

Basile, Roberto; Benedictis, Luca De

Conference Paper

Regional Unemployment and Productivity in Europe and the US

44th Congress of the European Regional Science Association: "Regions and Fiscal Federalism", 25th - 29th August 2004, Porto, Portugal

Provided in Cooperation with:

European Regional Science Association (ERSA)

Suggested Citation: Basile, Roberto; Benedictis, Luca De (2004) : Regional Unemployment and Productivity in Europe and the US, 44th Congress of the European Regional Science Association: "Regions and Fiscal Federalism", 25th - 29th August 2004, Porto, Portugal, European Regional Science Association (ERSA), Louvain-la-Neuve

This Version is available at:

<https://hdl.handle.net/10419/116949>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

REGIONAL UNEMPLOYMENT AND PRODUCTIVITY IN EUROPE AND THE US

Roberto Basile* Luca De Benedictis†

25 April 2004

Abstract

The existence and persistence of large spatial disparities in unemployment within national economies is a central issue in regional economics. Previous empirical analyses have largely disregarded the role of fundamentals. On the contrary in this paper we explore the link between labour productivity, international trade and regional unemployment differentials.

We base our empirical analysis on the predictions of a simple General Oligopolistic Equilibrium efficiency-wage trade model. Using semiparametric regression methods, controlling for industry-mix and labour force participation, we give evidence of a nonlinear negative relationship between labour productivity and regional unemployment, in the cases of European regions. Instead, no significant relationships between these variables have been found for the United States.

KEYWORDS: Productivity, Regional Unemployment, Oligopoly, Nonparametrics.

JEL CLASSIFICATION: C14, D50, F12, F16, J41, L13, R10.

*ISAE - Piazza Indipendenza 4, Roma 00185, Italy. +390644482874. r.basile@isae.it

†DIEF - University of Macerata - Via Crescimbeni 20, Macerata 62100, Italy. +390733258235. debene@unimc.it

A preliminary version of the paper has been presented at a DG Employment and Social Affairs seminar in Brussels, at the Denver meeting of the Western Economic Association, at the University of Catania, and at the ISAE. We thank Jeff Nugent, Hyeek Jeong, Martin Hallet, Stefano Staffolani, Lance Howe, Sergio de Nardis, Roberto Cellini and participants to the presentations for comments and suggestions. We bare responsibility for any remaining errors.

Contents

1	Introduction	6
2	A General Oligopolistic Equilibrium efficiency - wage model.	9
2.1	Preferences and effort	10
2.2	Two countries, three regions oligopoly	11
2.3	Autarkic equilibrium	13
2.4	Productivity, wages and regional unemployment	16
2.5	Trade and productivity shocks, labour mobility and minimum wages	18
3	From Theory to Empirics	21
4	Empirical Evidence	22
4.1	A Semiparametric Specification	22
4.2	Data	23
4.3	Econometric Results	24
5	Concluding remarks	28

Non technical summary

In this paper we explore the link between labour productivity and regional unemployment differentials. The many empirical analyses on regional unemployment that preceded our contribution have proposed a large set of explanatory variables while never explicitly considering labour productivity as a relevant explanatory factor of regional unemployment (Elhorst, 2003). In this paper, we have shown how this covariate largely explain wide and persistence regional unemployment disparities in Europe.

The predictions of a General Oligopolistic Equilibrium Neary (2002) efficiency wage model Shapiro and Stiglitz (1984) of a nonlinearity between labour productivity and unemployment is confirmed by the European data. A negative relation does exist in the case of low-productivity regions (the 'periphery'), while no relation occurs in the case of high-productivity regions (the 'center'). The argument is that the efficiency wage, induced by the necessity of firms to anticipate workers' shirking behavior, generates a wage-floor under which the productivity gap cannot be compensated by a wage gap.

The EU and US cases are depicted as different results of a general setup. When the core and the periphery have both high levels of labour productivity (as in the case of the US), a positive shock in the center, increases wages in the region and decreases wages in the periphery, leaving the regional unemployment level almost unchanged.

When the assumption of no labour mobility is relaxed, our model predicts a convergence in regional wages and unemployment rates in countries with high inter-regional migration (as in the US). The introduction of a minimum wage, instead, does not change significantly the results of the model, since the very existence of an efficiency wage behaviour generates *per se* an downward wage-rigidity.

The opening of the Home market to international trade has the effect of reducing the market power of all Home firms regardless of their location. The effect on unemployment and on wages depends on regional productivity. In the center the shock is absorbed mainly by a drop in wages, while in the periphery the shock would affect the unemployment rate more severely. In general, in a country with high average regional productivity the changes in trade integration or the variability in openness do not affect the unemployment rate.

In the setup we defined so far, the prevalent effect of trade integration is an increase in competition in the Home market. The reduction in trade costs allows Foreign firms to export more to the Home country, and that makes the Home production sold at Home shrinking, Home wages dropping and Home

unemployment rising. However, a second and opposite effect comes from the ability to catch the opportunity of a larger market, since also the Home firms could sell abroad if the Home country has an export potential. The negative effect of a trade shock can be reversed.

We carry out an empirical analysis to verify these predictions. Using semiparametric techniques, we study the relationship between regional unemployment, wages and labour productivity in Europe and the United States, controlling for the role played by export potential and labour force participation. The results match the prediction of the model, and the implications in terms of unemployment reactions to productivity shocks are emphasized in both the EU and the US cases.

For the European regions, our results confirm the prediction of a non-linear and asymmetric effect of labour productivity on regional unemployment: the unemployment rate declines with labour productivity for low levels of labour productivity (that is for peripheral regions); as productivity increases over the EU average, the unemployment rate does not appear to be any more affected by labour productivity differentials. Instead, no significant relationship between these variables have been found for the US.

Interestingly enough, once we drop labour productivity from the econometric analysis, our results suggest the existence of a negative relationship between wages and unemployment for the EU case, thus confirming the prediction of the efficiency wage model, and of a positive relation between the two variables in the case of US States, in line with the traditional neoclassical view.

Some economic policy implications for the European case can be associated to our results.

The most relevant one is that unemployment policies should be set at the regional level. The same policy has in fact different implications according to the level of regional labor productivity and export potential.

The most common proposal is the regional de-centralisation of the wage-setting process (Pench *et al.*, 1999). If wages followed productivity more quickly, the competitiveness of peripheral regions would be less penalized and the employment and unemployment conditions within these regions would improve. However, if the downward wage rigidity does not entirely reflect the institutional mechanism, but can be also attributed to efficiency wages, then the adjustment process discussed above cannot properly work.

The asymmetry in the relationship between unemployment and productivity makes evident that the reduction in the regional unemployment gap can be pursued through policies that increase labour productivity at the periphery level (such structural and cohesion funds) and the periphery export potential.

Finally, if this process is also followed by a higher labour mobility of workers from the periphery to the center, regional unemployment disparities would tend to decrease even faster. Given the very low workers' propensity to migrate from the periphery to the center, that would be possible only if the upward wage rigidities in the center were relaxed. A side effect of this dynamic process would be that the labour markets of the regions in the center of Europe would become more similar to US States' one.

1 Introduction

A central issue in regional economics is the existence and persistence of large spatial disparities in unemployment within national economies. The issue is of relevance also from a macroeconomic point of view. Since Blanchflower and Oswald (1994), the understanding of the regional dimension of unemployment is considered as "... a more appropriate testing ground for comparing Phillips curve and wage curve specifications" (Blanchard and Katz, 1999). From a policy making point of view the interest in the issue mirrors the empirical relevance of the phenomenon: it is particularly high in European countries and less relevant in the United States. Regional unemployment seems to be a case only in Europe.¹

As is reported by the European Commission (EC, 2002), regional unemployment rates in the European Union reveal a pronounced and persistent core-periphery structure, with very high unemployment rates concentrated in peripheral regions. Regional unemployment differentials are wide and persistent, regional wages are relatively insensitive to local economic conditions and labour mobility from the periphery to the economic core is insufficient in reducing regional disparities. Such insensitiveness and low mobility contribute to the definition of Europe as a case study of labour market rigidity. On the contrary, in the US unemployment rates are much more equally spread across regions and less persistent over time. This evidence fits the characterization of the US case as a model of labour market flexibility.

Empirical analyses on regional unemployment have proposed a large set of explanatory variables, capturing labour supply, labour demand and wage-setting factors. Surprisingly, among the many variables included, labour productivity has never been explicitly considered as a relevant explanatory factor of regional unemployment (Elhorst, 2003).

Following Blanchard and Katz (1992)², Fatàs (1998) analyzes the adjust-

¹Until the mid nineties the regional dimension in European unemployment was highly disregarded (Bean, 1994), and most of the studies were carried out on UK and US data. In the second half of the nineties many contributions set up the basis for the analysis of regional unemployment in Europe. Among the many, see Taylor and Bradley (1997), Martin (1997), Pench *et al.* (1999), Overman and Puga (2002), Decressin and Fatàs (1995), Kostas Padoa Schioppa and Basile (2002), Niebuhr (2002), and Elhorst (2003) for a review of the issue. Only one empirical study, however, provides a comparison between European regions and US States (Fatàs, 1998).

²The Blanchard and Katz (1992) model, under the assumption of interregional mobility of firms and people and of a high wage flexibility, predicts that the adjustment to a negative labour demand shock in a particular region works through two possible mechanisms: a) a reduction in wages favors the attraction of firms and, thus, the creation of new jobs within the region; b) a reduction in wages and an increase in unemployment determine

ment of labour markets both in European regions and US States, in response to region-specific shocks. He finds that these shocks cause permanent changes in the employment share of a region, both in Europe and in the US. Migration is the main adjustment mechanism in the latter case: inflows of workers to booming regions not only help the economy to adjust to the initial increase in labour demand but they create additional persistence through an after-shock build-up effect. In the former case, wages are less flexible and labour mobility is very low. Changes in regional participation rates bear most of the employment adjustment. Finally, both in Europe and the US, unemployment rates react very little and their response is not very persistent. In other words, both in Europe and in the US, the regional unemployment rate moves to a small extent and transitorily, suggesting the presence of natural unemployment rates at the regional level.

It is quite evident that this “adjustment approach”, although providing interesting explanations, underestimates the role of fundamentals in explaining wide and persistent regional unemployment disparities in Europe. Moreover, in the long run, unemployment is undeniably driven by labour productivity and real wages, and possible differentials should appear as the main long run determinants of regional unemployment disparities. One may also suggest that the regional natural unemployment rates are driven by fundamental factors, such as the regional wages and labour productivity. The same argument would apply both to the EU and US cases, but with different implications according to the degree of spatial flexibility of the labour market.

