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Abstract

In this article we use the unification of Germany in the 1990 to test the hypothesis that the increase of the supply of a production factor generates skill biased technical change. We test for this mechanism in the context of the Acemoglu and Autor (2011) model that allows for endogenous assignment of skills to tasks in the economy. We use cohorts of workers from comparable countries as a control groups.

After discussing the possible confounding factors, we conclude for the absence of this effect. The differential pattern among the countries seems to be determined by labor market flexibilization and tax reform, which had a pure inequality enhancing effect.

Keywords: Polarization, Skilled Biased Technological Change, Demand Pull

JEL Classification: J31, O33, O52

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1. Introduction

After more than twenty years in which Skill Biased Technical Change (SBTC) has raised an intense debate through a sizable strand of literature, we believe that a basic question has remained unsolved, i.e. the one concerning its main determinant. Why did it happen that from the 1970s onwards, technical change has followed a precise direction, tending to systematically favor certain production factors?

In the literature the issue has been addressed at a theoretical level and with some indirect evidence. However, to the best of our knowledge there is no empirical paper trying to identify any of the proposed mechanisms put forth by the theory.

The aim of this paper is to address this empirical issue. At the present stage of the debate, we have now a good workhorse to account for the basic stylized facts in terms of demand and supply of skills: this model is presented in Acemoglu and Autor (2011). By addressing together the allocation of skills and tasks, it is able to fit most of the main trends in terms of change of occupational structure and wage differentials in the US labor market.

However, the picture should be completed with an account of endogenous technological change. Since the hypothesis of a steady process of SBTC is not consistent with both the more recent post IIWW trends, because of the post 1970s breakthrough (Acemoglu, 2002) and the history of industrialization (Mokyr, 1993), we need a theory of directed technical change. In our opinion, the hypotheses can be only two: *demand pull* and *technology push*. The former puts forth a causal mechanism that goes as follows: a machine is relatively more productive if associated with a certain type of workers; machines are invented by forward-looking firms; if there is an increase in the supply of skill A in the labor market, then firms will develop machines that complement skill A (Acemoglu, 2007).[2] The technology push argument stresses the uneven evolution of technology and its paradigm-based nature: every cluster of new innovations shares certain properties, and the ICT revolution has a SBTC characteristic (Aghion, 2002).

While there is some indirect evidence for both theories, they both lack an empirical assessment. Indeed, it is very difficult to identify the causality link in both cases: besides cross-countries regressions (preliminary by definition) the only possible way is to look for some natural experiment.

In fact our strategy is to use an historical episode, namely the unification of Germany in 1990. As common to other former planned economies, Easter Germany had a good education system, with high enrollment rates and a focus on engineering and hard sciences (Berryman, 2000). In 1990, a large inflow of highly educated workers entered the labor market and if the *demand pull* hypothesis holds, we should expect an increase of SBTC, resulting into a polarization effect in the Acemoglu and Autor (2011) framework. Since the law of unique price for skill applies, we should expect to observe the effect when we restrict the analysis to

[2] In this framework, the term demand pull is borrowed from Schmookler (1966). In the latter, the reference is to the role of demand in the introduction of innovation. In this case, the downstream firms who employ the new skills represent the pool of consumers for the new machines; from this fact it is derived the analogy.

Western Germany only, avoiding the inclusion of measurement error induced by the dramatic changes that were occurring in the East part. As a control group, we will use the cohorts in the labor market in comparable countries.

With regards to the general trends, we show that there is some evidence of a polarization in the labor market, but the process started much later than in the US. Coming to the main interest of the paper, we do not find any statistically significant demand pull SBTC effect. After considering the other forces at work, we conjecture that the reforms in labor market and tax legislation played the main role in explaining the differential behavior of earning, with an inequality enhancing effect.

This paper proceeds as follows: Section 2 introduce the issue at stake and the theoretical hypothesis; Section 3 presents the data and the methodology; Section 4 discusses at length the robustness of the results; finally Section 5 concludes.

2. The Framework

2.1 From the canonical model to the Ricardian Model

The SBTC hypothesis originated in the 1990s, due to the mounting interest to explain the increase in the college premium, in an historical conjuncture in which the relative supply of college educated was sharply rising. The logic of the argument was quite simple: if both price and supply increase, it should be that demand increased as well.

If the production possibility frontier can be summarized by an aggregate CES function, then in a competitive market the marginal rate of transformation - and thus the skill premium in the labor market- has the following expression:

$$\log MRT = \rho \log(A_s / A_u) + (1-\rho)\log(U/S) \quad (1)$$

where *u* indicate unskilled, *s* skilled and the *A* is a technical progress term, in an augmenting form. As can be seen there is a race between education and technology (Tinberger, 1975), which explains the observed skill premium.

The skill bias nature of technology in recent years has been addressed by multiple contributions that tried to identify at micro, meso and cross-country level the effects of some proxy of innovation on the relative demand of skilled, sometimes expressed as white collars over blue collars, sometimes as higher educated over lower educated (Acemoglu, 2002; Chennels and Van Reenen, 2002). This literature is quite heterogeneous and an evaluation is beyond the scope of this paper, but we can tentatively conclude that most of the evidence is in favor of a positive answer to this question.

A more complicate issue is the capacity of this theory to fit data. After discussing at length the existing literature, Autor et al. (2006) and Acemoglu and Autor (2011) conclude with a negative answer. In fact, this basic version raises three puzzles. Since technical change occurs in an augmenting form, it can never generate replacement of skills and thus decreasing wages at any percentile of the distribution (a well-known stylized fact in the US). Moreover, it cannot explain the change in the occupational structure, biased against "middle class" jobs. Finally, it cannot generate polarization in the long run: another stylized fact is indeed the increase of relative wages at both the top and the bottom of the distribution together with a decrease in the middle.

Autor et al. (2003) and Autor and Dorn (2009) made the case for a theory of the labor market able to account for the replacement of the middle class jobs: technical change (or trade, or offshoring) is hitting those "routine jobs" that can easily be replaced by machines (or externalized), favoring instead those jobs that cannot be outsourced (manual jobs) or tend to "complement" the technology (abstract jobs).

Such a model is labeled Ricardian and is presented and discussed in Acemoglu and Autor (2011), building upon Acemoglu and Zilibotti (2001). In this model, there is a continuum of tasks of mass one that can be allocated across skills (high, medium and low) and each skill has a simple *perfect substitute* production function:

$$\begin{aligned} Y &= \exp\left[\int_0^1 \ln y(i)di\right] \\ y(i) &= A_L \alpha_L(i) l(i) + A_M \alpha_M(i) m(i) + A_H \alpha_H(i) h(i) \end{aligned} \tag{2}$$

where $\alpha_J(i)$ is the productivity of skill *j* in task *i*, and *A* is a standard factor augmenting productivity term. The equilibrium of this model is determined by three simple rules: each task should be assigned to maximum one skill, all those offering the same skill should be paid the same price and there is no arbitrage across skills.

