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Gender asymmetry in Okun's law in the four PIGS countries

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Abstract

Centred on the four PIGS countries (Portugal, Italy, Greece and Spain) and using the quarterly data from Q2/1998 until Q4/2014, the paper investigates whether there exists gender asymmetries in Okun's law and whether male unemployment reacts identically to economic fluctuations as female unemployment does. Whilst the trend components of output, male and female unemployment are estimated with the aid of the HP filter, Okun's relationships are modelled in the SVAR framework assuming that cyclical fluctuations of the economy and the labour market with both male and female labour force are endogenous. It is established that gender is indeed a factor that makes the respective segments of the labour market respond slightly differently to changes in real output.

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Keywords: Okun's law; gender, male unemployment; female unemployment, SVAR model.

1. Introduction

The title of the paper is rather bold and auspicious. It suggests that asymmetries between genders that are felt by many and fought against exist not only in society as such (and are then called discrimination) but also on a macroeconomic level since they appear to persist also in the empirical regularity which is called Okun's law – leastways for the four countries on which this paper is centred and whose initial letters form the maladroit acronym "PIGS". In the light of recent data, the paper investigates whether there exists any asymmetry in how unemployment of male and female workers react to economic fluctuations in the economic environments of Portugal (P), Italy (I), Greece (G) and Spain (S). With the intent of comparison and using the quarterly data covering the period from Q2/1998 to Q4/2014, the paper estimates for the economies of these four PIGS countries two Okun's equations: one

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relating the unemployment gap for males to the output gap and the other interlinking the unemployment gap for females to the output gap. The statistical methodology is based on two fundamental elements and their list includes: (a) the choice of the Hodrick-Prescott (HP) filter in obtaining the estimates of the underlying gap variables, and (b) the utilization of structural vector auto-regression (SVAR) framework in modelling the dynamics of these variables. Whilst the selection of the HP filter is rather conventional and this filter is a default instrument used in extracting cyclical components from economic time series, the SVAR models are scarcely used in modelling Okun's relationships. This circumstance is unfortunate as they permit modelling simultaneous relationships that are present between variables in question and at the same time they are at liberty to impose a priori economic restrictions on them. Certainly, there is simultaneity at play between the unemployment gaps (no matter whether considered in their true aggregated form or classified according to gender) and the output gap, but this simultaneity must obey the restriction that stems from the belief that the relationship between the variables is one-way only, in the direction from the output gap to the unemployment gap (as fluctuations in economic output mould themselves into variations in unemployment). Such a belief is dictated by the empirical evidence accumulated since the formulation of this relationship and its first known empirical acknowledgement in the form known as Okun's law, and is employed here as a valid economic restriction and a starting point of the analysis to come with economic justification (though atheoretical and empirical). These two components, in conjunction, facilitate the computation of Okun's coefficients separately for unemployment of males and females. These coefficients estimated separately for male unemployment and female unemployment are central to the analysis as they measure the divers reactivity of male and female unemployment to business cycles. Two versions of Okun's coefficients are distinguished therein: whereas instantaneous coefficients capture an immediate effect of output fluctuations upon fluctuations on the labour market, their long-run counterparts does this measurement to establish a net total effect.

The chief classification criterion of unemployment espoused in the study is with respect to gender roles and is motivated by the fact that there are notable differences between male and female unemployment. Females traditionally show a higher rate of unemployment and a lower rate of employment than males do, and their participation in labour force is typically lower and with smaller wages. Of course, the reasons for the different status of males and females on the labour markets can be seen e.g. in the subjective discrimination that continues to exist between sexes or in the objective existence of sex differences (reserving some occupations preferentially to males, and vice versa, or differentiating females during the maternity period). When taking account gender differences on the labour market in the context of cyclical development of the economy, it transpires important to separately investigate the (supposedly different) reaction of male and female unemployment to changes in real output, and through this investigation to contribute to a better understanding of phenomena and processes in the economies of the four PIGS countries with a practical benefit for economic-policy makers.

Such an undertaking may be seen vital as a large majority of research is directed to assessing the relationship between total unemployment and real output in cyclical terms as embodied in Okun's law. This research is stratified across various time spans for which the validity of this empirical law is verified and accomplished for various countries taking both variables in question as total aggregates on the level of the economy. Notwithstanding, more detailed investigations of the labour market must necessarily lead to the finding that labour force in the economy is very heterogeneous, which may affect the intensity with which individual segments of the labour market react to variations in economic development. Gender is an obvious and undeniable characteristic that splits the labour market into two different segments, and this study harbour the ambition to identify how these segments react to cyclical fluctuations and which of them is more exposed or sensitive to these fluctuations. An immediate practical dimension of this investigation is for interventionist economic policy. If an economy undergoes a spell of recession and interventionist steps are to be into effect in order to ameliorate unemployment, then the specification of labour force segments with heightened sensitivity to recession are of incontestable benefit.

Besides gender the paper is occupied also with the economies of the four PIGS countries. These four economies came under the spotlight in the period of the recent economic crisis and became anxiously monitored in connection to stability in the eurozone and its sustainability. These economies share several features that are attributed by economic theory as imbalances: trade deficits, high levels of unemployment and higher deficits (in comparison to the

averages of the European Union), and, last but not least, accelerating government debts. This provides the second source of motivation reflected in full to the paper.