The different distribution of regional unemployment rates, wages and productivity levels in Europe and in the US is well depicted in figure 1 using EU and US data for 1995-2000 average regional wages, labour productivity and unemployment rates standardized with respect to EU mean values. EU regions are represented by circles and US States by squares. The centroid of the distribution for the European data has coordinates (1,1), while the centroid for the US data takes in to account the average spread between the EU and US regional wages (negative), labour productivity (negative) and unemployment rates (positive).³

interregional migration. In the long run, because of firms’ and/or people mobility, the unemployment rate and wages return to their equilibrium level.

³The EU and US regional data suffer problems of comparability so we preferred to standardize it and to analyze the two data sets separately. Since the same data would be used in the empirical analysis, a complete description of the dataset would be given later on. A spot information of the gap between the EU and the US is however worthwhile: the average regional wage has been 22500 in the EU and 30500 in the US (both evaluated in US dollars), the average regional labour productivity has been 38400 in the EU and 53800

[Figure 1 about here]

In the two panels of figure 1, contours for regional wages and productivity with respect to regional unemployment are drawn. As in Bowman and Foster (1993) the contours illustrate the two-dimensional density estimate of the data and have been selected in order to contain a certain proportion of the observations. The contour labeled ‘75’ contains 75% of the observations, and similarly for the contours labeled ‘50’ and ‘25’.

It is evident that regional unemployment in the EU is sparse, being highly concentrated in the US. The unemployment rates of US States are always lower than the EU average. Regional wages and productivity disparities in the US are also lower than in the EU (even if not so concentrated as the unemployment rates), and almost all US States show wages and productivity levels higher than the EU average.⁴ Contrary to the US, the European data are also characterized by an evident multi-modality in the density estimate. Since the simple visual inspection of the data shows a remarkable difference between the EU and the US cases, the natural research question is if and how in each of the two cases the shapes of the distributions are related to each other.

The task of this paper is therefore to analyse the relationship between regional unemployment, wages and productivity differentials. We built our analysis along the lines of reasoning generated by merging the General Oligopolistic Equilibrium (GOLE) setup proposed by Neary (2002, 2003) with the Shapiro and Stiglitz (1984) efficiency wage model.⁵ The resulting model allows us to make predictions on the conditional effect of wages and labour productivity on regional unemployment. In particular, a nonlinear and asymmetric relationship between productivity and unemployment is predicted. A negative relationship does exist in the case of low-productivity regions (the periphery), while no relationship occurs in the case of high productivity regions (the center). The reason behind such asymmetric effect is the constraint imposed by the non-shirking condition on the possibility for regional productivity gaps to be fully matched by regional wage gaps. The model is

in the US (in US dollars), and the unemployment rate has been 9.9 in the EU and 4.8 in the US.

⁴The smaller differences in productivity in the US are generally considered as a consequence of a quicker diffusion of technological knowledge, through interregional spill-over, knowledge transfer, the high mobility of firms, researchers, and engineers.

⁵The model is explicitly data-driven, the selection of the variables to be included takes into account the constraint coming from data availability and the little emphasis on the role of national and international migration, on sectoral specificity, on institutional differences and on social and individual attitudes with respect to mobility depends on the unavailability of international comparable data.

constructed in order to evaluate the EU and the US as specific cases of a general framework.

At a second stage, we carry out an empirical analysis to verify these predictions. Using semiparametric techniques, we study the relationship between regional unemployment, wages and labour productivity in Europe and the United States, controlling for the role played by labour force participation and export potential, proxied by the industry-mix. The results match the predictions of the model, and the implications in terms of employment reactions to productivity shocks are emphasized in both the EU and the US cases.

The rest of the paper is organized as follows. Section 2 sketches a model which builds a link between productivity, wages, unemployment and trade, allowing for regional differentials. Sections 3 and 4 present the empirical evidence in support of the predictions of the theoretical model. Section 5 stresses the implications in terms of employment policies and concludes.

2 A General Oligopolistic Equilibrium efficiency - wage model.

In this section we sketch a model which builds a link between productivity, unemployment and trade, allowing for regional productivity and unemployment differentials. To stress the resulting effects of the interactions between the good's market and the labour market in an international trade environment, we opted for a general equilibrium trade model. However to allow for the possibility of firms with different productivity to coexist in the same international market, demanding labour up to a point where an involuntary unemployment equilibrium can result, we abandon the traditional competitive general equilibrium and we follow Neary (2002) and Shapiro and Stiglitz (1984) in drawing a General OLigopolistic Equilibrium (*GOLE*) model where firms imperfectly monitor workers' on-the-job effort.⁶

As in Neary (2002) firms are assumed to have sectoral market power, so that they act strategically only with respect to their direct rivals, but they take macro variables such as wages, unemployment or GDP as given. In Neary's terminology they are "large" in their own sectors, but "small" in the economy as a whole. As in Shapiro and Stiglitz (1984) each firm uses wages as an incentive to induce workers to a self-discipline in their effort production.

⁶ Previous merges of trade models with an efficiency-wages labour market setup are Copeland (1989) and Hoon (2001).

2.1 Preferences and effort

In our *Shapiro-Stiglitz economy* there is a fixed number of identical infinitely living individuals \bar{N} . Each individual offers labour inelastically with a disutility from working's effort $e_t \geq 0$ and receives utility from the consumption of X_t that the wage income $w_t \geq 0$ allows.

We assume that the period-by-period utility function is quadratic in consumption (Neary, 2002) and linearly decreasing in effort. Therefore all these risk-neutral individuals pursue the same goal

$$\arg \max E \int_0^\infty (aX_t - \frac{1}{2}bX_t^2 - e_t) \exp(-\rho t) dt. \quad (1)$$

For each worker there is a positive per unit time probability ω of loosing her job independently of her on-the-job behavior and a positive per unit time probability σ of being identified while shirking and fired. Hence, each individual will select e_t according to equation 1.

If V_E^S is the expected lifetime utility of an employed shirker, V_E^N is the expected lifetime utility of an employed nonshirker, and V_U is the expected lifetime utility of an unemployed individual, using Bellman's principle of dynamic programming, we obtain the following equation in case of shirking,

$$\rho V_E^S = (aX - \frac{1}{2}bX^2) + (\omega + \sigma)(V_U - V_E^S), \quad (2)$$

and in the nonshirking case,

$$\rho V_E^N = (aX - \frac{1}{2}bX^2) - e + \omega(V_U - V_E^N). \quad (3)$$

Substituting for the wage income and solving for V_E^S and V_E^N , we obtain

$$V_E^S = \frac{w + (\omega + \sigma)V_U}{(\rho + \omega + \sigma)},$$

$$V_E^N = \frac{w - e + \omega V_U}{(\rho + \omega)},$$

The *no-shirking condition*, derived from the choice of each worker if $V_E^N \geq V_E^S$, is in equilibrium

$$w = \rho V_U + \frac{(\rho + \omega + \sigma)e}{\sigma}, \quad (4)$$

where, in analogy with equations 2 and 3, ρV_U is

$$\rho V_U = \frac{\omega L}{U}(V_E^N - V_U), \quad (5)$$

where L is the number of working individuals, U is the number of unemployed individuals, and $\frac{\omega L}{U}$ is the probability of job finding among unemployed individuals. We do not consider the case of a positive opportunity cost of working.

Given the definition of the unemployment rate, $u = (1 - \frac{L}{L+U})$, and using equations 4 and 5, we finally obtain the *aggregate no-shirking condition*,

$$w = (1 + \frac{\rho}{\sigma} + \frac{\omega}{\sigma \cdot u}) \cdot e \quad (6)$$

that identifies the minimum wage that guarantees that workers will not shirk. The efficiency-wage is positively related with effort (e), the *quit rate* (ω), and the discount rate (ρ); and negatively related with the probability of being detected shirking (σ) and with the unemployment rate (u). Since we do not further explore the role of effort in determining the equilibrium in the labour market we normalize $e = 1$.

The *no-shirking condition* states that the lower the rate of unemployment, the shorter is the expected time of searching for a job when unemployed, to be fired is therefore less costly and shirking becomes a better option. Firms should therefore offer higher wages to counter balance the more convenient shirking option.

As far as we are concerned, the *aggregate no-shirking condition* can be reduced to the equilateral hyperbola

$$w = \theta_1 + \theta_2 \cdot u^{-1} \quad (7)$$

that goes to $+\infty$ when $u \rightarrow 0$ and has an horizontal asymptote at $(\theta_1 + \theta_2)$ when $u \rightarrow 1$, where $\theta_1 = (1 + \frac{\rho}{\sigma})$ and $\theta_2 = \frac{\omega}{\sigma}$.

2.2 Two countries, three regions oligopoly

Let now locate the \bar{N} individuals in two identical countries, an Home country and a Foreign country (denoted by an asterisk). The Home country has a center-periphery structure, with - for simplicity - one region being the center (denoted by a dot) and one region being the periphery (denoted by a ring), while the Foreign country - that we leave in the background - has an unspecified regional structure. In other words, there are two regions in the Home country, and one region in the Foreign country, and workers cannot move from one region to the other, both nationally and internationally. This

assumption of no spatial arbitrage in the labour market would be relaxed later on.

Both countries are endowed with the same amount of resources $\frac{1}{2}\bar{N} \equiv N \equiv N^*$, that are equally distributed among the two regions in the Home country, $\frac{1}{2}N \equiv \dot{N} \equiv \dot{N}$. In the Home country individuals can be employed in one of the $\frac{1}{2}\dot{n}$ ($\frac{1}{2}\dot{n}$) symmetric immobile firms active in the center (periphery) or be unemployed, so that $\dot{N} \equiv \dot{L} + \dot{U}$ and $\dot{N} \equiv \dot{L} + \dot{U}$, receiving a positive efficiency-wage or a zero reservation wage. The same is true for the Foreign country, so that $N^* \equiv L^* + U^*$.

