

How Okun's law is non-linear in Europe: A semi-parametric approach.

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Abstract

This article presents evidence of a non-linear Okun's law in European countries. We use a semi-parametric approach in a short-run framework without imposing any assumption on Okun's law functional form. Our estimations strongly support that effect of growth on unemployment is higher when economy is contracting than when economy is expanding. This kind of asymmetry has never been empirically stated for European countries. Our results could explain the current European jobless recovery and can be rationalized by theoretical explanations.

J.E.L classification: C14, E32, J00

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1 Introduction

European countries are recovering from the deepest economic crises since World War II. According to IMF (2010), some countries are facing persistently high unemployment level despite the ongoing recovery. These facts contrast with the sharp rise of unemployment caused by the huge fall of output during the Great Recession. The situation puzzle economists who expected a decrease of unemployment as the output recovers and some commentators ask if empirical relationship between output and unemployment is broken. Connection between labour market and goods market can be studied using Okun's law framework. Okun's law describes the inverse relationship between changes in real output and change in unemployment rate. Relation is intuitive: strong growth is associated with falling unemployment while growth slowdowns are accompanied by rising unemployment. As Knotek (2007) suggests, the appeal of this statistical relationship is its simplicity and its regularity as it receives a large empirical support. Indeed, validity of Okun's law is widely supported by many papers and belongs to core beliefs in practical macroeconomics. According to Huang (2005), this rule of thumb can be used for both theoretical and empirical reasons. First, Okun's law is a key element in construction of macro model like aggregate supply by combining Phillips curve with Okun's law. Second, it provides a benchmark to measure the cost of unemployment (e.g. effectiveness of disinflationary policy).

As shown by Neftci (1984) macroeconomic time series exhibit non-linear or asymmetric behavior over business cycle phases, so the output-unemployment relationship could be possibly non-linear. Silvapulle (2004) explains asymmetry means the response of unemployment to output is different when the economy is expanding or contracting. Testing for asymmetry in Okun's law is important for several reasons: asymmetry would provide an explanation for the varying effectiveness of structural and stabilization policies, can lead to forecast errors if ignored when present, and would have important implications for aggregation especially in the context of EMU (as advocated by Virén (2001)).

In a nice survey, Silvapulle (2004) confronts two ways of theoretically explain asymmetry in the Okun's law. One on hand, to justify that unemployment could respond more strongly to growth when economy is contracting than expanding; authors propose an interpretation based on the firm's risk aversion. In this first case, firms respond very quickly by laying off workers as the economy goes into a recession. In contrast, as the recession ends, firms fear the possibility that the recovery may not last long. Yet, they prefer to adjust their intensive margin (productivity of employees, number of hours) rather than their extensive margin (num-

ber of employees). This feature of asymmetry could be also link with hysteresis literature, Schorderet (2001) point out hysteresis implies an asymmetric response unemployment according to the state of economy. While unemployment strongly reacts to economic downturns, it slowly decreases in case of recoveries. A simple model insiders-outsiders can explain why after a recession unemployment don't return to its initial level. According this theory, any adverse shocks which raise unemployment increase number of outsiders (unemployed) and decreases insiders (currently employed), so insiders, which have all bargaining power, set equilibrium wages to insure their own employment rather for the outsiders. So, this theory implies unemployment persistence during recoveries.

On the second hand, to justify that unemployment could respond more strongly to growth when economy is expanding than contracting; authors propose this time, an explanation based on the labor market rigidity and the investment in the training of workers. In this second case, firms are reluctant to dismiss workers during recession because of the institutional restrictions on layoffs and their investment in staff training. Conversely, during recovery and because there are few restrictions on hiring additional workers, they would hire more workers, since the training process is costly. These reasons can explain why firms prefer keep their workforce when recession occurs. Yet, during recovery the response of unemployment to growth will be strong than during recession. This type of asymmetry will be called labour hoarding hypothesis hereafter.

