# Okun's Law at the Florida MSA Level

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*This paper applies a fixed effects panel data spatial econometric model of Okun's law to Florida Metropolitan Statistical Areas (MSAs) over the period 1990 to 2015. The regression coefficients are used to estimate the impact of increases in output on unemployment and each MSA's potential rate of output growth. Results indicate that Okun's coefficient ranges from -0.19 to -0.24 at the MSA level. Between one-half to two-thirds of changes in local unemployment occur as a spillover effect from neighboring MSA output growth. Each MSA's potential real output growth rate averages between 1.7 to 2.7 percent.*

## INTRODUCTION

Understanding how increases in economic growth can lower unemployment is crucial for forecasting economic performance and enacting successful fiscal and monetary policy. One common model of this relationship is known as Okun's law, which compares changes in unemployment to deviations in output growth from its potential. Okun (1970) postulated an inverse relationship between GDP and potential GDP – known as the "output gap" – and the difference between the unemployment rate and its "natural" rate – known as the unemployment gap. When actual output growth exceeds its potential growth rate, the unemployment rate will be below its natural rate; when actual exceeds potential, the unemployment rate will be above its natural rate. The coefficient relating these output deviations to changes in unemployment is called Okun's coefficient. Okun's coefficient for the United States has been estimated to be -0.3: every 1 percent increase in output growth causes a 0.3 percent decrease in unemployment. This relatively robust result at the national level has been found to be smaller and more variable as the level of analysis decreases from regional levels, to state levels, down to the level of a metropolitan statistical area (MSA).[1]

Examining the output-unemployment relationship at the MSA level requires accounting for spillover effects between neighboring MSAs. An increase in output in one MSA may induce a movement of neighboring MSA workers – either through commuting or local immigration – to the relatively more prosperous MSA. As such, spatial econometric techniques are required. This paper applies the spatial lag econometric model of Okun's law to data on unemployment and output from all 22 Florida MSAs. The paper follows the framework of Kuscevic (2014) and Periera (2015), both of whom measure output with real Gross Metropolitan Product, (real GMP). Kuscevic examines 358 MSAs in the US over the period 2002-2010 with a fixed effects panel data set. Kuscevic separates the impact on the annual change in the MSAs' unemployment rates due to the MSAs' real GMP growth rate and a spatially-weighted GMP neighboring MSAs' real GMP growth rate. He finds a direct (local) MSA effect of -0.051 and an indirect (spatial or "spillover") effect of -0.125, by weighting neighboring MSAs by the inverse of the distance squared. This sums to an Okun coefficient of -0.176 for these US MSAs. Periera uses data for ten Virginia MSAs and finds a local MSA effect of -0.064 and a spillover effect of -0.30, by weighting neighboring MSAs using the inverse of distance squared. Thus, Periera estimates that a one percent increase in growth across all other MSAs lowers the excluded MSA's unemployment by -0.30 percentage points, which, when combined with the local MSA coefficient of -0.06, yields a combined effect of local and regional growth on local area unemployment of -0.36 for Virginia, quite similar to that obtained at the national level.

In addition to measuring the responsiveness of changes in unemployment to changes in output growth, Okun's coefficient has also been used to determine the potential growth rate of a national economy as defined by the rate of output growth that occurs when unemployment is at its natural rate. Early applications of Okun's law to potential output include, Perry, Wachter, Eckstein and Clark (1977), who estimate the potential growth rate for Real Gross National Product using both the standard Okun's law equation (i.e., a contemporaneous model) and an Okun's law equation which includes a one-lag unemployment measure as an additional regressor. Kahn (1996) calculates the potential growth rate for Real Gross Domestic Product (RGDP) using an Okun's law equation with multiple lags of RGDP growth whose corresponding coefficients are summed to calculate the potential RGDP growth rate. Perhaps most significantly to the impact on actual policy, the U.S. Congressional Budget Office uses a variant of Okun's law with a Solow growth model to estimate potential output.

In this paper, we incorporate the spatial effects into an otherwise standard Okun's law model to calculate both Okun's coefficient and the potential growth rate for all 22 Florida MSAs. In the process, we introduce two innovations. The first innovation is the use of real Earnings, whose data range from 1990-2015 is more than twice that of the standard output measure, real Gross Metropolitan Product, which ranges from 2000-2015. Running our econometric models with the longer series may provide greater statistical significance in addition to shedding light on the robustness of parameter estimates from the shorter, but standard, real GMP time series. The second innovation is the calculation of MSA potential output growth rates as has been done at the national, but not local, level. We find that potential real output growth levels differ significantly between the Florida MSAs.

The paper is organized as follows. Section 2 examines the data and preliminary analysis. Section 3 presents the methodology. Section 4 presents empirical results and section 5 concludes.

## DATA AND PRELIMINARY ANALYSIS

We estimate the relationship between the unemployment rate and output growth over the 1990 to 2015 period for real earnings and 2000-2015 for real GMP, using a balanced panel of annual observations on all 22 Florida MSAs. Annual unemployment comes from the Bureau of Labor Statistics *Unemployment Rate*, *Annual Average*. For output growth, we use two measures, real earnings growth and real Gross Metropolitan Product (GMP) growth. MSA Earnings come from the Bureau of Economic Analysis *Economic profile* for each MSA observed and are specified as *Earnings by Place of Work*. For comparison, we also report US and Florida real earnings which also come from the Bureau of Economic Analysis. Total earnings include wages and salaries, other labor income, contributions for social insurance, and proprietors' income but exclude dividends, interest, rent, and transfer payments. US RGDP, State RGDP, and MSA GMP growth comes from the Bureau of Economic Analysis Regional Economic Accounts *GMP by Metropolitan Area*. Both measures are inflation-adjusted using the *Consumer Price Index- All Urban Consumers* obtained from the St. Louis Federal Reserve and calculated as the year-to-year growth rate from December to December with a 1982-1984 base year.