Let's focus for the moment on the Home country only. Since all individuals have a utility function which is quadratic in consumption, the resulting perceived⁷ inverse demand is

$$p = a - b \cdot X \quad (8)$$

where $X \equiv (n \cdot x + n^* \cdot x^*)$ and $x \equiv \dot{x} + \dot{x}$ is the production of each one of the $n \equiv \dot{n} + \dot{n}$ symmetric home firms serving the home market (and potentially exporting to the foreign market) and x^* is the correspondent for the n^* symmetric immobile foreign firms which are exporting to the home market.⁸

Each firm produces using only labour as a factor of production, so that we can write for each one of the n firms its production function, which is in the center and in the periphery respectively

$$\dot{x} = \dot{\phi} \cdot e \cdot \dot{l}_x = \dot{\phi} \cdot \dot{l}_x \quad (9)$$

$$\dot{x} = \dot{\phi} \cdot e \cdot \dot{l}_x = \dot{\phi} \cdot \dot{l}_x \quad (10)$$

where $\dot{\phi}$ and $\dot{\phi}$ are the marginal physical productivity of labour in the center and in the periphery; \dot{l}_x and \dot{l}_x are the amount of labour employed by firms (fixed cost are ignored for simplicity); and $e = 1$ is the normalized no-shirking effort.⁹

⁷The true inverse demand is $p = \frac{1}{\lambda}[a' - b' \cdot X]$, where λ is the marginal utility of income and is also chosen as the numeraire. In each sector, firms take λ as given, but in general equilibrium it is determined endogenously, so that $a = \frac{a'}{\lambda}$ and $b = \frac{b'}{\lambda}$ vary in general equilibrium but are taken as given by firms. See Neary (2002) for a detailed discussion of the issue.

⁸The setup is well suited for a multi sectoral specification (Neary, 2002), however the absence of sectoral data induced us to disregard this extension of the model. Therefore, we live sectors in the background and we consider x as the production of several sectors defined in its macro dimension.

⁹In principle, e would be zero in case of shirking and a positive value otherwise, but since in equilibrium all firms use wages as a worker-discipline device e always takes a positive value.

We will subsequently differentiate the center from the periphery associating a different level of ϕ to each region, but for the moment it is unnecessary to specify if the central region and the peripheral region differ or not in term of marginal physical productivity of labour, so that $\dot{\phi} \leq \dot{\phi}$.

The Home country employment-unemployment identity is

$$n \cdot l_x \equiv (1 - u) \cdot N \quad (11)$$

where N is the size of the Home labour force, $n \cdot l_x$ is the number of employed workers, and $u = (1 - \frac{n \cdot l_x}{N})$ is the unemployment rate, that can also be expressed as $u = \frac{\dot{N}}{N} \dot{u} + \frac{\dot{N}}{N} \dot{u}$.

The first-order condition for a maximizing firm that in the center and in the periphery follows a Cournot-Nash strategy, taking its rivals' output as given, is

$$p - \frac{\dot{w}}{\dot{\phi}} = \dot{x} \cdot b \quad (12)$$

$$p - \frac{\dot{w}}{\dot{\phi}} = \dot{x} \cdot b \quad (13)$$

Foreign firms exporting in the Home market would have an analogous expression

$$p - \frac{w^*}{\phi^*} = x^* \cdot \tau \cdot b \quad (14)$$

where $0 \leq \tau \leq 1$ is an *iceberg* trade cost. When $\tau = 1$ no trade costs are present and the Home firms and the Foreign firms are competing on an equal basis in the Home country internal market. When $\tau = 0$ trade costs are prohibitive and no Foreign firms are competing in the Home country internal market. We assume that trade costs are bidirectional, so that $\tau = \tau^*$, and that are binary, $\tau = \tau^* = [0 \vee 1]$.

2.3 Autarkic equilibrium

When trade costs are prohibitive, using equations (8), (12), and (13) we can obtain the best response functions for the center and periphery firms operating in the Home market,

$$\dot{x} = \frac{a - \frac{\dot{w}}{\dot{\phi}}}{b \cdot (1 + \dot{n})} - \frac{\dot{n}}{(1 + \dot{n})} \cdot \dot{x} \quad (15)$$

$$\dot{x} = \frac{a - \frac{\dot{w}}{\phi}}{b \cdot (1 + \dot{n})} - \frac{\dot{n}}{(1 + \dot{n})} \cdot \dot{x} \quad (16)$$

that can be solved in order to obtain the Nash equilibrium for \dot{x} and \dot{x} ,

$$\dot{x} = \frac{a - (1 + \dot{n})\frac{\dot{w}}{\phi} + \dot{n}\frac{\dot{w}}{\phi}}{b \cdot (1 + \dot{n} + \dot{n})} \quad (17)$$

$$\dot{x} = \frac{a - (1 + \dot{n})\frac{\dot{w}}{\phi} + \dot{n}\frac{\dot{w}}{\phi}}{b \cdot (1 + \dot{n} + \dot{n})} \quad (18)$$

The equilibrium is symmetric or not, according to the value of $\frac{\dot{w}}{\phi}$ and $\frac{\dot{w}}{\phi}$. Firms in the center have a larger market share than firms located in the periphery, $\dot{x} \geq \dot{x} \iff \frac{\dot{w}}{\phi} \leq \frac{\dot{w}}{\phi}$. As in Neary (2003), firms in the center are profitable only if $\frac{\dot{w}}{\phi} \leq \frac{a}{1+\dot{n}}$, while firms in the periphery make non-negative profits if $\frac{\dot{w}}{\phi} \leq \frac{a}{1+\dot{n}}$.

Using (9) and (10) we can find the equilibrium level of employment in both regions,

$$\dot{n} \cdot \dot{l}_x = \frac{a - (1 + \dot{n})\frac{\dot{w}}{\phi} + \dot{n}\frac{\dot{w}}{\phi}}{b \cdot (1 + \dot{n} + \dot{n})} \cdot \frac{\dot{n}}{\phi} \quad (19)$$

$$\dot{n} \cdot \dot{l}_x = \frac{a - (1 + \dot{n})\frac{\dot{w}}{\phi} + \dot{n}\frac{\dot{w}}{\phi}}{b \cdot (1 + \dot{n} + \dot{n})} \cdot \frac{\dot{n}}{\phi} \quad (20)$$

Finally, the autarkic system is closed using a regional specification of (11) and (7). Since no regional specificity has been assumed in (7), both regions in the Home country will deal with the same aggregate no-shirking condition.

The system is represented in figure 2, where the four panels represent respectively: (a) the reaction functions of firms in the center and in the periphery (equations 15-16); (b) the production functions in the two regions (equations 9-10); (c) the regional employment-unemployment identity (equation 11); (d) the regional no-shirking condition (equation 7), where the supplementary axis measures the center-periphery wage gap.

[Figure 2 about here]

In order to qualify the differences between the center and the periphery, let's start from the perfectly symmetric case. If firms in the center and in the periphery are perfectly symmetric, i.e. $\frac{\dot{w}}{\phi} = \frac{\dot{w}}{\phi}$, and the two regions are equal in terms of resources and in the number of active firms, the Nash equilibrium

would be located in point 1, along the 45° dotted line, where $\dot{x} = \dot{\hat{x}}$. The labour employed by each single firm is the same in each region, $\dot{l}_x = \dot{\hat{l}}_x$, and corresponds to the projection of point 1 in panel (b). In panel (c) the unemployment rate in the center and the periphery is derived, $\dot{u} = \dot{\hat{u}} = u$, determining in panel (d) the equilibrium regional efficiency-wage rate, $\dot{w} = \dot{\hat{w}} = w$. In the perfectly symmetric case there would be no spatial disparity in regional unemployment in the Home country.

Let's now move to an imperfectly symmetric case, assuming in accordance with the data that the physical productivity in the center is higher than in the periphery, $\dot{\phi} \geq \dot{\hat{\phi}}$.¹⁰ Since firms take macro variables as given, for any wage rate the best response of firms in the center moves upward, defining a *temporary* Nash equilibrium at point 2. The regional productivity gap generates an asymmetric distribution of market shares in favor of firms in the center. If we use the 45° line to project the \dot{x} on the vertical axis of panel (a), we can visualize the asymmetric effect of $\dot{\phi}$ on \dot{x} and $\dot{\hat{x}}$. With respect to the symmetric case, point 2 shows that the increase in \dot{x} is greater than the decrease in $\dot{\hat{x}}$. The respective change is depicted by the two grey arrows.

The effect in the periphery is straightforward. Labour used by each firm decreases, the unemployment rate increases, and the efficiency-wage that firms must pay to disincentivate shirking decreases in correspondence to point 3, along the peripheral no-shirking condition.

The effect in the center is a little bit more complex. The increase in $\dot{\phi}$ has in fact two opposite effects on the labour used by each firm: on the one hand, for any given \dot{x} equation 9 states that \dot{l}_x would decrease proportionally to the increase in $\dot{\phi}$, as it is depicted in panel (b) of figure 2, where the grey straight line represents the changed production function; on the other hand, since \dot{x} has increased, \dot{l}_x would also increase. The second effect would always prevail for small changes in $\dot{\phi}$, so that an increase in productivity always increases the employment level in the center.¹¹

Since \dot{l}_x increases, the unemployment rate decreases, and the efficiency-wage increases in correspondence to point 4, along the central no-shirking condition. The changes in regional unemployment and in regional wages are again depicted by the grey arrows. It is worth noticing that the relative

¹⁰ The regional difference is therefore exogenous on purpose. It could be made endogenous *via* trade links, as in Melitz (2003), if the benefit of strengthening the model would not face the unbearable cost of overwhelming complexity in the general equilibrium link between the production side and the labour side of the model.

¹¹ The condition can be properly derived from equation 25. The second effect is further magnified when international trade is a feasible option for firms in the Home country, since the foreign market offers the opportunity of expanding \dot{x} when the Ricardian comparative advantages are modified due to the increase of $\dot{\phi}$.

changes in unemployment and wages are asymmetric: the decrease in \dot{u} is greater than the increase in $\dot{\hat{u}}$, and the the increase in \dot{w} is greater than the decrease in $\dot{\hat{w}}$. The argument is that the efficiency-wage, induced by the necessity of firms to anticipate workers' shirking behaviour, generates an implicit "wage floor" under which the regional productivity-gap cannot be fully compensated by a regional wage-gap.

The equilibrium in point 2 is however only temporary, because wages have changed in the center and in the periphery and, subsequently, firms should take into account the general equilibrium effect coming from the labour market. The reaction function of firms in the center shifts downward while the reaction function of firms in the periphery shifts upward, defining a new Nash equilibrium in point 5. The relative change in the curves in panel (a) of figure 2 matches the relative change in regional wages.

The final effects are however consistent with the temporary one: *an increase in $\dot{\phi}$ has a positive impact on \dot{l}_x , \dot{w} and $\dot{\hat{u}}$, and a negative impact on \dot{l}_x , $\dot{\hat{w}}$ and $\dot{\hat{u}}$.*

2.4 Productivity, wages and regional unemployment

In the rest of the paper we take the asymmetric case as our setup, so that in the Home country the center is characterized by higher productivity, higher production, higher wages and lower unemployment, with respect to the peripheral region.

