that affected production and in turn consumption. However, even if these have been identified as causes of the cycle, they could not explain the persistence of its effects. It's for this reason that many economists started to look at institutional variables as determinant of the persistency of shocks, thus affecting different economics in different way.

Our research started from the great economic relevance that Information Technology (IT) assumed in the end of the century. The volume of investment in this sector reached in a few time incredibly high valued, which have affected productivity. Indeed economic research focused its attention on the impact of IT on productivity, and on growth. However little or no relevance has been given to the impact that investment in IT could have on unemployment rate. Our idea is that IT could influence unemployment

in different way: i) firstly, the development of the IT sector could increase the productivity of the whole economics environment, thus influencing unemployment rate; ii) secondly, IT could foster and improve investment also in other sectors, thus decreasing unemployment.

In this paper we will try to assess if IT could have an impact on unemployment and, if so, whether this is positive or negative. Specifically we will test the hypothesis that investment in ICT has an impact on unemployment which is determined by the institutional characteristics of each single country. In this sense the basic idea is that central government could have both a direct and indirect effect on the overall impact of ICT on unemployment; specifically the idea is that government could increase its public expenditure in ICT (direct effect), and, on the other side, it could set fiscal, monetary and institutional politics, aimed at improving the *Technological readiness level (*TRL). In other words government should work in order to make the overall environment more attractive with respect to the possibilities of internal and foreign investment, which will affect final output and unemployment. In this sense empirical evidence seems to suggest a negative impact of tax, stringent regulation and scarcity of infrastructure. A practical intuition of this phenomenon has been found in Unite States, where public governments worked in order to improve the IT level, both by a massive public expenditure, and by a series of directives aimed at increasing the level of investment in ICT. In our work we will first review the existing literature about unemployment, institutional variables, shocks and ICT. After we will try to determine expected effect of single variables on unemployment, ending in an econometric estimation of these effects.

1. LITERATURE REVIEW

1.1 SHOCKS AND INSTITUTIONS

A branch of literature focused on the role played by shocks and institutions (Blanchard and Wolfers, 2000; Scarpetta, 1996; Nickell, 2005; Bassanini and Duval, 2006; Layard, 1991) while a minority tried to understand which was, and also what could be the effect of TFP growth on unemployment aside from other kind of variables (Mortensen and Pissarides, 1999; Pissarides and Vallanti, 2007; Moiymoto, 2008). The basic intuition on which is based the analysis of the former group of economists is that shocks and institutions could affect unemployment through both a direct and indirect effect; effects that could be amplified or softened based on the degree of interactions between the variables. In other words the idea is that shocks have a direct effect on GDP, production and consumption, thus on unemployment. On the other side institutional variables like Employment Protection (EPL), tax wedge or Active Labour Market Policies (ALMPs) affecting the overall environment of the market labour and the reservation wage, also have an impact on unemployment rate. However what the authors claimed was that it's the combination of those two effects the determinant of the heterogeneity of unemployment trends among European countries. How we will see this kind of view found reasonable results through econometric analysis, leaving some degree of uncertainty as well.

The economics underpinning on which is based the entire analysis has to be found in an observable fact: the unemployment rose across European countries, but it did so in a heterogeneous way. Thus a common shock could not be the unique factor that has caused the rise in unemployment, since otherwise we should have observed equal trends for all countries. In order to find a solution economists tried to look at the impact of adverse market institutions combined with unfavourable shocks. The reason why economists

focused their attention on institutions is straightforward: after an initial attention to the impact of shocks there has been an attempt to understand how high unemployment could persist; thus the research started to take a look on the so-called "rigidities"[1]. Blanchard and Wolfers (2000) run two regressions, they tested for several hypotheses, namely a common unobservable shock among countries and different specific common shocks; however they also worked on institutions thus controlling for these variables, or letting them interact among themselves.

The starting point of their research is the idea that market institutions could determine the level of unemployment. This idea starts from the fact that the labour market has high flows of workers and continuous reallocation, and from the theoretical assumption than we could think about wage determination as the outcome of the interaction between firms and workers, influenced by theirs relative bargaining powers. This assumption implies that every institutions that increase workers bargaining power lead to an increase in wage, and more important, that unemployed are not able to bargain with firms. Thus we could think about steady state unemployment as being the result of duration times turnover and so the main questions should be how market institutions could affect these two variables. Let's start from the impact of employment protection. On the average duration its impact is positive (in the sense that it increases); two channels act in this way: employment protection increases firms' costs and secondly it makes workers bargaining power higher. Thus the only way to reconcile this two effect is an increase in the duration of unemployment. On the other hand the impact on turnover is negative: since firms have higher costs to dismiss a worker they will keep them longer. The final result of

[1] It is important to underline how some of these rigidities may represent institutional corrections to other market distortions in the labor market. It means that even if some rigidities have a negative impact on, for example, productivity they could still not have a negative effect on unemployment.

these two effects is trivial, for sure they make the unemployment pool stagnant, but it's not obvious an increase in the unemployment rate. Data seems to support this thought, having countries with the higher protection with a lower turnover and a high duration, but not with a clear effect on unemployment rate.

The authors then focused on the factors that affect the wage that firms could afford to pay (payroll taxes, user cost of capital, productivity). The point is trying to understand which is the effect on unemployment rate due to a change in the wage. The answer depends on the ratio between wage and reservation wage. If this reservation wage moves in the same direction, and in the same proportion, as wage, then there will be no change on duration, and so on unemployment rate. From a theoretical point of view, the idea that reservation wage moves in the same proportion of wage, is reliable.

Finally it has been taken into analysis the unemployment insurance system. Here the evidence is clear and in line with the main ideas about it: high unemployment benefits increase unemployment rate. This is because these kinds of benefits will make the unemployed conditions less painful, and so high duration is needed, in order to re-match the lower wage offered by firms, with the higher demanded by unemployed.

The conclusions on market rigidities are, as usual, trivial. Even if it could be argued that they harm economics, there is no clear evidence that they increase unemployment rate, and thus they could not explain the difference in unemployment trends among European countries. The relevant conclusion of the econometric analysis made by Blanchard and Wolfers is that once observable shocks[2] have been introduced, and once interaction has

[2] Namely TFP slowdown, shifts in labor demand and real interest rate shock

been allowed between them both shocks and variables resulted to be significant and robust, even if no clear effects could have been determined.

Further researches tried to focus more on institution, in particular on the empirical evidence of a "complementary environment", in which institutions could magnitude their single effect interacting with each other (Bassanini and Duval, 2006); in particular what Bassanini and Duval claimed[3] was that institutional variables should be analysed with respect to each others, in the sense that there was a "reinforcing cycle", by which reforms had more impact the more eco friendly the environment was. To test this hypothesis they run a regression in which institutional variables were the only one used, and they found significant result for EPL and union density, furthermore all the interaction terms were found to have a negative sign, thus giving reasonability to the idea of a self-reinforcing environment. After the overlook on institutions the authors took in consideration interaction between shocks and other variables as well. Their starting idea was not the same as Blanchard (1999) since they were able to find strong and significant results just from institutions. They however decide to study the interaction channels by which the specific impact of a shock could be amplified by the institutional characteristics; in particular those were almost the same identified by the previous analysis, namely the idea that strict protection of "insiders" through EPL could reduce wage sensitivity, or that "economic turbulence" could destabilise the all environment making the unemployment rate always differ from the natural one[4]. What Bassanini and Duval underlined was the fact that in their analysis, even if the two authors (Blanchard and Wolfers) were able to explain a part of the dispersion of the unemployment rate across Europe, no allowance was made for the direct impact of changes in institutions; thus they conclude that, considering also the results of

[3] "*Employment Patterns in OECD Countries: Reassessing the Role of Policies and Institutions", 2006*

[4] Idea supported by the theoretical model presented by Karanassou and Snower (1998).

unemployment regressions using only policies and institutions, interactions between shocks and institutions could account only for a complementary explanation of the observed trends. In the last part of their work the two authors run a final regression with two main variables, namely unemployment benefits and the degree of corporatism. High unemployment benefits have been found to amplify the effects of a shock, while a high degree of corporatism had the opposite effect. The analysis has been augmented implemented also the direct effect of policies and institutions on unemployment. The results support the idea that direct and indirect effect of policies and institutions complement each other in explaining unemployment trends. Finally it has been taken in consideration whether these variables considered in the response to a shock have a role also in the persistence of these results. In other words it has been used a dynamic approach that studies the short and medium run effects of the explanatory variables. The results are that high tax wedge mitigates the initial impact of a shock, having no effects on the persistence of this. Further, stringent EPL and PMR appear to reduce short-run impact of an adverse shock but they also lengthen the adjustment process. In the end high expenditures on ALMPs are found to reduce the persistence and also the initial impact of a shock.

The simple effects of institutions on unemployment has been further analysed, in particular empirical evidence has been assessed by Scarpetta (1996). In his work [5] the author tried to understand which was the link between institutional settings and unemployment, in particular he focused on *equilibrium* unemployment and on the *persistence* of the effects of an adverse shock caused exactly by specific institutional characteristics. In

[5] *"Assessing the role of labour market policies and institutional settings on unemployment: a cross country study", 1996*

the light of former analysis (Layard, 1991) the author focused on the dynamics of wage determination, in particular on specific *policies* that regulate it, identifying a clear positive effect on unemployment rate. Thus the author wanted to underline how policy makers could positively affect the overall labour market, by removing distortion and labour market slack by means of specific settings aimed at regulating the wage determination process. The same author identified a clear influence of institutions not only on wage determination, but also on the *speed of labour market adjustments*; namely he found clear econometric evidence of the negative effect of the employment protection legislation and of unemployment benefits. In turn this negative effect on the market adjustment turns to affect unemployment rate, in particular Scarpetta found how stringent EPL, combined with overly generous unemployment benefits would affect significantly, and positively (i.e. they *raise* unemployment) final unemployment rate. In the shed of this light the authors suggested how the overall environment could just benefit from the co-ordination of social partners involved in wage determination; remarkably this result holds regardless of the degree of unionisation of the labour market, thus reinforcing the claim for specific settings aimed at reducing friction between social parts. In the end of his analysis the author also focused on the relationship between the degree of centralisation of wage determination and unemployment. His works seemed to suggest the hypothesis of a *hump-shaped* effect, where the greatest results are obtained for highly centralised and fully decentralised wage bargaining system.

