Economics Letters 125 (2014) 243–248

Contents lists available at ScienceDirect

Economics Letters

journal homepage: www.elsevier.com/locate/ecolet

On Okun's law in OECD countries: An analysis by age cohorts

Luca Zanin

Prometeia, G. Marconi 43, Bologna 40122, Italy

HIGHLIGHTS

- Okun's law for some sub-groups of the population might be not statistically significant.
- The youngest generations are most vulnerable to the business cycle.
- The coefficient becomes smaller up to a certain age cohort and then tends to stabilize.

ARTICLE INFO

Article history:
Received 2 June 2014
Received in revised form
25 August 2014
Accepted 28 August 2014
Available online 8 September 2014

JEL classification:
C23
E24
F50

Keywords:
Age cohorts
Economic growth
Labor market
OECD countries
Okun's law

ABSTRACT

This study investigates Okun's law in OECD countries by examining estimates for male and female age cohorts for the period 1998–2012. We find that the estimated Okun coefficients are not always statistically significant for each subgroup of the population. Our results also highlight a general common pattern of higher Okun coefficients for the youngest cohorts. This suggests that the young population, and particularly the young male population, tends to be most exposed to the business cycle in both developed and emerging OECD countries.

1. Introduction

The global financial crisis that began in 2007 has led to one of the most significant economic shocks since World War II. The emergence of problems in the credit markets of developed countries primarily in the United States and Europe quickly led to a climate of extreme uncertainty among consumers and entrepreneurs and resulted in a slowdown of aggregate demand. In this scenario, many firms (particularly those in construction and manufacturing) revised their production schedules downward or even terminated production altogether. This contributed to a rapid increase in the unemployment rate (e.g., Edely, 2009 and Arechavala et al., 2014). In this study, we focus on the relationship between economic growth and the unemployment rate, which is well-known in the economic literature as Okun's law (Okun, 1962). In 1962, Arthur Okun suggested two approaches to study this relationship: the first difference model and the gap model. In the first approach, the model is defined as

$$\Delta y_t = \alpha + \beta(\Delta x_t / x_t) + \varepsilon_t, \quad t = 2, \ldots, T, \tag{1}$$

where T represents the number of time point observations, Δ is a difference operator, y_t represents the unemployment rate of a country, x_t is the country's real gross domestic product (GDP), α is the intercept of the model, and ε_t is a *i.i.d.* $N\left(0, \sigma^2\right)$ random variable. The parameter β is typically referred to as Okun's coefficient, which economic theory expects to be negative. Eq. (1) models the contemporaneous relationship between changes in the unemployment rate and real GDP in percentage terms. The second approach is based on the gap equation,

$$y_t - y_t^g = \beta(x_t - x_t^g) + \varepsilon_t, \tag{2}$$

where y_t^g and x_t^g represent the natural rate of unemployment and potential output, respectively. Note that y_t^g and x_t^g are not observable and must thus be determined by economists.

Scholars have documented the asymmetric relationship between economic growth and changes in the unemployment rate

E-mail address: luca.zanin@studio.unibo.it.

http://dx.doi.org/10.1016/j.econlet.2014.08.030
0165-1765/

extensively, and this relationship exhibits higher effects during recessions than during economic expansions (e.g., Holmes and Silverstone, 2006). Other economists have emphasized that such a relationship is spatially heterogeneous and time-varying (e.g., Zanin and Marra, 2012 and references therein). Hutengs and Stadtmann (2013, 2014) focused on Okun's law as applied to age cohorts for both the Eurozone and a subset of eastern European countries; their main finding was that Okun's coefficient is highest for the youngest cohorts, particularly when compared with the oldest cohorts, which suggests that the youngest cohorts have the most exposure to the business cycle. However, Hutengs and Stadtmann (2013, 2014) limited their study to those countries for which a long time series of unemployment rates by age cohorts is available. Furthermore, a crucial issue in using a long historical period to estimate Okun's coefficient within the framework of a linear model is that inconsistent results might be obtained with respect to recent economic dynamics (see Zanin and Marra, 2012). The purpose of our study is to investigate Okun's law in subgroups of the population as determined by age cohorts (15–24, 25–34, 35–44, 45–54, and 55–64 years of age) and gender for a wide number of countries that are members of the Organization for Economic Co-operation and Development (OECD) and to focus the analysis on the last 15 years available. In contrast to Hutengs and Stadtmann (2013, 2014), we extend the Okun's law analysis in the following directions: first, we examine a much larger group of countries (both developed and emerging OECD countries); second, we use a common sampling period that allows results across countries to be compared; and third, we distinguish the analysis by male and female age cohorts (not provided by Hutengs and Stadtmann, 2013 for the Euro area countries).