Equations (9), (10), (19), (20), and the regional specification of (11) can be transformed so that the system of equations that represents our setup is condensed in the four equation system, in four unknowns, \dot{w} , $\dot{\hat{w}}$, \dot{u} and $\dot{\hat{u}}$:

$$\dot{w} = \theta_1 + \theta_2 \cdot \dot{u}^{-1} \quad (21)$$

$$\dot{\hat{w}} = \theta_1 + \theta_2 \cdot \dot{\hat{u}}^{-1} \quad (22)$$

$$\dot{w} = \left[a - (\dot{N} \cdot b \cdot \dot{\phi}) \frac{(1 + \dot{n})}{\dot{n}} - (\dot{N} \cdot b \cdot \dot{\phi})(1 - \dot{u}) \right] \dot{\phi} + \left[\dot{N} \cdot b \cdot \dot{\phi}^2 \cdot \frac{(1 + \dot{n})}{\dot{n}} \right] \cdot \dot{u} \quad (23)$$

$$\dot{\hat{w}} = \left[a - (\dot{N} \cdot b \cdot \dot{\phi}) \frac{(1 + \dot{\hat{n}})}{\dot{\hat{n}}} - (\dot{N} \cdot b \cdot \dot{\phi})(1 - \dot{\hat{u}}) \right] \dot{\phi} + \left[\dot{N} \cdot b \cdot \dot{\phi}^2 \cdot \frac{(1 + \dot{\hat{n}})}{\dot{\hat{n}}} \right] \cdot \dot{\hat{u}} \quad (24)$$

where the first two equations are the regional no-shirking conditions, and the second two equations are the regional good-market schedules.

It's worth noticing that the regional equilibria cannot be solved independently in the two regions, and that only the last two equations depend on productivity:

$$\frac{\partial \dot{w}}{\partial \dot{\phi}} = - \left[\dot{N} \cdot b \cdot \frac{(1 + \dot{n})}{\dot{n}} (1 - \dot{u}) \right] \dot{\phi} + \frac{\dot{w}}{\dot{\phi}} \geq 0 \quad (25)$$

$$\frac{\partial \dot{u}}{\partial \dot{\phi}} = - \left[\dot{N} \cdot b \cdot (1 - \dot{u}) \right] \dot{\phi} \leq 0. \quad (26)$$

The system 21-24 is represented in the top panel of figure 3, where in the $w - u$ space the two regional no-shirking conditions are two equilateral hyperbola perfectly overlapping and the two positively sloped darker strait lines are the regional good market schedules. The equilibrium in the center is defined by higher productivity, higher wages and lower unemployment (\dot{w}, \dot{u}), while the equilibrium in the periphery is characterized by lower productivity, lower wages and higher unemployment (\dot{w}', \dot{u}').

[Figure 3 about here]

Let's now shock the system through an increase in productivity in the center. The result is the same shown in figure 2, an increase in $\dot{\phi}$ increases the regional wage and unemployment gap. This is visualized in figure 3 by the shift of the grey regional good market schedules: in the center, as shown in equation (25), the schedule shifts upward and the equilibrium becomes (\dot{w}', \dot{u}'), in the periphery, as shown in equation (26), the schedule shifts downward and the equilibrium becomes (\dot{w}, \dot{u}).

A productivity shock in the center has a positive effect on employment and wages in the center and a negative effect on employment and wages in the periphery.

The relative size of the effect on wages and unemployment depends on where the regional good market schedules cross the regional no-shirking conditions. As it is shown in the bottom panel of figure 3, if productivity in both regions is sufficiently high, both regional good market schedules cross the regional no-shirking conditions along their vertical bit. In this case a productivity shock in the center has a positive effects on wages in the center and a negative effect on wages in the periphery, leaving the regional unemployment level almost unchanged.¹²

¹²In that case the system 21-24 reduces to the two equation system 23-24 where $\dot{u} = \dot{u}' = u$. We do not describe the effect on regional unemployment or wage differentials for every possible case, nor we do report the composite effect of regional unemployment rates on the national rate or we elaborate on the different results of symmetric or asymmetric shocks. Even if all these issues are of relevance the analysis is straightforward and does not require any further specification.

The two different cases just described recall the structure of the data plotted in figure 1, so that we can name the two panels of figure 3 the *EU case* (top panel) and the *US case* (bottom panel). We will now show how international trade, labour mobility and institutional norms in the Home labour market can change the results obtained so far.

2.5 Trade and productivity shocks, labour mobility and minimum wages

Trade If trade costs are not prohibitive and Foreign firms sell in the Home market, the best response functions are:

$$\dot{x} = \frac{a - \frac{\dot{w}}{\phi}}{b \cdot (1 + \dot{n})} - \frac{\dot{n}}{(1 + \dot{n})} \cdot \dot{x} - \frac{n^*}{(1 + \dot{n})} \cdot x^* \quad (27)$$

$$\hat{x} = \frac{a - \frac{\dot{w}}{\phi}}{b \cdot (1 + \hat{n})} - \frac{\hat{n}}{(1 + \hat{n})} \cdot \hat{x} - \frac{n^*}{(1 + \hat{n})} \cdot x^* \quad (28)$$

$$x^* = \frac{a - \frac{w^*}{\phi^*}}{b \cdot (1 + n^*)} - \frac{\dot{n}}{(1 + n^*)} \cdot \dot{x} - \frac{\hat{n}}{(1 + n^*)} \cdot \hat{x} \quad (29)$$

and the Nash equilibrium for \dot{x} , \hat{x} , and x^* will be

$$\dot{x} = \frac{a - (1 + \dot{n} + n^*)\frac{\dot{w}}{\phi} + \dot{n}\frac{\hat{w}}{\phi} + n^*\frac{w^*}{\phi^*}}{b \cdot (1 + \dot{n} + \hat{n} + n^*)} \quad (30)$$

$$\hat{x} = \frac{a - (1 + \hat{n} + n^*)\frac{\hat{w}}{\phi} + \hat{n}\frac{\dot{w}}{\phi} + n^*\frac{w^*}{\phi^*}}{b \cdot (1 + \hat{n} + \dot{n} + n^*)} \quad (31)$$

$$x^* = \frac{a - (1 + \dot{n} + \hat{n})\frac{w^*}{\phi^*} + \dot{n}\frac{\dot{w}}{\phi} + \hat{n}\frac{\hat{w}}{\phi}}{b \cdot (1 + \dot{n} + \hat{n} + n^*)} \quad (32)$$

The opening of the Home market to international trade has the immediate effect of increasing competition and reducing the market power of all Home firms regardless of their location. As it is shown in equations (27) and (28) the entrance of foreign firms shifts downward the best response function of firms in the center and in the periphery, and the symmetry of the shift depends only on the level of competition in the two regions (i.e. the number of firms \dot{n} and \hat{n}). The drop in \dot{x} and \hat{x} is higher the lower is $\frac{w^*}{\phi^*}$ with respect to $\frac{\dot{w}}{\phi}$ and $\frac{\hat{w}}{\phi}$. In any case, the increase in x^* reduces \dot{x} and \hat{x} , causing an increase in \dot{u} and \hat{u} , and a drop in \dot{w} and \hat{w} , even if $\frac{w^*}{\phi^*} \geq \frac{\hat{w}}{\phi} \geq \frac{\dot{w}}{\phi}$. As before, the relative effect on unemployment and on wages depends on if the Home country is a

EU case or a *US case*. Referring to figure 3, if in the top panel the central region and the peripheral region are hit by the same trade shock, the effect on unemployment would be however asymmetric. In the center the shock is absorbed mainly by a drop in wages, while in the periphery the shock would affect the unemployment rate more severely. In general, in a country with high average regional productivity the changes in trade integration or the variability in openness do not affect the unemployment rate.

In the setup we defined so far, the prevalent effect of trade integration is an increase in competition in the Home market. The reduction in trade costs allows Foreign firms to export more to the Home country, and that makes the Home production sold at Home shrinking, Home wages dropping and Home unemployment rising. Referring again to figure 3, both regional good market schedules shift downward.

However that is not the only effect brought about by trade integration. A second and opposite effect comes from the ability to catch the opportunity of a larger market, since also the Home firms could sell abroad if the Home country has an export potential. In other words, if $\frac{w^*}{\phi^*} \geq \frac{\dot{w}}{\phi} \geq \frac{\dot{w}}{\phi}$ the negative effect of a trade shock can be reversed. In fact, the reduction in trade costs gives the Home country an advantage in terms of export opportunities that can outweigh the negative effect of an increase in imports from the Foreign country. If the country has a relevant export potential, x would rise in both regions, as would w , and the regional and the national equilibrium rate of unemployment would decrease.

Finally, an interesting case is when $\frac{\dot{w}}{\phi} \leq \frac{w^*}{\phi^*} \leq \frac{\dot{w}}{\phi}$. In this particular case the center is advantaged by the process of trade integration and the periphery is disadvantaged. The effect on regional unemployment is again not symmetric: \dot{u} remains unchanged, while \dot{u} increases.

Productivity shock Let's now examine the effects of an increase in $\dot{\phi}$ when the Home country is open to trade. The opportunity offered by international trade can in fact partially modify the negative effect in the periphery of a productivity shock in the center. There would be four distinct effects.

The first one comes from international competition. Since the number of firms is fixed at n and n^* , an increase in $\dot{\phi}$ affects the quantity of x^* exported by the Foreign firms in the Home market. *Domestic production substitutes Foreign exports.*

The second effect comes from national competition. As it has been shown in panel (a) of figure 2, an increase in $\dot{\phi}$ increases \dot{x} and reduces \dot{x} . The regional composition of domestic production does not remain unchanged. *Production in the center substitutes production in the periphery.*

The third effect comes from general equilibrium and it is quite relevant since it can reverse the previous negative effect hitting the periphery. An increase in $\dot{\phi}$ reduces \dot{x} , generating an increase in \dot{u} and a reduction in \dot{w} . The periphery loses in the domestic game but the reduction in \dot{w} increases its advantage in the trade contest. *Export by the periphery substitutes production in the Foreign country.* The effect would be larger the larger is the export potential of the periphery.

The fourth effect (Neary, 2002) comes from the demand for labour in the Foreign market and it is in contrast to the previous one: the fall in x^* reduces the demand for labour in the Foreign country, and w^* falls. *Foreign exports substitute domestic production.*

As in autarky, the total effect depends on if the Home and the Foreign country are more similar to the *EU case* or to the *US case*. Some of the effects would be null or fully active depending on where the two regional good-market schedules cross the regional no-shirking condition. For example, if in the *EU case* the productivity of the peripheral region is so low that the good-market schedule crosses the regional no-shirking condition in its horizontal segment, the third effect would be null, since the shift of the good-market schedule would only affect the unemployment rate in the periphery, leaving \dot{w} unchanged. Ricardian comparative advantages remain as well unchanged leaving the periphery in a no-export potential lock-in.