An empirical analysis similar to the one conducted in this paper and focused on validity of Okun's law was done recently for age cohorts in the OECD countries by Zanin (2014), although the statistical aspect of his analysis footed upon ordinary least squares (OLS) estimation may be freely criticized as it is in all likelihood insufficient to exhaust the entire systematicness of disturbance term. Nevertheless, the author ascertains that there seem to exist different reactions of unemployment rate to business cycle fluctuations or even that for some age cohorts unemployment rate may be insensitive to business cycle. A study that is closely related to the present paper is Razzu and Singleton (2013) who examined whether business cycles are gender neutral, but their research question differs substantially from the goal pursued in this paper. Confining their scope to the UK economy, Razzu and Singleton (2013) investigate for both genders the relationship between employment rate and output gap in the UK and conduct their analysis in the framework of multivariate generalized auto-regressive conditional heteroskedasticity (GARCH) modelling. The authors conclude that business cycles are not gender neutral for the UK economy and that impact of business cycle is stronger upon male employment rate rather than upon female employment rate.

A similar observation is established in this paper, as is found that male unemployment and female unemployment react differently to economic fluctuations. Except for Italy (for which the converse is true), economic fluctuations exert a stronger impact upon male unemployment than upon female unemployment. Another finding concerns the horizon over which these effects evolve and are of impact. Irrespective of gender, it seems that for Portugal, Italy and Greece a cyclical movement in output exerts a much higher influence upon both male and female unemployment in the long run than is the influence in the instance when this change is initiated. Leastways, this is but in compliance with common wisdom as over time the effects of an initial impetus accumulate, take on a new dynamics stimulated by past reactions and strengthen. The only exception is Spain, which defies this general scheme. In Spain, an initial stimulus in output appears to bring about a large deflection of unemployment from its natural level, but this deflection does dampen over time and softens.

Aside from this introduction, the paper consists of four other sections. The following section, Section 2, clarifies the economic structure of Okun's law. After formulating Okun's law in mathematical terms and commenting on the possibilities of its estimation, Section 2 then passes on to the methodological section, Section 3, which explains and advocates in full the statistical framework utilized in the analysis. The other two sections in turn describe the data, present the results, and discuss the findings (Section 4), then – eventually – draw the conclusions from the conducted analysis (Section 5).

2. Okun's law and its logic

In the background of Okun's law is the belief that shifts in aggregate demand cause the actual output to fluctuate about the potential output, which motivates firms to engage or lay off workers and this has an impact upon the economy's unemployment. Using different models for capturing the relationship between unemployment and output, Okun (1962) showed for the quarterly post-war US data from Q2/1947 to Q4/1960 that “in the post-war period, on average, each extra percentage point in the unemployment rate above four percent [i.e. the natural rate of unemployment] has been associated with about a three percent decrement in real GNP” (Okun, 1962, p. 99). Okun's law is a significant concept in modern macroeconomics both for theoretical reasons and for policy considerations. Whilst in the former application, it serves a theoretical link between the aggregate supply curve and the Phillips curve; in the latter application, it is utilized as a rule of thumb in economic forecasting and policy-making.

The provenience of Okun's law lies with fiscal and monetary policy considerations that were of utmost interest to US policy-makers in the 1960's, in which one of the central questions was the amount of output that an economy can produce under the conditions of full employment of labour. This led Okun (1962) to link the target of full employment to the corresponding target of potential output (i.e. the output at full employment). In his research paper, Okun considered a total of three methods of relating output to the unemployment, the one termed by him as “trial gaps” is subject of further exposition. Slightly modified from the original establishment, this method goes at present under the name “gap version” of Okun's law.

Denote the unemployment rate by the symbol u, actual output measured by real gross domestic product by the symbol y. The asterisks in the left-hand superscript will indicate the natural rate of unemployment (i.e. the unemployment rate at full employment) and potential output respectively. The output gap will be denoted by g_y and will be defined in a continuous way as $g_y = \log(y) - \log(y^*)$. Similarly, the unemployment gap will go under the notation g_u and will be introduced as $g_u = u - u^*$. All these variables, y, y^*, u, u^*, g_y and g_u, may be exposed to change over time and are treated accordingly. The gap version of Okun's law is governed by the (static) equation

$$g_u = \beta\, g_y, \tag{1}$$

in which β takes the role of Okun's coefficient and in which the stochastic component was neglected for simplicity. (Actually, Okun (1962, pp. 98, 100) assumed, which was common at his time, that the natural rate of unemployment u^* is constant at a 4 % level corresponding to the US economy. Then his regression equation was $u = \alpha + \beta\, g_y$ with α being an a priori known intercept. In effect, it was thus not necessary for Okun to estimate the unemployment gap.) Okun suggested estimating exponential paths of potential output y^* (quite arbitrarily) using alternative assumed growth rates and benchmark levels and using a regression equation. There, of course, are difficulties with obtaining reasonable estimates of y^* and u^* as well as of g_y and g_u, respectively. Okun (1962, p. 99) was very well aware of these difficulties of "selecting and testing certain exponential paths" and catalogued two relevant criteria for assessment of the validity of these potential paths: goodness of fit and absence of any trend in the residuals. In contemporary applications, for the purpose of obtaining such potential paths, data filters are usually employed, especially and most frequently the Hodrick-Prescott (HP) filter (cf. e.g. Lee, 2000, pp. 334-335; Cevik et al., 2013, p. 562). Naturally, there are also some other options how to obtain the unobservable potential output and natural rate of unemployment, including chiefly the Beveridge-Nelson decomposition (e.g. Lee, 2000, pp. 334-336) or a structural model used jointly with the Kalman filter (e.g. Moosa, 1999, pp. 294-296). In actual applications equation (1) is modified in order to capture as best as possible the true dynamics of g_y and g_u. In some studies only a disturbance term is only appended to (1) and the OLS is utilized for the purpose of estimating Okun's coefficient (e.g. Durech et al., 2014; Zanin, 2014), but in others the model defined by (1) is expanded into a dynamic linear regression model using also lags of g_y and g_u on the right-hand side (e.g. Moosa, 1999; Ball et al., 2013). The possibilities catalogued so far may be cast into the univariate approach, which posits g_y as the explained variable and g_u as the explanatory variable and which ignores the simultaneity of these two variables. On the other hand, there is a possibility of employing the multivariate approach based e.g. upon the vector auto-regression (VAR) or vector-error correction (VEC) modelling methodology. In a rare case, when g_y and g_u prove co-integrated, VEC models may be used as in Lee (2000). However, when g_y and g_u are both I(0) and short of any deterministic pattern (which is both a statistical and economic desideratum for gap variables), then VAR models are appropriate. Although for most studies (each cited study afore except Lee, 2000), researchers tend to employ a univariate framework and do not avail themselves of capacity to allow for simultaneity and shared dynamics between gap variables. To the authors of this paper, only one study is familiar that uses the VAR approach in estimating Okun's law, and incidentally it was published of late, viz. Cháfer (2015). In modelling Okun's relationship for the four PIGS countries, this paper uses the structural vector auto-regression (SVAR) framework, which adds identifying structural restrictions to an otherwise traditional VAR model.