This model has two main advantages for the purpose of explaining the change in the earning distribution: on the one hand, the replacement of skills across tasks can generate decreasing wages for some workers; on the other hand (and related to the previous point), it can account for polarization.

The reason why this is possible is straightforward: while technical change still occurs in an augmenting form, in this framework it can change the pattern of competitive advantages, displacing some workers from the tasks that they were previously performing.

Using this theoretical framework as a benchmark, a third question should be addressed, which is the main interest of our contribution. What is the source of SBTC? The theory needs to put forth a source because across the history we observe different "biases": as discussed

by Acemoglu (2002), assuming a steady process of SBTC is not consistent with data, given the acceleration of the post 1970s and given the presence of historical episodes of de-skilling.

As a matter of fact, we can provide only two general hypotheses, i.e. the direction can only be exogenous or endogenous.[3] The first case - the technology push story - is a general label under more specific mechanisms are put forth, such the technological revolution (Caselli, 1999), the decline in the price of ICT capital (Autor et al. 2003, Krusell et al. 2000), the introduction of General Purpose Technology (Aghion, 2002). The second case is the one in which technological change is directed because of profits incentives. The most important theory is in Acemoglu (2007) (a generalization of Acemoglu, 1998), which is based on a demand pull argument: technologies complement skills, so in presence of an increase in the relative supply of a skill, there are more incentives to "direct" the new machines towards the skill which is becoming relatively abundant.

To the best of our knowledge, any other possible argument can be reframed in either one or the other: a) besides demand and supply, there may be institutional changes, but to have an effect they should either drive the adoption skill biased machines (exogenous) or affect the profits incentives (making one of the factor market relatively more scarce or abundant[4]); b) any behavioral impulse towards skill bias is a technology push argument as well, i.e. related to the logic of the scientific discovery along a trajectory (Dosi, 1988) or related to some cultural factor (as in the version that stresses the "ideological" shift of the 1980s, as in Howell, 1999).

In the Acemoglu (2007) framework a weak skill bias effect occurs when the partial effect of an increase in the skill supply on the wage is positive, a strong effect, instead, when the total effect including the adjustment in the supply is positive.

In both case the assumptions that should hold are the ones necessary to have a locally isolated equilibrium: the equilibrium technology should be in the interior of the convex set of technology set, and the net production function should be twice differentiable. The strong version of bias requires also non-convexity of the production function (a standard assumption of Endogenous Growth Theory).

2.2. An empirical framework

[3] Exogenous and endogenous refer to the presence of the bias, the underlying theory of technical change can be an exogenous or endogenous one, of course.

[4] Technically, even a Marxian-Hicksian argument in which technical change is "Unskilled Labor" Saving because of bargaining power can be relabeled as a demand pull effect. In that framework, the introduction of machines is triggered by the induced scarcity of a factor. However, we will not state that our test of demand pull *à la Acemoglu* can cover these cases, because the environment (in particular the assumptions on the functioning of the labor market) are very different and we opt for a conservative interpretation of our results.

In their empirical framework, Acemoglu and Autor (2011) regress the rate of change of hourly wage per cohort over a set of proxies of technological change, controlling for the initial pattern of competitive advantage:

$$\Delta w_{sejk\tau} = \sum_t \beta_t^A \gamma_{sejk}^A \cdot 1[\tau = t] + \sum_t \beta_t^M \gamma_{sejk}^M \cdot 1[\tau = t] + \Lambda + e_{sejk\tau} \quad (3)$$

where *s* stands for sex, *e* for educational level, *j* for the region, *k* for age group and τ for time, the gammas are the shares of each cohort in abstract and manual jobs (the excluded category is the routine jobs) and are interacted with decade dummy. Λ is a set of dummies, related to the various characteristics of the cohorts.

The logic of the argument is the following. They classify the occupations into three categories: abstract, routine and manual. The central group is made by those occupations that are more prone to replacement by Information and Communication Technologies (and/or outsourced); the first group is the one that has a strong complementarity with new technologies and the last group is the one with a weak complementarity, since it is not outsourceable. The implication of the model is that the decline in the market price of the routine tasks (due to technological change) will drive downwards the price of the skill groups that initially has a comparative advantage to this task.

If the betas are positive there is polarization (given the omitted category of routine jobs), if only β_t^A is positive, then the complementarity occurs only for the high skilled group.

By taking the initial occupational shares they control for the pattern of comparative advantage; interacting the shares with the decade dummies they try to identify changes in wage structure as an effect of the raising competition of the information technologies. They control for all the observable characteristics, which are related to the definition of the cohorts.

It is difficult to give to the coefficient a causal interpretation in this framework because one should interpret the time dummies as fully capturing the technical change. Even assuming a pure reduced form interpretation, endogeneity of the supply makes it impossible to interpret the effects as endogenous bias of technology.

3. Data and Methodology

3.1. Empirical Strategy

We propose to use a natural experiment. We look for an exogenous source of variation of skill supply, in our case with regards to the high-skill group. Under the abovementioned assumptions, SBTC occurs. Since those workers had a comparative advantage in abstract

tasks, we should expect the interaction between the time dummy and the initial share of abstract occupations to impact positively on the rate of growth of wage, i.e. we interact it with the treatment effect.

Our proposed formulation is a slight modification of (3):

$$\Delta w_{sejk\tau} = \sum_t \alpha_t^A \gamma_{sejk}^A \cdot 1[\tau = t] \cdot D_{it} + \sum_t \alpha_t^M \gamma_{sejk}^M \cdot 1[\tau = t] \cdot D_{it} + \sum_t \beta_t^A \gamma_{sejk}^A \cdot 1[\tau = t] + \sum_t \beta_t^M \gamma_{sejk}^M \cdot 1[\tau = t] + \Lambda + e_{sejk\tau} \quad (4)$$

where the only change is in the D_{it} variable, which is a standard treatment dummy: it is equal to one for the treated country after the shock and zero otherwise. Indeed, this is the only way we can try to identify the treatment effect, in the relationship between the initial pattern of comparative advantage and the wage, while any other effect would be confounded with any other country-level factor.

As a natural experiment, our source of variation is the unification of Germany in 1990.[5] Like all the other Soviet economies, Eastern Germany had very high enrollment rates and high quality of education, especially in the engineering and scientific domain. We consider the effect on Western Germany alone, to eliminate other source of variability coming from the adjustment and to control for composition effects (Friedberg, 2001).

As a control groups we use other countries in the same data source, following criteria of comparability, lack of treatment and availability of homogeneous data. Details are given in the next section.