Labour mobility Until now we assumed that labour was inter-regionally immobile. In that case regional wage and unemployment disparities could persist along time, with the periphery steadily lagging behind. With labour mobility regional disparities can be reduced via migration. In fact, Blanchard and Katz (1992), Decressin and Fatàs (1995) and Fatàs (1998) point out that the degree of labour mobility modifies the channels through which shocks hit labour market equilibrium in the *US case* differently from the *EU case*. So we should consider, at least for the *US case*, the possibility of workers to move from one region to the other when the former is hit by a negative shock.

A way of introducing in the model a mechanism reminiscent of labour mobility is through contemporaneous and opposite changes in \dot{N} and \dot{N} in presence of regional wage or unemployment differentials. For example, if $\dot{w} > \dot{w}$ workers can move from the periphery to the center until when the wage gap persists. Referring to figure 3, this change in regional labour endowment induces a convergence in regional wages due to the simultaneous shift of the center good-market schedule downward and of the periphery good-market schedule upward.¹³ Thus, *migration induces convergence in regional wages*

¹³The shifts in the good-market schedules are however not parallel since also the linear

and unemployment rates in countries with high inter-regional mobility of labour.

Minimum wages Institutional wage setting, the introduction of a minimum wage, and wages in the periphery depending on wages in the center all these wage schemes can partially modify the results of the model.¹⁴

Let's just examine how the existence of a downward rigidity in wages can modify the effect of a productivity shock in the regional labour market equilibria. As we said, the presence of a minimum wage, \bar{w} , only partially modify the structure of the model, since the very existence of a wage curve induced by the necessity of firms to anticipate workers' shirking behavior generates an implicit minimum wage in correspondence with the horizontal asymptote of the no-shirking condition. If $\bar{w} \leq \theta_1 + \theta_2$, the minimum wage is not binding and nothing changes in the structure of the model. If $\bar{w} > \theta_1 + \theta_2$ the minimum wage produces a kink in the no-shirking condition. The effect is therefore a reduction in the level of \dot{u} necessary for a productivity shock in the periphery to affect \dot{w} . *Minimum wages bring about an over reaction of unemployment to productivity shocks*, especially in peripheral regions.

3 From Theory to Empirics

Let's now summarize the main findings of the theoretical model that can be subjected to empirical validation, using EU and US data.

The first one is the existence of a nonlinear relationship between productivity and unemployment in the *EU case*, while no relationship should exist in the *US case*.

The second one is the existence of a nonlinear relationship between wages and unemployment in the *EU case*, while no relationship should exist in the *US case*. Once controlling for productivity changes, the relationship should be weakened in the *EU case*, since productivity changes are only partially compensated by wage changes.

The third one is that export potential has a negative effect on unemployment, especially in the *EU case*.

coefficient of (23) and (24) change when \dot{N} and \dot{N} change. Even if it is possible to show cases in which migration generates *divergence*, the general case is *convergence* in regional wages, *but* migration does not induce complete equalization in regional wage and unemployment rates.

¹⁴ Pench *et al.* (1999) show that the presence of a *country-wide wage floor* can generate an equilibrium in which the unemployment rate is permanently higher in the low-productivity regions.

In solving the General Oligopolistic Equilibrium efficiency-wage model represented by the system of equations 21-24, it is convenient to assume ϕ to be a continuous variable, and that each country is defined by a continuous of regions associated with ϕ . The regional interaction previously highlighted is still there but it is masked by aggregation of regional data. The solution of the system yields to a nonlinear model of the form

$$E(u|\mathbf{C}, \phi, w) = \sum_{j=1}^J C_j + g_1(w) + g_2(\phi), \quad (33)$$

where \mathbf{C} is a matrix of dimension J of control variables depending on region and country characteristics, such as N , n , a , b , and export potential, labour mobility, and institutional wage setting.

The theoretical relationship between productivity and unemployment is nonlinear, as it is the one between wages and unemployment coming from the no-shirking condition. The form of nonlinearity of $g_1(w)$ and $g_2(\phi)$ depends on regional specificities, so that we leave it as arbitrary.

In the following section we perform an econometric analysis to test the effect of labour productivity (defined as the ratio between gross product and total employment), wages (i.e. labour compensation per employee), and export potential on regional unemployment rates (i.e. the ratio between unemployed people and total labor force). Since no data is available on regional export, a set of industry mix variables is used to reflect the influence of a region's export potential on its product demand, and hence on its unemployment rate (see also Taylor and Bradley (1997), on this interpretation). As in many of the empirical studies on regional unemployment (Elhorst, 2003), we also add to (33) the participation rate (i.e. the ratio between labour force and working population) as a covariate. Finally, in the European case we include country dummies to take account of national specificities.

4 Empirical Evidence

4.1 A Semiparametric Specification

Empirical works on regional unemployment usually impose an essentially (log)linear relationship between unemployment rates and a set of factors of labour supply, labour demand and wage-setting (Elhorst, 2003). This type of model is usually estimated through ordinary least squares.

Our theoretical model, instead, introduces certain nonlinearities in the behavior of the "fundamental" variables, that is wages (w) and labour productivity (ϕ). Thus, we argue that a partial linear (PLR) semiparametric

specification for the regional unemployment regression function must be applied here. As is shown below, a test of the standard linear parametric specification against the semiparametric PLR alternative found the latter to be an adequate representation of the European regional data. By using a particular version of the PLR model that allows for additive semiparametric components - the additive PLR model – we are able to obtain graphical representations of these components that shed light into the nonlinear behavior of the "fundamental" variables. Indeed, additivity ensures that the effects of each of the model predictors can be interpreted net of the effects of the other predictors, just as in linear multiple regression. The semiparametric PLR model can be written as

$$u_i = \alpha + \mathbf{C}_i^T \beta + g_1(w_i) + g_2(\phi_i) + \varepsilon_i \quad i = 1, \dots, n; \quad (34)$$

where, i stands for region i , ε_i is an i.i.d. stochastic term and $g_s(\dots)$, ($s = 1, 2$), is an unknown function. We take the shares of agriculture and services employment on total employment, the participation rate, and country dummies as controls (C) entering the model linearly, whereas we allow the wage and the labour productivity variables to make up the nonlinear components of the model. We use local regression techniques to estimate $\hat{g}_s(\dots)$. Specifically, we use a *lowess* locally weighted regression smoother¹⁵, which is a particular specification of the local polynomial regression model (Cleveland, 1979; Cleveland and Devlin, 1988).

In this paper we will use the estimates of individual components of $g_s(\dots)$, and their respective 95% confidence intervals as a diagnostic to detect the possible nonlinear shapes of these two components in the context of a cross-region unemployment regression.

4.2 Data

European regional data are extracted from the EUROSTAT-REGIO data system at the NUTS-2 spatial level, except for Germany and United Kingdom

¹⁵ The *lowess* can be understood as a tri-cube kernel scatterplot smoother, adapting to local fluctuations in the density of the independent variable. The combination of three features - nearest neighbours, a smooth weight function (the tri-cube kernel), and forming the local expected value via locally weighted regressions - helps local regression outperform many other scatter-plot smoothers, such as moving averages and overlapping regressions. For a comprehensive review of the literature on nonparametric regression analysis and generalized additive models see Hastie and J.Tibshirani (1990).

that provide complete information only at the NUTS-1 level.¹⁶

Data on gross product and standard employment, used to calculate regional labour productivity, compiled according to the last European economic account review (ESA95), are available only for the period 1995-2000: this period represents the time series constraint of the empirical analysis. As the conclusions of our model apply to long-term equilibrium, data are averaged across that period. Therefore, our European sample includes 152 regions in 15 European countries: Belgium (11 regions), Germany (16), Greece (13), Spain (15), France (22), Italy (20), The Netherlands (12), Austria (9), Portugal (5), Finland (6), Sweden (8), United kingdom (12), Denmark (1), Ireland (1) and Luxemburg (1) (see Appendix).¹⁷

For the USA, we use data at the State level (48 States), since information on labour productivity at a finer level of spatial aggregation is not available.¹⁸ Moreover, labour productivity of the US States is calculated differently from that of European regions: in the last case we use standard employment (i.e. equivalent full-time employment), while in the US case we have information only on the number of employed persons. The source of data on gross State product, employment (both total and sectoral) and wage and salary disbursements is the Bureau of Economic Analysis (Regional Accounts Data); the source of data on unemployment rates is the U.S. Department of Labour (Bureau of Labor Statistics - Local Area Unemployment Statistics).

4.3 Econometric Results

Table 1 shows the regression results of the linear specification for the European regions (with and without Greek and Portuguese regions) and for the US States. In the case of European regions, the OLS coefficients for the labour productivity, the industry mix variables and the participation rate are significant at the 5% level and with the expected sign, whereas the one for the wages is not significant. In the case of the US States, only the coefficients for the participation rate and the share of agriculture employment on total employment are significantly different from zero.

The evidence of a negative effect of the participation rate is perfectly coherent with the results of previous analyses on regional unemployment

¹⁶ NUTS is an acronym for "Nomenclature of Territorial Units for Statistics". In this nomenclature, NUTS-1 means European Community Regions while NUTS-2 means Basic Administrative Units and NUTS-3 corresponds to provinces. Luxemburg, Ireland and Denmark may be considered as NUTS-2 regions according to Eurostat.

¹⁷ As it is usual, we exclude Balears, Canaries and Ceuta y Melilla (Spain), Guadeloupe, Martinique, Reunion (France), Acores and Madeira (Portugal).

¹⁸ As it is usual, we exclude Alaska, District of Columbia and Hawaii from the sample.

(Elhorst, 2003). This effect is usually interpreted as follows: factors determining low participation rates in a particular region also reflect relatively low investments in human capital and low commitment to working life, resulting in higher risk for people with these characteristics to become unemployed.

As we wrote in section 3, industry-mix variables (employment shares in agriculture and in services) are used to reflect the influence of a region's export base. The estimated coefficients of both variables are significantly positive in the case of European regions, while only the coefficient for the employment share in agriculture is significant in the case of the US States. This evidence indicates that those regions in Europe and those States in the US with a higher proportion of workers in the industry sectors (which are also the most export-oriented sectors) tend to have lower unemployment rates than regions (States) with a lower proportion.

