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Estimates of okun's law using a new output gap measure

Vladimir Arčabić
University of Zagreb

Eric Olson
West Virginia University

Abstract

This paper analyzes new measures for output and unemployment gaps proposed by Hamilton (2017) and estimates Okun's law. We compare the Hamilton (2017) approach to the popular Hodrick and Prescott (1997) filter. Our results show that HP filter tends to underestimate the magnitude of Okun's law relationship across 20 OECD countries.

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Contact: Vladimir Arčabić - varcabic@efzg.hr, Eric Olson - eric.olson@mail.wvu.edu.
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1. Introduction

Since the financial crisis of 2008, several macroeconomists have revisited the validity of Okun's law. Gordon (2011) and Meyer and Tasci (2012) argue that Okun's law has broken down; that is, the relationship between deviations of output from its potential level and deviations from unemployment from its natural rate are not related anymore. On the other hand, Ball, Leigh, and Loungani (2017) argue that Okun's law is tact and is stable over time. In many previous papers that examine Okun's law, output gaps and deviations of unemployment from its natural rate are produced by using the Hodrick and Prescott (1997) filter. Our aim in this paper is to re-evaluate the strength of Okun's law using the new methodology outlined in Hamilton (2017). Hamilton (2017) strongly argues against using the HP filter; in fact, the title of the paper is "Why You Should Never Use the Hodrick-Prescott Filter." As such, Hamilton (2017) proposes an alternate concept of a cyclical component and states that the cyclical component should be interpreted as "how different is the value at date $t+h$ from the value that we would have expected to see based on its behavior through data t?" We use two different methods to produce output and unemployment gaps for comparative purposes; output and unemployment gaps generated from Hamilton's (2017) approach and output and unemployment gaps from the HP filter. We find that when using the HP filter, the effect of increasing unemployment on the output gap is substantially lower than when using Hamilton's (2017) method. As such, we believe that results from previous studies that used the HP filter likely understated the strength of Okun's law. The rest of the paper proceeds as follows. Section II describes our methodology, section III discusses our results, and section IV concludes.

2. Data and Methodology

Hodrick and Prescot (1997) propose the following methodology to decompose a series into its trend and stationary components.

$$\frac{1}{T}\sum_{t=1}^{T}(x_t - \mu_t)^2 + \frac{\lambda}{T}\sum_{t=2}^{T-1}[(\mu_{t+1} - \mu_t) - (\mu_t - \mu_{t-1})]^2 \tag{1}$$

where x_t is the series of interest, e.g., output and unemployment in our case, λ is a constant, and T is the number of observations. The point is to select the μ_t sequence so as to minimize the above sum of squares. The λ parameter is a constant which imposes a penalty of allowing fluctuations in the trend. The λ parameter is different depending upon the frequency of the data. Most of the previous literature sets $\lambda = 1{,}600$ for quarterly data.[1]

Hamilton (2017) proposes a projection of series x_{t+h} on a constant and the four most recent values of x as of date t. That is, for our quarterly data, we follow Hamilton (2017) and estimate the following regression for the log of real GDP:

[1] For robustness, we also consider $\lambda = 16{,}000$ as in Ball, Leigh and, Loungani (2017).

$$y_{t+8} = \alpha_0 + \alpha_1 y_t + \alpha_2 y_{t-1} + \alpha_3 y_{t-2} + \alpha_4 y_{t-3} + \varepsilon_t \tag{2}$$

As in Hamilton (2017), the output gap is then defined as the residuals from (2). We estimate the same equation for the unemployment rate u_t.