By using the patterns of comparative advantage before the unification, identification occurs under the following assumptions: a) the pattern of comparative advantage of Eastern German workers is not systematically different from their Western German colleagues, for a given type of skill; b) the pattern of comparative advantage of Eastern Workers before the unification should not be correlated with the subsequent dynamics of wage in Western Germany. For the latter we could not find any possible objection (to the best of our knowledge) and is also accepted in the literature (Friedberg, 2001). The former may be questionable, but given the good level of the educational system and given that those workers were certainly facing less integration problems, we do not expect a systematic post shock occupational downgrading.[6]

[5] Close to our spirit is the use of the Russian immigration to Israel in the 1990s, as in Gandal et al. 2004. However, in that case they do not try to identify any causal relationship.

[6] As we discuss in the Conclusions below, this assumption is actually more relevant for the interpretation, but not for the validity of the test.

To summarize, this is the set of issues that we are investigating:

a) the presence of polarization in Europe, as a response to the changes in the technological domain (regardless of its origin), which is reflected in positive β_t^A and β_t^M . Essentially, we expect to observe a baseline trend in Europe approximately similar to the one sketch by Acemoglu and Autor (2011) for the US, expect for the possibility of different timing and magnitude, and keeping into account that our time window is shorter;

b) since the Western Germany economy witnessed a supply shock on the labor market which does not characterize our control group, we expect to have a differential effect for the former. Under the assumptions discussed above, this shock should generate SBTC, thus we expect a positive and significant effect of the treatment, captured by positive α_t^A and α_t^M .

3.2. Data

Data for this study come from the Luxembourg Income Study, a project that collects national survey data, standardize them (where possible) and provide to researchers remote access to the anonymized data. Data are organized in waves. For each survey a household and a personal database are available (LIS, 2011).

The main object of our study is Germany. We use the data from the 1989 wave of the person level survey (pre-treatment) that covers only Western Germany. From the following two waves (1994 and 2000) we extract the subsample belonging to Western Germany: we match the household and person database using the unique identification variable and we extract the region of residence information.

In selecting the countries that we should use as a control sample we used two criteria: comparability of countries and comparability of data in the LIS questionnaire. France is the best candidate: it is comparable to (Western) Germany for GDP per capita, population, labor market institutions (high firing cost) and size of the welfare system (level of taxation and so on). Fortunately, the quality of the data in terms of comparability is also very high. The waves are 1989, 1994 and 2000 as for Germany.

We exclude all the former soviet countries because they were "treated". We exclude non-European countries for comparability. We exclude Scandinavian countries and Finland because they did not provide comparable educational classification: in the database they don't have the re-ranking of educational attainment harmonized to ISCED 1997 (UNESCO 2006). We exclude Austria, Belgium, Italy and the Netherlands because they don't provide the ranking of occupational classification according to the ten classes ISCO (ILO, 1987), and finally we exclude Ireland because the variable wage is empty for the pre-treatment wave.

We include Spain (1990, 1995, and 2000) as a further robustness check, because we have comparable variable definitions.

The variable wage refers to annual gross wage, including both taxes and contribution to social security system. We don't have information on hours for Spain and France. We will discuss the role of hours in Section 4 below. We express everything in 2000 PPP euros, using inflation rate information from IMF and exchange rates and PPP conversion rates from Eurostat.

In the German case wages are available gross of taxes and employee contribution to social security system. We add the employer contribution using the information provided by OECD Tax database (OECD, 2011a). For France, the data are gross of taxes and net of social security contribution, and we add them using the same OECD source. Spanish data are net of taxes and contribution: we use OECD data for both (for taxes, information on the methodology are in OECD, 2011b).

The cohorts are based on sex (male or female), education (primary, secondary or tertiary according to ISCED classification), age (25-34, 35-44, 45-54, 55-64) and macro-region of residence. For the latter, we define two regions for Western Germany, two for France and two for Spain. In Germany in the North there are West Berlin, Schleswig-Holstein, Hamburg, Lower-Saxony, Bremen and North Rhino-Westfalia; in the South, Hessen, Rheinland-Pfalz, Saarland, Baden-Wuerttemberg, and Bayern. In France, in the first region we include the following NUTS-1[7] regions: Ile-de-France, Bassin Parisienne, Nord, Ouest; in the second one we include: Sud-ouest, Centre-est, Méditerranée. In Spain, in the center-north we have the North-East, North-West, Center, and Madrid NUTS 1 regions, while in the South we have South, East and Canary Islands.

To determine the pattern of comparative advantage, we split occupations among three groups: *Abstract jobs category* corresponds to the ISCO groups of managers, professionals, technicians and associate profession, and skilled agricultural; *Routine jobs* include clerical support workers, crafts and related trades workers, and plant and machine operators; finally, manual tasks are those classified as ISCO groups services and sales workers, elementary occupations and armed forces occupations.

In order to weight the regressions, we build weights from the normalized sample ones provided by the original survey: the new cohort weights are the sum of the weights of all the individuals belonging to a cohort. In this way, we also the impact of cells in which there are few individuals.

[7] Nomenclature of territorial units for statistics (NUTS). For definition and discussion see Eurostat (2011).

4. Results and Discussion

4.1. The Treatment

Looking at the distribution of educational attainment in West and East Germany in 1994[8] we can have an appraisal of the existence of a supply shock.

In the east the share of population aged 25-64 with tertiary education was 36% for males and 31% for females, against respectively 27.8% and 27.1% for the West. For the 35-44 age group the shares are 40 and 41 for the East against 33 and 25 for the West; for the 44-55 age group they are 44 and 32 against 30 and 19; for the 55-64 age group they are 50 and 19 against 23 and 12. The only small difference occurs for the 25-34 age group, where the shares are 17 and 32 for the East and 24 and 21 for the West. In computing the shares, we used the sample weights.

The exogeneity of the treatment is based on the political scenario that paved the way to the reunification and we are not aware of any factor behind a systematic correlation with the dynamics of wages in Western Germany or the pattern of comparative advantage of skills groups before the unification, as compared to other countries such as France and Spain.

We test the effect on Western Germany only, because including the overall Germany would include a significant noise due to the adjustment process to the market economy by the East and since we want to correct for composition effects.

As a statistical support for the validity of the treatment we add two further arguments. On the one hand, the pattern of comparative advantages in the pre-treatment period is not statistically different for the treated and control groups. The t-test for the share of abstract jobs is 1.02 and equality of the means is not rejected (p-value 0.30); for the manual share the statistics is -0.41 (p-value 0.67). In both cases we corrected for the possibility of unequal variances.