The results can be a meaningful guide for macro-economists and policymakers interested in identifying and comparing countries and subgroups of populations regarding whether they are more or less sensitive to fluctuations in the business cycle.

2. Data

We investigated Okun's law with respect to the following OECD countries: Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, The Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. The source for the annual real GDP and unemployment rate data for all countries (in constant 2005 prices) is the OECD (2014). For most of the selected countries, information regarding unemployment rates by gender and age cohort prior to 1998 is not available. Thus, we have restricted our analysis to the historical period that ranges from 1998 to 2012, which allows us to confidently compare results across countries.

Descriptive statistics by gender and age cohort highlight that unemployment in the youth cohort (15–24 years old) is a concern for many countries worldwide and that the great recession has exacerbated this problem in several cases. During the great recession, record high unemployment rates were recorded in Greece (48.4% and 63.2% for men and women, respectively), Ireland (38.9% and 26.7% for men and women, respectively), Italy (33.7% and 37.5% for men and women, respectively), Portugal (36.4% and 39.2% for men and women, respectively) and Spain (54.4% and 51.8% for men and women, respectively). The high unemployment rate for the youth cohort compared with older cohorts is attributable partly to a lack of work experience and partly to labor market policies that influence school-to-work transitions.

3. Estimating Okun's coefficient: the trade-offs among theory, available data, and methodology

A recent surge in both political and academic interest has focused on the great recession's negative effects on people's lives and on possible action-strategies that might lead to rapid economic recovery. Thus, some attention has focused on the relationship between GDP growth and the unemployment rate. In this sense, Okun's coefficient represents a simple indicator to quantify the magnitude and statistical significance of the relationship between fluctuations in real GDP and the unemployment rate, which are two relevant economic measures for economists and policymakers when aiming to monitor the economic health of a country. In this study, Okun's law is investigated using model (1). Calmfors and Holmlund (2000) identified the following features that might influence the relationship between economic growth and unemployment: "(a) exogenous changes of the rate of growth can affect unemployment; (b) exogenous changes of the type of growth can affect unemployment; (c) changes in labor-market institutions can affect the growth rate indirectly via changes in unemployment; (d) changes in labor-market institutions can affect both unemployment and growth directly but through different mechanisms". Population growth, labor market structure (rigid or flexible), tax policies, labor productivity, job specialization and the business cycle are among the factors that can affect such a relationship over time and space. From this theoretical perspective, Zanin and Marra (2012) suggested that Okun's coefficient should be estimated within a flexible time-varying framework using a penalized regression splines approach. Thus, we should let the data determine whether the relationship under investigation is linear or non-linear (i.e., stable or varying over time) and determine which countries or subgroups of the population are involved. However, such an approach requires lengthy historical series for which the applicable measurements are available; in our case, such historical series are generally not available for all the countries selected (see Section 2). For this reason, we estimate (1) using the traditional ordinary least squares (OLS) approach.

The size of the sampling period considered (1998–2012) is consistent with the choice of the temporal window used by Moosa (1997) and Zanin and Marra (2012) for estimating Okun's coefficient within a rolling regression framework. Accordingly, our results might be viewed as an estimation of the last point of a rolling regression approach. Although we recognize that the use of a linear model produces estimates that are constant within the sampling period, it is reasonable to assume that our findings are reliable and consistent with recent economic dynamics.

4. Results

We begin the discussion of the estimates of Okun's coefficients by focusing on the results for the working age population (ages 15–64) of men and women (see the last columns of Tables 1 and 2). Our main findings support those studies that are available in the literature regarding the existence of a significant inverse relationship between changes in unemployment rates and economic growth (excluding certain exceptions) and that demonstrate the manner in which the magnitude of Okun's coefficient is spatially heterogeneous (e.g., Zanin and Marra, 2012). As an additional insight, the analysis highlights that the absolute size of Okun's coefficient is higher for men than for women. One reason for this result is that men are predominantly employed in sectors that are more sensitive to economic cycles (such as manufacturing and construction) than women, who are typically concentrated in the service sectors (see also the Azmat et al., 2006; World Bank report, 2012). In general, the highest Okun's coefficients are found for Spain (−0.99 for both genders) and

Table 1
Estimated Okun's coefficient for the male subgroup by age cohort. Confidence intervals are reported in the square parentheses. Diagnostic tests have excluded the presence of structure in the error terms. The results of these analyses are available upon request.