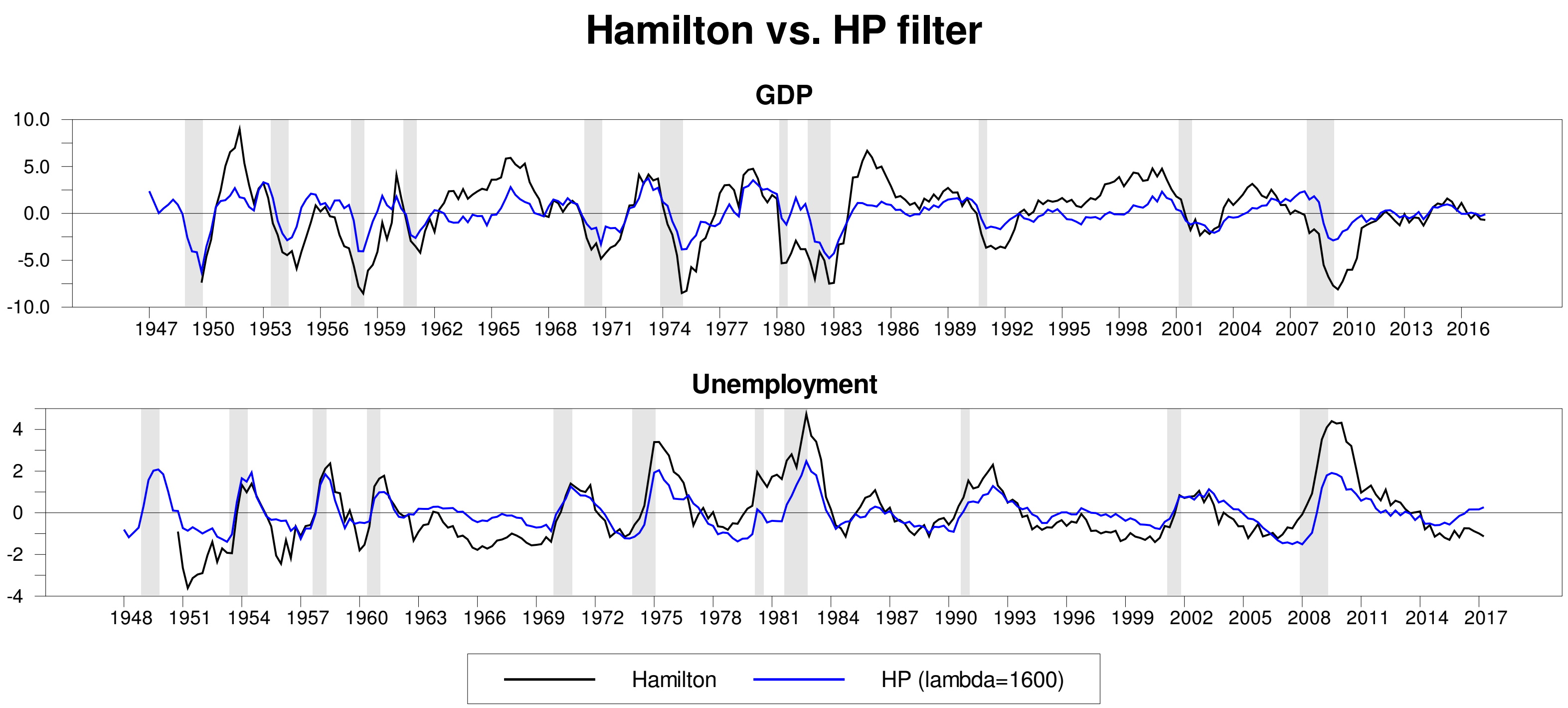
In order to estimate Okun's law, we follow Ball et al. (2017) and estimate the following

$$(u_t - u_t^*) = \beta(y_t - y_t^*) + e_t \tag{3}$$

where $(u_t - u_t^*)$ is the deviations of unemployment from its natural rate, $(y_t - y_t^*)$ is the deviation of output from its potential level and e_t is the regression residual.

We obtained quarterly data on U.S. real GDP and the unemployment rate from the FRED database for the 1947Q1 – 2017Q2 time period. As noted above, we generate output gaps and deviations of unemployment from its natural rate using the HP filter and the procedure outlined in Hamilton (2017). Figure 1 displays the output gaps and the unemployment gaps from using the above two methodologies. The black line in panel A is the output gap from using the Hamilton procedure whereas the blue lines are output gaps from the HP filter with a smoothing parameter of λ=1600. Likewise, in panel B the black line is the deviation of unemployment from its natural rate using the Hamilton (2017) approach whereas the blue lines use the HP filter. Note that in both panels of Figure 1 the series from Hamilton (2017) has substantially more variation in both series than does the HP filter. Shaded areas represent NBER recession dates. Note the differences between the two series during the last recession in 2008. The Hamilton (2017) approach suggests that output was 7.5 percent below its potential level whereas the HP filter suggests that output was only 2.5 percent below. The HP filter suggests that recession in 1981 was more severe than the recession in 2008 which doesn't seem plausible; also note that the HP filter in panel B suggests that unemployment was only 1 percent above its natural rate whereas the Hamilton (2017) methodology suggests that it was 4 percent.

