Okun's Law Paper *

Mariam Camarero [†1], Juan Sapena [‡2] and Cecilio Tamarit [§3]

[1]Economics Department. Universitat Jaume I
[2]Economics and Business Department. Catholic University of Valencia
[3]Applied Economics II Department. University of Valencia

11 · 15 · 2021

Abstract

In this paper, we develop a State-Space framework for modeling panel time series. Our research extends the simple framework generally employed at the literature, into a panel-data time-varying parameters framework, combining both fixed (either common and country-specific) and varying components. Under determinate circumstances, this setting can be understood as a mean-reverting panel time-series model, where the mean fixed parameter can, at the same time, include a deterministic trend. Regarding the transition equation, our structure allows for the estimation of different autoregressive alternatives, and include control instruments in the transition equation, whose their coefficients can be set-up either common or idiosyncratic (this is particularly interesting for detecting asymmetries among individuals (countries) to common shocks). The code performed in GAUSS allows for the introduction of restrictions regarding the variances of both the transition and measurement equations. Finally, we perform an empirical application of the frame to the Okun's Law for a XX-countries panel on the support of its usefulness in solving complexities in macroeconomics empirical research.

Keywords: monetary policy; EMU; velocity of money, QE, panel unit root tests, multiple structural breaks, Kalman Filter, Time varying parameters.
JEL Classification: C23, F32, F36.

*The authors are indebted to James D. Hamilton and J. LL. Carrion-i-Silvestre for providing them with the Gauss codes to implement some of the tests used in the paper. They also thank for comments and suggestions to participants in the 12th International Conference on Computational and Financial Econometrics 2018 (Pisa). The authors gratefully acknowledge the financial support from AEI/MINEIC-FEDER project ECO2017-83255-C3-3-P and the Generalitat Valenciana (PROMETEO/2018/102 and GV/2017/052). J. Sapena is also indebted to the Chair "Betelgeux" for a Sustainable Economic Development for its specific funding of this research. Cecilio Tamarit and Mariam Camarero also acknowledge the funding from European Commission project 611032-EPP-1-2019-1-ES-EPPJMO-CoE. The European Commission support did not constitute an endorsement of the contents, which reflect the views only of the authors. On behalf of all authors, the corresponding author states that there is no conflict of interest. All remaining errors are ours.

[†]camarero@uji.es. Universitat Jaume I, INTECO Joint Research Unit. Department of Economics. Campus del Riu Sec, E-12071 Castellǿ de la Plana, Spain.

[‡]juan.sapena@ucv.es. Catholic University of Valencia, Economics and Business Department. 34 Calle Corona, E-46003 Valencia, Spain. Corresponding Author

[§]cecilio.tamarit@uv.es. University of Valencia, INTECO Joint Research Unit. Applied Economics II Department. PO Box 22.006 - E-46071 Valencia, Spain

1 Okun's Law

After Okun (1962) found a negative short-run relationship between unemployment and output, its empirical support has made Okun's law become a fixture in standard macroeconomics, and a simple rule of thumb frequently used by economic forecasters.

In its "gap specification", Okun's law postulates an inverse relationship between the deviation of unemployment rate, ur_t, from its natural level, ur_t^*, and (log transformed) actual GDP ($\ln y_t$) gap from trend or potential output ($\ln y_t^*$), or percent deviation from trend output

$$(ur_t - ur_t^*) = \beta \left(\ln y_t^* - \ln y_t\right) \tag{1.1}$$

Where the parameter β is usually referred to as Okun's coefficient, and the natural unemployment rate, ur_t^*, can also be interpreted as the unemployment rate associated with full employment.

It is obvious that the stationary or cointegration conditions have to be fulfilled for these gaps. Moreover, the problem with both potential output and full employment is that neither is a directly observable macroeconomic statistic, and and their calculation relies on the researcher's choice.

An alternative specification is the"first-differences" version of the Okun's law, that relies on observable data, although its "as-is" validity requires the fulfillment of additional conditions.

To obtain the "first-differences" specification, we must difference (1.1) with respect to the analogous expression for $t-1$:

The same specification can be expressed similarly for t-1:

$$(ur_{t-1} - ur_{t-1}^*) = \beta \left(\ln y_{t-1}^* - \ln y_{t-1}\right) \tag{1.2}$$

Taking annual differences on both sides on (1.1), we obtain:

$$(ur_t - ur_{t-1}) - (ur_t^* - ur_{t-1}^*) = \beta \left[(\ln y_t^* - \ln y_{t-1}^*) - (\ln y_t - \ln y_{t-1})\right] \tag{1.3}$$

$$(ur_t - ur_{t-1}) = (ur_t^* - ur_{t-1}^*) + \beta \left(\ln y_t^* - \ln y_{t-1}^*\right) - \beta \left(\ln y_t - \ln y_{t-1}\right) \tag{1.4}$$