The economists Nickell, Nunziata and Ochel have carried out a pure empirical analysis in 2005[6] starting from the, observable, different trend in unemployment between European and American countries: what we observed in fact was a strong increasing path

[6] "U*nemployment in the OECD since the 1960s. What do we know?", 2005*

for EU, while a quite flat for US. Nickell started from the already expressed idea (Blanchard and Wolfers, 2000) that shocks are the remote causes of an increase in unemployment, while the scale of economics consequences are driven by institutional structure. The authors seemed to believe this ides, since it could be, in theory, the sole explanation of differences between EU and US. According to them this idea found reasonably confirmation due to empirical data; indeed they found how the broad movements in unemployment rate among OECD could be explained by shifts in institutions. In conclusion they tried to test for the hypothesis of a significant effect from the interaction of shocks and institutions; however they do not found a remarkably contribution, reinforcing the idea of shock being the remote cause of unemployment, but then having no influence on the long-run unemployment effect (Blanchard, 1999).

1.2 TECHNOLOGIES AND UNEMPLOYMENT

We will now focus on the other topic of the research, namely that which investigates the relationship between TFP growth and unemployment. It has been argued (Mortensen and Pissarides, 1999) how the widespread trends of unemployment rate between countries could be partially explained by the growth of productivity[7]. In particular, starting from the unemployment equilibrium framework (Mortensen and Pissarides, 1994), it has been tried to assess the effect of common skill-biased shocks that increase the labour productivity. The result is that the final effect of these kinds of shock is modelled and determined by specific countries policies, and thus the differences among institutional settings could explain part of the difference in the response to common shocks. The argument expressed by the authors, on how and why different Unemployment Insurance

[7] "*Unemployment responses to skill-biased shocks: the role of labour market policies", 1999*

(UI) and Employment Protection (EP) systems should affect the impact of skilled-biased shocks, works as follow: it is assumed, in line with empirical labour economics literature, that less skilled workers suffer higher unemployment because of the longer of unemployment spell duration. This follows from the assumption that the economic value of non-employment does not increase proportionally with skills. Then the dynamic of the model implies worker skills to increase, and then the unemployment rate to decrease, but is bounded by zero everywhere. It's for this reason that the relationship between worker skill and unemployment is strictly convex, in the sense that as skill increases the unemployment declines, but the absolute rate of this decline is decreasing. The conclusions of the model are that: i) a higher UI increases the unemployment rate, but it does so increasing the rate of unskilled more than that of the skilled; ii) a more stringent EP decreases unemployment, but it decrease the unemployment rate of unskilled by less than that of the skilled; iii) finally higher UI and higher implicit EP tax work on the unemployment-productivity relationship making it more convex.

The research then went a step further, trying to put apart the role of institutions and just focusing on the relationship between TFP growth and unemployment (Pissarides and Vallanti, 2007), considered at a microeconomic level. The starting point of their work[8] was that the impact of new technology was not uniform among firms; that's because firm's behaviour with respect to new technology is not the same: a firm could decide to incorporate the new technology with the current workers, leading to the so-called "capitalization effect", or it could find impossible to embody the innovation, thus forcing the firm to fire the old workers, which will imply the Schumpeterian process know as "creative destruction". Based on a few assumptions, and after having been calibrated by

[8] "*The impact of TFP growth on steady-state unemployment, 2007*

current data for US economy, the model has been found to be reliable in estimate the steady state level of unemployment, thus confirming in a way the negative relation between the two variables. The basic connection behind TFP and unemployment goes as follow: there are, in theory, two channels by which the former could influence the latter, leading in both cases to a lower rate of unemployment. The first one works on the *supply of labour (*Ball and Moffit , 2001), in the sense that a faster productivity growth could increase the supply of labour. The idea is that workers adjust to change in productivity with a long lag and thus when we observed a change in productivity growth the ratio of wages to productivity gets distorted, ending in an employment effect. The two authors then decided to test for this hypothesis adding a new variable into the Philips Curve, namely the gap between productivity growth and an average of past wage growth. This new estimation of the Philips Curve found a good approximation form the empirical analysis, and it was able to explain why unemployment rose during the TFP slowdown, and why it fell after 1995. What the two authors argued was that the fall in the NAIRU (Non Accelerating Inflation Rate of Unemployment) was not sustainable[9]. Their conclusion was that the economics environment moved from a regime in which wage aspirations exceeded productivity growth, then increasing unemployment, to one in which aspirations are below productivity growth.

The other channel by which productivity growth could influence unemployment, that is also the one on which we focus more, works the other way round: instead of considering the impact on the supply it focuses on the *demand for labour*. The intuition is that with a development in technology firms are faced to a strong decision: they have to decide whether to adopt or not this improvement, and, maybe more important, how to adopt it. As a matter of fact the firm, giving an initial decision to embody the new technology, could

work on his existing team of workers, thus importing this new technology upgrading present job, or it could find impossible to do it, and so it has to destroy the job and fire the worker. The first effect, descripted as *capitalization effect,* will lead to a higher demand for labour in response to a growth in productivity, and so it will permanently lower unemployment. The work carried out by Pissarides and Vallanti (2007) relied on some assumptions*:* in particular about unemployment elasticity of wages equal to zero and an infinite firm horizon in deciding whether to adopt or not a new technology. Clearly these assumptions are not fully reliable, thus the model failed to explain the overa[10]ll trend in unemployment; notwithstanding it is able to fit, by econometric estimation, data for US and European economies. What is claimed in the model is that TFP growth could lead to two phenomena: *job destruction and job creation.* In an analytical way it has been shown that job would be destroyed when the reservation wage becomes equal to the worker's marginal product, since wage keep on growing with the reservation wage, while marginal product of labour could not sustain the kind of growth. On the other hand the effect on job creation is not sure, it strongly depends on the extent to which technology is disembodied. The disembodied rate that has been estimated through the model turned out be .96, which is consistent with the entire model, in the sense that allows a negative effect of TFP growth on unemployment also in presence of a creative destruction effect. In conclusion the model is able to explain a part of the path of unemployment due to TFP growth changes.

The model developed by Mortensen and Pissarides (1994) has been the starting point for further researches; in particular Miyamoto (2008) showed how productivity growth could lower unemployment by decreasing separation and increasing job finding. In

his work[11] Miyamoto incorporated disembodied technological progress, on the sunk and on the job search costs incurred in creating job position, into the model of endogenous separation by Mortensen and Pissarides. This incorporation leads the model to develop a new channel of influence from productivity growth on unemployment; namely separation rate are reduced and more job creation is induced. In particular the model is augmented considering the job search as endogenously determined, and as said, sunk costs, which have been defined as physical capital required to create a job, are added. According to the author, this augmented version of the model is consistent with the empirical observation, and it is able to magnify the decline in unemployment due to an increase in TFP, compared to the standard model. We will after have a closer look at the role played by ICT spending on unemployment.

The last part of our literature review aims at analysing the existing works on the topic of the specific interaction between ICT and institutions. The basic idea is that government could have both a direct and indirect impact on ICT (Gotti Tedeschi, 2009). In particular it has been argued[12] that fiscal and monetary policies, which are of course managed by the central government, are aimed at structuring a sustainable growth. In this sense, in last years, sustainable growth followed the path of the ICT expansion. In other words, in lasts decades central government, in particular, as stressed by Nickell (2005), in United States, have based their growing path on the technological sector. This expansion path has been translated into public funds to finance the research, taxes relieves to company who invested in R&D, credit access for entrepreneurs to develop firms and a massive expansion of the financial market into the Hi-Tech sector. This strong intervention

[11] "*The impact of productivity growth on labour market", 2008*

[12] "ICT e crescita economica: call of duty per l'Italia", 2009

acted by the central government has been seen to be the main explanation to the different evolution in unemployment trends between Europe and United States. Furthermore it has been stressed how, in US, the ICT sector accounted for more than the 20% of contribution to the GDP growth (Gotti Tedeschi, 2009).

On the other side, apart from the direct effect that the central government could have on developing the ICT sector, there is an indirect one; namely government is responsible also for the *Technology readiness level (TRL),* which is a descriptive variables developed in the 70s by the NASA to define the technological maturity of a country with respect to the level of implementation of an existing technology. TRL depends basically on the level of infrastructure present on the territory, on the skills level of workers, but also on the overall level of developed technology. It is in this framework that the government could act in improving the level of TRL, thus improving the ICT level, but also working on the existing environment, for example giving more public funds to the research sector, or conceding some tax exemptions to firms that perform high research level, or not allowing for extremely high level of unemployment benefits, or reducing the bargaining power of insiders in wage determination. All these kinds of initiatives will in turn affect both the productivity of the workers and the unemployment rate; indeed, by offering a mix of favourable labour market conditions and a high level of public investment, foreign investment would be attracted (Gotti Tedeschi, 2009). In this sense there is the great effect that specific institutional characteristic could have on (firstly) output per worker. According to Colecchia and Shreyer (2001) there is empirical evidence of a combined, positive effect, of a low weight of bureaucracy, and investment in ICT plus a developed managerial skill, on final output. Specifically it has been noted how taxation, government regulation and the absence of adequate infrastructure is a sever bound on both output and unemployment rate. Eventually, it has been inferred, by econometric analysis, how investment made by the

public sector in ICT are correlated with an increase of productivity and a decline in costs (McKinsey, Quarterly reports, 2004).