Figure 1: Hamilton's and HP filter gaps of GDP and unemployment



Note: Shaded areas represent NBER recession dates.

3. Results

3.1 U.S. Quarterly Results

Table 1 displays the results from estimating equation (3) using OLS estimation.[2] Panel A in Table 1 displays the results from estimating (3) using the Hamilton (2017) methodology, Panel B displays the results using the HP filter and Panel C displays the results from Wald tests that test whether the two coefficients are statistically different from each other. As noted above, we use a smoothing parameter (λ=1,600) for the HP filter similar to Ball, Leigh, and Loungani (2017). In addition, we also estimate (3) allowing lags of the output gap. In that case, we estimate the following equation $\tilde{u}_t = \beta\tilde{y}_t + \theta_1\tilde{y}_{t-1} + \theta_2\tilde{y}_{t-2} + e_t$, where $\tilde{u}_t = u_t - u_t^*$, and $\tilde{y}_t = y_t - y_t^*$ are unemployment and output gaps, respectively. For ease of exposition, the lagged results are italicized in Panels A and B. Given that the two models are non-nested, we report Wald tests from a system of Seemingly Unrelated Regressions (SUR) to cope with the dependency problem between the samples of the HP and Hamilton filters. As such, the null hypothesis of the Wald test is that the coefficients $(\beta)_{Hamilton} = (\beta)_{HP}$ and the test statistic is a standard F-test. We report p-values for simplicity.

Note in Table 1 that when lags are excluded from the regression, using the Hamilton methodology results in a coefficient of (−0.35) whereas the HP filter's coefficient is (−0.45). Inverting these coefficients results in the usual interpretation of the output gap. For the Hamilton procedure, the inverted coefficient yields a value of −2.86 whereas the HP filter coefficient is −2.22. This suggests that using the HP filter *understates* the negative effect that a 1% increase in the unemployment rate above its natural rate has on the output gap. Specifically, using the Hamilton approach results in the output being an additional 0.5% lower than estimates from the HP filter suggest. Note also that the standard errors of all three estimates are quite low. Including lags of the output gap further, highlights this point. In Table 1 the row in bold font displays the sum of the lagged output gaps coefficients. Inverting the summed coefficients results in a coefficient of −2.70 for the Hamilton gaps whereas using the HP filter results in a coefficient of −2.0. Again, note that using the lagged coefficients results in the HP filter underestimating the negative effect on the output gap of the unemployment rate being above its natural rate. Using the results from the HP filter suggests that output is 0.7% higher than when using the Hamilton procedure. The last column in Table 1 displays results from the Wald tests formally evaluating whether the coefficients (β and $\beta + \theta_1 + \theta_2$) are statistically different from each other. In both cases, our results suggest that the coefficients are statistically different.

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[2] We also checked robustness of our results using GMM estimator as suggested by the referee, and results are almost identical.

Table 1: Estimates of Okun's law for the U.S.

	Hamilton's filter		HP filter		Wald Tests	
	Panel A		Panel B		Panel C	
	No lags	*Lags*	No lags (λ=1,600)	*Lags* (λ=1,600)	Wald test no lags (*p*-values)	Wald test lags (*p*-values)
β	-0.350*** (0.024)	*-0.237*** (0.044)*	-0.449*** (0.017)	*-0.308*** (0.024)*		
θ_1		*-0.082* (0.049)*		*-0.108*** (0.030)*	**30.34 (0.00)**	**51.98 (0.00)**
θ_2		*-0.049 (0.040)*		*-0.079*** (0.027)*		
$\boldsymbol{\beta + \theta_1 + \theta_2}$		***-0.367*** (0.026)***		***-0.495*** (0.017)***		
# obs	267	*267*	267	*267*		
Adj R^2	0.657	*0.677*	0.795	*0.844*		
Std. er. of estimate	0.840	*0.819*	0.369	*0.322*		

Note: ***, **, and * represent statistical significance at 1%, 5%, and 10% level, respectively. Standard errors are in parenthesis. All regressions are controlled for serial correlation by using Newey-West standard errors. Wald tests for differences in estimated coefficients are presented in the last column of the table for regressions with no lags and with included lags. For the model with no lags we test $(\beta)_{Hamilton} = (\beta)_{HP}$, and for the model with lags we test $(\beta + \theta_1 + \theta_2)_{Hamilton} = (\beta + \theta_1 + \theta_2)_{HP}$.