Traditionally, higher wages are believed to have a positive effect on labour supply and a negative effect on labour demand, hence unemployment will increase if wages go up. Models of unemployment based on efficiency wages, as well as matching models or bargaining models, all generate a negative relation between the level of real wages and unemployment rates. In our case, the coefficient on wages is never significant: wages do not have any effect on regional unemployment. However, if we exclude labour productivity from our specification, this coefficient becomes negative and significant in the case of Europe, thus confirming the prediction of the efficiency wage model; while the results for the US States are coherent with the traditional view. These results are not new in the literature on regional unemployment (Elhorst, 2003). However, some authors (Taylor and Bradley, 1997) have pointed out that firms are concerned not with the wage *per se*, but with the wage in relation to labour productivity, since productivity differences tend to compensate for wage differences across regions. These authors, therefore, propose to consider unit labour costs (i.e. the ratio between wages and labour productivity) instead of wages. None of these empirical studies have, however, tried to identify the separate effect of wages and labour productivity.

The labour productivity OLS coefficient is negative and significant only in the case of Europe. This finding would offer some support to the notion that in Europe labour productivity affects unemployment rates negatively at a constant rate. However, we cannot accept this as a final result. Indeed, as discussed above, our theoretical model predicts a negative but nonlinear relationship between labour productivity and regional unemployment rates. This yields us to discuss the nonlinear nonparametric estimation results.

Table 2 shows the regression results of the semiparametric PLR formulation, where the wages and the labour productivity are treated as nonlinear nonparametric components. In the case of Europe, the fit of the PLR model

Table 1: Cross section OLS regressions for regional unemployment rates: European regions and US states

	EU15 (NUTS2)		US States	
Constant	2.314 (0.002)	1.885 (0.009)	2.975 (0.000)	3.230 (0.000)
Wages	0.121 (0.815)	-1.080 (0.000)	-0.177 (0.556)	0.293 (0.027)
Labour Productivity	-1.108 (0.007)		0.496 (0.104)	
Share of agricultural employment	0.085 (0.017)	0.076 (0.038)	0.191 (0.002)	0.196 (0.001)
Share of service employment	1.382 (0.000)	1.460 (0.000)	0.087 (0.834)	
Participation rate	-1.794 (0.000)	-1.539 (0.003)	-2.575 (0.000)	-2.716 (0.000)
N	152	152	48	48
SSR	0.346	0.355	0.117	0.118
R^2	0.630	0.610	0.691	0.669

Notes: p -values are given in parenthesis. Regression estimates for the European regions include country dummy variables.

improves and all coefficients are statistically significant. Table 2 also reports the results of the specification test for the null hypothesis of a linear model against the PLR alternative. The results suggest that in the case of Europe the null hypothesis can be rejected at the 5% level.

Having established that the PLR specification is the most preferred formulation, we proceed to discuss the results for the nonlinear nonparametric components, obtained for the sample of EU regions. The *lowess* regression is specified as a 1-degree polynomial with a span of 0.5 (each local neighborhood contains 50% of the observations) in the case of $\hat{g}(w)$ and as a 2-degree polynomial with a span of 0.5 in the case of $\hat{g}(\phi)$. The choice of the polynomial degree and of the span are always based on the distribution of the error term. The two parameters are chosen at level indicated by an orthogonal deviance of residuals with respect to fitted values (Hastie and J.Tibshirani, 1990).

These estimates are presented graphically in figure 4 and 5 alongside 95% pointwise confidence intervals, $\hat{g}_s(\dots) \pm 2\hat{\sigma}[\hat{g}_s(\dots)]$. The vertical axis reports the scale of relative regional unemployment rates; the horizontal axis reports

the scale of relative regional wages and productivity levels.

Table 2: Cross section PLR regressions for regional unemployment rates: European regions and US States

	EU15 (NUTS2)	EU15 (NUTS2) without Greece and Portugal	US States
Constant	1.632 (0.026)	0.565 (0.459)	3.517 (0.000)
Wages	See fig. 4	See fig. 6	See fig. 8
Labour Productivity	See fig. 5	See fig. 7	
Share of agricultural employment	0.056 (0.141)	0.125 (0.066)	0.196 (0.001)
Share of service employment	1.247 (0.000)	1.669 (0.000)	
Participation rate	-1.881 (0.000)	-1.445 (0.007)	-2.736 (0.000)
N	152	134	48
SSR	0.343	0.319	0.119
R^2	0.641	0.717	0.670
F test for linearity	3.802 (0.053)	9.193 (0.000)	0.103 (0.750)

Notes: p -values are given in parenthesis. The regression estimates for the European regions include country dummy variables. At the bottom of the table, F test for the linearity hypothesis against the PLR alternative are reported.

The results are quite revealing. On the one hand, an F test suggests that there is not a significant impact of wages on regional unemployment rates, thus confirming the OLS results: the F statistics is equal to 0.818 and its p -value is 0.490.¹⁹ Figure 6 graphically show the lack of any relationship between the two variables. On the other hand, the *lowess* results suggest that, in the case of European regions, the unemployment rate is strongly related with the labour productivity levels: the F statistics is equal to 3.709 with a p -value of 0.006. Surprisingly, figure 5 shows that unemployment rates increase for very low levels of labour productivity (precisely for relative levels lower than 0.5). An inspection of the data set reveals that this positive

¹⁹ The F test in a nonparametric estimation has the same meaning of the F test for the evaluation of the explicative power of each independent variable in the linear regression models.

relation is confined to all Portuguese and to some Greek regions. A part from these few regions, the rest of the European regional sample shows a very clear path: the unemployment rate declines with labour productivity, as the negative OLS coefficient would suggest. However, the relationship between the two variables is highly nonlinear: as labour productivity increases, the unemployment rate drops steeply, before nearly levelling out at higher levels of productivity.

The results remarkably change when we exclude Greek and Portuguese regions.²⁰ In this case, the *lowess* regression is specified as a 2-degree polynomial with a span of 0.75 (each local neighborhood contains 75% of the observations) both in the case of $\hat{g}(w)$ and of $\hat{g}(\phi)$. Now, figure 6 and 7 shows graphically the results of the two nonparametric terms. The F tests strongly confirm the results of non-significant effect of wages (the F statistics is 1.587 with a p -value of 0.202) and of a significant impact of labour productivity (the F statistics is 3.163 with a p -value of 0.048). Using this reduced sample, however, the nonlinear relationship between regional unemployment and labour productivity appear much clearer (see figure 7).

The last column of table 2 presents the PLR results of the semiparametric formulation for the US States. The model is now specified without the labour productivity variable. Figure 8 shows graphically the *lowess* result for wages. The F test confirms the significant impact of wages on unemployment rates in the US; the F statistics is 1.391 with a p -value of 0.076). Unlike the European case, however, the null hypothesis on linearity cannot be rejected.

As a concluding comment, we can say that in the case of European regions the relationship between unemployment and labour productivity is highly nonlinear and asymmetric, while no relation emerges in the US case.

5 Concluding remarks

In this paper we explore the link between labour productivity and regional unemployment differentials. The many empirical analyses on regional unemployment that preceded our contribution have proposed a large set of explanatory variables while never explicitly considering labour productivity as a relevant explanatory factor of regional unemployment (Elhorst, 2003). In this paper, we have shown how this covariate largely explain wide and persistent regional unemployment disparities in Europe.

The predictions of a General Oligopolistic Equilibrium efficiency wage model of a nonlinearity between labour productivity and unemployment is

²⁰ Previous studies by (Blanchard and Portugal, 2001) and (Puga, 2002) reported and discussed the anomalies of Portuguese and Greek data on unemployment.

confirmed by the European data. A negative relation does exist in the case of low-productivity regions (the 'periphery'), while no relation occurs in the case of high-productivity regions (the 'center'). The argument is that the efficiency wage, induced by the necessity of firms to anticipate workers' shirking behavior, generates a wage-floor under which the productivity gap cannot be compensated by a wage gap.

So for European regions, the unemployment rate declines with labour productivity for low levels of labour productivity (the 'periphery'). As productivity increases over the EU average (the 'center'), the unemployment rate does not appear to be any more affected by labour productivity differentials. In the US case, no significant relationship between these variables have been found.

In this case the argument runs as follow: when the core and the periphery are both characterized by high levels of labour productivity (as in the the US), the wage floor induced by efficiency wages is not binding and productivity differentials are more likely to be compensated by wage differentials.

The presence of institutional factors such as minimum wages set at the national level, may reinforce the asymmetric effect in some middle productivity European countries (the ones that lie along the negatively-sloped arch of the efficiency-wage curve). On the other hand, regional labour mobility in the US facilitates the reduction in dispersion of regional wages and unemployment rates. Finally, in regions with high export potential the opportunity related to a large international market fosters the role of productivity and reduce the asymmetry between productivity and unemployment.

Some economic policy implications for the European case can be associated to our results.

The most relevant one is that unemployment policies should be set at the regional level. The same policy has in fact different implications according to the level of regional labor productivity and export potential.

The most common proposal is the regional de-centralisation of the wage-setting process (Pench *et al.*, 1999). If wages followed productivity more quickly, the competitiveness of peripheral regions would be less penalized and the employment and unemployment conditions within these regions would improve. However, if the downward wage rigidity does not entirely reflect the institutional mechanism, but can be also attributed to efficiency wages, then the adjustment process discussed above cannot properly work.

The asymmetry in the relationship between unemployment and productivity makes evident that the reduction in the regional unemployment gap can be pursued through policies that increase labour productivity at the periphery level (such structural and cohesion funds) and the periphery export potential.

Finally, if this process is also followed by a higher labour mobility of workers from the periphery to the center, regional unemployment disparities would tend to decrease even faster. Given the very low workers' propensity to migrate from the periphery to the center, that would be possible only if the upward wage rigidities in the center were relaxed. A side effect of this dynamic process would be that the labour markets of the regions in the center of Europe would become more similar to US States' one.