On the other hand, there is almost perfect balancing in terms of age composition in the pre-treatment period: considering the four age cohorts (25-34; 35-44; 45-54; 55-64) the shares for Germany are 32.6, 27.8, 26.8, and 12.6 while for the control group they are 31.1, 32.5, 22.8, and 13.4. (The shares are weighted with sample weights). With regards to the distribution by skill, the share of high skill in Germany is indeed higher in 1989 (24.3% against 16.3%), but if we run a t-test for the high-skilled wages in the pre-treatment period the equality of the means is not rejected (the statistics is equal to -0.67, p-value 0.50).

In terms of interpretation of the results we should point out that since we are not able to correct for the subsequent endogenous allocation of the skill supply (although we control for

[8] The educational attainments of population aged 25-64 in 1994 is of course determined by choices done in the pre-treatment period.

part of it through the educational and age dummies) we will identify only the total effect. Since this version of SBTC occurs under stronger assumptions (although the non-convexity is rather standard in this kind of literature), a rejection does not imply anything on the existence of a weak form of the bias.

As we said above, the implication of the model holds regardless of the endogenous re-allocation of skills to tasks: a SBTC effect should translate in an increase in the relative wages of high and low skilled. Since these groups have comparative advantages in abstract and routine tasks, this should be seen in the interaction between the pre-shock shares and the treatment. However, in the identification, we should be careful in the attribution of the effect to labor demand through technological change, for the present of confounding factors. We will discuss them in details in a subsection below.

4.2. The Results

We run separate regressions for male and female workers. In each case we use Weighted Least Squares, the weights are the computed summing by cohort the sample weights. We include country, region, age group, and educational attainment fixed effect. Results are shown in Table 1.

Table 1. WLS Stacked First-Difference Estimates of the Relationship Between Demographic Group Occupational Distributions in 1989 and Subsequent Annual Changes in Demographic Groups' Mean Log Wages by LIS wave, 1989 – 2000

Source: LIS data for Western Germany 1989, Western Germany 1994, Western Germany 2000, France 1989, France 1994, France 2000, Spain 1990, Spain 1995, Spain 2000. Each column represents a WLS regression of average (annual) rate of change of annual wages by cohort and year, where cohorts are defined by sex, age (25-34, 35-44, 45-54, 55-64), region of residence (North and South), country of residence, and educational attainment (ISCED 1, 2 and 3). Weights are calculated as sum by cell of the sample weights.

Abstract, Routine (the omitted category) and Manual jobs are defined according to ISCO classification, homogeneous among the three countries: abstract includes ISCO classes managers, professionals, technicians and associate profession, and skilled agricultural; manual includes services and sales workers, elementary occupations and armed forces occupations.

Lambda includes time, country, region, age groups, and educational attainment fixed effects.

Standard errors in parenthesis. One, two, three stars indicates significance at ten, five and one percent respectively.

	(1) Males	(2) Females
Abstract Occupation Share		
1989 Share x 1989-1994 dummy	-0.021	-0.084
	(0.056)	(0.056)
1989 Share x 1994-2000 dummy	0.061	0.199
	(0.040)*	(0.075)***
1989 Share x 1989-1994 dummy x West Germany	0.020	0.036
	(0.044)	(0.100)
1989 Share x 1994-2000 dummy x West Germany	0.048	0.009
	(0.043)	(0.097)
Manual Occupation Share		
1989 Share x 1989-1994 dummy	-0.034	-0.268

	(0.011)***	(0.150)*
1989 Share x 1994-2000 dummy	0.428	0.411
	(0.079)***	(0.105)***
1989 Share x 1989-1994 dummy x West Germany	0.097	0.047
	(0.146)	(0.182)
1989 Share x 1994-2000 dummy x West Germany	0.061	-0.143
	(0.158)	(0.185)
Lambda	Yes	Yes
Obs	142	136
R-squared	0.51	0.38
F-test	7.41	4.01
(Pvalue)	(0.00)	(0.00)

First of all, a few comments are due on the general pattern of change, for comparability with Acemoglu and Autor (2011). The decade can be broken down into two sub-periods, in the first part there is clearly a compression effect (negative coefficients for both abstract and manual jobs). In the second period there is a polarization effect. These effects are statistically significant. This first set of results suggests that the dynamic of polarization in Europe started at least ten years later than in the US. Most of the change seemed to occur in the manual jobs category, which means that those affected were the low skilled.

In principle the sign of the treatment effect is coherent with the demand pull SBTC theory, but it is not statistically significant. The only exception is the coefficient for the treatment interacted with the second wave dummy and the share in manual occupation for women, which is negative (but not significant). According to this evidence, even if there has been an increase in the demand for skilled, we cannot speak of an acceleration with regards to the control group. Acemoglu and Autor (2011) consider a much larger time span; however, we think that it is difficult to assume than in ten years technical change is not displaying its effects (although the literature is not unanimous on this point, e.g. David, 1990), and in any case if we further extended the time period the identification of the treatment effect would raise serious doubts, because of the complex set of factors intervening.

4.3. Robustness of the results

In table 2 we report the results of the demand pull effect estimated from a series of slightly modified versions of (4). The regressions are identical to those in Table 1, but in the first six columns we omit Spain from the control group, in the columns 3-8 we exclude categories six and ten from the ISCO classification (skilled agricultural and armed forced occupations), which may be affected by some peculiar dynamics, and finally in the last six we weight the regressions using the mean start and end-year share of employment of each demographic group for each wave. (This is the same weighting procedure of Acemoglu and Autor, 2011).

The main change is that the exclusion of Spain makes some of the coefficient turning out significant: a positive effect for male high skilled in the second wave and a negative effect for female lower skilled in both periods. As we will argue below, we suggest that this can be attributed to the confounding factors.

Table 2. Summing up of the estimated demand pull effect

Source: LIS data for Western Germany 1989, Western Germany 1994, Western Germany 2000, France 1989, France 1994, France 2000, Spain 1990, Spain 1995, Spain 2000. Each column represents a WLS regression of average (annual) rate of change of annual wages by cohort and year, where cohorts are defined by sex, age (25-34, 35-44, 45-54, 55-64), region of residence (North and South), country of residence, and educational attainment (ISCED 1, 2 and 3). Weights are either calculated as sum by cell of the sample weights (labeled *sample* in the table) or as mean start and end-year share of employment of each demographic group for each wave. (*cohort* in the Table). The treatment is a dummy for West Germany interacted with 1989 occupational shares and time dummies (the regressions are identical to those in Table 1).

Abstract, Routine (the omitted category) and Manual jobs are defined according to ISCO classification, homogeneous among the three countries: abstract includes ISCO classes managers, professionals, technicians and associate profession, and skilled agricultural; manual includes services and sales workers, elementary occupations and armed forces occupations. The ISCO 6-10 row indicates is "skilled agricultural" and "armed force" are included.

Lambda includes time, country, region, age groups, and educational attainment fixed effects.