3.2 *Quarterly International Results*

As a robustness check, we follow Ball, Leigh, and Loungani (2017) and estimate Okun's law coefficients for 20 OECD countries using quarterly data from the OECD database for the 1960Q1-2017Q2 time period. The results are presented in Table 2. Again, we estimate the model using the Hamilton procedure as well as the HP filter.

Similar to Ball, Leigh, and Loungani (2017), we get a wide range of estimates for Okun's law coefficient for our sample of countries. The last column of Table 2 displays the p-values from the Wald tests which tested the statistical difference between the two series. Bolded rows in Table 2 indicate that the Wald test was statistically significant at the 5% level. The Wald test for ten out of the twenty countries suggested that the coefficients were statistically different. The estimates from the HP filter again tend to be larger in absolute value which suggests a weaker Okun's law relationship than does the Hamilton methodology. One particularly interesting part of the international results is the wide range of coefficients across countries that share the euro. Estimates from Hamilton's filter range from −0.131 in Austria to −0.66 in Spain. An interesting line of future research would be to further explore those differences.

4. Conclusion

Our results suggest that previous studies that have investigated Okun's law may have understated the magnitude of its relationship if the HP filter was used to generate the unemployment and output gaps. Our results certainly do not suggest that Okun's law has broken down over time. Our results confirm the results from Ball, Leigh, and Loungani (2017) in that the Okun's law relationship varies substantially across countries. We believe that future research should first, revisit results that relied exclusively on output gaps generated from the HP filter (i.e., for example, research that used the HP-filtered output gaps in Taylor rules and monetary policy prescriptions); second, given the econometric advances in estimating time-varying parameters, it would be interesting to examine the degree to which the relationship between the unemployment gap and output gap changes throughout the business cycle and how/if the relationship changes over long horizons as the structure of the economy changes.

Table 2: International estimates of Okun's law

		Hamilton's filter			HP filter			Wald test
Country	# obs	β	Std. err.		β	Std. err.		P-values
Australia	194	-0.380***	(0.035)		-0.376***	(0.040)		0.506
Austria	**89**	**-0.131*****	**0.023**		**-0.204*****	**(0.033)**		**0.024**
Belgium	129	-0.263***	0.042		-0.332***	(0.051)		0.728
Canada	216	-0.375***	(0.032)		-0.422***	(0.025)		0.795
Denmark	128	-0.250***	(0.036)		-0.301***	(0.041)		0.274
Finland	**108**	**-0.143*****	**(0.040)**		**-0.310*****	**(0.053)**		**0.001**
France	129	-0.294***	(0.041)		-0.323***	(0.039)		0.329
Germany	**96**	**-0.282*****	**(0.052)**		**-0.192*****	**(0.038)**		**0.032**
Greece	**67**	**-0.308*****	**(0.034)**		**-0.557*****	**(0.063)**		**0.000**
Ireland	**128**	**-0.151*****	**(0.036)**		**-0.176*****	**(0.040)**		**0.026**
Italy	128	-0.202***	(0.048)		-0.185***	(0.043)		0.300
Japan	220	-0.077***	(0.012)		-0.073***	(0.012)		0.484
Korea	**101**	**-0.179*****	**(0.045)**		**-0.314*****	**(0.044)**		**0.000**
Netherlands	**128**	**-0.207*****	**(0.026)**		**-0.302*****	**(0.041)**		**0.024**
New Zealand	**116**	**-0.244*****	**(0.040)**		**-0.210*****	**(0.054)**		**0.018**
Norway	104	-0.066***	(0.024)		-0.111***	(0.034)		0.737
Portugal	**128**	**-0.339*****	**(0.042)**		**-0.335*****	**(0.047)**		**0.063**
Spain	**116**	**-0.667*****	**(0.057)**		**-0.826*****	**(0.056)**		**0.000**
Sweden	128	-0.262***	0.029)		-0.302***	(0.043)		0.875
United Kingdom	128	-0.266***	0.031)		-0.338***	(0.041)		0.412

Note: ***, **, and * represent statistical significance at 1%, 5%, and 10% level, respectively. Standard errors are in parenthesis. All regressions are controlled for serial correlation by using Newey-West standard errors. The last column presents the results of the Wald test for $\beta_{Hamilton} = \beta_{HP}$.

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