Unemployment invariance hypothesis and structural breaks

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Abstract

This article extends the Österholm (2010, **Economics Letters** 106, 205-208) analysis of the long-run relationship between unemployment and labour force participation rate by taking into account possible structural breaks and the possible existence of differences by gender, using US data. The Kejriwal-Perron tests are applied to this end. In the last regime, the current one, our findings support the unemployment invariance hypothesis except for males, in which case a discouraged worker effect is found.

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1. Introduction

In two recent articles Österholm (2010) and Emerson (2011) provide evidence of a long-run equilibrium relationship between unemployment rates and labour force participation rates in Sweden and in the United States, respectively. As it is well-known the crisis may triggers two opposite phenomena in relation to labour participation rates: on the one hand people who want for a job, abandon the search due to the lack of job offers (discouraged effect). On the other hand, in some households affected by unemployment, other family members will decide to search for a job (added worker effect). Overall, the literature on the cyclical behavior of the labor force participation at the business-cycle frequency appears as essentially split between studies finding evidence of a significant cyclical sensitivity, and others finding no evidence of pro- or counter-cyclicality (unemployment invariance hypothesis). A possible explanation of these ambiguous results could be based on the existence of structural changes, the existence of opposed movements between different groups (e.g. by gender) or both. For this reason we propose to test the unemployment invariance hypothesis, allowing for the possibility of structural breaks in the long-run relationship and taking into account the possible existence of differences in the observed relationship by gender, in line with the recent empirical literature (e.g., Benati, 2001, Congregado et al, 2010, Österholm, 2010, Emerson, 2011). We argue that the evidence of two opposite long run relationships between unemployment and labour participation identified by Emerson in the US - discouraged worker effect for males and added worker effect for females- arises due to the failure to account for potential instabilities in the long run relationship between them. It is important to emphasize that our results on the nonlinear nature of the relationship does not necessarily contrast with previous results. By contrast, this article contributes to this line of research by assessing whether or not there are some structural

changes in the relationship. In sum, this article try to test the invariance/ discouraged/added hypotheses by gender group, by means of the analysis of a linear VECM and testing if the relationship is subjected to structural breaks, using seasonally adjusted monthly data, for the US (Bureau of Labor Statistics) during the period 1948:1-2011:2. This paper is organized as follows: Section 2 will present an econometric framework for studying the tendency of some groups of workers to move in and out of the labor force over the cycle while section 3 presents the basic results. Finally, section 4 concludes.

2. Econometric framework

The common way to check the previous hypotheses empirically, using time series, consists in analyzing the relationship between the labour participation rate and the unemployment rate, by means of a linear cointegration approach. The benchmark model is a finite-order VAR of the following form:

$$x_t = c + \sum_{i=1}^{k} A_i x_{t-i} + \varepsilon_t \qquad (1)$$

In the above model, $x_t = [p_t, u_t]'$ is a vector of non-stationary variables containing the labour force participation rate (p_t) and the unemployment rate (u_t), A_i is a *2x2* matrix of parameters, and ε_t is an *2x1* vector of residuals. In order to characterize the long run dynamic adjustments, we can rewrite the equilibrium VAR model as a vector error correction model (VECM):

$$\Delta x_t = c + \sum_{i=1}^{k-1} \Gamma_i \Delta x_{t-i} + \Pi x_{t-k} + \varepsilon_t \qquad (2)$$

where $\Gamma_i = -\left(I - \sum_{i=1}^{k-1} A_i \right)$ and $\Pi = -\left(I - \sum_{i=1}^{k} A_i \right)$. The matrix Π, is usually decomposed as $\Pi = \alpha\beta'$, where α and β are nxr matrices containing the adjustment coefficients and the cointegrating vector, respectively, *n* is the number of variables, *r* is the number of cointegrating relationships. In this form all terms in equation (2) are stationary. In our application the system can be written as:

$$\begin{bmatrix} \Delta p_t \\ \Delta u_t \end{bmatrix} = \Gamma(L) \begin{bmatrix} \Delta p_{t-i} \\ \Delta u_{t-i} \end{bmatrix} + \begin{bmatrix} \alpha_p \\ \alpha_u \end{bmatrix} \left(p_{t-1} - \beta u_{t-1} \right) + \begin{bmatrix} \varepsilon_t^p \\ \varepsilon_t^e \end{bmatrix} \qquad (3)$$

where α_p and α_u indicate the speed of adjustment of each variable back to its long-run value. In the above model, the lagged residuals from the cointegrating vector act as an error correction term. This term, $p_{t-1} - \beta u_{t-1}$, captures the extent of disequilibrium for the system of variables with respect to the long-run relation between all variables in the system. The existence of a cointegration relationship in the model would lead us to reject the unemployment invariance hypothesis. However, as Österholm (2010) suggests since the two series may not have exact unit roots, we also need to test whether the restrictions β=(1 0)' and β=(0 1)' can be rejected. On the other hand, testing the restrictions on the error-correction terms -$\alpha=(\alpha_p,0)$' and $\alpha=(0,\alpha_u)$' – we could know whether the unemployment rate adjusts to the labour participation rate or vice versa.