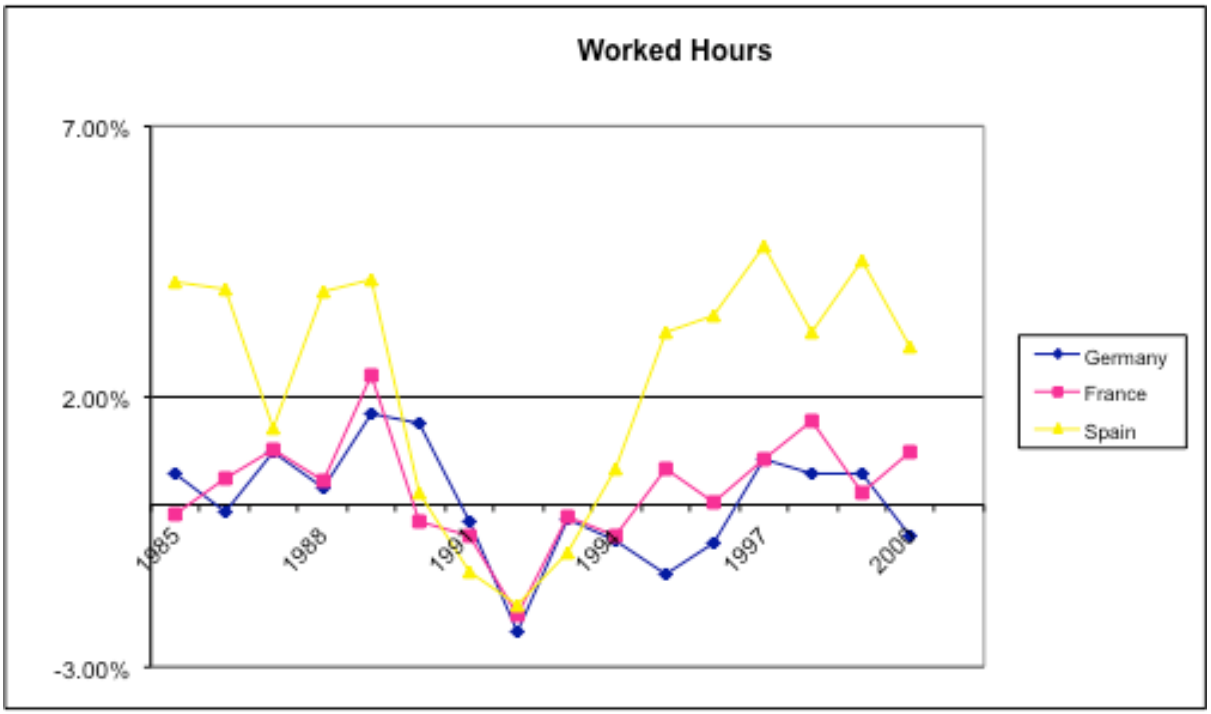
Standard errors in parenthesis. One, two, three stars indicates significance at ten, five and one percent respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
Treatment Effect										
abstract-first wave	0.015	-0.050	0.019	-0.035	0.017	-0.031	-0.014	0.014	-0.006	-0.017
	(0.029)	(0.038)	(0.026)	(0.034)	(0.028)	(0.035)	(0.048)	(0.113)	(0.052)	(0.117)
abstract-second wave	0.045	0.005	0.046	0.016	0.044	0.018	0.017	-0.025	0.027	-0.047
	(0.028)	(0.036)	(0.025)*	(0.032)	(0.026)*	(0.033)	(0.045)	(0.107)	(0.048)	(0.111)
manual-first wave	0.023	-0.140	0.057	-0.088	0.046	-0.080	0.011	0.004	0.030	-0.079
	(0.099)	(0.069)**	(0.089)	(0.060)	(0.091)	(0.059)	(0.154)	(0.193)	(0.163)	(0.206)
manual-second wave	0.098	-0.148	0.140	-0.100	0.130	0.094	-0.040	-0.203	-0.016	-0.279
	(0.106)	(0.070)**	(0.095)	(0.060)	(0.095)	(0.060)	(0.160)	(0.196)	(0.169)	(0.209)
1989 Shares x Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lambda	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Spain included	No	No	No	No	No	No	Yes	Yes	Yes	Yes
ISCO 6 and 10	Yes	Yes	No	No	No	No	No	No	Yes	Yes
Weights	Sample	Sample	Sample	Sample	Cohort	Cohort	Cohort	Cohort	Cohort	Cohort

As usual, for the identification to be consistent we need to discuss the confounding factors. In the previous section we have already discussed the time length (to let technical change fully display its effects) and the use of Western Germany to eliminate the distortionary effects of the economic adjustment in the East.

The first variable to take into consideration is the role of worked hours. In fact, Acemoglu and Autor (2011) consider hourly wage. Besides the fact that hours are usually subject to measurement error in surveys, we don't expect them to play any significant role in this case. In Figure 1 we plot the rate of change of working hours over the 1985-2000 period. Data are taken from EUKLEMS database (Mahony and Timmer, 2009). We consider Germany as a whole because we cannot distinguish between West and East. The two series for France and Germany are almost indistinguishable. Spain has a slightly most pronounced U-shaped pattern at the beginning of the 1990s but the dynamics is the same. Besides this, change in working hours related with endogenous re-allocation of skills to tasks are not relevant for affecting the basic prediction of the model, as we have already discussed above.

Figure 1. The change in worked hours over the period 1989-2000 in the three countries.
Source: EUKLEMS.



Another important confounding factor is represent by institutional changes: at least labor market regulations and taxes should be taken into consideration, since they affect the incentives to supply production factors and to innovate.

In Figure 2 and 3 we show the indices for the strictness of employment protection for regular and temporary contracts. Data are taken from OECD EPL (Venn, 2009). An increase of the index means an increase of the rigidity of the labor market. Germany introduced labor

market flexibilization as many other countries in Europe in the period of the treatment; Spain made pronounced liberalization in the same period, while France maintained the same legislation. As a result, the regressions in Table 1 control for the effect of labor market reform, while the exclusion of Spain sums up the two effects. A confirmation of our interpretation comes from the emerging of a negative and significant effect for female lower skilled workers: since these reforms lower the bargaining power of unskilled, this is acting in the sense of decreasing wages on the lower tail of the distribution. We retain the estimation in Table one as our preferred test, given that the assumptions on the labor market in Acemoglu (2007) are the standard competitive ones.

Figure 2. The change in Employment Protection Legislation
Source: OECD EPL. The index shown is the EPR_v1.