Country	Age cohort—men					Total
	15–24	25–34	35–44	45–54	55–64	15–64
Australia	−1.10** [−1.90; −0.30]	−0.50** [−0.95; −0.05]	−0.38** [−0.72; −0.03]	−0.45** [−0.81; −0.09]	−0.47** [−0.77; −0.17]	−0.57** [−0.98; −0.15]
Austria	−0.41** [−0.74; −0.09]	−0.27** [−0.42; −0.12]	−0.22** [−0.33; −0.10]	−0.20** [−0.37; −0.04]	−0.10 [−0.37; 0.17]	−0.24** [−0.34; −0.14]
Belgium	−1.24** [−2.44; −0.04]	−0.43** [−0.67; −0.19]	−0.24** [−0.41; −0.07]	−0.17 [−0.46; 0.12]	−0.26** [−0.49; −0.04]	−0.36** [−0.61; −0.12]
Canada	−0.78** [−1.03; −0.52]	−0.48** [−0.71; −0.26]	−0.39** [−0.55; −0.24]	−0.36** [−0.51; −0.22]	−0.39** [−0.53; −0.25]	−0.46** [−0.62; −0.30]
Chile	−0.90** [−1.36; −0.44]	−0.61** [−0.89; −0.32]	−0.37** [−0.59; −0.15]	−0.42** [−0.64; −0.19]	−0.35** [−0.56; −0.15]	−0.50** [−0.76; −0.25]
Czech Republic	−0.74** [−1.25; −0.23]	−0.26** [−0.43; −0.09]	−0.16** [−0.30; −0.02]	−0.14 [−0.32; 0.04]	−0.12 [−0.29; 0.06]	−0.24** [−0.43; −0.04]
Denmark	−0.62** [−1.06; −0.81]	−0.45** [−0.76; −0.14]	−0.28** [−0.49; −0.06]	−0.37** [−0.58; −0.17]	−0.22 [−0.48; 0.05]	−0.38** [−0.60; −0.16]
Estonia	−0.77** [−1.19; −0.35]	−0.47** [−0.66; −0.27]	−0.49** [−0.69; −0.29]	−0.54** [−0.74; −0.34]	−0.23 [−0.54; 0.08]	−0.50** [−0.71; −0.29]
Finland	−0.70** [−1.00; −0.40]	−0.28** [−0.39; −0.17]	−0.22** [−0.33; −0.10]	−0.23** [−0.35; −0.11]	−0.16* [−0.32; 0.00]	−0.26** [−0.35; −0.18]
France	−1.15** [−1.84; −0.47]	−0.48** [−0.80; −0.15]	−0.27** [−0.47; −0.06]	−0.20** [−0.40; −0.01]	−0.25* [−0.54; 0.04]	−0.39** [−0.66; −0.13]
Germany	−0.42** [−0.72; −0.11]	−0.39** [−0.61; −0.16]	−0.22** [−0.39; −0.05]	−0.24** [−0.45; −0.04]	−0.11 [−0.43; 0.21]	−0.27** [−0.47; −0.07]
Greece	−0.89** [−1.11; −0.67]	−0.59** [−0.79; −0.39]	−0.38** [−0.49; −0.26]	−0.37** [−0.45; −0.28]	−0.28** [−0.41; −0.15]	−0.45** [−0.57; −0.33]
Hungary	−0.57** [−0.99; −0.14]	−0.25** [−0.44; −0.07]	−0.15** [−0.28; −0.03]	−0.15** [−0.27; −0.02]	−0.08 [−0.27; 0.10]	−0.21** [−0.34; −0.08]
Iceland	−0.50** [−0.95; −0.06]	−0.45** [−0.74; −0.16]	−0.18** [−0.34; −0.02]	−0.14 [−0.32; 0.05]	−0.15 [−0.36; 0.05]	−0.28** [−0.48; −0.08]
Ireland	−0.87** [−1.21; −0.52]	−0.52** [−0.78; −0.25]	−0.41** [−0.56; −0.26]	−0.37** [−0.50; −0.24]	−0.30** [−0.38; −0.23]	−0.47** [−0.65; −0.29]
Israel	−0.48** [−0.90; −0.06]	−0.35** [−0.54; −0.16]	−0.17 [−0.41; 0.07]	−0.27** [−0.44; −0.09]	−0.07 [−0.23; 0.08]	−0.27** [−0.44; −0.10]