However, nothing guarantees the stability of our estimates. Accounting for parameter shifts is crucial in cointegration analysis, we propose to use the Kejriwal and Perron (2010) testing procedure that not only enables detection of parameter instability but also allows consistent estimation of the number of breaks. Once structural breaks are found, we apply the Österholm approach for each regime.

3. Results

As a preliminary step in our analysis, we examine the time series properties of the series by testing for a unit root. We have used a modified version of the Dickey-Fuller and Phillips-Perron tests proposed by Ng and Perron (2001), which try to solve the main problems present in these conventional tests for unit roots[1]. The null hypothesis of nonstationarity in levels is also clearly rejected at the usual significance levels. Therefore, according to the results of these tests, u_t and p_t would be I(1).[2]

As we argued before, it is important to account for structural breaks in the cointegration relationship. Our data covers sixty three years, during which time the relationship have probably changed. Therefore, we apply the tests for structural change that have been proposed in Kejriwal and Perron (2010). We use 15% trimming so that the maximum numbers of breaks allowed under the alternative hypothesis is 5.[3] Both the intercept and the slope are allowed to change.

Table 1: Kejriwal-Perron tests for testing multiple structural breaks in cointegrated regression models

Trimming	*15%*	*15%*	*15%*
Sample	*All in labour force*	*Males*	*Females*
Sup F(1)*	10.013	4.158	6.391
Sup F(2)*	6.069	5.644	4.543
Sup F(3)*	6.045	4.560	3.921
Sup F(4)*	4.936	4.613	3.351
Sup F(5)*	4.029	4.488	2.888
UDmax	10.013	5.644	6.391
Seq	0	0	0
BIC	4	5	5
LWZ	4	5	5
Numbers of breaks allowed	5	5	5
Break dates	1967:4	1957:9	1957:7
	1977:1	1969:7	1967:2
	1986:5	1981:2	1977:7
	2001:4	1990:10	1986:11
		2001:4	1996:3

Note: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The critical values are taken from Kejriwal and Perron (2010).

Table 1 presents the results of stability tests as well as the number of breaks selected by the sequential procedure (*Seq*) and the information criteria *BIC* and *LWZ*. For the three groups, the sequential procedure selects no break - i.e. it does not suggest any

instability. However, the two information criteria –BIC and LWZ- suggest four breaks for the aggregate rate and five breaks for males and females. Overall, the results of the Kejriwal-Perron tests suggest as current regimes from 2001:4 until now for the aggregate rate and for males and from 1996:3 for females. In order to compare the coefficients obtained from a model with different regimes with those reported from a model without any structural break[4], we proceed to estimate the cointegration equation (3) for the sub-samples using the Johansen procedure. The results are reported in the last three columns of Table 2.

Table 2: Estimated cointegration vector

	All in labour force	Males	Females
Full sample		**1948:1-2011:2**	
p_t	1	1	1
u_t	-5.144*** (A) (1.369)	4.842***(D) (0.946)	-11.679***(D) (2.679)
constant	-33.326	-105.418	22.124
1st regime	**1948:1-1967:4**	**1948:1-1957:9**	**1948:1-1957:7**
p_t	1		1
u_t	3.359***(D) (0.803)	(I)	7.880***(D) (2.039)
constant	-75.413		-72.511
2nd regime	**1967:5-1977:1**	**1957:8-1969:7**	**1957:8-1967:2**
p_t	1	1	1
u_t	-0.407***(A) (0.057)	-1.186***(A) (0.171)	4.435***(D) (0.906)
constant	-58.338	-76.268	-65.297
3rd regime	**1977:2-1986:5**	**1969:8-1981:2**	**1967:3-1977:7**
p_t		1	1
u_t	(I)	0.884***(D) (0.167)	-1.370***(A) (0.168)
constant		-83.311	-35.296
4th regime	**1987:6-2001:4**	**1981:3-1990:10**	**1977:8-1986:11**
p_t		1	
u_t	(I)	-0.068***(A) (0.019)	(I)
constant		-75.864	
5th regime	**2001:5-2011:2**	**1991:11-2001:4**	**1986:12-1996:3**
p_t		1	
u_t	(I)	-0.247***(A) (0.038)	(I)
constant		-73.743	
6th regime		**2001:5-2011:2**	**1996:4-2011:2**
p_t		1	
u_t		0.766***(D) (0.122)	(I)
constant		-78.050	

Note: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.
Estimates are not reported when the Johansen (1988, 1991) cointegration test rejects the cointegration relationship. Johansen's tests results available upon request. A, D and I, denotes evidence of Added worker effect, Discouraged effect and Invariance unemployment hypotheses, respectively.