The crucial aspects of the methodology are elucidated in the ensuing section.

3. Methodology

The concepts of output gap and unemployment gap are one of the key terminological categories of mainstream economic theory. They both represent a certain excess of a variable over its sustainable long-run quantity and they serve as good descriptors of cyclical fluctuations of an economy as a whole or on the labour market, respectively. The exact definitions are provided in the earlier section: whereas the output gap is defined here in logarithmic terms and derives from the actual real output y and the corresponding potential output y^*, the unemployment gap is an excess of the true unemployment rate u over its natural rate u^*. To this paper a total of three variables are of interest:

the output gap g_y and two other quantities that are imprecisely addressed as the male unemployment gap and the female unemployment gap. For them, an additional notation is introduced, g_u^{m} and g_u^{f}, respectively. The paper seeks to establish and compare for the four PIGS countries how g_u^{m} responds to changes in g_y and what reaction of g_u^{f} is there for changes in g_y. This is not flawless, though. Strictly speaking, in contrast to the unemployment gap, which is constructed by means of economically legitimate quantities, the male and female unemployment gaps do not exist as they would have to be constructed from what might be called as the natural rate of male unemployment and the natural rate of female unemployment.

Having full understanding of this issue, two variables are withal introduced relating to the trend pattern of the male unemployment rate, u^{m}, and the female unemployment rate, u^{f}. The variable $u^{\mathrm{m}*}$ will thus represent the trend component associated with u^{m} and the variable $u^{\mathrm{f}*}$ will similarly stand for the trend component of u^{f}. The derived variables, $g_u^{\mathrm{m}} = u^{\mathrm{m}} - u^{\mathrm{m}*}$ and $g_u^{\mathrm{f}} = u^{\mathrm{f}} - u^{\mathrm{f}*}$, will then still capture cyclical fluctuations on the labour market for male labour force and female labour force, respectively. This will be the only interpretation of g_u^{m} and g_u^{f} and they will miss the usual economic interpretation. For example, it will not be possible to construe g_u^{m} as the lowest rate of unemployment of male labour force that an economy can sustain over the long run. Despite this theoretical deficiency, these variables suit the purposes of this paper in full and are empirically valid to the same degree as is valid Okun's law itself.

Using the quarterly time series of y, u^{m} and u^{f} and in conformity to conventional practice, the potential output y^* and the trends $u^{\mathrm{m}*}$ and $u^{\mathrm{f}*}$ are in the paper extracted with the aid of the HP filter. As this data filter is a standard technique used for extracting trend component of economic time series (see. e.g. Lee, 2000, pp. 334-335; Cevik et al., 2013, p. 562), it is not necessary to delve into unnecessary details on it. It suffices to say that it decomposes a time series into a permanent component (trend) and into a transitory component (cycle), in which it minimizes the sum of square deviations of time series values from trend values penalized for a sufficient degree of smoothness. This smoothness is controlled and enforced by means of the smoothing parameter, which is selected here in line with usual practice as 1600 (the recommended for quarterly data). The employment of the HP filter for obtaining the estimates of y^*, $u^{\mathrm{m}*}$ and $u^{\mathrm{f}*}$ comes with the full recognition of its vices such as that its usage can result in spurious cyclical behaviour (see e.g. Moosa, 1999, p. 295; Lee, 2000, p. 335).

In consequence, the HP filtration of y, u^{m} and u^{f} facilitates the estimation of the corresponding gaps, g_y, g_u^{m} and g_u^{f}. Of course, there should be no deterministic trends present in any of the three gap variables, but stochastic trends may despite this remain. Nonetheless, if its confirmed that they are all I(0), in view of the existing simultaneity between output fluctuations and unemployment fluctuations, it is adequate to describe their dynamics through the VAR framework. the prior belief that contemporaneous causal flows are unidirectional from g_y towards g_u^{m} and g_u^{f} only justifies the use of the SVAR framework to this end. The next few paragraphs are committed to a necessary description of the SVAR model used for each country.