Italy	−0.84** [−1.35; −0.34]	−0.38** [−0.62; −0.14]	−0.20** [−0.31; −0.09]	−0.21** [−0.30; −0.11]	−0.14** [−0.28; −0.00]	−0.30** [−0.46; −0.14]
Japan	−0.22* [−0.48; 0.04]	−0.16** [−0.26; −0.05]	−0.14** [−0.21; −0.07]	−0.08 [−0.19; 0.02]	−0.12 [−0.28; 0.03]	−0.13** [−0.24; −0.02]
Korea	−0.40** [−0.66; −0.14]	−0.14* [−0.29; 0.01]	−0.15** [−0.24; −0.06]	−0.18** [−0.29; −0.06]	−0.07 [−0.24; 0.10]	−0.16** [−0.27; −0.05]
Luxembourg	−0.31 [−0.79; 0.18]	−0.02 [−0.17; 0.13]	−0.01 [−0.09; 0.06]	−0.04 [−0.15; 0.07]	−0.10 [−0.08; 0.29]	−0.04 [−0.11; 0.03]
Mexico	−0.24* [−0.49; 0.02]	−0.19** [−0.28; −0.10]	−0.16** [−0.22; −0.09]	−0.17** [−0.25; −0.09]	−0.12** [−0.23; −0.01]	−0.18** [−0.29; −0.07]
The Netherlands	−0.45** [−0.74; −0.17]	−0.31** [−0.45; −0.17]	−0.27** [−0.41; −0.13]	−0.17** [−0.32; −0.02]	−0.04 [−0.21; 0.13]	−0.25** [−0.40; −0.11]
New Zealand	−0.69** [−1.13; −0.24]	−0.31** [−0.56; −0.05]	−0.28** [−0.45; −0.10]	−0.24** [−0.47; −0.01]	−0.17 [−0.45; 0.13]	−0.34** [−0.55; −0.12]
Norway	−0.37 [−0.97; 0.23]	−0.34* [−0.75; 0.07]	−0.11 [−0.38; 0.16]	−0.20* [−0.43; 0.02]	−0.02 [−0.21; 0.16]	−0.20 [−0.45; 0.05]
Poland	−2.07** [−3.32; −0.83]	−0.99** [−1.61; −0.36]	−0.69** [−1.11; −0.25]	−0.76** [−1.29; −0.23]	−0.52** [−0.93; −0.11]	−0.94** [−1.51; −0.36]
Portugal	−1.12** [−1.57; −0.67]	−0.59** [−0.83; −0.36]	−0.39** [−0.52; −0.26]	−0.40** [−0.60; −0.19]	−0.27** [−0.46; −0.08]	−0.49** [−0.66; −0.32]
Slovak Republic	−1.16** [−1.63; −0.69]	−0.42** [−0.69; −0.14]	−0.39** [−0.56; −0.21]	−0.37** [−0.60; −0.15]	−0.37** [−0.68; −0.05]	−0.48** [−0.72; −0.25]
Spain	−1.96** [−2.46; −1.47]	−1.22** [−1.49; −0.96]	−0.85** [−1.08; −0.62]	−0.74** [−0.87; −0.60]	−0.66** [−0.88; −0.44]	−0.99** [−1.22; −0.76]
Sweden	−0.63** [−1.14; −0.12]	−0.37** [−0.60; −0.13]	−0.19** [−0.36; −0.02]	−0.18** [−0.32; −0.05]	−0.11 [−0.27; 0.04]	−0.26** [−0.45; −0.07]
Switzerland	−0.41** [−0.61; −0.21]	−0.57** [−0.90; −0.24]	−0.13 [−0.34; 0.07]	−0.17 [−0.38; 0.04]	−0.06 [−0.31; 0.20]	−0.26** [−0.44; −0.08]
Turkey	−0.38** [−0.60; −0.16]	−0.25** [−0.39; −0.11]	−0.19** [−0.30; −0.07]	−0.15** [−0.26; −0.04]	−0.08* [−0.16; 0.01]	−0.23** [−0.36; −0.10]
United Kingdom	−0.55** [−0.86; −0.24]	−0.40** [−0.57; −0.22]	−0.23** [−0.37; −0.10]	−0.21** [−0.35; −0.07]	−0.24** [−0.41; −0.07]	−0.31** [−0.45; −0.17]
United States	−0.88** [−1.22; −0.54]	−0.67** [−0.96; −0.39]	−0.56** [−0.80; −0.32]	−0.54** [−0.78; −0.29]	−0.45** [−0.67; −0.24]	−0.61** [−0.85; −0.36]