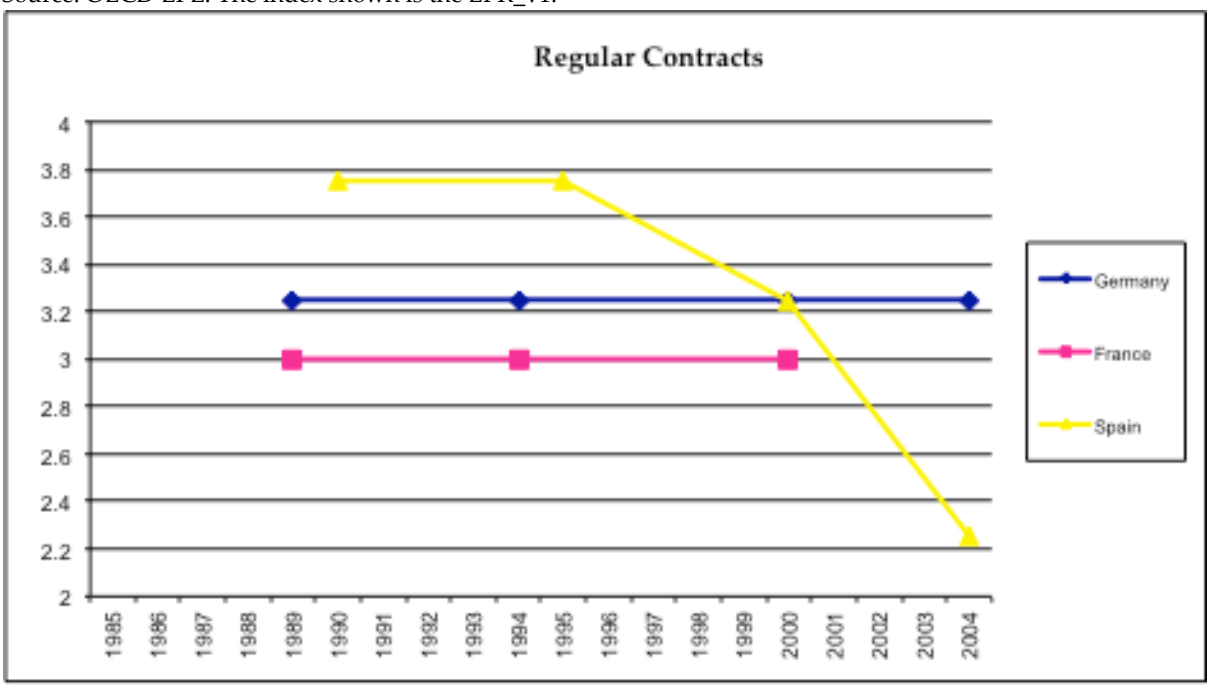
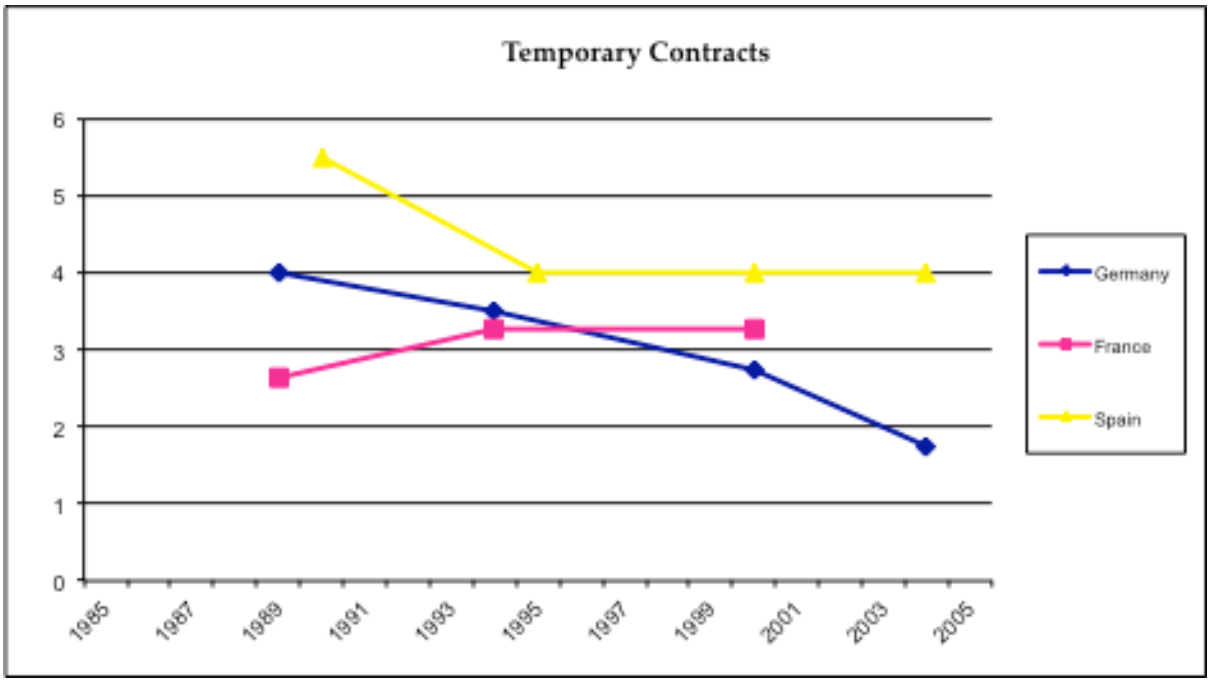
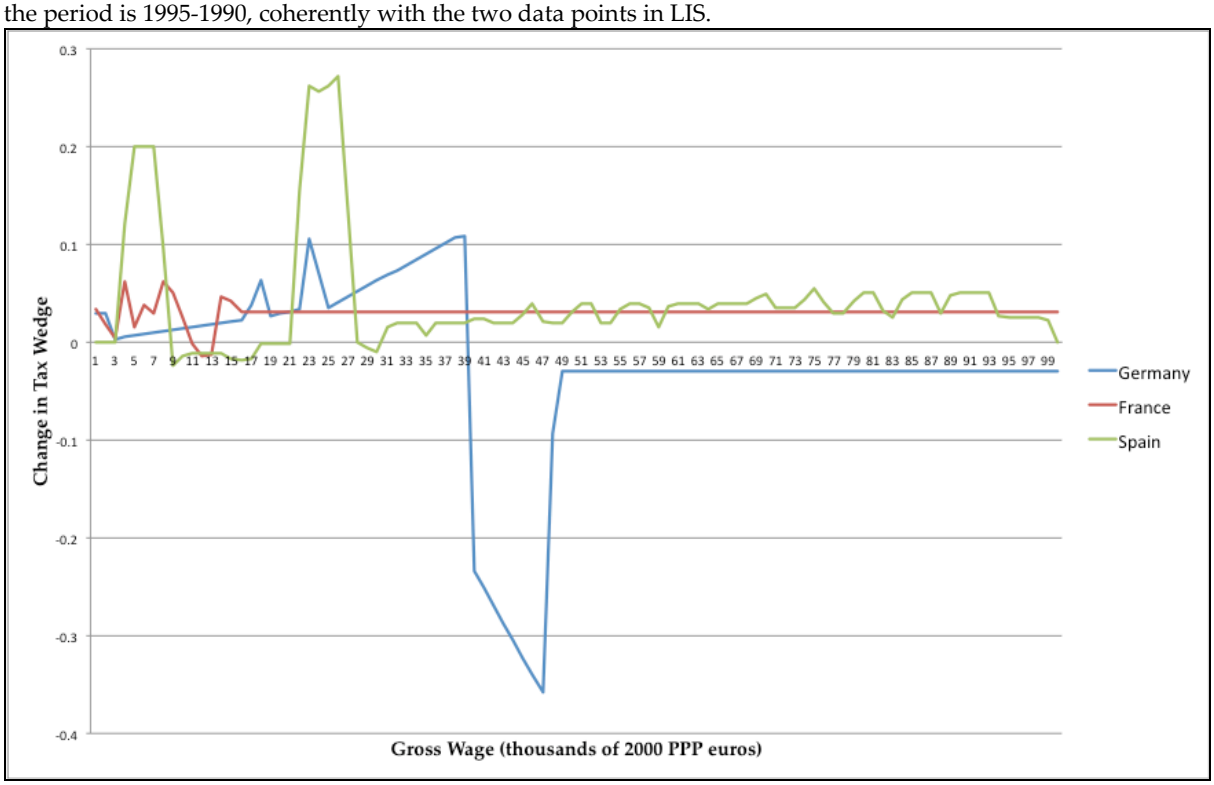