There is today a consensus about the qualitative nature of Okun's law in industrialized countries. However, we note discrepancies about the actual quantitative magnitude of the relationship. Indeed, estimates of Okun's coefficient seem to vary across countries and time periods as shown by Freeman (2001). Economic literature offers otherwise a large body of empirical studies devoted to examine asymmetry of output - unemployment relationship. For USA, numerous papers like Palley (1993), Crespo Cuaresma (2003), Silvapulle (2004) show that effect of growth on unemployment is asymmetric and stronger during contraction than during expansions, results which are in line with firm's aversion risk hypothesis. For European case, on the contrary, evidences for asymmetry are rather mixed. Lee (2000), with annual data, uses a model where growth is determined by positive and negative changes in unemployment. He finds that correlation between growth and unemployment are similar during contractions and expansions for countries like Austria, Germany and United Kingdom. Okun's coefficient is higher during recessions than expansions for countries like France and Netherlands whereas the

opposite effect appears for Finland. Using a panel of OECD countries with annual data, Virén (2001) presents a model whereby changes in unemployment depends of an error-correction term (which represents the long-run level of unemployment related to working-age population and labour market structure) and on changes in output in a short-run perspective. He uses different thresholds variables to study effect of output on unemployment. When changes in output are split into positive and negative value, he finds that for OECD countries effect of growth on unemployment is higher when economy is contracting than expanding. Conversely, when growth depends of the level of the long-run trend of output (calculated using HP filter) and the long-run level of unemployment rate, results are modified. Indeed, for European countries, he concludes that output growth has a strong effect on unemployment when output is high (above the long-run trend) or unemployment is low (below the long-run level). Thus, he concludes that effect of output growth on unemployment can be close to zero during "bad times". These findings are conform with labour hoarding hypothesis. All these studies use models where Okun's law is partitioned into two regime, while there is no reason to limit analysis of asymmetry to two regimes. Using a non-dynamic panel transition regression for OECD countries with quarterly data, Fouquau (2008) points out asymmetry implies existence of four regimes, irrespective of the first difference or gap version of Okun's law. There is strong correlation between growth and unemployment for contractions and fast expansions (extremes regimes), whereas this relation tends to weaken when economy stands at intermediate regimes. France or Italy for instance, belongs intermediates only. But Spain and United Kingdom can belong to both intermediates and extremes regimes. Yet, no consensus has emerged about which hypothesis of asymmetry seems valid in Europe.

In this article, the aim is to propose an empirical framework (semi-parametric) to estimate Okun's law taking into account potential non-linearity. Applied to a panel of European countries, our paper clearly shows an asymmetric Okun's relationship. Overall, like Silvapulle (2004), our findings support that unemployment responds more strongly to output growth when economy is contracting than expanding. A finding which pleads in favor of the firm's risk aversion hypothesis. The paper is organized as follows. Section 2 describes the data source and the methodology. Section 3 presents empirical results. Section 4 discusses the findings and concludes.

2 Data and Methodology

2.1 Data

Present study use data for 16 European countries¹ from 1984 to 2009 using quarterly data. We use harmonized level of unemployment rate and log. of real GDP, both extracted from OECD.Stat. As stated in Freeman (2001), using harmonized data is crucial because criteria for assembling data are not the same among countries. Our dataset and variables are presented in Table 1. Besides, are displayed hereafter the two main variable empirical densities².