* P-value < 0.1.
** P-value < 0.05.

Table 2
Estimated Okun's coefficient for the female subgroup by age cohort. Confidence intervals are reported in the square parentheses. Diagnostic tests have excluded the presence of structure in the error terms. The results of these analyses are available upon request.

Country	Age cohort—women					Total
	15–24	25–34	35–44	45–54	55–64	15–64
Australia	−0.61** [−1.16; −0.06]	−0.24 [−0.53; 0.05]	−0.30** [−0.52; −0.08]	−0.16 [−0.40; 0.09]	−0.20 [−0.50; 0.10]	−0.31** [−0.55; −0.06]
Austria	−0.16 [−0.52; 0.20]	−0.07 [−0.25; 0.11]	−0.07 [−0.26; 0.12]	−0.06 [−0.18; 0.06]	−0.10 [−0.12; 0.32]	−0.07 [−0.22; 0.09]
Belgium	−0.72** [−1.43; −0.01]	−0.32* [−0.66; 0.02]	−0.19 [−0.52; 0.13]	0.01 [−0.50; 0.50]	−0.03 [−0.78; 0.73]	−0.22 [−0.57; 0.13]
Canada	−0.40** [−0.55; −0.25]	−0.24** [−0.38; −0.11]	−0.20** [−0.34; −0.07]	−0.18** [−0.28; −0.09]	−0.15** [−0.28; −0.01]	−0.23** [−0.32; −0.14]
Chile	−0.74** [−1.22; −0.26]	−0.36** [−0.65; −0.07]	−0.41** [−0.66; −0.16]	−0.14 [−0.39; 0.10]	−0.15** [−0.28; −0.02]	−0.34** [−0.58; −0.11]
Czech Republic	−0.70** [−1.18; −0.22]	−0.34** [−0.60; −0.08]	−0.18* [−0.37; 0.01]	−0.12 [−0.31; 0.07]	−0.10 [−0.23; 0.03]	−0.24** [−0.44; −0.04]
Denmark	−0.31 [−0.77; 0.15]	−0.32* [−0.69; 0.06]	−0.18* [−0.37; 0.01]	−0.21* [−0.44; 0.03]	−0.15 [−0.36; 0.05]	−0.23** [−0.40; −0.07]
Estonia	−0.59** [−1.04; −0.15]	−0.29** [−0.40; −0.18]	−0.19* [−0.39; 0.00]	−0.24** [−0.39; −0.09]	−0.28** [−0.53; −0.04]	−0.28** [−0.44; −0.11]
Finland	−0.27** [−0.43; −0.11]	−0.15** [−0.25; −0.05]	0.00 [−0.13; 0.14]	−0.10** [−0.19; −0.01]	−0.07 [−0.27; 0.13]	−0.09** [−0.17; −0.01]
France	−0.72* [−1.47; 0.04]	−0.32* [−0.65; 0.01]	−0.17 [−0.43; 0.09]	−0.22** [−0.39; −0.05]	−0.23 [−0.52; 0.07]	−0.29** [−0.55; −0.03]
Germany	−0.20 [−0.55; 0.14]	−0.16 [−0.38; 0.07]	−0.16* [−0.33; 0.01]	−0.12 [−0.30; 0.06]	−0.00 [−0.32; 0.33]	−0.13 [−0.33; 0.06]
Greece	−0.92** [−1.27; −0.57]	−0.53** [−0.77; −0.35]	−0.41** [−0.61; −0.21]	−0.38** [−0.56; −0.20]	−0.24** [−0.40; −0.08]	−0.48** [−0.66; −0.30]
Hungary	−0.16 [−0.49; 0.17]	−0.13* [−0.26; 0.00]	−0.05 [−0.21; 0.11]	−0.05 [−0.19; 0.09]	−0.08 [−0.32; 0.16]	−0.09 [−0.22; 0.05]
Iceland	−0.32** [−0.55; −0.09]	−0.33** [−0.61; −0.06]	−0.14** [−0.28; −0.01]	−0.11** [−0.20; −0.02]	−0.09 [−0.22; 0.04]	−0.20** [−0.29; −0.10]
Ireland	−0.52** [−0.72; −0.31]	−0.22** [−0.33; −0.11]	−0.20** [−0.31; −0.10]	−0.21** [−0.31; −0.10]	−0.09* [−0.19; 0.00]	−0.24** [−0.34; −0.14]