In conclusion our aim is trying to define if there is an evidence of this positive correlation between institutional characteristics, namely the level of EPL, union density, unemployment benefits and taxes, on unemployment, when combined with a change in ICT. In other words we would like to see if changing those aspects, which have been found to have a negative effect on output, could improve the level of both foreign and internal public investment level, which in turn affect unemployment.

1.3 ICT SPENDING

As stressed in previous pages the aim of this work is trying to investigate more in deep what is, if any, the impact of ICT on unemployment, and how this impact could change depending on the institutional framework. We will now analyse more in depth this variable, starting from its description, ending with some expectation with respect to the impact that we could observe.

ICT spending is defined as an extended synonym for information technology (IT), but is a more specific term that stresses the role of unified communications and the integration of telecommunications (telephone lines and wireless signals), computers as well as necessary enterprise software, middleware, storage, and audio-visual systems, which enable users to access, store, transmit, and manipulate information. In post war years we observed an increasing flow of capital devoted to research in this field. As a matter of fact, nowadays, ICT spending represents one of the most important fields into the research

sector. Before taking into consideration the specific impact that ICT could have on unemployment, we should think about TFP. In the first chapter we underlined how Pissarides and Vallanti (2007) found evidence for a negative and significant impact of TFP growth on unemployment, thus if we could assume ICT as a determinant of TFP we could, in theory, expect a similar impact on unemployment rate. The basic idea is that research and development increase labour productivity, but its effect is not bounded to the labour sector, thus we could think as innovation as having some *spill over,* which are captured by the Total Productivity, thus TFP. More in deep it has been analysed how ICT could have effect on TFP by two channels: i) first of all spending on ICT would affect the productivity of the ICT sector itself. This could be easily seen through the technological progress, every single invention would affect subsequent innovation. As a matter of fact the concentration of innovation is based after the industrial revolution, and is increasing year by year. ii) ICT has also a direct effect on TFP by reducing inefficiency of the overall system. Let us just think at the impact of communication in reducing transaction costs, or in helping the matching process for supply and demand (Ebay)[13]. What we could assume then, is that the expected effect of ICT on TFP is positive (i.e. increasing ICT would increase TFP), thus we could assume that ICT has a similar effect of TFP on unemployment, as stressed by Pissarides (2007). We could now analyse briefly which could be the impact of ICT without the passage through TFP, in other words if we could expect an impact that is not grounded on researches on TFP. According to the work of Mabry and Sharplin (1986)[14], the effect of ICT on unemployment should be negative (i.e. it should reduce unemployment) in the long run. Nevertheless the two authors accepted the idea that ICT could lead to some unwanted effect in the short run: this is however due to human behaviour. Their view is that each

[13] This is the idea expressed by Rossi in her paper "l'impatto delle ICT sui fondamenti dell'economia: Produttività, Occupazione, Crescita", 2006

[14] "Does more technology creates unemployment?" R. H. Mabry, A. D. Sharplin, 1986

worker tries to act as a full economic agent, and then he tries to maximize his economic rent, which is defined as the difference between the value of his work and the salary that he receives. What the authors argued is that technology would erase any space for economic rent for some workers[15], which in turn would react by not accepting any job with a lower wage compared to before. This situation would imply a short-term unemployment, which is forced to disappear, in particular for those workers with high skills: they just need to realize that they could not anymore be rent seekers.

Apart from behavioural explanations, that however found some reasonability through data according to the authors, a last remark should be underlined: innovations and technologies are aimed at reducing human efforts, it has been so since the first technologies introductions, (e.g. the plow) thus leaving more leisure time to people. What the authors believes is that ICT spending will increase the availability of "machine replacing workers", and so they will allow people to spend less time working. According to their thought, even if not reflected in accounts measures, technology could just improve human living standards.

In the graph below we plot the evolution of R&D and TFP, where we assume R&D as a proxy for ICT investments. This sketch shows a positive correlation between the two variables, giving validity to the idea expressed above that ICT could have a positive impact on TFP[16].

[15] According to the authors the most affected class is that of manual workers, which saw their economic rent devaluated soon, due to the lack of specific skills in performing their task

[16] Data for the two variables are taken from the OECD database and the Penn world table 8.0. Both are weighted average for 7 EU countries: Austria, Belgium, France, Germany, Italy, Netherlands and Spain.

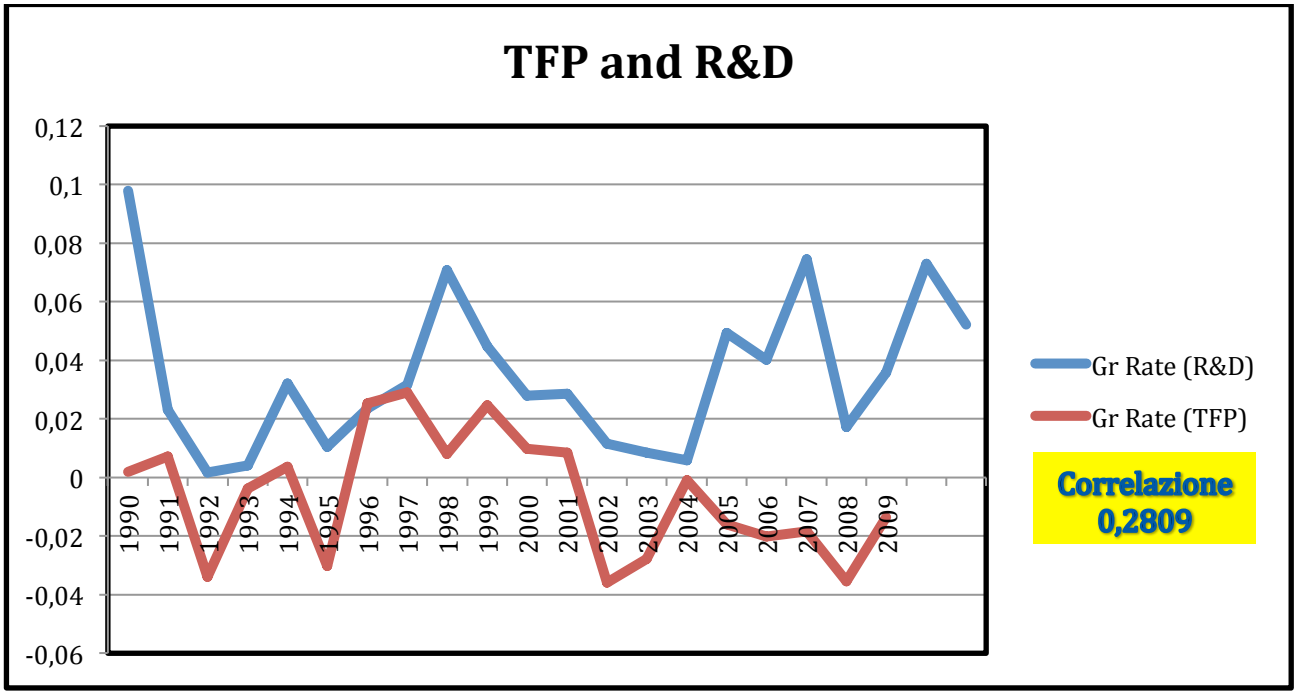


Figure 1. Estimation made by the author; relationship between TFP and R&D. Data taken from OECD dataset

Having seen from the graph above that a certain kind of correlation between R&D and TFP exists, we tried to have an empirical evidence of the relationship between ICT and Unemployment. To do so we took three different economies, France, Japan and United Kingdom, with different paths both for unemployment and ICT, and then see what was

the correlation. We could see graphically what the results have been: [17]

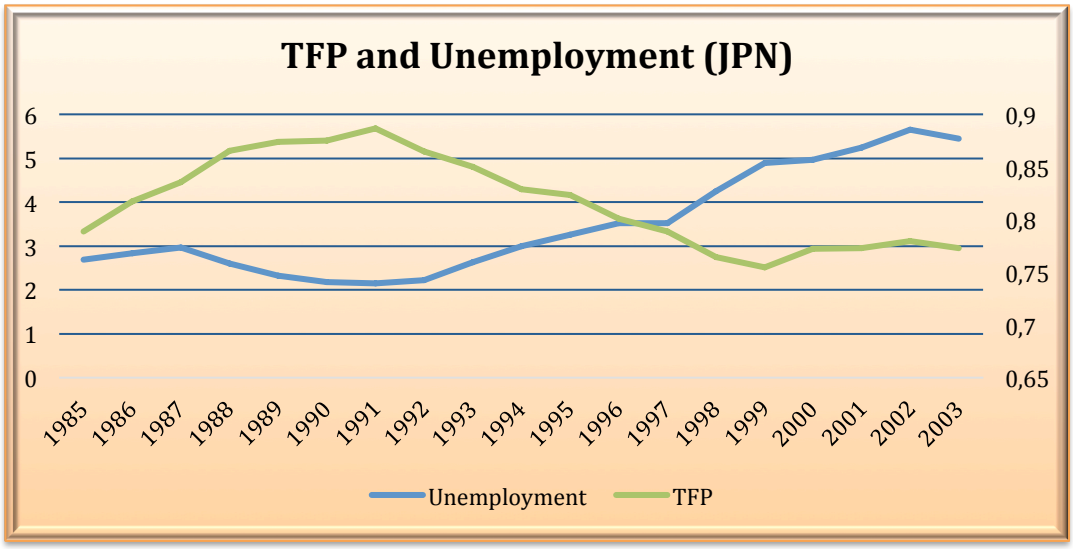


Figure 2. Estimation made by the author; relationship between the level of TFP and unemployment rate for Japan. Data taken from the Bassaini and Duval's dataset and the OECD one.