Let $\mathbf{x}_{\mathrm{t}}$ be the vector of the gap variables g_y, g_u^{m} and g_u^{f} observed for some time period t. They all are assumed to be endogenous and are represented by the following SVAR(k)-process

$$\mathbf{\Gamma}\mathbf{x}_{\mathrm{t}} = \mathbf{A}_1\mathbf{x}_{\mathrm{t}-1} + \ldots + \mathbf{A}_k\mathbf{x}_{\mathrm{t}-k} + \mathbf{u}_{\mathrm{t}}, \tag{2}$$

where $\mathbf{\Gamma}$, $\mathbf{A}_1$, ..., $\mathbf{A}_{\mathrm{k}}$ are (3 × 3) coefficient matrices and $\mathbf{u}_{\mathrm{t}}$ is a 3-dimensional white noise process with expectation $\mathbf{0}$ and a time invariant positive definite covariance matrix $\mathbf{\Xi}$. The matrix $\mathbf{\Gamma}$ of economic restrictions on $\mathbf{x}_{\mathrm{t}}$ is required invertible, and in such case equation (2) can be re-written as

$$\mathbf{x}_{\mathrm{t}} = \mathbf{A}_1^{\#}\mathbf{x}_{\mathrm{t}-1} + \ldots + \mathbf{A}_k^{\#}\mathbf{x}_{\mathrm{t}-k} + \mathbf{u}_{\mathrm{t}}^{\#}, \tag{3}$$

whilst $\mathbf{A}_1^{\#} = \mathbf{\Gamma}^{-1}\mathbf{A}_1$, ..., $\mathbf{A}_k^{\#} = \mathbf{\Gamma}^{-1}\mathbf{A}_k$ and $\mathbf{u}_{\mathrm{t}}^{\#} = \mathbf{\Gamma}^{-1}\mathbf{u}_{\mathrm{t}}$ are again (3 × 3) coefficient matrices and a 3-dimensional white noise process with. Now, however, equation (3) is a VAR(k) process that acts as the reduced form to the SVAR(k) model in equation (2). The matrices are $\mathbf{A}_1^{\#}$, ..., $\mathbf{A}_k^{\#}$ are consistently estimable by the OLS method and the matrix $\mathbf{\Gamma}$ in a second step is estimated by the profile maximum likelihood (PML) method under the assumption of normality of $\mathbf{u}_{\mathrm{t}}$. Another characteristic required for the model is its stability (in the sense of stationarity). All these assumptions

(i.e. the white-noiseness and normality of the error process as well as the model's stability and structural stability) must be diagnostically checked.

The implementation of model (2) stipulates that both the time lag k and the matrix $\mathbf{\Gamma}$ be specified. Whilst the lag order k may is in the paper chosen by means of the information criteria (in line with best practices), the matrix $\mathbf{\Gamma}$ of economic restrictions is for each country under consideration set to be of the form

$$\mathbf{\Gamma} = \begin{pmatrix} 1 & 0 & 0 \\ -\beta^{\mathrm{m}} & 1 & 0 \\ -\beta^{\mathrm{f}} & 0 & 1 \end{pmatrix}, \tag{4}$$

wherein β^{m} and β^{f} are instantaneous Okun's coefficients of male unemployment and female unemployment, respectively. This matrix is constructed on the unidirectional principle of influence flows as follows:

- The current value of g_y is not influenced by the current values of both $g_u{}^{\mathrm{m}}$ and $g_u{}^{\mathrm{f}}$ (but may be and is influenced by the past values of all the three gap variables).
- The current value of $g_u{}^{\mathrm{m}}$ is influenced by the current value of g_y, which embodies the fact that output fluctuations manifest themselves in labour market fluctuations and answers to the relationship established by Okun's law. However, the current value of the female unemployment gap is not of influence upon the current value of the $g_u{}^{\mathrm{m}}$. (Still, the current value of the male unemployment gap is influenced by the past values of all the gap variables concerned.)
- Likewise, the current value of $g_u{}^{\mathrm{f}}$ depends on the current value of g_y (and, of course, upon the past values of each gap variable included), but does not depend upon the current value of $g_u{}^{\mathrm{m}}$.

Two points need clarification. First, taking only contemporaneous relationships into account for now, no contemporaneous relationship is assumed between the unemployment gaps, i.e. the male unemployment gap is not a contemporaneous factor for the female unemployment gap, and vice versa, which is indicative that each segment of the labour market has its own instantaneous dynamics. Yet, the claim of Okun's law necessitates that the output gap contemporaneously impacts upon the labour market and thus upon both its segments separated according to the gender characteristic of labour force. Second, the statements in round brackets in each bulleted item translate the required simultaneity of the system. Each variable must exert a certain (though perhaps fading-out) effect on the future values of itself and of the other two variables. For instance, the current male unemployment gap will influence the next-period value of the output gap, the male unemployment gap as well as the female unemployment gap. This is reflected by imposing no constraints on the values of the matrices $\mathbf{A}_1$, ..., $\mathbf{A}_k$.

A distinction must be drawn between instantaneous influences and long-run effects. The coefficients β^{m} and β^{f} quantify an immediate impact of output fluctuations upon unemployment and represent instantaneous "endogeneous" multipliers. Having made sure that model (2) is stable (i.e. it describes a stationary dynamics), they may be converted into the long-term "endogenous" multipliers, ${}^{\mathrm{LT}}\beta^{\mathrm{m}}$ and ${}^{\mathrm{LT}}\beta^{\mathrm{f}}$, that measure net total effect of output fluctuations upon unemployment. This conversion is, nonetheless, facilitated by means of two essential assumptions, viz. the assumption of *ceteris paribus* and the proviso that after an initial movement in output there are no other perturbations in the system. Denote by $\mathbf{\Xi}$ the matrix of long-run multipliers obtained through the Wold moving average representation of (2), whose expression is $\mathbf{\Xi} = (\mathbf{I} - \mathbf{A}_1{}^{\#} - \ldots - \mathbf{A}_k{}^{\#})^{-1}\mathbf{\Gamma}^{-1}$, in which $\mathbf{I}$ signifies the identity matrix of an appropriate dimension. Derived in the process of the impulse response analysis of system (2), this matrix, $\mathbf{\Xi}$, summarizes the permanent and accumulated response of the gap variables $\mathbf{x}_\bullet$ to the shocks $\mathbf{u}_\bullet$, and thus its elements constitute respective long-run multipliers. Assume that there has been a perturbation in the output gap. Then its impact is immediately seen in the output gap itself, which is in turn reflected in the unemployment gaps, and further proliferated in the next rounds through the system as part of the continuing and permanent response to such an initial impulse. The total responses of the output gap, the male and female unemployment gaps to a one-percentage-point shock impulse in the output gap are then captured by $\{\mathbf{\Xi}\}_{11}$, $\{\mathbf{\Xi}\}_{21}$ and $\{\mathbf{\Xi}\}_{31}$, respectively. In this notation, $\{\bullet\}_{ij}$