Or, in a simplified form,

$$\Delta ur_t = \Delta ur_t^* + \beta\ g_t^* - \beta\ g_t \tag{1.5}$$

Where

$$\Delta ur-_t = ur_t - ur_{t-1} \tag{1.6}$$

$$\Delta ur_t^* = ur_t^* - ur_{t-1}^* \tag{1.7}$$

And

$$g_t^* = \ln y_t^* - \ln y_{t-1}^* \tag{1.8}$$

$$g_t = \ln y_t - \ln y_{t-1} \tag{1.9}$$

To obtain the basic "first difference" version of the Okun's law at Okun (1962), we need to make two additional assumptions, i.e. the constancy of the natural unemployment rate, $\Delta ur_t^* = 0$; and also a constant average annual growth rate for potential full-employment output, $g_t^* = g^*$
Then, We rename the corresponding parameters into $\beta\ g^* = \beta_0$ and $-\beta = \beta_1$, and equation (1.5) becomes the static first-differences version:

$$(ur_t - ur_{t-1}) = \beta_0 + \beta_1 \left(\ln y_t - \ln y_{t-1}\right) \tag{1.10}$$

Or in a simplified form

$$\Delta ur_t = \beta_0 + \beta_1 g_t \tag{1.11}$$

The main advantage of the difference version of Okun's law is that it avoids requiring sometimes controversial assumptions regarding the definition and computation of potential output and full employment, but the strong assumptions required, in particular on the constancy of the natural unemployment rate, make its basic formulation less realistic for empirical applications. Besides, for this specification to be correct, the series between brackets have to be stationary or, if nonstationary, they must be cointegrated to avoid spurious regressions.

The parameter β_1 is expected to be negative, so that while rapid output growth is associated with a falling unemployment rate, slow or negative output growth is associated with a rising unemployment rate, while the ratio $-\frac{\beta_0}{\beta_1}$ gives the output growth rate consistent with a stable unemployment rate, or how quickly the economy would typically need to grow to maintain a given level.

Nevertheless, as pointed out at Knotek II (2007), the "static version" of Okun's law captures only the contemporaneous correlation, but ignores the rich dynamics between Δur_t and g_t, such as the effect of past GDP growth on the current unemployment rate or the effect of the past unemployment rate on the current unemployment rate, as suggested by the literature on unemployment persistence (i.e. Barro, 1988; Mortensen and Pissarides, 1994). This fact leads to the use of a dynamic version of Okun's law, also including past real output growth, and past changes in the unemployment rate on the right side of the first-differences version, contributing to the explanation of the current change in the unemployment rate on the left side.

Another approach has led to production-function versions of Okun's law, combining a theoretical production function with the gap-based version of Okun's law, allowing economists to assess all of the economy's idle resources. The main drawback to this approach stems from difficulties associated to measuring inputs such as capital and technology.

The hysteresis hypothesis ((Blanchard and Summers, 1987; León-Ledesma, 2002), where "history matters" ((Lang and de Peretti, 2009) deserves atention for a correct specification of Okun's law, as it crucially determines the time evolution of unemployment rate, and for the first-difference specification, invalidates the constancy of the equilibrium unemployment rate above assumption.

Knotek II (2007) reestimates the original Okun's law first-differences version extending the period until the second quarter of 2007, and the only minor difference lies in the estimated constant term. and obtains similar results. Since the (negative of the) constant term divided by Okun's coefficient gives the rate of output growth consistent with a stable unemployment rate, this implies that the economy required slightly more rapid growth to maintain a given level of unemployment in Okun's time than it has over a longer time span.

Recently, Ball et al. (2017) has shown that while the Okun's law fits the data in most countries, the coefficient in the relationship, i.e. the effect of a 1% change in output on the unemployment rate, varies substantially across countries.

Moreover, linearity in the Okun's law has also been cricicised in the literature, suggesting that the relationship is characterized by nonlinearities and asymmetries (e.g. Virén, 2001; Crespo-

Cuaresma, 2003; Silvapulle et al., 2004).

A time-varying parameter model representation can tackle the issues above:

$$\Delta ur_{i,t} = \left(\bar{\beta}_{0,i} + \xi_{0,i,t}\right) + \left(\bar{\beta}_{1,i} + \xi_{1,i,t}\right) g_t \tag{1.12}$$

$$\xi_{k,i,t} = \phi \xi_{k,i,t-1} + \mu_{k,1,i} \Delta ur_t^* + \mu_{k,2,i} \Delta g_t^* \tag{1.13}$$

********** REVISING Cœuré (2017) highlights that potential output estimates are chronically unreliable and often subject to substantial revisions ex post.

Moreover, recessions often tend to have a permanent effect on the level of potential output. It is much less clear, however, whether the crisis will also leave a permanent footprint on the trend potential growth rate – something in Ball (2014) is called "super-hysteresis" effects.