Israel	−0.43** [−0.75; −0.11]	−0.24** [−0.47; −0.01]	−0.25** [−0.46; −0.05]	−0.21* [−0.34; 0.01]	−0.13 [−0.30; 0.05]	−0.25** [−0.43; −0.07]
Italy	−0.94** [−1.39; −0.49]	−0.43** [−0.68; −0.17]	−0.25** [−0.41; −0.09]	−0.16** [−0.31; −0.01]	−0.13 [−0.29; 0.04]	−0.34** [−0.53; −0.15]
Japan	−0.15* [−0.31; 0.01]	−0.16** [−0.28; −0.05]	−0.10** [−0.19; −0.02]	−0.11** [−0.20; −0.02]	−0.10** [−0.18; −0.02]	−0.13** [−0.20; −0.05]
Korea	−0.27** [−0.46; −0.07]	−0.14** [−0.22; −0.06]	−0.10* [−0.20; 0.00]	−0.09** [−0.15; −0.04]	−0.03 [−0.11; 0.06]	−0.13** [−0.21; −0.04]
Luxembourg	0.16 [−0.79;1.12]	−0.01 [−0.26; 0.24]	−0.24** [−0.48; −0.00]	0.01 [−0.14; 0.17]	−0.15* [−0.32; 0.02]	−0.08 [−0.28; 0.11]
Mexico	−0.21 [−0.53; 0.10]	−0.09 [−0.25; 0.08]	−0.07 [−0.18; 0.04]	−0.03 [−0.11; 0.05]	0.01 [−0.09; 0.11]	−0.08 [−0.22; 0.06]
The Netherlands	−0.29* [−0.60; 0.03]	−0.24** [−0.40; −0.09]	−0.21** [−0.39; −0.03]	−0.16* [−0.31; 0.00]	−0.16 [−0.37; 0.04]	−0.21** [−0.37; −0.04]
New Zealand	−0.51 [−1.15; 0.13]	−0.24 [−0.57; 0.08]	−0.22** [−0.41; −0.02]	−0.19** [−0.33; −0.04]	−0.13 [−0.36; 0.09]	−0.26** [−0.49; −0.02]
Norway	−0.21 [−0.68; 0.27]	−0.16 [−0.45; 0.13]	−0.13 [−0.34; 0.08]	0.01 [−0.19; 0.21]	−0.03 [−0.24; 0.18]	−0.10 [−0.29; 0.09]
Poland	−1.48** [−2.86; −0.11]	−0.89** [−1.69; −0.09]	−0.81** [−1.37; −0.24]	−0.73** [−1.28; −0.17]	−0.28 [−0.77; 0.22]	−0.84** [−1.52; −0.15]
Portugal	−0.84** [−1.43; −0.26]	−0.36* [−0.74; 0.02]	−0.22 [−0.49; 0.05]	−0.20** [−0.35; −0.05]	−0.17* [−0.35; 0.03]	−0.31** [−0.52; −0.09]
Slovak Republic	−0.88** [−1.32; −0.44]	−0.36** [−0.55; −0.15]	−0.29** [−0.53; −0.05]	−0.26** [−0.51; −0.01]	−0.19 [−0.66; 0.26]	−0.37** [−0.57; −0.17]
Spain	−1.78** [−2.15; −1.41]	−1.12** [−1.50; −0.74]	−0.87** [−1.22; −0.52]	−0.76** [−1.02; −0.51]	−0.58** [−0.88; −0.28]	−0.99** [−1.32; −0.66]
Sweden	−0.27 [−0.75; 0.21]	−0.15 [−0.42; 0.11]	−0.09 [−0.27; 0.09]	−0.11 [−0.25; 0.03]	−0.05 [−0.18; 0.08]	−0.12 [−0.31; 0.06]
Switzerland	−0.53* [−1.14; 0.07]	−0.27* [−0.57; 0.04]	−0.08 [−0.28; 0.11]	0.01 [−0.15; 0.17]	0.07 [−0.16; 0.29]	−0.16 [−0.37; 0.04]
Turkey	−0.21** [−0.40; −0.02]	−0.18** [−0.34; −0.03]	−0.12** [−0.23; −0.01]	−0.04 [−0.12; 0.04]	0.00 [−0.04; 0.04]	−0.15** [−0.27; −0.02]
United Kingdom	−0.27** [−0.51; −0.03]	−0.25** [−0.37; −0.12]	−0.13** [−0.25; −0.01]	−0.11** [−0.21; −0.03]	−0.10* [−0.21; 0.01]	−0.17** [−0.27; −0.07]
United States	−0.57** [−0.78; −0.36]	−0.45** [−0.61; −0.28]	−0.37** [−0.51; −0.22]	−0.29** [−0.41; −0.17]	−0.29** [−0.43; −0.14]	−0.39** [−0.53; −0.25]

* P-value < 0.1.
** P-value < 0.05.