denotes the element of • in the *i*-th row and the *j*-th column. This permits the definition of the long-term Okun's coefficients, ${}^{LT}\beta^{m}$ and ${}^{LT}\beta^{f}$, as ${}^{LT}\beta^{m} = \{\Xi\}_{21}/(\{\Xi\}_{11}-1)$ and ${}^{LT}\beta^{f} = \{\Xi\}_{31}/(\{\Xi\}_{11}-1)$. The division by $(\{\Xi\}_{11}-1)$ is inevitable to purge the impact upon the unemployment gaps of the very change induced in the output gap, and secures that these coefficients measure the percentage-point change in the unemployment gaps associated with a one-percentage-point impulse in the output gap. Computed in this fashion, the long-term Okun's coefficients are made comparable to the instantaneous ones.

The model is put to practice for the four PIGS countries in the next section, in which the data are described and followed by a presentation of the results.

4. Data and results

The SVAR model exposited in the previous section is elaborated by use of three variables, g_y, g_u^m and g_u^f, derived from y, u^m and u^f. As a matter of fact, only these three variables are needed for the analysis. Nonetheless, in the introductory part of this section, for the purpose of illustration, the total unemployment rate u is also considered in addition to u^m and u^f. The usage of u is but limited solely to demonstration of the pro-cyclical features and similarity patterns of the variables of interest. As neither total unemployment nor its gap are included in the SVAR model, and they are not sensibly incorporable so that the genuine descriptive features of the model be retained, this comparison cannot continue in the modelling phase.

The data on the three plus one time series (y, u^m, u^f plus extra u) per each PIGS country were downloaded at the quarterly frequency from the Eurostat web page (http://ec.europa.eu/eurostat). The attempt to unify the time span between the countries resulted in consolidating them to the period from Q2/1998 until Q4/2014, and, consequently, there were 67 observations for each time series participative in the analysis. The variable y was represented by the real gross domestic product in mio. € evaluated at 2005 prices (seasonally adjusted and adjusted by working days) and the variables u^m and u^f were substituted by the percentage unemployment rate (quarterly average and seasonally adjusted) for male labour force and female labour force, respectively. Naturally, the variable u was represented by the total percentage unemployment rate (quarterly average and seasonally adjusted).

The following analysis was in its entirety accomplished in program R (R Core Team, 2013) using the codes included in the mFilter and vars packages (Balcilar, 2007; Pfaff, 2008).

In keeping with the methodological exposition unfolded in Section 3, out of each time series the trend component was filtered out using the HP filter with the conventional choice of smoothing parameter for quarterly time series, 1600. The output gap g_y was constructed from the estimated trend component in logarithmic terms, whilst the unemployment gaps, g_u^m, g_u^f and g_u^f, were computed from the estimated trends of u^m, u^f and u additively as excesses. For convenience, each estimated gap was pre-multiplied by the factor of 100 to assure better interpretability. The output gap is then stated as percentages (more precisely, measuring the continuously-compounded percentage deviation of the real actual GDP from its estimated potential) and the unemployment gaps are reported as percentage points (stating the nominal excess of the respective percentage unemployment rate over its estimated long-run trend). The estimated gaps are exhibited in Fig. 1, which shows for each PIGS country two time plots, in turn for Portugal, Italy, Greece and Spain. The ordering respected in Fig. 1, and henceforth, conforms to the acronym "PIGS". Whereas the smaller time plot on the left-hand side compares the development of the estimated output gap and the total unemployment gap, the larger time plot on the right-hand side shows the development of the three estimated unemployment gaps. Note that for the left-hand side plots the range of the vertical axes have been set identical in order to enhance comparability.

The complementary pattern of output gaps and total unemployment gaps support the expectation of the pro-cyclical behaviour of these two variables. Economic downturns and recessionary tendencies (signalized by negative output gaps) appear to be accompanied with unemployment increased above their natural level (indicated by positive unemployment gap), and vice versa, though this complementary effect need not be ideally synchronous. Somewhat an optically ideal impression is gained in the case of Portugal. The economic crisis after 2008 is detectable best for Spain and Portugal and indicated by the plummeting output gap. There is also a presence of some violations in the regularity of the compensation relationship, in some periods the unemployment gap tend to react

slowly and late to changes in the output gap, which may be taken as a sign that Okun's relationship may not hold universally in the entire period or that its strength may be lower for the given country. This may be the case of Greece. Also the development patterns for unemployment fluctuations on the labour market manifest an optically high level of similarity. This similarity is an indication that to a great extent the labour markets of the four PIGS countries do not reveal differences for males and females and that unemployment fluctuations triggered by business cycles are synchronous for either gender. In Greece, for most of the period, there is a close match between male and female unemployment gaps, except the years 2004 and 2005 and the period around 2008, which is the believed start of the economic crisis. In other countries, differences are more aggravated, but with the patterns still ascribing to synchronous development.