First, in most countries the loss of potential output is almost as large as the shortfall of actual output from its pre-crisis trend.

Second, in the countries hit hardest by the recession, the estimated growth rate of potential output is significantly lower today than it was before 2008.

According to Friedman (1968) "There is always a temporary trade-off between unemployment and inflation; there is no permanent trade-off. The temporary trade-off comes not from inflation per se, but from unanticipated inflation, which generally means, from a rising rate of inflation". Eventually, says Friedman, unemployment returns to the natural rate.

economists use NAIRU (for non-accelerating inflation rate of unemployment) as a synonym for the natural rate, because the natural rate is the unemployment level consistent with stable inflation.

Friedman says the natural rate depends on features of the labor market such as minimum wages, labor unions, and frictions in matching the unemployed with job vacancies. He says that monetary policy cannot affect the natural rate. A large literature has tried to explain changes in the NAIRU.

For the shock/institution theory proposed by Krugman (1994) Krugman (1994) among others, the shock is a decrease in the demand for low-skill labor caused by technological change. The institutions are labor-market distortions that create wage rigidity. The equilibrium wages of

low-skill workers have fallen but their actual wages have not, so unemployment has risen.

There is strong evidence against the hypothesis that movements in the NAIRU are independent of aggregate demand. Shifts in aggregate demand, such as those driven by monetary policy, push inflation and unemployment in opposite directions, at least in the short run.

The value of NAIRU is hard to measure, largely because it changes over time. The economy experiences many kinds of shocks that influence inflation and unemployment. Considering this fact, it would be remarkable if the level of unemployment consistent with stable inflation were easy to measure.

(Virén, 2001) Non-linear Okun's law. The model is estimated using a threshold model estimator We should think about threshold variable and value choices: i.e. increase or decrease in unemployment rate.

$$y_t^c = \alpha + \beta_{1,i,t} u_t^{c+} + \beta_{2,i,t} u_t^{c-} + \nu_{i,t} \tag{1.14}$$

Abel et al. (2017) macro textbook Okun's law specification

y=-bx

References

Abel, A. B., Bernanke, B. S., and Croushore, D. (2017). *Macroeconomics*. Pearson, 9th edition.

Ball, L. (2014). Long-Term Damage from the Great Recession in OECD Countries. Technical report, National Bureau of Economic Research, Cambridge, MA.

Ball, L., Leigh, D., and Loungani, P. (2017). Okun's Law: Fit at 50? *Journal of Money, Credit and Banking*, 49(7):1413–1441.

Barro, R. J. (1988). The Persistence of Unemployment. *American Economic Review*, 78(2 - Papers and Proceedings of the One-Hundredth Annual Meeting of the American Economic Association):32–37.

Blanchard, O. J. and Summers, L. H. (1987). Hysteresis in unemployment. *European Economic Review*, 31(1-2):288–295.

Cœuré, B. (2017). Scars or scratches? Hysteresis in the euro area. Speech by Benoît Cœuré, Member of the Executive Board of the ECB, at the International Center for Monetary and Banking Studies, Geneva, 19 May 2017. Technical Report May, International Center for Monetary and Banking Studies, Geneva.

Crespo-Cuaresma, J. (2003). Okun's Law Revisited. *Oxford Bulletin of Economics and Statistics*, 4:439–451.

Friedman, M. (1968). The Role of Monetary Policy. Presidential address delivered at the 80th Annual Meeting of the American Economic Association. *The American Economic Review*, 58(1):1–17.

Knotek II, E. S. (2007). How Useful is Okun's Law? *Economic Review - Federal Reserve Bank of Kansas City*, 4:73–103.

Krugman, P. (1994). Past and prospective causes of high unemployment. *Reducing unemployment: Current issues and policy options*, pages 49–80.

Lang, D. and de Peretti, C. (2009). A strong hysteretic model of Okun's Law: theory and a preliminary investigation. *International Review of Applied Economics*, 23(4):445–462.

León-Ledesma, M. A. (2002). Unemployment hysteresis in the US states and the EU: A panel approach. *Bulletin of Economic Research*, 54(2):95–103.

Mortensen, D. T. and Pissarides, C. A. (1994). Job Creation and Job Destruction in the Theory of Unemployment. *The Review of Economic Studies*, 61(3):397–415.

Okun, A. M. (1962). Potential GNP, its measurement and significance. In *Proceedings of the Business and Economic Statistics Section of the American Statistical Association*, pages 98–104, Alexandria, VA. American Statistical Association.

Silvapulle, P., Moosa, I. A., and Silvapulle, M. J. (2004). Asymmetry in Okun's law. *Canadian Journal of Economics/Revue Canadienne d'Economique*, 37(2):353–374.

Virén, M. (2001). The Okun curve is non-linear. *Economics Letters*, 70(2):253–257.

Tables and Figures