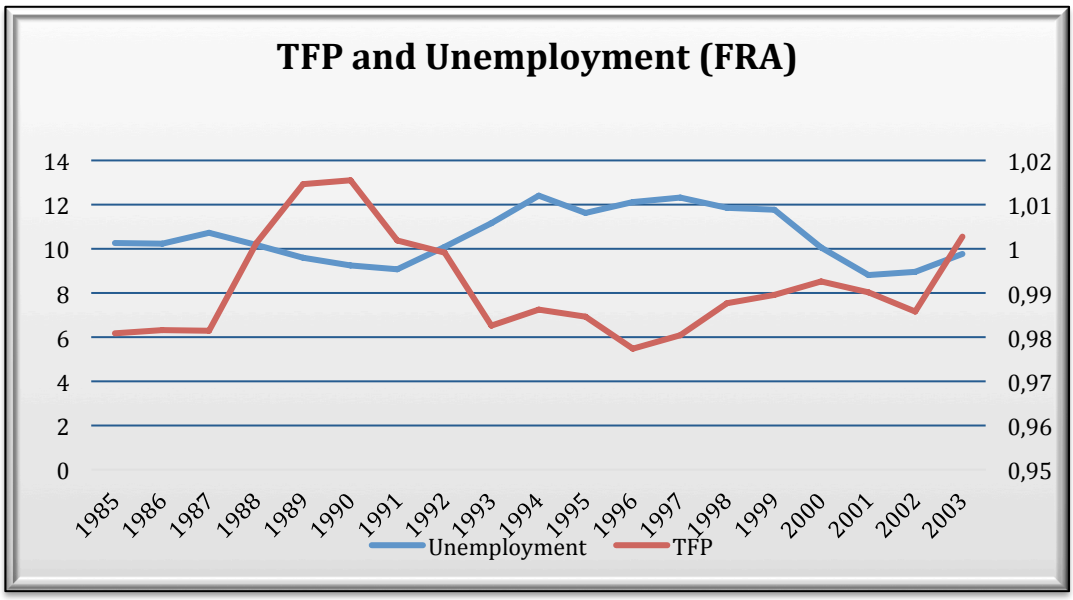


Figure 3. Estimation made by the author; relationship between the level of TFP and unemployment rate for France. Data taken from the Bassaini and Duval's dataset and the OECD one.

[17] For all the three graphs the right axis are referred to the level of TFP.

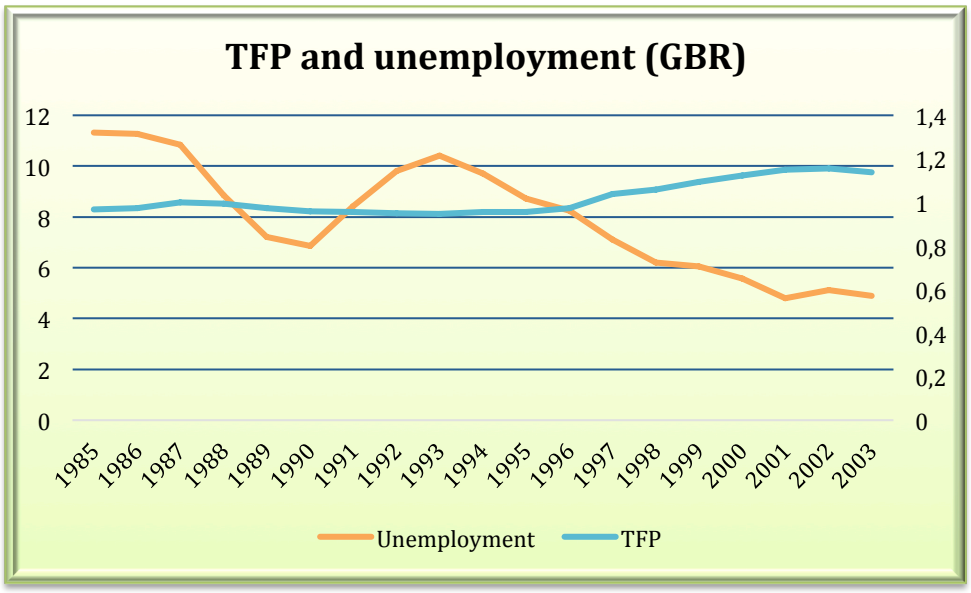


Figure 4. Estimation made by the author; relationship between the level of TFP and unemployment rate for United Kingdom. Data taken from the Bassaini and Duval's dataset and the OECD one.

For all the computation we ended up with the expected sign for the correlation, specifically for France we had a correlation of -0.57, for Japan -0.85 and for UK -0.81. This negative sign seemed to suggest empirically that the effect, for which we are looking for, is consistent, and thus an increase in ICT spending should be counterbalanced by a decline in unemployment rate.

2. MODEL DESCRIPTION

The aim of our research is trying to assess first of all the impact of ICT on unemployment, and then, based on this preliminary result, trying to see if this impact has any relation with the overall environment. In other words we would like to see if institutional variables could soft or amplify the effect. With respect to institutional variables we will consider two approaches: we will first look for direct impact, thus not allowing for interaction, while in a second moment we will remove this restriction, relying on the Bassanini and Duval's theory of a *reinforcing environment,* thus considering the overall institutional impact on ICT spending. In the next pages we will describe the econometric model, with a closer overlook at the explanatory variables and on their expected impact.

2.1 INSTITUTIONAL VARIABLES

Our first variable of interest is the *unemployment benefit*. The structure of unemployment benefits is not equal among European states; we could however define it as social welfare payments made by the state or other authorized bodies to unemployed people. Depending on the jurisdiction and the status of the person, those sums may be small, covering only basic needs, or may compensate the lost time proportionally to the previous earned salary. The precise effect of these payments is not clear: on one side they could have an adverse effect through two channels, basically the ones identified by Blanchard, namely high unemployment benefits could reduce the search intensity of a job by unemployed, moreover they could reduce the unemployment pressure on wage claims, thus increasing separations and reducing vacancies. This positive effect of unemployment

benefits on unemployment rate could be offset by a *positive productivity mechanism*: it means that job seekers have now more time to look for a job, precisely they could find the perfect job for their skills, thus subsequently reduce job separation and eventually increasing productivity. Even if theory allows for both positive and negative impact, empirical data suggests the former to be more significant compared to the latter.

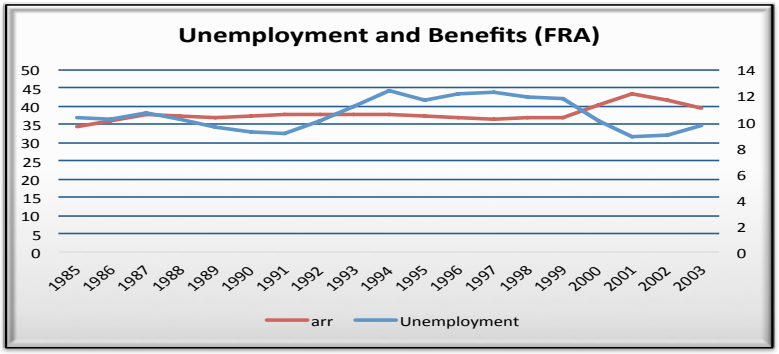


Figura 5. Estimation made by the author; relationship between unemployment benefits and unemployment rate for France. Data taken from the Bassaini and Duval's dataset and the OECD one.

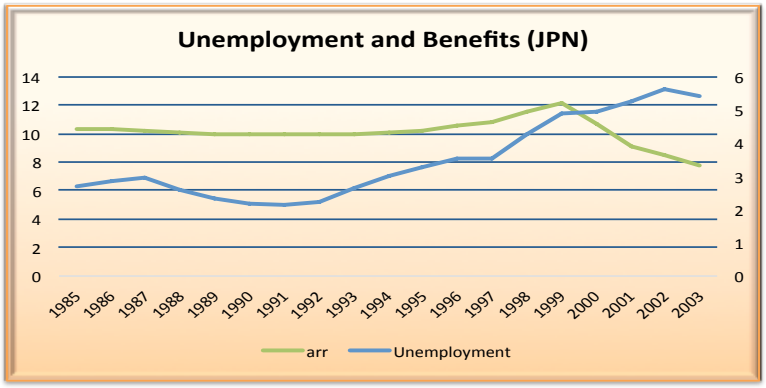


Figure 6. Estimation made by the author; relationship between unemployment benefits and unemployment rate for Japan. Data taken from the Bassaini and Duval's dataset and the OECD one

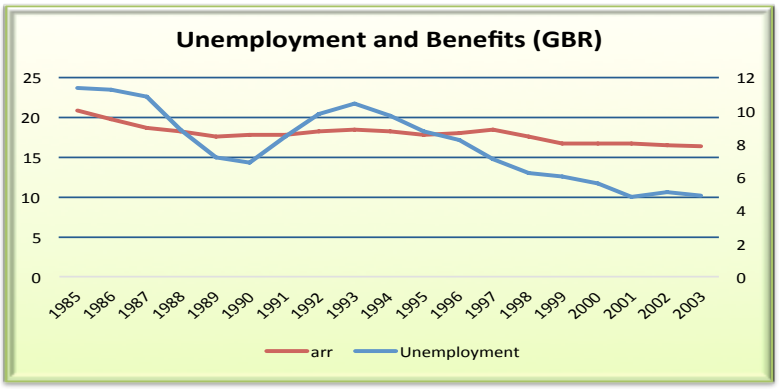


Figure 7. Estimation made by the author; relationship between unemployment benefits and unemployment rate for United Kingdom. Data taken from the Bassaini and Duval's dataset and the OECD one

In the graphs above, estimated as for ICT and Unemployment, for France, Japan and UK, which as said, expressed different characteristics, we could see triviality of the impact of unemployment benefits on unemployment rate. In particular we found a positive correlation in France (i.e. Unemployment benefits increase unemployment), while for Japan, and in particular for UK we find a negative effect[18].