The analysis further proceeded only with the estimates of the gap variables, g_y, g_u^{m} and g_u^{f}, for each of the four PIGS countries. Insomuch as the optical examination of these time series as well as their unit root analysis (based on the ADF test and the KPSS tests) did not reveal any indication that they might not be stationary, all the time series in question were taken for realizations of I(0) and were utilized directly in the set-up and estimation of the underlying SVAR model. The results of the testing for unit roots are not reported here because they are marginal to the focus of this analysis and are needless in what follows. In a traditional way, the information criteria were a vehicle to identifying the lag order for the formulated SVAR model. Tree information criteria were considered: the Akaike information criterion (AIC), the Hannan-Quinn information criterion (HQIC) and the Schwarz information criterion (SIC) The lag order two was tentatively chosen two for each country. The AIC indicated the lag order 4 or 5 for Italy, Greece and Spain, ant the SIC the lag order 1 for Greece, but otherwise the “optimal” lag order was selected as two.

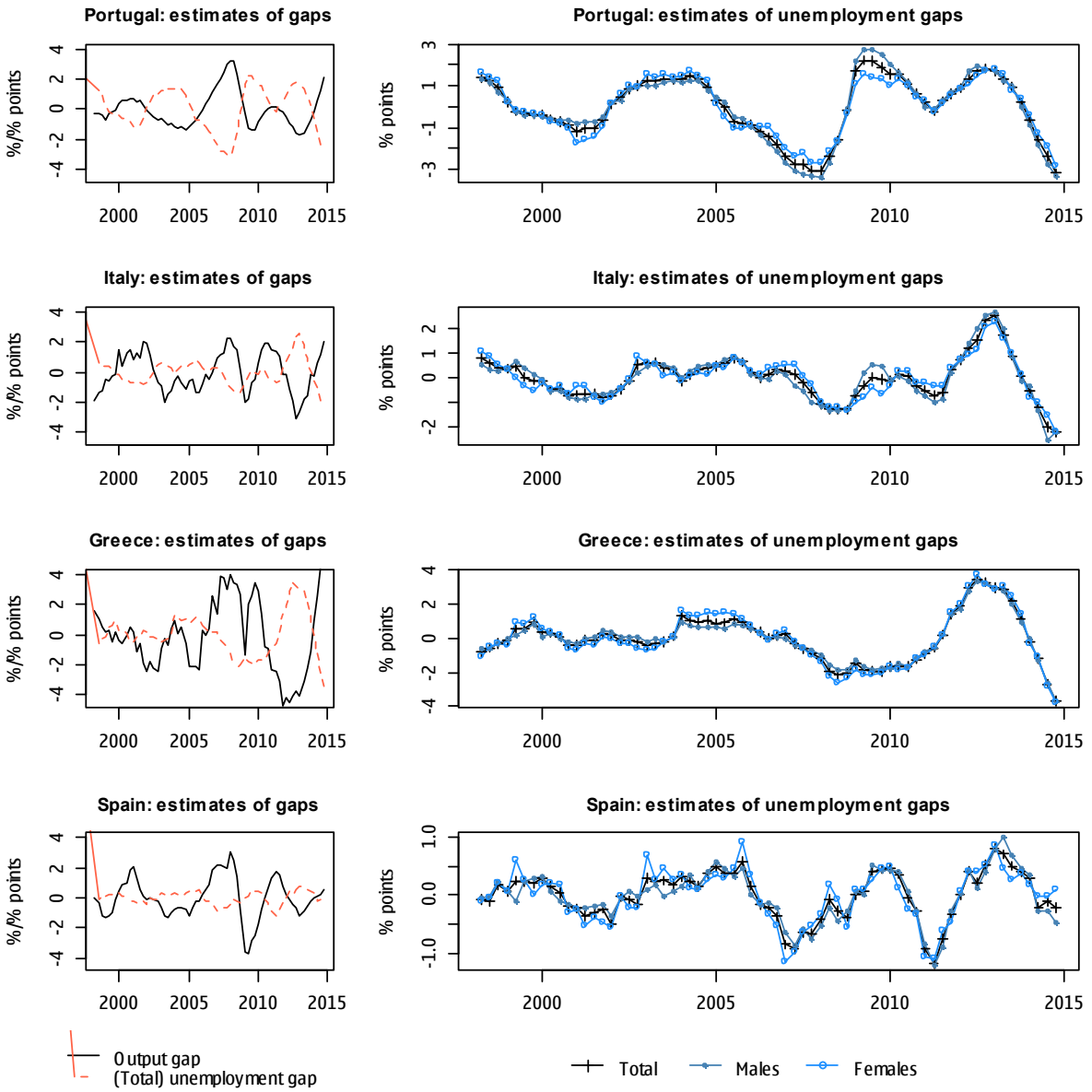

Fig. 1. Estimated gap variables for the four PIGS countries for the period from Q2/1998 to Q4/2014

The relevant estimation report for the SVAR(2) model as specified in (2) is the content of Table 1. For the individual three countries, Table 1 shows the estimated matrices $\mathbf{\Gamma}$, $\mathbf{A}_1$, $\mathbf{A}_2$ (there are only two $\mathbf{A}_\bullet$-matrices as k is set to two). The rows of these matrices correspond to the individual gap variables, g_y, g_u^{m} and g_u^{f}, and represent the regression coefficients of the SVAR relationship formulated in (2). Each row represents a separate regression equation of this multivariate system (although not expressed in the normalized form) and is supplemented with a measure of goodness of fit. Quality of statistical fit is communicated in Table 1 by the adjusted coefficient of determination (adj R^2) which measures merely the goodness of fit of any single equation comprised in the reduced

form VAR stated in (2). Eventually, Table 1 reports on Okun's coefficients in both the instantaneous and long-run version organized separately for male and female labour force.