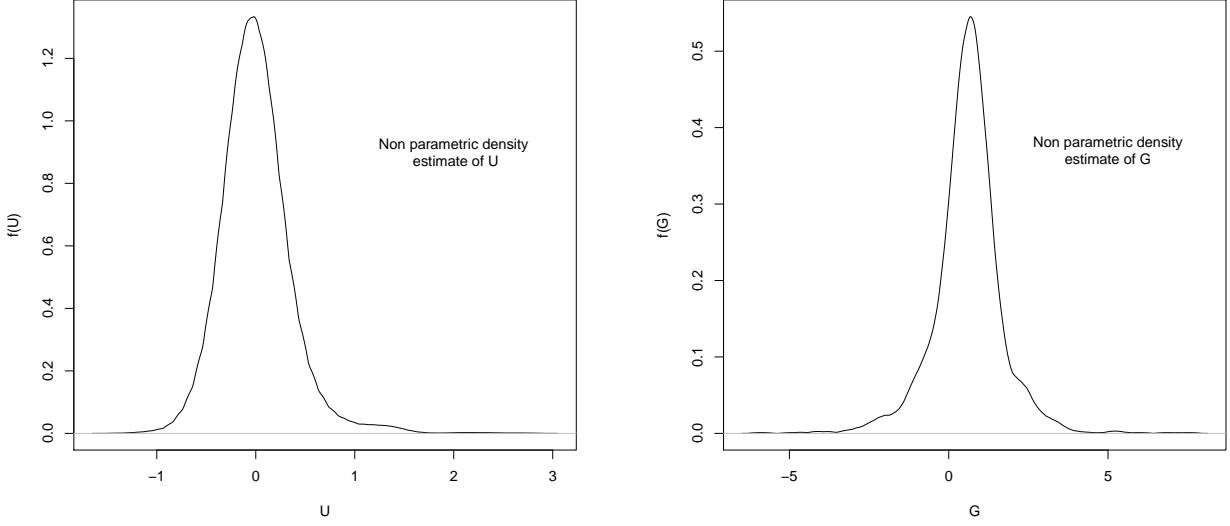
Table 1: Data and Variables

Name	Definition	Summary Statistics		
		Min	Mean	Max
U	Change in unemployment rate measured in percentage points	-1.2	0.003	2.6
G	Change in log. of real GDP in percentage (i.e. growth)	-5.883	0.601	7.518
OC	Cyclical Output, as the gap between the observed output and the long-run trend output in percentage (using Hodrick-Prescott filter)	-7.526	-0.009	6.691
UC	Cyclical Unemployment as the gap between the observed unemployment rate and the equilibrium unemployment rate in percentage points (using Hodrick-Prescott filter)	-3.183	0.003	3.645
$Ulevel$	Level of unemployment rate in percentage points	0.4	7.055	19.8
$time$	Index for time period (from 1984 to 2009, by quarter)	1	-	104

¹Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

²We obtain these two densities using non parametric kernel estimations

Figure 1: Non parametric density estimates of U and G



2.2 Methodology

We propose a two steps empirical strategy. First, we try to investigate whether the Okun's law is linear or not in Europe. In this prospect, we use a semi-parametric estimation method allowing the Okun's relation to vary freely. By doing so, no assumption is imposed on the functional form of the relationship. In addition, no assumptions are made a priori on the variable distributions which are not normals, as exposed in Fig.1. The equation to be estimated is so:

$$U = \alpha + m(G) + \beta U_{t-1} + \epsilon \quad (1)$$

Where $m(G)$ is the non parametric part of the model and βU_{t-1} is the traditional (linear) parametric part. U_{t-1} is the change of unemployment rate lagged by one period, it is included in order to better capture short-run dynamics (like in Moosa (1997)). Focusing on a short-run perspective, we regress unemployment on output as recommended by Barreto (1993) to measure impact of activity on labour market.

Once the non linearity has been established, our second step purpose is to investigate the potential reasons why the relation is non linear. We alternatively test several hypotheses³. The first hypothesis we want to question, in line with Virén (2001), is about the link between

³Note that these hypotheses are not in concurrence and can be complementary explanations. So our goal here is not to test an explanation against another but rather to propose elements of thought.

the business cycle and the Okun's relation. We use Hodrick-Prescott filter (HP hereafter) to measure the business cycle according to both unemployment rate and (log.) real GDP. The second potential asymmetry source we want to test is the unemployment level. We seek to highlight potential thresholds in the way the unemployment level impacts the Okun's law. Finally, we study the Okun's relation evolution across our sample time span.

For this second step, the model to be estimated can be written:

$$U = \alpha + m(G, W) + \beta U_{t-1} + \epsilon \quad (2)$$

with

$$W = \{OC, UC, Ulevel, time\}$$

This specification allows to test alternatively each potential asymmetry explanation. Estimating this semi-parametric model class requires to follow the steps exposed hereafter. Consider the simplified model:

$$y = \alpha + m(z) + \beta X + \epsilon \quad (3)$$

With y the endogenous variable, z the variable to be estimated non parametrically and X a vector of variables to be estimated parametrically. We have:

$$E[y|z] = E[X|z]\beta + m(z)$$

And therefore

$$y - E[y|z] = X\beta - E[X|z]\beta + \epsilon$$

We estimate $E[y|z]$ and $E[X|z]$ by a set of bivariate non parametric (local linear) regressions, and β by a linear regression of