The second variable analysed is *taxes*[19]. The theoretical analysis suggests that in a perfectly competitive labour market, with high degree of international mobility of capital, labour costs depend just on the real cost of capital and the level of technological progress. Based on these conditions, theory suggests that workers should bear the entire burden of taxes, with no change in the equilibrium level of unemployment. However these conditions do not necessarily hold, and so we could have an imperfect labour market, thus changing the bargaining position of employees and employers. Moreover in order to analyse the effect of a change in taxes on unemployment it should be considered how the effect of taxes on reservation wages is not equal to that on wages. Specifically the effect on the former should be lower than that on the latter, considering the fact that reservation wage is

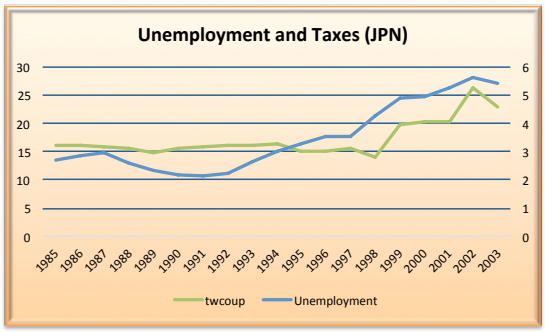
[18] For all the three graphs the right axis refers to unemployment rate
[19] Considered as payroll, consumption and income taxes

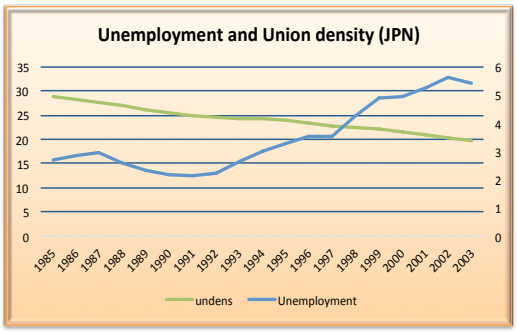
only partially affected by taxes, since it takes in consideration also other social welfare components which are less likely to be influenced by a change in taxes. The final idea is that changes in taxes affect positively unemployment. In conclusion it has to be noted how workers could bargain over net wages, since it could be assumed that they prefer high direct wage rather than social welfare benefits that could be financed by taxes. In this contest becomes relevant the impact of *union trade*, since a centralised system of union could bargain in a stronger position, putting upward pressure on wages, ending in a less strong effect of taxes. Concentring on *trade union* the analysis becomes more uncertain, and the expected impact of this variable on unemployment controversial. As for unemployment benefits we are faced with different mechanism affecting the final unemployment rate, but in this case the empirical evidence does not lead to a final conclusion. The starting point is the already expressed idea that strong union could be more able to bargain with firms, thus putting upward pressure on wages. However this pressure turns out to be positive[20] for those groups whose labour supply is less elastic. It implies that the ones who pay for this employment effect are youth, women and older workers. However the overall effect of unions depends not just on their relative power, rather that on the structure of collective bargaining. For instance a decentralised system has been taught as employment friendly, since it should be able to prevent excessive wage claim, which would end up with a negative effect on employment. Moreover a decentralised system is found to be helpful with respect to low skilled workers, since with a central system they could be priced out of the market. The counterbalance effect of centralised system is to facilitate the "social pacts", by which unions are able to get policy concession giving up some degree of wage demands. This framework lets us understand why the final effect is uncertain, and also why

[20]Here by positive impact we mean with respect to employment, thus a positive impact implies more employment.

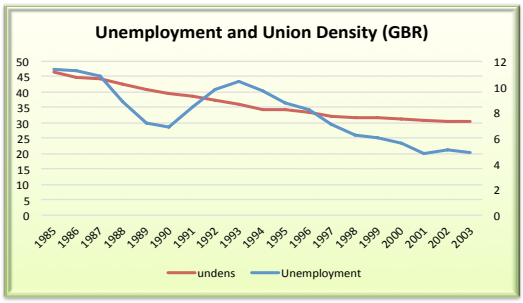
we could expect a different impact based not just on the specific characteristic of union trade, but, as suggested by Bassanini and Duval, on the overall institutional system.

In the graphs below we tried to find some empirical evidence of the stated effects of taxes and union density on unemployment. Our estimations found some degree of certainty for a negative impact of taxes on unemployment rate. In particular we estimated a positive and significant correlation for all the three economies. This empirical evidence seemed to suggest the idea of an imperfectly competitive labour market.

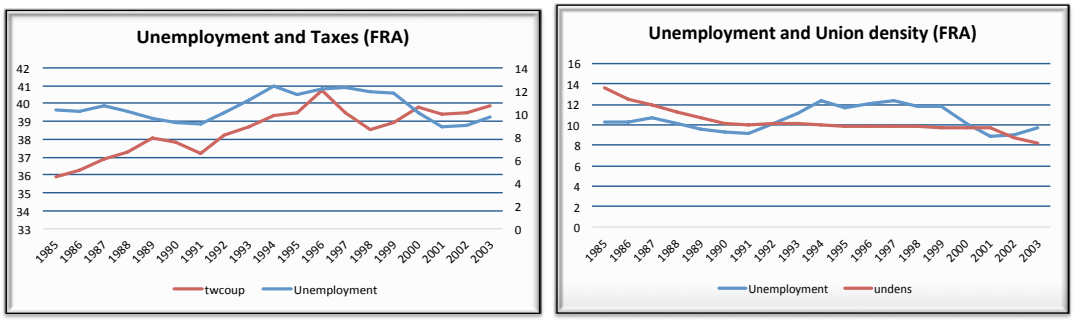




Figures 8 and 9. Estimation made by the author; relationship between taxes and unemployment rate (left), and Union density and unemployment rate (right) for Japan. Data taken from the Bassaini and Duval's dataset and the OECD one



Figures 10 and 11. Estimation made by the author; relationship between taxes and unemployment rate (left), and Union density and unemployment rate (right) for United kingdom. Data taken from the Bassaini and Duval's dataset and the OECD one



Figures 12 and 13. Estimation made by the author; relationship between taxes and unemployment rate (left), and Union density and unemployment rate (right) for France. Data taken from the Bassaini and Duval's dataset and the OECD one

With respect to trade unions and unemployment the evidence is trivial; indeed we found three different kinds of correlation, almost zero for France, high and positive for UK and finally high and negative for Japan. The final idea is that union density could not be analysed on its own, but it has to be considered with respect to overall economics environment.

Another important variable, which has been central into the recent Italian labour debate, is *employment protection legislation*. EPL describes all types of employment protection measures, whether grounded primarily in legislation, court rulings, collectively bargained conditions of employment or customary practice. Employment protection refers both to regulations concerning hiring and firing, but in our context we will focus more on the former regulation. The basic idea behind EPL is that firm is faced with high costs when dismissing a worker. These costs are however predicted by the firm, which in turn offer to workers lower wage. The problem that arises from this mismatch is the one underlined by Blanchard, the "insiders" one. The idea is that incumbent workers (insiders) have more power in bargaining compared to outsiders, thus they could ask for higher wage. This tension will end up in higher unemployment duration for unemployed, which in turn puts downward pressure on their reservation wages, eventually making them willing to accept

lower wages. However the counter effect of this tension is that now firms are less willing to dismiss a worker, thus reducing the turnover, and thus the unemployment rate. While it is not clear which effect predominates, if high duration or less spells, it could noticed that the insiders problem could negatively affect the productivity of workers, based on their power position. Another concern on EPL is that in presence of different degree of legislation for different class of workers a further tension would be originated between temporary workers and permanent ones, with the former bearing the cost of the insiders' bargaining power[21]. As we did for the other variables we tried to assess a kind of empirical evidence for the effect of EPL on unemployment[22]. Considered with respect to France, Japan and UK EPL seems to have a quite certain effect on unemployment rate:

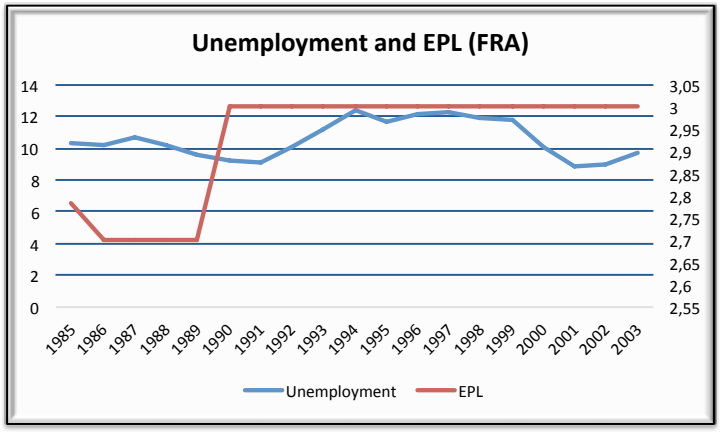


Figure 14. Estimation made by the author; relationship between employment protection legislation and unemployment rate for France. Data taken from the Bassaini and Duval's dataset and the OECD one

[21] Even if not central to our analysis, this idea, expressed by Bentolia and Dolado (1994), suggests that deregulating just temporary contracts would not favor labor market. Empirical evidence seems to support this vision.

[22] We still considered France, Japan and UK; for all the three graphs the right axis refers to EPL.