Table 1.The estimated SVAR(2) results for the four PIGS countries and estimated Okun's coefficients

Equation		Estimated $\boldsymbol{\Gamma}$			Estimated $\mathbf{A}_1$			Estimated $\mathbf{A}_2$			Adj R^2	β	$^{LT}\beta$
		g_y	g_u^m	g_u^f	$g_y(-1)$	$g_u^m(-1)$	$g_u^f(-1)$	$g_y(-2)$	$g_u^m(-2)$	$g_u^f(-2)$			
Portugal	g_y	1	0	0	0.872	-0.583	-0.099	-0.155	0.600	-0.062	0.731	---	---
	g_u^m	0.204	1	0	0.061	1.130	0.247	-0.001	-0.509	-0.146	0.889	**-0.204**	**-0.587**
	g_u^f	0.107	0	1	0.045	0.460	0.830	0.122	-0.124	-0.236	0.850	**-0.107**	**-0.290**
Italy	g_y	1	0	0	1.481	-0.165	0.057	-0.695	0.345	-0.303	0.881	---	---
	g_u^m	0.158	1	0	0.152	0.652	0.277	-0.093	-0.177	-0.112	0.723	**-0.158**	**-0.339**
	g_u^f	0.196	0	1	0.192	0.179	0.618	-0.107	-0.068	-0.143	0.580	**-0.196**	**-0.333**
Greece	g_y	1	0	0	0.699	-0.911	-0.285	0.165	1.099	0.220	0.786	---	---
	g_u^m	0.131	1	0	0.059	1.158	0.160	-0.022	-0.365	-0.127	0.929	**-0.131**	**-0.691**
	g_u^f	0.117	0	1	0.069	0.727	0.766	-0.041	-0.659	0.016	0.909	**-0.117**	**-0.732**
Spain	g_y	1	0	0	1.248	-0.271	-0.112	-0.468	0.196	0.044	0.965	---	---
	g_u^m	0.792	1	0	0.542	0.951	0.147	0.246	-0.051	-0.186	0.964	**-0.792**	**-0.076**
	g_u^f	0.615	0	1	0.783	0.436	0.892	-0.244	-0.296	-0.193	0.930	**-0.615**	**-0.289**

From a statistical viewpoint, all the four estimated SVAR(2) models passed a routine check for their desired properties: they are found stable (in the sense of both stationarity and structural integrity), the residual terms are found to comply to the requirement of white-noisedness and do not contradicts the notion of multivariate normality. Furthermore, the adjusted coefficients of determination show that individual equations of the reduced form VAR models (whose parameters are contained in the elements of the matrices $\mathbf{A}_1$ and $\mathbf{A}_2$ and are estimated by the OLS) provide a good fit. Neither the application of the PML method used for estimating $\boldsymbol{\Gamma}$ experienced any convergence troubles. In summary, this all implies that these estimates are not unsatisfactory approximations of economic reality. (Of course, no one should bear a belief that any statistical model is able to capture the exact nature of a data generating process.)

The SVAR-based analysis of an endogenous system usually proceeds by computing the impulse response function of shocks perturbing the system. However, in this case a presentation of the results of the impulse response analysis would add no extra value to what follows from Okun's coefficients alone. This is the reason why this analysis is omitted from here.

Before going into interpreting the direction and strength of the relationship between business cycles and unemployment fluctuations, it must be highlighted that the fact that the lag order of 2 was chosen for each PIGS country is decisive for how past cyclical variations of both the economy and the labour market carry over and last in their direct effect. It seems that output and unemployment cycles remain effective and unmediated for two quarters and after this period they fade out in their open influence. In other words it is established unanimously for the four PIGS countries that once there has been a cyclical perturbation, it takes two quarters till its direct effects disappear and cease to manifest themselves directly. Although self-evident, one should contrast this half-year period with the periods to which Okun's coefficients reported in Table 1 relate. The instantaneous Okun's coefficients relate to an instance when the change in the output gap occurs as opposed their long-term versions that relate to an infinitely long period of accrued and repetitive changes self-induced in the system under consideration.

As suggested by reason and as expected on empirical grounds, the estimated values of Okun's coefficients are negative, and this finding points to the existence of a compensation/inverse relationship between the output gap and the unemployment gap as was first noticed and formulated by Okun himself. For three PIGS countries these estimates are in magnitude lower than 0.22 irrespective of whether they pertain to male or female labour force

provided that instantaneous effects are considered. Therefore, in Portugal, Italy and Greece during the investigated period of 67 quarters from Q2/1998 until Q4/2014, an increase in the output gap by one percentage point was translated into, and accompanied by, an instantaneous decrease of both the male and the female unemployment gap by no more than 0.22 percentage points. This concludes a somewhat weaker strength of relationship as found by Okun (1962) for the US data and measured it by the value of (–)0.33. Of course, the coefficients in Table 1 and the value computed by Okun are not directly comparable as they are estimated by completely different models. Understandably, the long-term *ceteris paribus* Okun's coefficients point to a fairly stronger relationship differentiated for these countries, but no estimate is lower than 0.74 in absolute value. The effect of output fluctuations upon unemployment in the long run is for Portugal, Italy and Greece found stronger than in the instance when these fluctuations commenced, and this scheme is violated by Spain, in which in the long run this effect weakens and is offset. As studying the Okun relationship in a long-run perspective, for Portugal the net accumulated effect of a sudden output shift is found triple than the instantaneous effect, for Italy it is about twice as much, whilst for Greece about five- or sixfold.