$$y - \hat{E}[y|z] \text{ on } X - \hat{E}[X|z]$$

We then have:

$$m(z) = E[y|z] - E[X|z]\beta$$

and an estimate:

$$\hat{m}(z) = \hat{E}[y|z] - \hat{E}[X|z]\beta$$

It is important to note that this class of semi-parametric model has been proved to be as good as a well-specified parametric model (with m known, Robinson (1988)). It would have been interesting to test all our hypotheses at the same time in one estimation of model 2 (Eq. 2). But the "Curse of dimensionality" prevent us to estimate a semi-parametric model with more than two variables estimated non parametrically at the same time⁴. The estimation procedure of model 1 and 2 follows the demonstration above; the presented univariate case can easily be generalized to a multivariate case⁵. Besides, the interpretation of the parameter (β) is similar to a standard linear regression.

3 Results

Effect of growth on unemployment is shown in Figure 2. We present our estimation (solid Black curve) and display the linear equivalent estimation on the same graph (dotted Grey line)⁶. We do find, for each specification, a negative relation between growth and changes in unemployment. Our graph shows, indeed, that positive growth causes a decrease of unemployment rate whereas a negative growth is associated with an increase of unemployment rate. So, it provides solid evidence of Okun's law validity for European countries. Overall, Figure 2 presents a non-linear relation and shows that there is not one unique trade off between growth and changes in unemployment rate. In fact, changes in unemployment rate seems to responds in different ways to changes in real output and our estimation supports the existence of two regimes. First, the Okun's relation is stronger for level of growth inferior to 1 percent. Then, the relation seems to soften beyond this threshold. It can even be stated that a rapid output growth fails

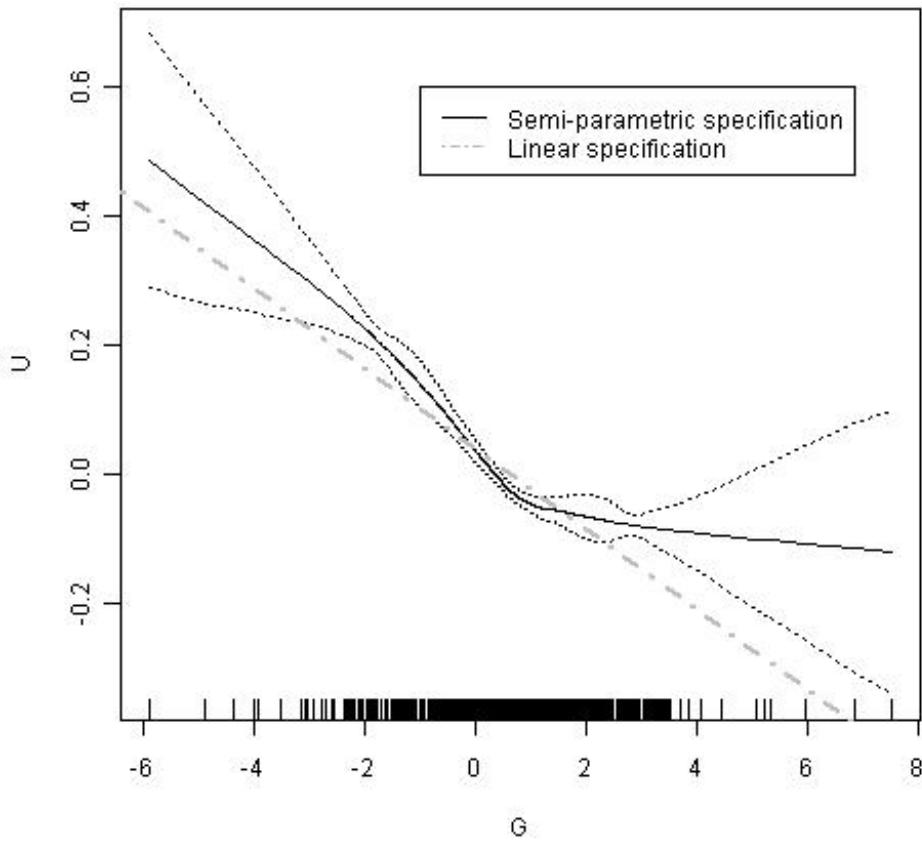
⁴The "Curse of dimensionality" is the non parametric method main limit. The resolution of a multivariate model is theoretically simple but the huge dataset required makes it almost impossible in practice.