Poland (−0.94 and −0.84 for men and women, respectively), whereas the lowest coefficients are observed in Japan (−0.13 for both genders).

Investigating the estimated Okun's coefficient for male and female age cohorts adds knowledge regarding the so-called "rule-of-thumb" (i.e., Okun's law) compared with an analysis that covers the entire working age population (15–64 years of age) without differentiation. The results are reported in columns 2–6 of Tables 1 and 2. We observe the following Okun's law patterns: (i) Okun's coefficient becomes smaller as age increases (e.g., the United States, Spain, and Greece— Table 1), or (ii) Okun's coefficient becomes smaller up to a certain age cohort and thereafter tends to stabilize around a certain magnitude (e.g., the United Kingdom and the United States— Table 2).

However, in focusing only on estimated coefficients to establish the Okun's pattern that is observed for a country, we might draw biased conclusions because we do not assess whether changes in the magnitude of the estimated Okun's coefficients across age cohorts are significantly different from one another. Consider Spain, for example, for which it is argued (on the basis of the results presented in Table 1) that Okun's coefficient follows pattern (i), i.e., it has a non-linear increasing trend. Thus, we expect that the vulnerability of the labor force to business cycle fluctuations decreases non-linearly as we move across the older age cohorts. However, we observe that all the confidence intervals overlap the estimated Okun's coefficients for the three highest cohorts; that is, the estimated Okun's coefficients of these three highest cohorts can each fit within the confidence intervals of the other two. This result might mean that the Okun's coefficients for these cohorts are in fact insignificantly different from one another. Thereby, we can conclude that the Okun's coefficients in Spain follow pattern (ii) rather than (i). We can also observe cases in which there are non-significant differences between the Okun's coefficient estimated for the entire working age population (ages 15–64) and the analysis performed for age cohorts (e.g., Japan).

In general, the patterns that we observe highlight that the estimated Okun's coefficient tends to be higher among the youngest cohort than among the oldest cohorts, which suggests that the former are more sensitive to business cycle fluctuations than the latter. In particular, the magnitude of the coefficients for the youngest cohort is higher for both genders in Spain and Poland than it is for the other countries examined. It is important that policy-makers pay attention to this evidence because the high Okun's coefficients in the youngest age cohort might indicate that the transition phase from the end of compulsory education to entry into the labor market can be particularly problematic during economic crises. Thus, this empirical result can be interpreted as a warning signal that there is a mismatch between the supply of and demand for labor. This mismatch among the youngest generations can be triggered by several factors. For example, firms and entrepreneurs may be searching for the best workers, whereas young workers are seeking employment that is tailored to the knowledge and skills acquired during their education. Such factors can contribute to the generation of frictional unemployment, which may become a structural problem when there is no effective action-strategy in place (Refrigeri and Aleandri, 2013). Furthermore, because young people are also frequently employed under temporary contracts, they are subject to a higher probability of layoff during periods of recession or weak economic growth than older cohorts.

However, issues of matching between the supply of and demand for labor are not confined to the youngest generations. Some studies that are available in the literature have opened a discussion about the fact that elderly individuals who lose their jobs or who want to enter into the labor market after a period of absence might encounter obstacles associated with age discrimination against older workers. In particular, the reasons for this phenomenon might include the (lack of) skills and abilities of elderly workers who have not kept pace regarding new processes and technologies; thus, such elderly workers may be more likely to suffer long-term unemployment (see also Rothenberg and Gardner, 2011 and Langot and Moreno-Galbis, 2013). The high magnitude of the Okun's coefficient among male elderly cohorts (which are more sensitive to the business cycle than female cohorts) in countries such as Spain (−0.66), Poland (−0.52), Australia (−0.47) and the United States (−0.45) might reflect such issues, at least in part.