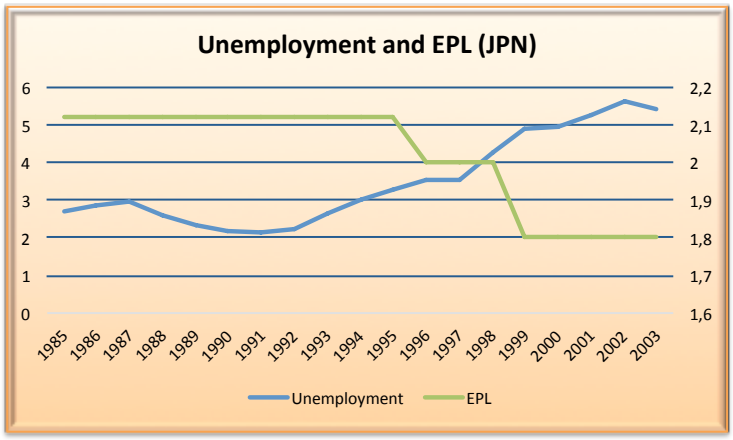


Figure 15. Estimation made by the author; relationship between employment protection legislation and unemployment rate for Japan. Data taken from the Bassaini and Duval's dataset and the OECD one

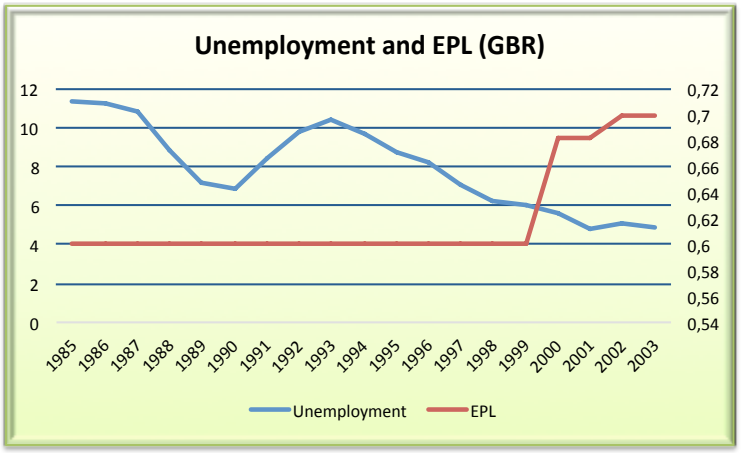


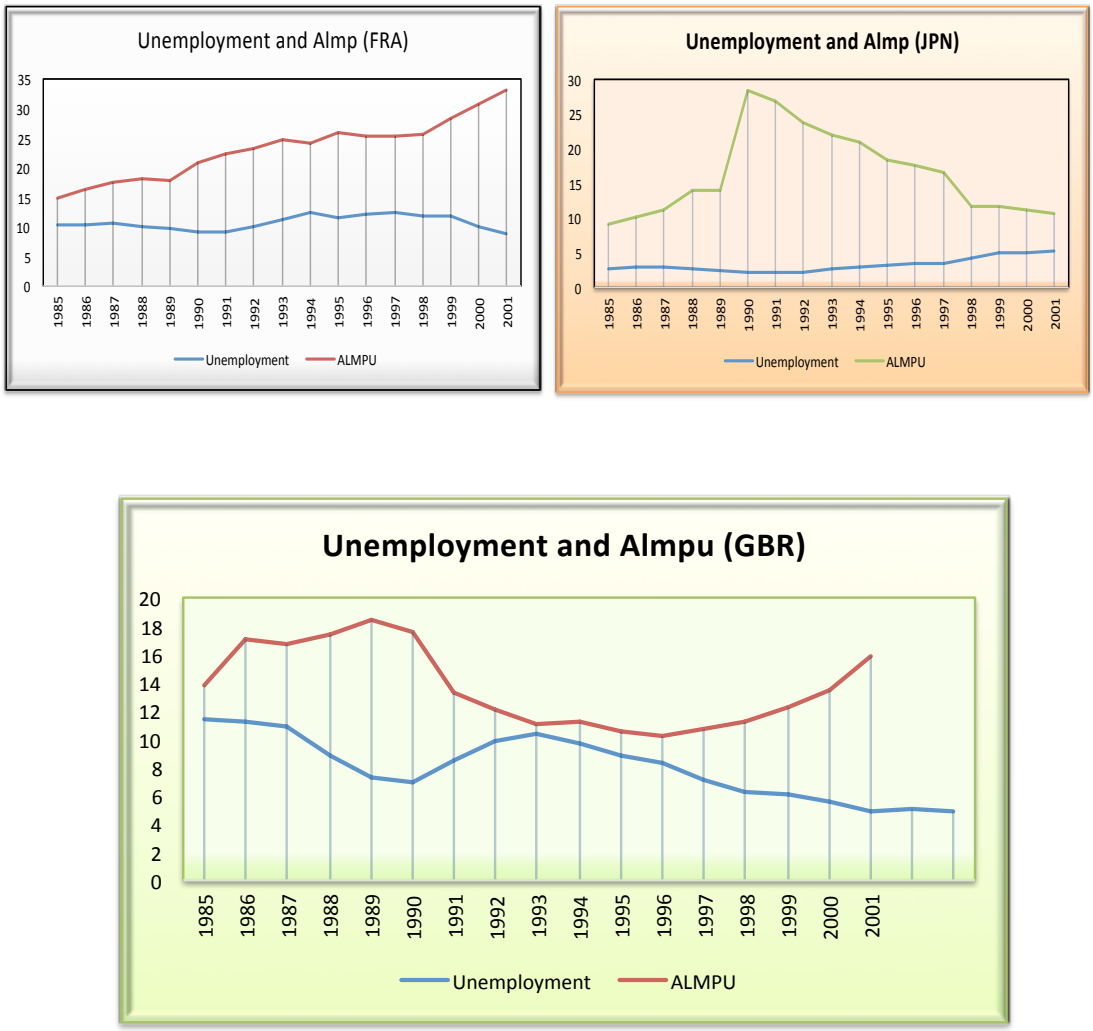
Figure 16. Estimation made by the author; relationship between employment protection legislation and unemployment rate for France. Data taken from the Bassaini and Duval's dataset and the OECD one

Indeed what we found was a degree of correlation almost null for France, while it is high and negative for UK and Japan. According to the empirical evidence, between the two impacts (positive and negative), is the negative one that predominates on the unemployment rate.

A last remark has to be done concerning *Active Labour Market policies;* these are government programmes that intervene in the labour market to help the unemployed find work. While their singular impact has been found to be negatively associated with

unemployment, it may not be effective if taking in consideration with respect to EPL. The idea is that the job creation process of ALMPs could be offset by strict EPL, since it reduces turnover and in turn the probability to find a job. Focusing on ALMPs is important to underline how, even in presence on a negative effect on unemployment rate, the net effect should be considered against the cost of these policies, mainly the taxes but also the dead-weight loss that these policies could generate. Empirical evidence found a general negative effect for ALMPs, but does not found an agreed magnitude of this effect[23].
As we did before, we tried again to estimate a graphic relation between unemployment and ALMPs. Even if it's again just a sketch of the real situation, and so it's not useful to derive final conclusions, it's interesting to notice some empirical evidence: as it has been for the others variables no clear effect has turned out. Indeed we found a null correlation for UK, while a positive and low effect in France and a negative and quite high effect for Japan. This result seemed to confirm the idea that ALMPs do not have a defined effect, and thus it has to be evaluated with respect to the specific country.
In conclusion the idea of a self reinforcing effect of institutional settings is confirmed for almost all the variables, where controversial effects have been identified, leading to the reasonable idea that is the interaction of all the institutions that determines the final result on unemployment rate (Bassanini and Duval, 2006).

[23] This is the view of economists like Scarpetta, Nickell and Layard



Figures 17 18 and 19. Estimation made by the author; relationship between active labour market policies and unemployment rate for France (up left), Japan (up right) and United Kingdom (bottom). Data taken from the Bassaini and Duval's dataset and the OECD one

2.2 DATA DESCRIPTION

We will now have an overlook about the data we are going to use. The final dataset has been constructed from the Bassanini and Duval one, plus other data obtained from the OECD databank. In particular for what it concerns ICT we found the value of investment in ICT as a percentage of Gross Fixed Capital Formation. In the table below we could have a first glance of the main characteristics of data, where *urt1564* is unemployment rate, *inICT* is the percentage of investment in ICT with respect to GFCF, *epl* is employment protection legislation, *undens* union density, *arr* is a variable for unemployment benefits and *twcoup* for income taxes.

	Median	Mean	Var	Std.dev
urt1564	7.02	7.67	17.22	4.15
inICT	14.91	16.11	33.44	5.78
epl	2.20	2.06	1.15	1.07
undens	34.05	38.95	430.20	20.74
arr	29.64	30.29	153.32	12.38
twcoup	28.00	28.69	78.83	8.88

Table 1. Estimation made by the author. Descriptive values of variables present into the final dataset

Some preliminary considerations about data could be done about unemployment: as it is possible to see in the chart above, the value for the variance of unemployment is remarkably high, thus giving the idea of an heterogeneous dataset with respect to this variable. However it is easy to see that heterogeneity of the dataset is confirmed by the value of all variances.

Further, how it is possible to see in the graph below, we had a closer look about the unemployment rate trend among the countries in the dataset, and we found an empirical trend's difference: indeed it is possible to underline two main path in the unemployment trends, which have been, more or less, common to all countries in the dataset.