By using the framework proposed by Österholm (2010) we are interested in testing the restrictions reported in the first column in table 3. For the full sample, our results confirm the previous findings of Emerson (2011). Focusing on the last regime, the unemployment invariance hypothesis is again confirmed for the aggregate labour force participation rate and for females. For males, in the current regime, we reject the four restrictions. Therefore the discouraged worker effect is confirmed for males in the US from 2001:5.

Table 3: Test of restrictions in cointegrated VAR. P-values.

Restriction	All in labour force	Males	Females
Full sample		**1948:1-2011:2**	
$\beta=(1\ 0)'$	**0.0007**	**0.0000**	**0.0001**
$\beta=(0\ 1)'$	0.1536	**0.0170**	**0.0176**
$\alpha=(\alpha_p,0)'$	**0.0030**	**0.0000**	0.0535
$\alpha=(0,\alpha_u)'$	0.2244	0.0890	**0.0005**
1st regime	**1948:1-1967:4**	**1948:1-1957:9**	**1948:1-1957:7**
$\beta=(1\ 0)'$	**0.0011**		**0.0000**
$\beta=(0\ 1)'$	0.7394		0.4874
$\alpha=(\alpha_p,0)'$	**0.0010**		**0.0076**
$\alpha=(0,\alpha_u)'$	0.8702		**0.0023**
2nd regime	**1967:5-1977:1**	**1957:8-1969:7**	**1957:8-1967:2**
$\beta=(1\ 0)'$	**0.0000**	**0.0019**	**0.0000**
$\beta=(0\ 1)'$	**0.0000**	**0.0035**	0.1369
$\alpha=(\alpha_p,0)'$	**0.0000**	**0.0023**	**0.0000**
$\alpha=(0,\alpha_u)'$	0.1037	0.3715	**0.0201**
3rd regime	**1977:2-1986:5**	**1969:8-1981:2**	**1967:3-1977:7**
$\beta=(1\ 0)'$		**0.0017**	**0.0012**
$\beta=(0\ 1)'$		**0.0290**	**0.0004**
$\alpha=(\alpha_p,0)'$		**0.0039**	**0.0000**
$\alpha=(0,\alpha_u)'$		**0.0378**	0.2310
4th regime	**1987:6-2001:4**	**1981:3-1990:10**	**1977:8-1986:11**
$\beta=(1\ 0)'$		**0.0029**	
$\beta=(0\ 1)'$		**0.0000**	
$\alpha=(\alpha_p,0)'$		**0.0005**	
$\alpha=(0,\alpha_u)'$		**0.0089**	
5th regime	**2001:5-2011:2**	**1991:11-2001:4**	**1986:12-1996:3**
$\beta=(1\ 0)'$		**0.0002**	
$\beta=(0\ 1)'$		**0.0000**	
$\alpha=(\alpha_p,0)'$		0.0594	
$\alpha=(0,\alpha_u)'$		0.0000	
6th regime		**2001:5-2011:2**	**1996:4-2011:2**
$\beta=(1\ 0)'$		**0.0004**	
$\beta=(0\ 1)'$		**0.0369**	
$\alpha=(\alpha_p,0)'$		**0.0144**	
$\alpha=(0,\alpha_u)'$		**0.0005**	

Note: In bold p-values lower than 5% of the likelihood ratio test for the restrictions.

4. Conclusions

This paper has produced empirical evidence supporting the discouraged worker effect notion only for men in US, in the current regime. Our estimates suggest that male participation rate will be still lower in the future if unemployment rate among men shows persistence. By contrast, our findings support the unemployment invariance hypothesis for the aggregate and female labour force participation rates, at least in the last and in the more recent regimes. Therefore, our results point to the need to take into account structural breaks in the analysis of this long-run relationship.

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[1] See Ng and Perron (1995).

[2] Results are suppressed for brevity but are available from the authors on request.

[3] Jaeger and Parkinson (1990) show that the average periodicity of the U.S. cyclical unemployment rate is about 8 years. For this reason, we use a trimming of 15%. Then, each segment should contain at least 113 observations, i.e, 9 ½ years.

[4] Our estimates for the full sample confirms the previous ones (see Emerson, 2011)