We also observe that the Okun's coefficient can be statistically significant for the entire working age population (ages 15–64), but not for all male and female age cohorts (e.g., Czech Republic, Denmark, and Iceland). This evidence is likely to have implications for policymakers who are considering Okun's law as a meaningful guide for monetary, welfare and labor market policies at the macro level because the heterogeneity and weakness of the relationship investigated for certain subgroups of the population might otherwise be ignored. Weak or nonexistent statistical significance can suggest that the relationship between changes in the unemployment rate and economic growth for certain age cohorts might be more complex or multi-faceted than the functional form of the rule-of-thumb is able to capture (see also Dustmann, 2005, Congregado et al., 2011 and Larsen and Pedersen, 2013), particularly when considering a historical period that includes the great recession. Thus, future research is suggested in this direction.

5. Concluding remarks

We provide insights regarding the relationship between changes in the unemployment rate and economic growth by estimating Okun's coefficients for male and female age cohorts. The data cover the 1998–2012 period on an annual basis and cover a substantial number of OECD countries. The main evidence found by our study shows that the youngest cohorts tend to be most vulnerable to economic fluctuations compared with elderly cohorts in both the developed and emerging countries examined. It is notable that the observed cases of statistical non-significance of the rule-of-thumb might be interpreted as a limitation of the Okun's specification employed. In particular, this limitation may arise because the specification is unable to capture more complex or multi-faceted aspects of the relationship between changes in the unemployment rate and economic growth that can characterize subgroups of a population, particularly during a historical period that includes an economic event such as the great recession.

Our evidence might represent a useful guideline for policy-makers to address certain action strategies such as those targeted at sub-population groups in the labor market while our findings might stimulate scholars to further investigate those aspects of the relationship that remain unexplained.

Acknowledgments

We would like to thank the Editor and one reviewer for many suggestions that helped to improve the presentation and quality of the article. The opinions expressed herein are those of the author and do not reflect those of the institution of affiliation.

References

Arechavala, N.S., Espina, P.Z., Trapero, B.P., 2014. The economic crisis and its effects on the quality of life in the European Union. Soc. Indicators Res. http://dx.doi.org/10.1007/s11205-014-0595-9.

Azmat, G., Guell, M., Manning, A., 2006. Gender gaps in unemployment rates in OECD countries. J. Labor Econom. 24, 1–37.

Calmfors, L., Holmlund, B., 2000. Unemployment and economic growth: a partial survey. Swedish Econ. Pol. Rev. 7, 107–153.
Congregado, E., Golpe, A.A., van Stel, A., 2011. Exploring the big jump in the Spanish unemployment rate: evidence on an 'added-worker' effect. Ecol. Modell. 28, 1099–1105.
Dustmann, C., 2005. The assessment: gender and the life cycle. Oxford Rev. Econ. Policy 21, 1–16.
Edely, M., 2009. The global financial crisis and its effects. Econom. Papers: J. Appl. Econ. Policy 85, 207–234.
Holmes, M.J., Silverstone, B., 2006. Okun's law, asymmetries and jobless recoveries in the United States: a Markov-switching approach. Econom. Lett. 92, 293–299.
Hutengs, O., Stadtmann, G., 2013. Age effects in the Okun's law within the Eurozone. Appl. Econ. Lett. 20, 821–825.
Hutengs, O., Stadtmann, G., 2014. Don't trust anybody over 30: youth unemployment and Okun's law in CEE countries. Bank Credit 45, 1–16.
Langot, F., Moreno-Galbis, E., 2013. Does the growth process discriminate against older workers? J. Macroecon. 38, 286–306.
Larsen, M., Pedersen, P.J., 2013. To work, to retire—or both? Labor market activity after 60. IZA J. Eur. Labor Stud. 2–21.
Moosa, I.A., 1997. A cross-country comparison of Okun's coefficient. J. Comp. Econ. 24, 335–356.
Okun, A.M., 1962. Potential GNP: its measurement and significance. In: Proceedings of the Business and Economics Statistics Section. American Statistical Association, pp. 98–104.
Organisation for economic co-operation and development [OECD], 2014. OECD Stat. Extracts. http://stats.oecd.org/ (accessed 3.04.14).
Refrigeri, L., Aleandri, G., 2013. Educational policies and youth unemployment. Procedia Soc. Behav. Sci. 93, 1263–1268.
Rothenberg, J.Z., Gardner, D.S., 2011. Protecting older workers: the failure of the age discrimination in employment act of 1967. J. Soc. Soc. Welfare 38, 9–30.
World Bank, 2012. Gender differences in employment and why they matter, Chapter 5, World Development Report 2012, Washington, DC.
Zanin, L., Marra, G., 2012. Rolling regression versus time-varying coefficient modelling: an empirical investigation of the Okun's law in some Euro area countries. Bull. Econ. Res. 64, 91–108.