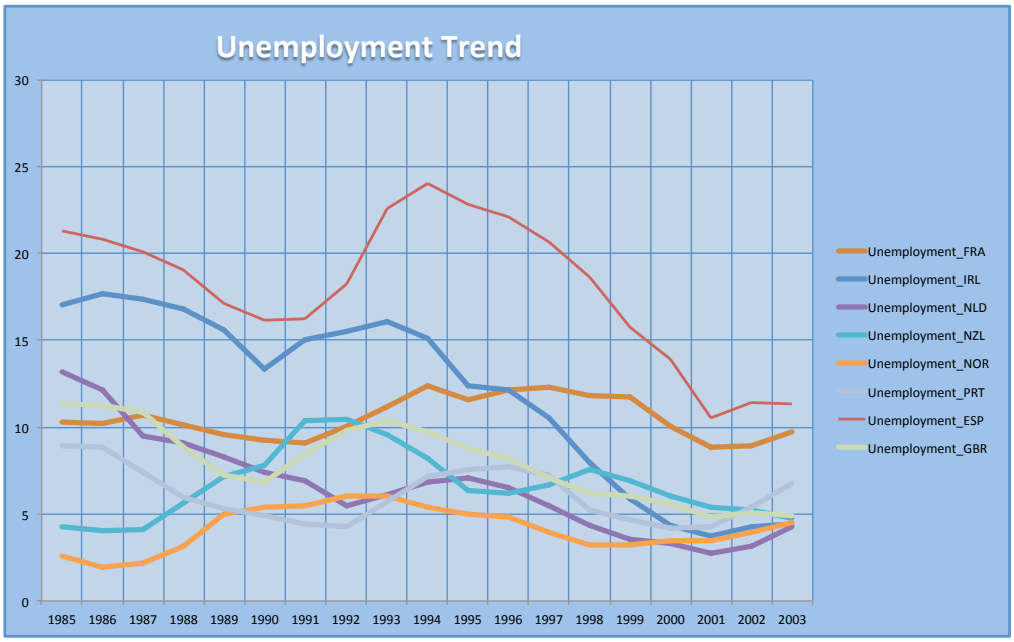


figure 20. Estimation made by the author. Unemployment trend for France, Ireland, Netherland, New Zealand, Norway, Portugal, Spain and United Kingdom. Data taken from Bassanini and Duval's dataset.

Indeed, isolating from the outliers Spain and New Zealand (the dark blue and red lines in the graph) it is possible to see how unemployment rate tended to rise until a peak reached among the years 1993-1994. After those years we observed in fact a declining trend, which brought almost all unemployment around a 5% rate. Based on this observation we decided to split our dataset in two parts and look at descriptive values for the variables. The first table, which is the one below, has been estimated for all the countries in the dataset, for a period of time that starts in 1985 and ends in 1993.

	urt1564		arr		twcoup		epl		undens		almpu		inlCT	
	mean	st. dev	mean	st.dev	mean	st.dev	mean	st.dev	mean	st.dev	mean	st.dev	mean	st.dev
Australia	8,3	1,7	25,2	1,3	15,4	1,3	0,9	0,0	41,5	2,7	10,0	2,5	15,9	2,5
Austria	3,5	0,4	29,1	1,3	24,8	1,0	2,2	0,0	47,6	2,9	18,9	2,5	9,6	0,6
Belgium	9,1	2,0	42,0	0,9	37,8	2,1	3,2	0,0	53,0	1,4	29,0	3,0	13,4	2,0
Canada	9,6	1,5	19,3	0,0	17,4	2,0	0,8	0,0	33,3	0,9	12,1	0,7	13,5	0,3
Denmark	8,1	1,6	51,4	1,0	34,1	2,5	2,3	0,0	76,0	1,4	29,7	5,2	18,9	1,9
Finland	5,6	2,8	36,0	1,8	35,1	1,5	2,3	0,1	72,3	2,5	42,3	11,9	13,9	1,3
France	10,1	0,7	36,9	1,1	37,4	0,9	2,8	0,2	11,2	1,3	19,5	3,4	14,0	1,0
Germany	6,1	0,8	28,0	0,4	33,5	0,7	3,2	0,0	33,6	1,4	35,3	10,7	13,9	1,7
Ireland	16,1	1,4	29,0	1,1	29,9	0,6	0,9	0,0	51,3	1,2	23,7	2,0	12,4	0,9
Italy	11,4	0,8	4,1	5,5	42,8	1,3	3,6	0,0	39,7	1,2	4,5	1,4	16,9	2,1
Japan	2,5	0,3	10,1	0,2	15,8	0,4	2,1	0,0	26,3	1,7	17,7	7,6	13,2	9,9
Netherlands	8,7	2,6	54,3	1,2	39,3	2,1	2,7	0,0	25,9	1,3	38,5	8,3	11,2	1,3
New Zeland	8,7	2,7	54,3	1,0	39,3	2,7	2,7	0,0	25,9	8,1	38,5	11,8	11,2	2,2
Norway	4,2	1,7	38,8	0,0	26,9	2,0	2,9	0,0	57,4	1,0	35,9	7,4	13,9	1,2
Portugal	6,2	1,8	31,0	4,5	27,9	2,5	4,1	0,2	39,4	10,0	23,9	2,9	17,6	2,6
Spain	19,1	2,3	33,5	0,9	32,6	0,9	3,8	0,0	11,8	3,6	9,1	2,9	17,6	3,1
Sweden	2,8	1,4	29,0	0,5	42,2	3,1	3,5	0,0	81,4	1,1	148,8	27,5	24,2	2,1
United Kingdor	9,4	1,7	18,5	1,0	25,0	0,9	0,6	0,0	41,1	3,6	15,2	2,7		

Table 2. Estimation made by the author, descriptive values for variables present into the final dataset for the time period 1985-1993

From the graph is it possible to see how in this period Spain and Ireland accounted for almost all of the high value of unemployment. Interesting it is possible to note a positive correlation between *undens* and *arr* , specifically the union density and the unemployment benefits, consistent with the idea expressed above that the latter is highly determined by the former. We then estimated the same values, for the same countries, but in the second period, namely from 1993 to 2003.

	urt1564		arr		twcoup		epl		undens		almpu		inlCT	
	mean	st. dev	mean	st. dev	mean	st. dev	mean	st. dev	mean	st. dev	mean	st. dev	mean	st. dev
Australia	7,35	1,23	25,31	1,57	15,72	1,87	1,14	0,13	27,64	4,26	14,49	2,46	20,42	1,81
Austria	6,52	0,30	36,82	0,96	32,31	1,38	2,69	0,09	45,52	2,52	26,45	4,11	13,11	1,40
Belgium	8,32	1,32	39,52	1,07	40,20	0,84	2,50	0,48	55,57	0,41	27,73	2,80	18,62	1,43
Canada	8,44	1,20	16,18	1,73	22,21	1,00	0,80	0,00	29,91	2,85	11,12	0,77	15,31	1,62
Denmark	5,61	1,30	57,87	5,89	30,67	0,48	1,49	0,28	75,72	1,45	56,66	8,71	20,36	1,27
Finland	10,00	2,89	10,97	1,06	38,68	1,49	39,50	0,06	3,00	0,94	9,52	1,99		
France	10,97	1,42	38,68	2,39	39,50	0,59	3,00	0,00	9,52	0,59	28,62	3,95	6,52	4,19
Germany	8,72	0,67	26,72	0,67	34,42	1,63	2,60	0,31	25,61	2,50	30,79	2,71		
Ireland	8,08	4,15	31,29	4,23	19,10	7,72	0,92	0,06	41,56	4,70	47,43	14,97	15,35	3,24
Italy	10,76	1,19	27,07	7,78	39,36	3,95	2,82	0,66	35,98	1,65	11,58	3,45	23,13	3,97
Japan	4,37	0,98	10,12	1,34	18,56	3,99	1,92	0,14	22,15	1,54	13,86	4,02	9,50	2,25
Netherlands	4,72	1,64	52,37	0,24	34,04	1,05	2,40	0,32	24,05	1,41	82,81	32,24	13,52	0,87
New Zeland	6,34	1,64	28,04	0,24	18,11	1,05	1,14	0,32	24,00	1,41	20,64	32,24	11,32	0,87
Norway	4,07	0,79	40,23	1,77	25,60	1,41	2,69	0,09	55,43	1,42	46,86	4,59	16,72	1,76
Portugal	6,02	1,44	39,04	3,61	25,73	1,39	3,73	0,05	24,23	0,74	28,45	4,74	21,64	2,58
Spain	17,13	5,18	37,12	1,67	32,20	1,41	3,02	0,11	15,04	1,34	10,83	5,53	25,00	4,05
Sweden	7,67	2,07	37,12	1,52	42,49	2,08	2,28	0,13	80,68	2,27	50,14	6,28		
United Kingdc	6,64	1,74	17,23	0,79	22,38	3,55	0,64	0,05	31,93	1,41	12,66	2,27		

Table 3. Estimation made by the author, descriptive values for variables present into the final dataset for the time period 1993- 2003

What we could see is that apart from Spain, now the unemployment rate is quite stable for all the countries, and that positive correlation between *arr* and *undens* persisted over all the periods. These tables also helped us to get an insight about the change in investment in ICT, with an increase in all the mean values for the variable *inICT*.

This separation will help us, after having the results from the regressions, to assess a more specific impact of ICT on unemployment. Moreover it will be useful to analyse the residual between the estimated effect and the effective one.

ECONOMETRIC ANALYSIS

3.1 REGRESSIONS' RESULTS

We started our econometric analysis by a simple regression, where the dependent variable is the unemployment rate and the independent one is the investment in the ICT sector. The dataset we used for this and for all subsequent variables it's a balanced panel data, with four institutional variables and three shock variables. Data have been taken for 16 countries along a time space of 17 years. Namely our variables of interest are: *undens,* which measures the percentage of union density in the labour market; *twcoup,* which is the variable for the tax wedge, measured as percentage of income; *epl,* is the variable describing the employment protection legislation and finally *arr,* which is average unemployment benefits, and it is also described as a percentage. Variables describing for shocks are *ltfpshock (*TFP shock*), rintshcok1 (*real interest rate shock*) and ldshock (*labour demand shock*).* Finally we have the dependent variable *urt1564,* which is the unemployment rate, and our variable of interest, *inICT,* the investment in ICT, described as percentage of Gross Fixed Capital Formation (GFCF). In all of our regression we used to control for time and country specific effect. Thus our starting equation is:

$$U_{it} = \beta_0 + \beta_{inICT} inICT + \sum \beta_i * X_i + \varepsilon_{it}$$ [24]

Results for all the regressions are reported in the table below.

[24] in the expression above the specification "i" is for the specific institutional variable used and the shocks considered.