⁵Interested reader can find a fully detailed resolution for bivariate case in Ahamada (2008).

⁶The pooled model we estimate is similar to model 1 (Eq. 1), except m is considered as a traditional parameter. The usual tests lead to the rejection of any individual effects.

to make unemployment rate go down. Moreover, Figure 2 confirms the inappropriateness of an Okun linear specification. Clearly, the linear specification underrate (overrate) the impact of negative and low (positive) growth on unemployment rate and leads to inaccurate forecasts. To summarize, the semi-parametric estimation method clearly confirms the suspected non-linearity of Okun's law for European countries.

Figure 2: Okun's law in Europe

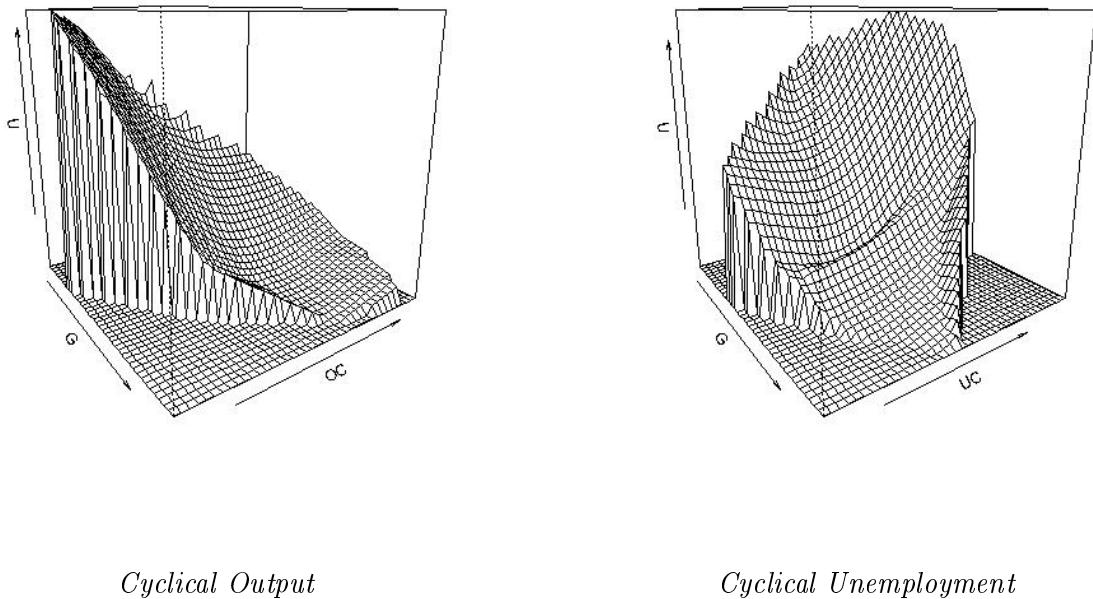


Dashed curves are the confidence intervals at the 5 % level

Our results support the existence of an asymmetric Okun curve, and so we want to seek potential factors causing these different regimes between growth and unemployment. As already stated, business cycle is one of the factor that could explain the non-linearity of Okun's law. Following the approach developed in Virén (2001), we study the way this cycle can affects the growth-unemployment relationship. Here, business cycle is modeled as the cyclical component of unemployment or output (using HP). Results are shown in Figure 3. Along x and y axis

are the usual variables involved in the Okun's relation (G and U); along the z axis (horizontal right in each graph), is displayed the variable measuring the business cycle (OC or UC). Both surfaces are steeper when economy is contracting (low output cycle, i.e Fig. 3 left side or high unemployment cycle, i.e Fig. 3 right side). It points out that output growth has a stronger effect on unemployment when unemployment is high (above his equilibrium level) or when output is low (below his long-run trend)⁷. Thus, these results confirm that Okun's relationship is more responsive when economy is contracting.