Appendix: European Regions and US States

Belgium	Spain	Italy	Portugal
Bruxelles-Brussel	Galicia	Piemonte	Norte
Antwerpen	Asturias	Valle d'Aosta	Centro
Limburg	Cantabria	Liguria	Lisboa e V.do Tejo
Oost-Vlaanderen	Pais Vasco	Lombardia	Alentejo
Vlaams Brabant	Navarra	Trentino-Alto Adige	Algarve
West-Vlaanderen	Rioja	Veneto	Finland
Brabant Wallon	Aragon	Fr.-Venezia Giulia	Ita-Suomi
Hainaut	Madrid	Emilia-Romagna	Vali-Suomi
Liege	Castilla-Leon	Toscana	Pohjois-Suomi
Luxembourg	Castilla-la Mancha	Umbria	Uusimaa
Namur	Extremadura	Marche	Etela-Suomi
Denmark	Cataluna	Lazio	Aland
Germany	Com. Valenciana	Abruzzo	Sweden
Baden-Wuerttemberg	Andalucia	Molise	Stockholm
Bayern	Murcia	Campania	Ostra Mellansverige
Berlin	France	Puglia	Sydsverige
Brandenburg	Ile de France	Basilicata	Norra Mellansverige
Bremen	Champagne-Ard.	Calabria	Mellersta Norrland
Hamburg	Picardie	Sicilia	Ovre Norrland
Hessen	Haute-Normandie	Sardegna	Smaland med oarna
Mecklenburg-Vorpomm.	Centre	Luxemburg	Vastsverige
Niedersachsen	Basse-Normandie	The Netherlands	United Kingdom
Nordrhein-Westfalen	Bourgogne	Groningen	North East
Rheinland-Pfalz	Nord-Pas de Calais	Friesland	North West
Saarland	Lorraine	Drenthe	Yorkshire and the Humber
Sachsen	Alsace	Overijssel	East Midlands
Sachsen-Anhalt	Franche-Comte	Gelderland	West Midlands
Schleswig-Holstein	Pays de la Loire	Flevoland	Eastern
Thuringen	Bretagne	Utrecht	London
Greece	Poitou-Charentes	Noord-Holland	South East
Anatoliki Makedonia	Aquitaine	Zuid-Holland	South West
Kentriki Makedonia	Midi-Pyrenees	Zeeland	Wales
Dytiki Makedonia	Limousin	Noord-Brabant	Scotland
Thessalia	Rhone-Alpes	Limburg	Northern Ireland
Ipeiros	Auvergne	Austria	
Ionia Nisia	Languedoc-Rouss.	Burgenland	
Dytiki Ellada	Prov-Alpes-Cote d'Azur	Niederosterreich	
Stereia Ellada	Corse	Wien	
Peloponnisos	Ireland	Karnten	
Attiki		Steiermark	
Voreio Aigaio		Oberosterreich	
Notio Aigaio		Salzburg	
Kriti		Tirol	
		Vorarlberg	

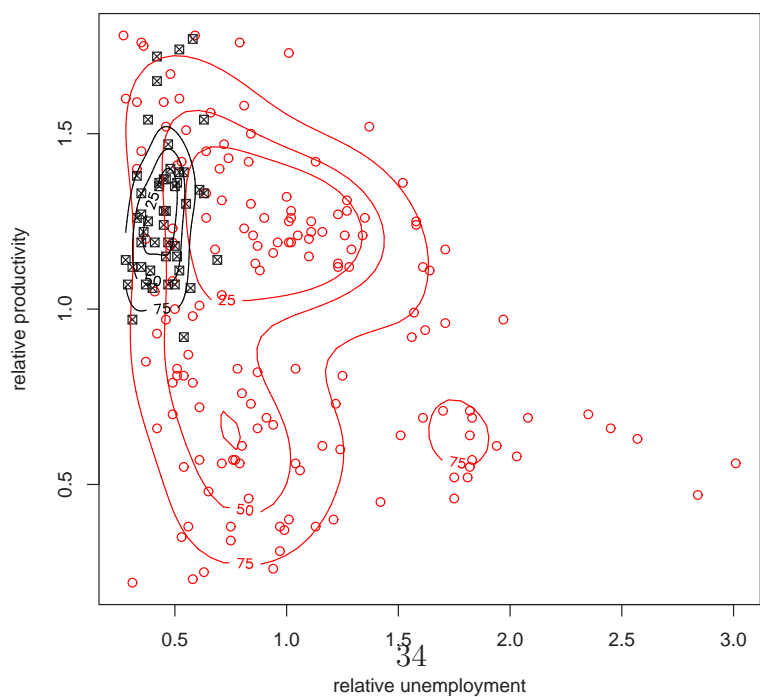
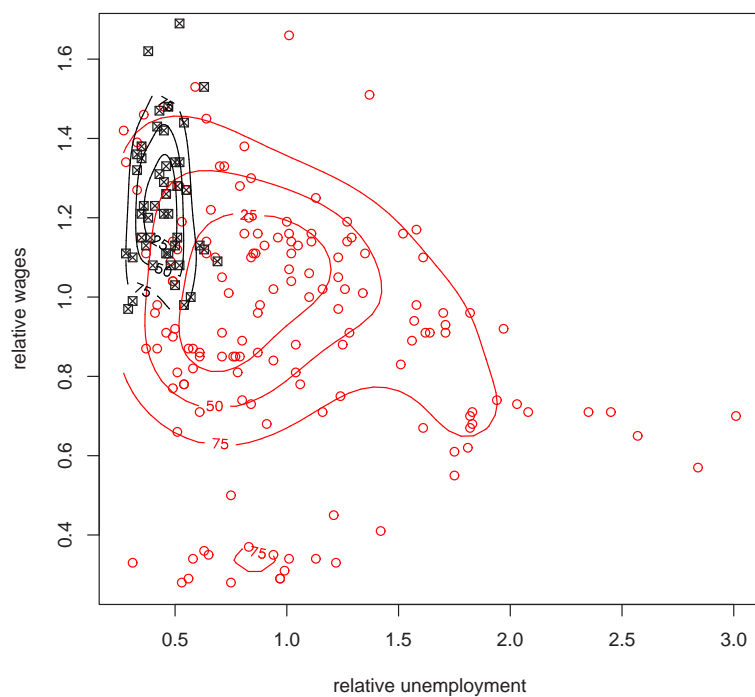
Alabama	Iowa	Nebraska	Rhode Island
Arizona	Kansas	Nevada	South Carolina
Arkansas	Kentucky	New Hampshire	South Dakota
California	Louisiana	New Jersey	Tennessee
Colorado	Maine	New Mexico	Texas
Connecticut	Maryland	New York	Utah
Delaware	Massachusetts	North Carolina	Vermont
Florida	Michigan	North Dakota	Virginia
Georgia	Minnesota	Ohio	Washington
Idaho	Mississippi	Oklahoma	West Virginia
Illinois	Missouri	Oregon	Wisconsin
Indiana	Montana	Pennsylvania	Wyoming

References

- Basile R., de Nardis S. and Girardi A. (2003) Dinamiche di sviluppo nel Centro e nella Periferia d'Europa: il ruolo delle politiche strutturali, *Rivista di Politica Economica*, July-August, 89–134.
- Bean C.R. (1994) European Unemployment: A Survey, *Journal of Economic Literature*, 32, 2, 573–619.
- Blanchard O. and Portugal P. (2001) What Hides Behind an Unemployment Rate: Comparing Portuguese and U.S. Labor Markets, *American Economic Review*, 91, 1, 187–207.
- Blanchard O.J. and Katz L.F. (1992) Regional evolutions, *Brooking Papers on Economic Activities*, , 1, 1–75.
- Blanchard O.J. and Katz L.F. (1999) Wage Dynamics: Reconciling Theory and Evidence, *American Economic Review*, 89, 2, 69–74.
- Blanchflower D.G. and Oswald A.J. (1994) *The Wage Curve*, The MIT Press, Cambridge, MA.
- Bowman A.W. and Foster P.J. (1993) Adaptive smoothing and density-based tests of multivariate normality, *Journal of the American Statistical Association*, 88, 529–537.
- Cleveland W.S. (1979) Robust locally-weighted regression and scatterplot smoothing, *Journal of the American Statistical Association*, 74.
- Cleveland W.S. and Devlin S.J. (1988) Locally-Weighted Regression: an Approach to Regression Analysis by Local Fitting, *Journal of the American Statistical Association*, 83.
- Copeland B.R. (1989) Efficiency wages in a ricardian model of international trade, *Journal of International Economics*, 27, 2-3, 221–244.
- Decressin J. and Fatàs A. (1995) Regional Labor Market Dynamics in Europe, *European Economic Review*, 39, 1627–55.
- EC (2002) Employment in europe 2002, Technical report, European Commission - DG Employment and Social Affairs, Brussels.
- Elhorst P.J. (2003) The mystery of regional unemployment differentials: A survey of theoretical and empirical explanations, *Journal of Economic Surveys*, 17, 5, 709–748.

- Fatàs A. (1998) Intranational labour migration, business cycles and growth.
- Hastie T.J. and J.Tibshirani R. (1990) *Generalized Additive Models*, Chapman and Hall, New York.
- Hoon H.T. (2001) Adjustment of wages and equilibrium unemployment in a ricardian global economy, *Journal of International Economics*, 54, 193–209.
- Kostoris Padoa Schioppa F. and Basile R. (2002) Unemployment Dynamics in the "Mezzogiornos of Europe": Lessons for the Mezzogiorno of Italy, *CEPR WP. n.3594*.
- Martin R. (1997) Regional unemployment disparities and their dynamics, *Regional Studies*, 31, 237–252.
- Melitz M.J. (2003) The impact of trade on intra-industry reallocations and aggregate industry productivity, *Econometrica*, , 3.
- Neary P. (2002) Globalization and market structure, *Journal of the European Economic Association*, 1, 4, 1–28.
- Neary P. (2003) Competitive versus comparative advantage, *The World Economy*, forthcoming.
- Niebuhr A. (2002) Spatial Dependence of Regional Unemployment in the European Union, HWWA discussion paper, 186.
- Overman H.G. and Puga D. (2002) Regional Unemployment Clusters. Nearness Matters Within and Across Europe's Borders, *Economic Policy*, 115–147.
- Pench L., Sestito P. and Frontini E. (1999) Some Unpleasant Arithmetics of Regional Unemployment in the EU - Are There any Lessons for EMU?, Technical Report 134, European Commission - Economic Papers, Brussels.
- Puga D. (2002) European Regional Policies in Light of Recent Location Theories, *Journal of Economic Geography*, 2, 372–406.
- Shapiro C. and Stiglitz J. (1984) Equilibrium Unemployment as a Worker Discipline Device, *American Economic Review*, 74, 3, 433–444.
- Taylor J. and Bradley S. (1997) Unemployment in Europe: A Comparative Analysis of regional Disparities in Germany, Italy and the U.K., *Kyklos*, 50, 221–245.