Variables\Equation	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
inICT	-0,12	-0,08	0,10	-0,14	-0,14	0,06	-0,08	-0,16
	(-3,603)	(-2,495)	(-1,729)	(-1,729)	(-1,913)	1,88	(-1,495)	(-1,765)
epl		-0,13	-0,20	-0,43	-0,20	-0,60	-0,25	-2,18
		(-0,295)	(-0,704)	(-0,704)	(-0,509)	(-1,283)	(-0,568)	(-2,745)
undens		-0,03	-0,04	-0,04	-0,06	-0,04	-0,04	-0,09
		(-1,109)	(-1,394)	(-1,394)	(-1,320)	(-1,352)	(-1,361)	(-1,789)
twcoup		0,38	0,34	0,34	0,34	0,43	0,34	0,55
		[9,776]	(8,369)	(8,369)	(8,618)	(7,518)	(8,396)	(7,184)
arr		0,10	0,10	0,10	0,10	0,09	0,11	0,02
		(-3,932)	(4,106)	(4,106)	(4,113)	(3,816)	(2,641)	(0,379)
ltfpshock			-23,22	-23,35	-23,56	-21,51	-0,23	-22,10
			(-5,068)	(-5,068)	(-5,078)	(-4,488)	(-4,898)	(-4,727)
rintshock1			0,16	0,16	0,16	0,16	0,16	0,16
			(1,983)	(1,983)	(1,913)	(1,864)	(1,938)	(2,007)
ldshock			-3,09	290539,00	-3,75	-2,72	-3,25	-1,39
			(-1,005)	(-1,005)	(-1,228)	(-0,942)	(-1,069)	(-0,51)
inICTepl_				0,02				0,10
				(0,439)				(2,359)
inICTundens_					0,00177			0,00308
					(0,797)			(1,421)
inICTtwcoup_						-0,0059		-0,0144
						(-2,131)		(-3,618)
inICTarr_							-0,00083	0,00465
							(-0,394)	(1,679)
Serial Correlation								
R-squared	0,8287	0,8776	0,8914	0,8914	0,8917	0,8929	0,8914	0,8962
Years	16	16	16	16	16	16	16	16
Countries	17	17	17	17	17	17	17	17

Table 4. Estimation made by the author; results for all the regressions made.

As said we first regress unemployment on investment in ICT. Results, as it is possible to see in the table above [1], are quite good: first of all we ended up with the sign which we expected for the *inICT* coefficient, namely a minus, which implies a negative impact of ICT on unemployment. Surprisingly results have been found to be statistically significant (z value = -3.603), with a high value for the R-squared (0.8287). However this first regression is not more than a simple estimation of the correlation between ICT and unemployment rate, controlled for time and country effect. Nevertheless these results have been in line with our theoretical estimation, thus leading to further regressions, controlling for the explanatory variables stated above.

We obtained another positive result [2], since by adding the four institutional variables we ended up with the same negative sign for ICT, without loosing significance in the estimation and a higher value for the R-squared. Results are still reported in the table

above, where a one-percentage change in in ICT is associated with a negative change in unemployment of .07%.

After the observation of the institutional variables, we decided to control for the effect of shocks [3]. In this chapter we will report just the final regression, with all the three variables included. We however tested the singular impact of each shock on ICT in separate regressions, and we found in all of them significant results with the expected sign for the coefficient of ICT. Among these regressions ICT assumed the highest value when considered just with labour demand shock. Adding the three variables [4] in the regression with institutional ones, lead us to the following results: as it is possible to see from the table ICT is again significant, with a negative sign and furthermore it is associated with a high value of R-squared (0.8913).

At this point we got a clear result of the possible impact of ICT on unemployment. Remarkably, it has to be noted that the previous estimations seem to find a good proof in past trends: in almost all the regression Sweden has been found to be the country where the effect of ICT on unemployment could have the greatest impact. This is in line with the technological trend of the Swedish economics, which is the most advanced among European countries. Then we decided to go further, and as expressed in previous chapter, we followed the idea of Blanchard (2000), i.e. the idea that the relation between the dependent and independent variables is not linear, thus depending on the interaction between the explanatory variables. We then constructed a model that took in consideration the interaction between variables, and we run several regressions, firstly considering the impact of this interaction one by one (again introducing in the equation variables for both institutions and shocks), and then, the final one, which included all the interaction terms.

The econometric means of this analysis is the idea that the effect of a change of ICT on unemployment depends on the value of (for example) union density, and, conversely, that the effect of a change in union density depends on ICT. In the last equation tested all these interaction effects are considered. Specifically the equation took this form:

$$U_{it} = \beta_0 + \beta_{inICT} inICT + \sum \beta_i * X_i + \sum \beta_i * (inICT * X_i) + \varepsilon_{it}$$

The preliminary results showed us that among the four interactions, introduced one at time, the greatest and desirable effect is the one made by taxes. In the table above [7] we could see how the sign of the interaction term is negative, thus increasing the negative effect on unemployment, and remarkably both the coefficients (inICT and inICTtwcoup) are significant. Again the value for the R-squared is notably high (0.8929).

As said before our last regression took in consideration the combined effect of all the possible interactions between institutional variables [8]. Not surprisingly the greatest impact is given by the taxes interaction that again expressed a negative impact on unemployment. Contrarily, the effect of the interaction between ICT and epl, which was positive but small and not significant in the regression when considered on its own, it is now high (i.e. it has a positive effect on unemployment) and significant. This regression seems to confirm the idea expressed in the previous chapter that a positive change in taxes, even if encompassing social security benefits and other welfare benefits, have a positive (it increases) effect on unemployment. Also the interactions between ICT and unemployment benefits and union density have been found to be positive and significant, even if small.

3.2 CALIBRATION OF RESULTS

In this section we will try to have an empirical test of our results. Basically we will see if our estimated effect of a change in ICT has a result similar to the effective one. To do so we recalled the time division that we have made before, namely the period between 1985 and 1993 and between 1993 and 2003.

Country\Variables	ΔinICT	Δurt1564(Exp)	Δurt1564(Eff)
Italy	-0,509	0,061	-0,042
Japan	-2,439	0,293	-0,006
Spain	-0,790	0,095	0,146

Table 5. Estimation made by the author. Comparing results for Italy, Japan and Spain for the time period 1985-1993

This table refers to the first period. We took three countries as benchmark, namely Italy, Japan and Spain. We chose these countries because of their specific paths, with respect both to Unemployment and to ICT spending. Specifically we had all countries that reduced their ICT spending, but theirs starting points were quite different: Japan had the highest ICT level, while Italy and Spain had a lower one. On the other side Japan had a starting low rate of unemployment while Spain had a particular high one.

Results told us that with respect to this time period estimation are not reliable since only for Spain we obtained an expected change with the same sign of the effective one. Nevertheless the effective change is remarkably high compared to the expected one.
We then decided to consider the entire period, so to look at changes from 1985 to 2003. Results are reported in the following tables.

Country\Variables	ΔinICT	Δurt1564(Exp)	Δurt1564(Eff)
Italy	0,529	-0,063	-0,094
Japan	-0,944	0,113	0,153
Spain	0,445	-0,053	-0,551

Table 6. Estimation made by the author. Comparing results for Italy, Japan and Spain for the time period 1993-2003

It is easy to see, from the table above, how the latter results work better in estimating the final effect of a change in ICT on Unemployment rate. Namely we have that all the expected changes have the same sign of the effective ones and, more important, also quite similar. The reason of the lack of reliability of the first estimation with respect to the second could be due to the fact that there is a time lag between the change of ICT and the effect on unemployment rate.

CONCLUSIONS

The starting point of our analysis was trying to assess if there was an impact of ICT investments on unemployment, and if so, if there was a combined effect with respect to the institutional framework. We started by looking at the simple correlation coefficient between unemployment and some explanatory variables like *taxes, epl and union density*, finding some evidence for a negative impact of these variables on unemployment. We then took in consideration the relationship between ICT and unemployment starting from the research of Pissarides and Vallanti (2007) that found how, under some assumptions, TFP could negatively affect unemployment (i.e. it could reduce it), and that ICT could be seen as a proxy of TFP. We then run several regressions trying to define clear effects of ICT on unemployment. What we reached in conclusion is that a change in ICT has been found to negatively affect unemployment. This result was significant and moreover it persisted over all the set of regressions. Adding institutional variables to the equation lead to better estimation of the connection between the two variables of interest, specifically we found how all the institutional variables affected in the expected way the unemployment rate, and that the results obtained have been significant. Eventually, based on the idea of a non-linear effect of ICT on unemployment, we analysed the effect of the interaction between ICT and the institutional variables, finding consistent results in particular for the combined effect of *taxes* and *epl* on unemployment. All the regression have been run using a balanced panel data for 17 years and 16 countries, and all the regressions have been fixed for time and country effect.

The limits of our analysis could be found into low value of variables used into the regressions (4), and on the similarity of characteristics among the countries took in

consideration. For these reasons a further step in the research could be to enlarge the dataset, thus considering also those states where the starting level of technology is lower, and where the institutional characteristics are much different from those observed in this analysis.

With respect to the significance of the results estimated we referred to the estimation made at the end of the third chapter, where we found how: i) effects of a change in ICT needs time to be tangible; ii) there is a part of the final change in unemployment that should be addressed to other factors. As explained when we described the data, *inICT* was a variable describing the investment in ICT as a percentage of Fixed Gross Capital Formation (FGCF). Accounting balance showed how the percentage of FGCF to GDP varied in last years, and basically it dropped for all the observed countries. With respect to the countries considered in describing the results, we have how FGCF declines in Italy from 20% to 18%, in Japan from 22% to 20% and in Spain from 24% to 19%. If we considered that, in the most investing countries in ICT (Sweden), the value of technological spending was around 24%, and that in Sweden FGCF did not decline, on the contrary it increased over time, and that its actual unemployment rate is around the 8%, we could understand how the impact of ICT should not be under considered, both by investors and central government.

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