Figure 3: Business cycle/Okun's law relation



Cyclical Output

Cyclical Unemployment

Then, we want to explore non-linearity of Okun's law thanks to unemployment rate in level. It can be seen from Figure 4 that Okun's relation becomes sharper when unemployment rate increases. Thus, when unemployment stands to low level, impact of growth tends towards zero. This finding is quite intuitive if we consider that a low unemployment rate means the labor factor is fully employed in the country's production process, preventing additional growth to create jobs.

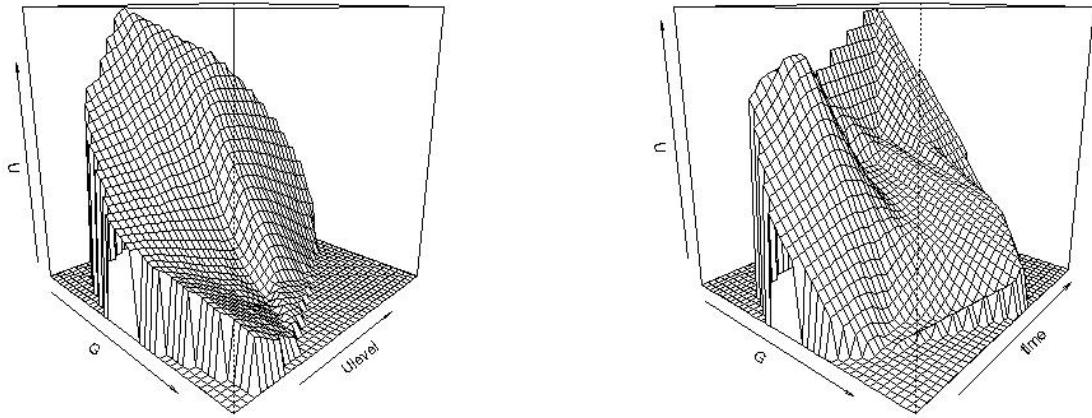
Finally, we see in Figure 5 that Okun's law also presents an instability over time. Indeed, the relation between growth and unemployment, if always negative, varies along the time axis. The response of unemployment to growth is found to be stronger during the beginning and the end

⁷Similar results are found using Band-Pass filter to extract the cyclical component of unemployment and output

than during the middle of the sample period. This middle period (broadly running from 1996 to 2001), corresponds to a period where growth was important in Europe. It pleads again, like our previous findings (i.e. Fig. 3), in favor of a weaker (resp. stronger) growth-unemployment relation during expansion (resp. recession).

Figure 4: The unemployment level/Okun's law relation

Figure 5: Okun's law across time



4 Discussion and Conclusions

Using a semi-parametric approach, we characterized the Okun's law for European countries. Our estimation indicates an asymmetric Okun's relation, suggesting that the linear specification usually employed may leads to inaccurate forecasts. The parametric estimation method fails indeed to catch the two regimes nature of the growth-unemployment relation. We find that the impact of growth on unemployment dramatically soften for rapid output growth (with an inflection point around 1 percent growth).

Besides, we point out the importance of the business cycle on the Okun's relation. The more the economy is contracting (both according to unemployment or output gap), the more the relation is negative and strong between the two variables involved in Okun's law. Yet, it implies a long period of expansion to bring back unemployment rate around pre-crisis levels and these results can explain the stylized fact of a currently observed jobless recovery in Europe. In addition, outcome supports the theoretical proposition exposed in introduction that firms

tend to be more pessimistic during contraction than optimistic during recoveries. The way the law evolves across time seems also to consolidate this finding, since we observe weaker Okun's relation during expansion periods in our sample. This asymmetry has to be taken into account when designing structural and stabilization policies. During contraction, the high Okun's coefficient advocates management policies of short-run demand to reduce unemployment rate. Conversely, these policies will be inadequate in expansion because the coefficient is very low, rather justifying active labor market programs.

This paper is a contribution to a better understanding of European labor market at an aggregate level. Nevertheless, a lot of work still has to be done on how the non linearity of Okun's law can be explained. The elements of thought we have exposed in this study deserve deeper attention and give directions for further studies. This work also provides a good illustration of how non-parametric methods can highlight features of the data that parametric techniques fail to uncover.

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