The magnitudes of Okun's coefficients being for female labour force lower than for male labour force mean that, with the exception of Italy, in the PIGS countries female unemployment appears to be less sensitive to cyclical oscillations in real output. Only for Italy, female unemployment is found more reactive than male unemployment, although in the long-run this difference is not present. On the other hand, for Greece, the striking similarity of Okun's coefficients for male and female labour force (regardless of whether instantaneous or long-terms ones are inspected) indicates that both gender-based segments of the labour market react comparably to cyclical variations. Having said that, male labour force in Portugal is found twice as much tied up with output fluctuations than female labour force.

A special case is Spain, which has in comparison with the other three PIGS countries markedly higher instantaneous Okun's coefficients for both male and female labour force, and this is in accord with the ascertainment of Ball et al. (2013) who carried out a similar analysis (though in a completely different and simpler framework) for some selected countries. They, too, found a relatively high Okun's coefficient in absolute value. Ball et al. (2013, p. 19) explain this finding of theirs by the unusually high incidence of temporary employment contracts. On account of labour reforms in the 1980s, the labour market in Spain is accustomed to hiring labour under temporary contracts that make it easier for employers adjust employment as output changes, thus raising Okun's coefficient.

In Greece, Portugal as well as in Spain, both instantaneous and long-term Okun's coefficients are higher in absolute value for male labour force than for female labour force, which may follow from the underlying structure of their economies. In the past recession of 2008, the most affected economic sectors were manufacturing and construction, in which male labour force is of prevalence (e.g. in these countries male labour represents a 91.5 % share in the construction sector). The higher impact of cyclical variations upon male labour force (in comparison to female labour force) as indicated by the differences in Okun's coefficients may be partly explained also by the differences in the participation of male labour and female labour across industrial sectors of the economy. There are some other factors which may have been at play, such as educational differences or different demographical characteristics.

5. Summary

The labour market possesses in comparison with other markets some specifics; among other things, it is more linked with social factors and vulnerable to economic shocks and conjunctural development. Economic recession in market economies forces enterprises to reduce their economic activities (including closing down their premises) and to narrow down their demand for labour, which in turn leads to a decrease in unemployment and an increase in involuntary unemployment in the economy. On the other hand, periods of economic boom are often connected to new jobs creation, having thus subsequent consequences on employment and unemployment. The labour market is often the centre of interest not only of scholars and politicians, but is also in the centre of focus for common people – these are not involved in studying economics and its relationships but their interest is intensely with keeping or

losing their occupation. The recent period of a deep economic depression has shown that involuntary unemployment is one of permanent problems in modern and even most developed economies.

This is the main reason why many researchers examine the relationship that must be logically present between changes in the performance of an economy and changes in its labour market. This investigation was first initiated by Okun who in 1962 suggested, on the basis of empirical evidence for the US economy, that there exists a compensation relationship between unemployment and output. Now this empirical observation has become a traditional element in macroeconomic textbooks, has been rationalized and goes under the name Okun's law.

Okun's investigation is prolonged in this paper in two directions. First, the factor of gender is accommodated in the paper and a distinction is drawn between male and female unemployment. The reason being that, as there are societal asymmetries between the two sexes, there may also be asymmetries from an economic point of view. These economic asymmetries may then propagate themselves on the labour market and may shape and differentiate its reactions to cyclical variations of the economy as a whole. Second, the paper does its investigations on a comparative basis for a foursome of countries that are infamously known for their imbalances and sovereign debt troubles as the PIGS countries. This characteristic marks Portugal, Italy, Greece and Spain as different from other (better-disciplined) members of the European Union and the eurozone. The paper thus seeks to uncover whether there is any asymmetry in how male and female labour force react to economic variations in the four PIGS countries. To this end, the quarterly data for the period from Q2/1998 to Q4/2014 are made used in modelling and the econometric methodology is based on estimating potential or long-run components of output, male and female unemployment by dint of the HP filter and on describing the dynamics of the resulting gap variables in the framework of SVAR model. Whereas HP filtration is a standard technique used for estimation of both output and unemployment gaps, SVAR models are surprisingly underestimated and incomprehensibly not used in Okun's analyses. This being despite the fact that they combine in a unique manner sort of the best of two approaches, the atheoretical and flexible approach of VAR modelling and the approach based on simultaneous equations respecting apriori economic restrictions. These restrictions on the data generating process of output gap, male and female unemployment gaps were in the paper formulated through apriori reasoning and with support of empirical evidence evinced in Okun's analyses. Following these restrictions, it is the output gap that instantaneously influences both the male and female unemployment gaps, and vice versa.

The analysis revealed that for these four countries, cyclical variations in output exert their direct influence over the labour market instantaneously and further two quarters from their initiation. After two quarters, the effect of cyclical variations in output upon both male and female unemployment transform into latent endogenous communications between output and unemployment. More importantly, some asymmetries were ascertained for each PIGS country, although the difference in the intensity with which both male unemployment and female unemployment react to output fluctuations in Greece is minimal and for Italy becomes negligible and vanishes. With the exception of Italy and of Spain in the long-run, in the PIGS countries female unemployment appears to be less sensitive to output fluctuations. It is established that in the three PIGS countries the immediate reaction of both male and female unemployment to output fluctuations is multiplied and accumulated over time (for Portugal it triples in size, for Italy it roughly doubles, and for Greece it rises five- or sixfold). The only exception to this pattern is Spain, for which the long-run reaction of unemployment is diluted and much milder and even changes the direction of asymmetry. As a shift in real output in Spain prolongs its long-run effects infinitely over time, the resulting new cyclical development on the labour market wears off and decreases tenfold (for male labour force) and double (for female labour force) as compared to the initial reaction of the labour market. Whilst it is male labour force which is a little more sensitive to output fluctuations when they come into effect, in the long run the net reaction of male labour force is ascertained of a fourfold lower intensity than the net reaction of female labour force.

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