Figure 3. The change in Employment Protection Legislation
Source: OECD EPL. The index shown is the EPT_v1



With regards to taxation, we consider in Figure 4 the change in the tax wedge, including employer and employee social security contribution and taxes. We consider the situation of a single individual, but they should be interpreted with caution since in France and Germany the family situation matters. The amount are expressed in 2000 PPP euros. Germany has a formula based system: the marginal rate increases monotonically from a minimum to a maximum. However, we cannot compute them for 1989 and 1994 because some of the necessary data are missing, so we used a linear approximation. The change in tax wedge is the simple difference between the tax wedge in 1994 and the tax wedge in 1989. Although preliminary, the evidence suggests that the three countries increased regressivity in the period under consideration. As in the case of labor market regulation, the change is stronger for Spain and Germany and lower for France. As in the case of labor market regulation, this effect tends to amplify the effect of the high skill supply shocks (which have systematically higher wages): as a results we reassert that the best estimation is the one in Table 1 which is (at least partially) filtering out this effect.

Figure 4. The change in the marginal tax wedge between 1989 and 1994.
Source: OECD (2011a) and (2011b). Tax wedge includes both contribution to social security (by the employer and the employee) and taxes. The wages are in 2000 PPP euros (thresholds have been properly adjusted in order to compute the taxes). Change in tax wedge is the difference between the tax wedge in 1994 minus 1989. For Spain the period is 1995-1990, coherently with the two data points in LIS.



Finally, a comment is due on the role of demand. There are two possible way in which it may affect the dynamics of wage. The first one is in terms of effective demand, but we are including both time fixed effect and country dummies separately; the second one is related to change in sectorial specialization as long as the latter is characterized by strong diversity in tasks composition. However, using data from OECD STAN (OECD, 2011c). we can see that the pattern of sectorial specialization changes homogeneously in the three countries. Data are plotted in Figure 5-7. The decline of Medium High Tech in Germany after the reunification is more pronounced, but this is due to the decline in car manufacturing in Eastern Germany and in the estimation we are considering only Western Germany.

Figure 5. Change in Sectoral Composition of the economy: Germany 1985-2000.
Source: OECD STAN. The reported shares are computed in terms of value added with regards to the sum of manufacturing and market services. Sectors are defined according to NACE rev.3. High tech (HT) is the sum of 30, 32, 33; Medium High Tech (MHT) is the sum of 24, 29, 31, 34, 35; Medium Low tech (MLT) is the sum of 23, 25-28; Low Tech (LT) is the sum of 15-22 and 36-37; High Tech Knowledge Intensive Services (HTKIS) are 64, 72, 73.

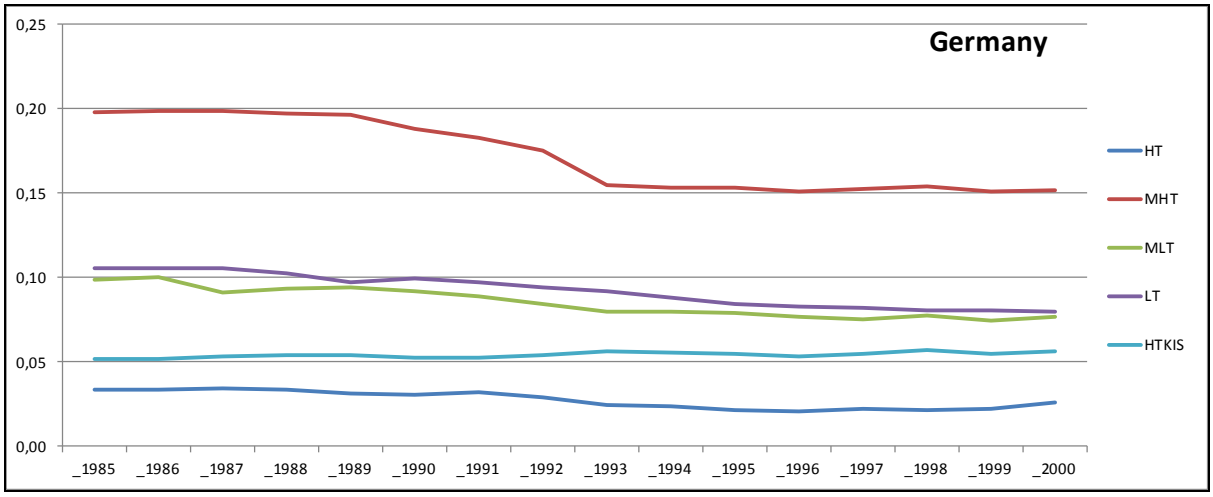


Figure 6. Change in Sectoral Composition of the economy: France 1985-2000.
Source: OECD STAN. The reported shares are computed in terms of value added with regards to the sum of manufacturing and market services. Sectors are defined according to NACE rev.3. High tech (HT) is the sum of 30, 32, 33; Medium High Tech (MHT) is the sum of 24, 29, 31, 34, 35; Medium Low tech (MLT) is the sum of 23, 25-28; Low Tech (LT) is the sum of 15-22 and 36-37; High Tech Knowledge Intensive Services (HTKIS) are 64, 72, 73.