Figure 1: Regional Wage-Productivity-Unemployment in Europe (red) and the US (black)



34
Fonts: Eurostat, US Bureau of Economic Analysis and Department of Labour.

Figure 2: The Home country equilibrium

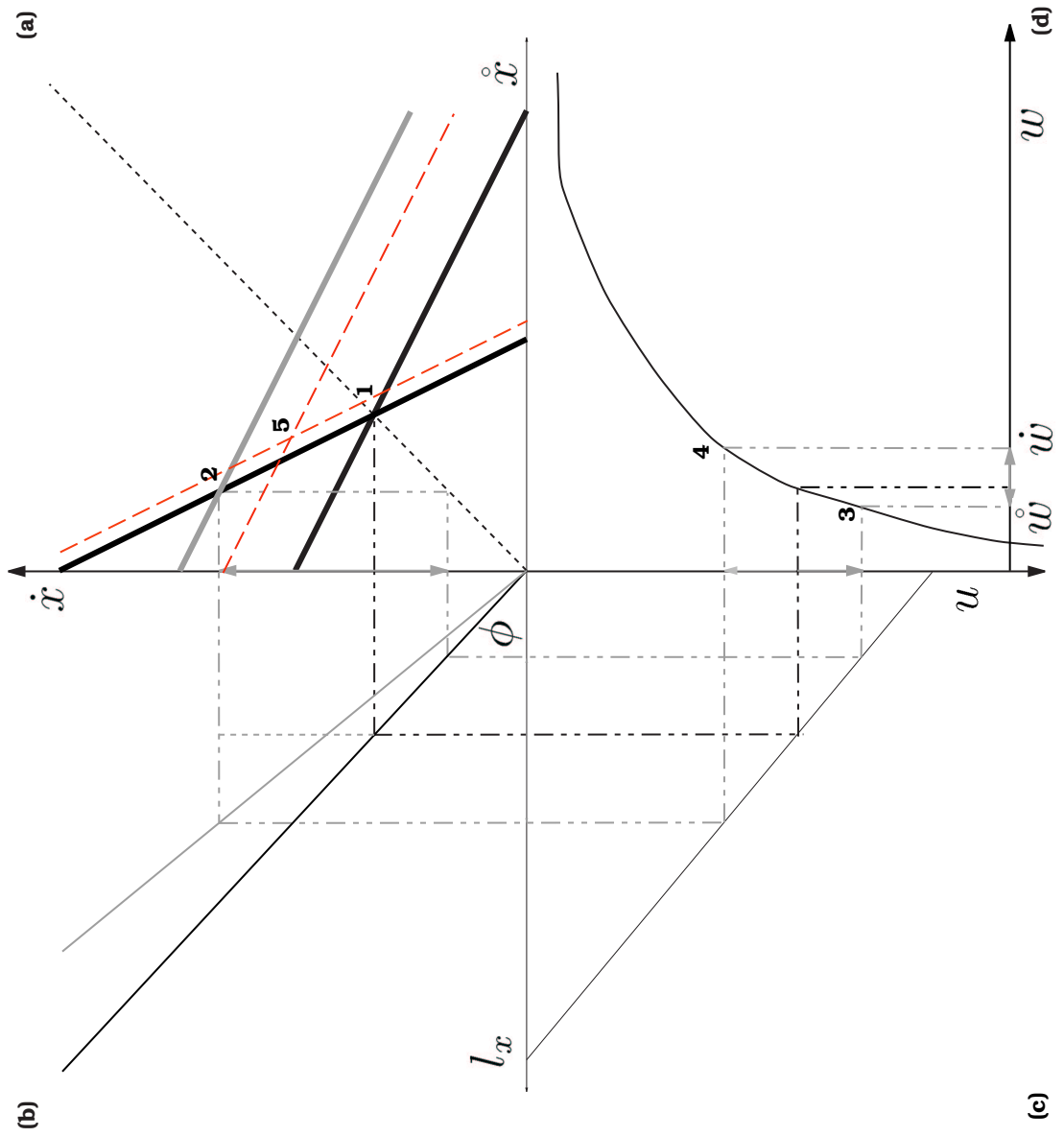


Figure 3: Productivity shocks

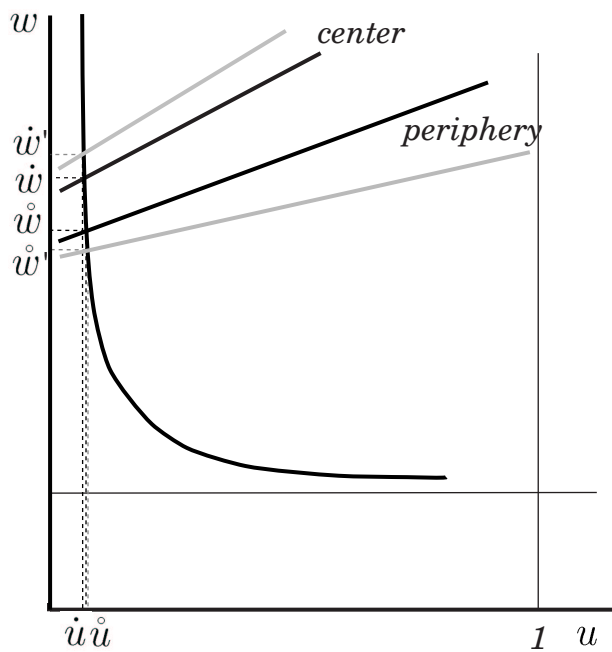
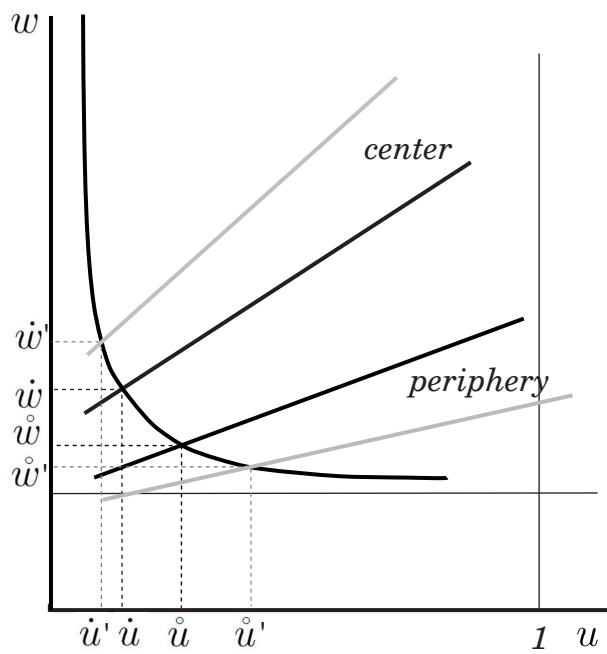


Figure 4: Europe (full sample). *Lowess* for wages

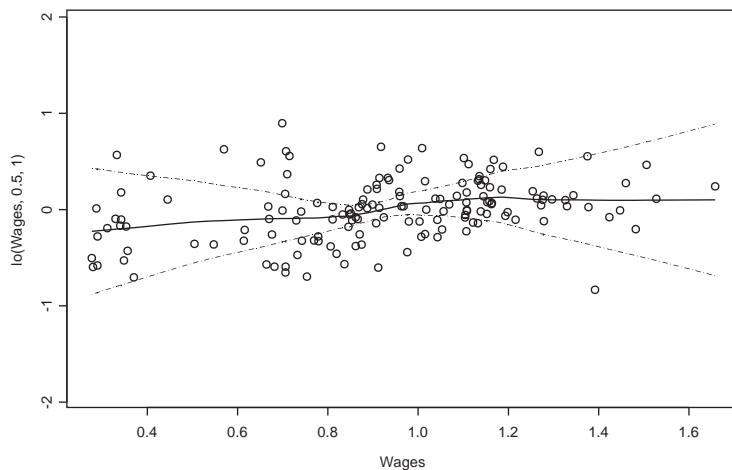


Figure 5: Europe (full sample). *Lowess* for labour productivity

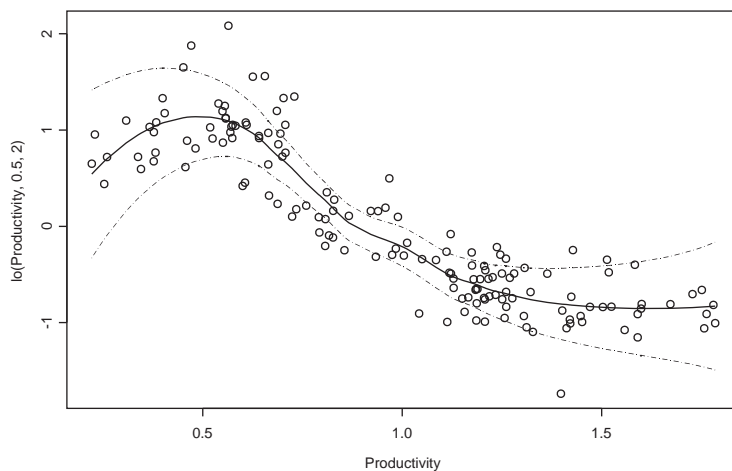


Figure 6: Europe (without Greece and Portugal). *Lowess* for wages

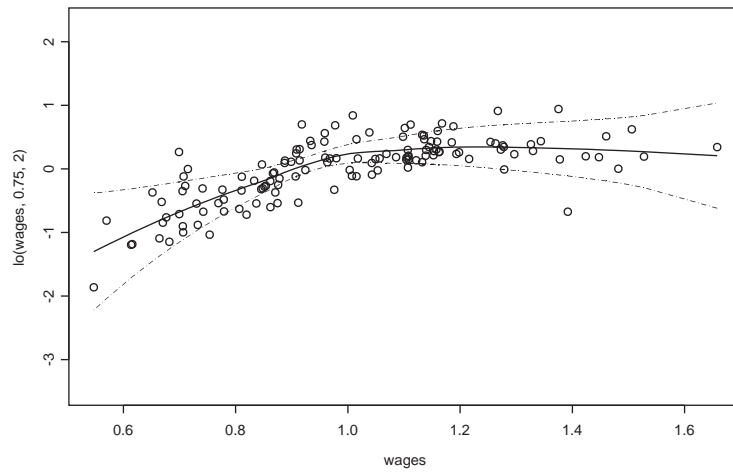


Figure 7: Europe (without Greece and Portugal). *Lowess* for labour productivity

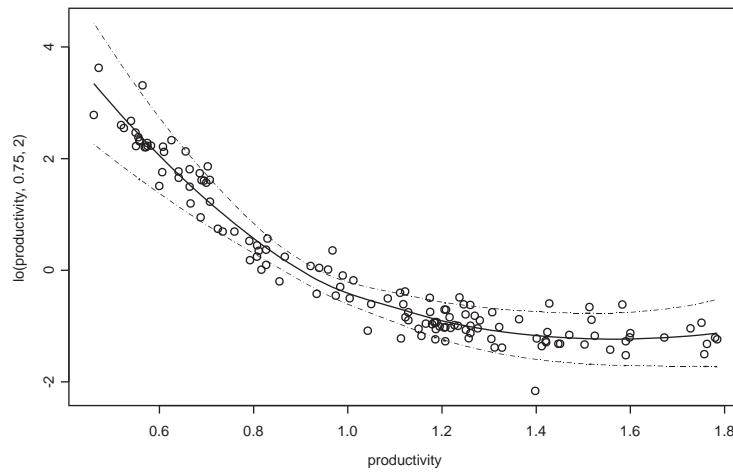


Figure 8: US States. *Lowess* for wages