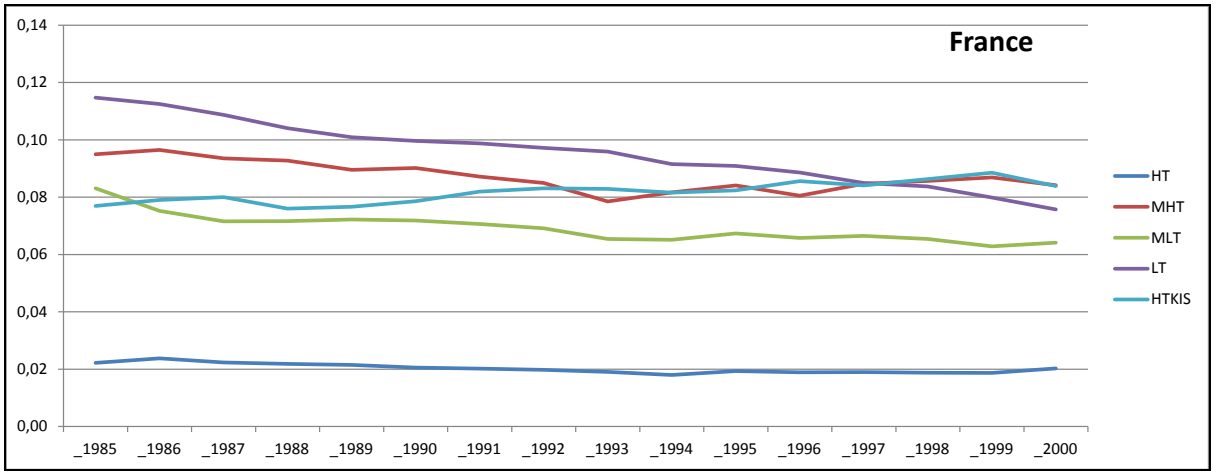
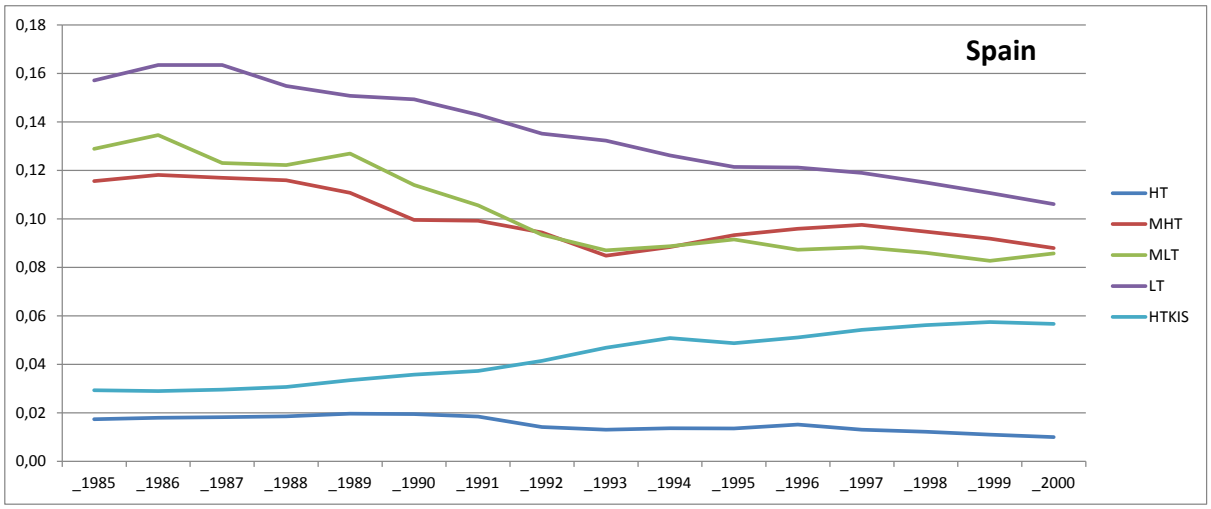


Figure 7. Change in Sectoral Composition of the economy: Spain 1985-2000.
Source: OECD STAN. The reported shares are computed in terms of value added with regards to the sum of manufacturing and market services. Sectors are defined according to NACE rev.3. High tech (HT) is the sum of 30, 32, 33; Medium High Tech (MHT) is the sum of 24, 29, 31, 34, 35; Medium Low tech (MLT) is the sum of 23, 25-28; Low Tech (LT) is the sum of 15-22 and 36-37; High Tech Knowledge Intensive Services (HTKIS) are 64, 72, 73.



5. Concluding Remarks

In this paper we use a natural experiment – the German re-unification – to assess the existence of demand pull SBTC. Under some assumptions, the enlargement of the supply of skilled workers should change the incentives of innovators, directing technical change in a way that tends to complements skills. We used France and Spain cohorts of workers in the labor market as control sample to filter out the confounding factors.

The evidence suggests the presence of non-monotonic trends in the labor market in Europe, with the emergence of polarization in the 1990s. No significant presence of demand pull effect is found, which would have been materialized in a further polarization shock.

The identification of the effect is based on two key assumptions: the absence of correlation between the pattern of comparative advantage of Eastern Europe before the reunification and the subsequent change in wages in Western Europe (an assumption which is difficult to reject) and the correlation between the occupational allocation of the workers sharing the same skills across the border. Although we were not able to find evidence of a systematic downgrading of Eastern German workers, even this assumption is not very problematic. In fact, unless we assume a perfect substitutability of Eastern workers across the full set of skills, their entrance in the labor market should have change the supply of skill in a way that should generate a skill biased response (for some skill). Since we cover all the occupational structure, this should affect at least one of the three categories of jobs. As discussed by

Acemoglu and Autor (2011), the post shock reallocation of skills through tasks is irrelevant for the implication of the model, so does not prevent identification.

The existence of demand pull SBTC is very important for the design of policies. We think that this aspect has been largely neglected by the literature. Indeed, under these assumptions educational policies affects in the long run the direction that inequality will take. Since, as discussed in Section two above, the only potential alternative explanation for SBTC is the technology push, then policies against inequality are "paradigm-specific", i.e. they depend on the type of techno-economic paradigm which prevails in the economy. Moreover, besides the obvious "general equilibrium" effects, policies for innovation enablers (such as those favoring human capital accumulation) and inequality reducing ones should be coupled since they are not necessarily related.

Another implication of our work is that most of the effect of earning distribution seems to be shaped by context specific effects, related in particular with labor market institutions, as can be seen by the differential effect produced by the inclusion/exclusion of Spain from the control sample, which helps us filtering out the effect of taxation and labor market deregulation. The latter change had clearly a negative effect for the wage of the low skilled, enhancing inequality.

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