Table 1 below shows summary statistics for the variables and Table 2 shows their correlations. The number of observations differ because the MSA Real Earnings data series, denoted $RE_{MSA}$, begin in 1990 while MSA Real GMP data, denoted $RGMP_{MSA}$, begin in 2000. First note that real earnings appears to be a very good proxy for RGMP as the two series are highly correlated at 0.84 at the MSA level, 0.95 at the state level, and 0.89 at the national level.[2] Second, note that growth rates are more volatile as the scale decreases from national to state to MSA, as seen by increases in standard deviations with decreases in scale. The maximum and minimum Florida MSAs growth rates vary significantly but are similar for both measures of output. The maximum $RGMP_{MSA}$ ($RE_{MSA}$) was 24.68 (22.16) from 2000-2015 (1990-2015); the minimum was -13.79 (-13.74), respectively.

**TABLE 1**
**SUMMARY STATISTICS**

| | $RE_{MSA}$ | $RE_{FL}$ | $RE_{US}$ | $RGMP_{MSA}$ | $RGDP_{FL}$ | $RGDP_{US}$ | $\Delta UN_{MSA}$ | $UN_{MSA}$ | $WRE_{MSA}$ |
|---|---|---|---|---|---|---|---|---|---|
| **Mean** | 2.68 | 2.51 | 2.02 | 1.92 | 1.73 | 1.78 | -0.03 | 6.38 | 2.74 |
| **Median** | 3.04 | 2.99 | 1.92 | 2.12 | 2.38 | 2.13 | -0.40 | 5.80 | 3.54 |
| **Max** | 22.16 | 7.69 | 6.36 | 24.68 | 6.66 | 4.72 | 4.70 | 14.30 | 7.99 |
| **Min** | -13.74 | -6.63 | -3.89 | -13.79 | -7.07 | -2.64 | -2.80 | 2.30 | -7.89 |
| **Std. Dev.** | 4.28 | 3.34 | 2.40 | 5.50 | 3.79 | 1.96 | 1.32 | 2.66 | 3.34 |
| **Obs** | 572 | 572 | 572 | 308 | 308 | 308 | 550 | 572 | 572 |

**TABLE 2**
**CORRELATIONS (BALANCED PANEL)**

| | $RE_{MSA}$ | $RE_{FL}$ | $RE_{US}$ | $RGMP_{MSA}$ | $RGDP_{FL}$ | $RGDP_{US}$ | $\Delta UN$ | UN | $WRE_{MSA}$ |
|---|---|---|---|---|---|---|---|---|---|
| $RE_{MSA}$ | 1.00 | | | | | | | | |
| $RE_{FL}$ | 0.78 | 1.00 | | | | | | | |
| $RE_{US}$ | 0.60 | 0.84 | 1.00 | | | | | | |
| $RGMP_{MSA}$ | 0.84 | 0.69 | 0.51 | 1.00 | | | | | |
| $RGMP_{FL}$ | 0.78 | 0.95 | 0.73 | 0.76 | 1.00 | | | | |
| $RGMP_{US}$ | 0.73 | 0.92 | 0.89 | 0.71 | 0.92 | 1.00 | | | |
| $\Delta UN$ | -0.58 | -0.74 | -0.81 | -0.44 | -0.63 | -0.73 | 1.00 | | |
| UN | -0.44 | -0.44 | -0.37 | -0.50 | -0.53 | -0.46 | 0.26 | 1.00 | |
| $WRE_{MSA}$ | 0.79 | 0.95 | 0.73 | 0.73 | 0.95 | 0.88 | -0.67 | -0.50 | 1.00 |

**Unit Root and Causality Tests**

Before running regressions, it is important to examine the properties of our unemployment and output variables to ensure they are stationary. Variables suffering from changing means, variances, or covariances can yield biased regression estimates and standard errors. We run a series of unit root tests to check for stationarity. We use the Levin, Lin & Chu test, which assumes a common root for all MSAs, the Augmented Dickey-Fuller unit root and Phillips Perron tests, which allow for each MSA to have its own unit root, and the Im, Pesaran and Shin (2003) panel unit root test, which is computed from the individual Augmented Dickey-Fuller unit root test statistic for each series.[3] Table 3 presents unit root tests results for unemployment, the change in unemployment, and real earnings growth rate.[4] In addition to indicating stationarity, this implies unemployment hysteresis – the potential for unemployment to remain elevated over time – is unlikely. Hysteresis is present if increases in cyclical unemployment cause increases in structural unemployment by affecting the underlying structure of the MSA economy. This would appear in the time series as previous unemployment rates being highly correlated with future unemployment rates.[5] The results suggest that both the change in unemployment and growth rate of real earnings and real GMP are stationary and that hysteresis in unemployment is not evident among Florida MSAs.

Table 3 also presents the *Pairwise Dumitrescu Hurlin Panel Causality Test*. This test is calculated by running standard Granger Causality regressions for each cross-section individually. The W-stat and the standardized version of this statistic, the Zbar-stat, follow a standard normal distribution. Economic theory suggests that causality runs from output growth to unemployment, and not vice versa. Results from the tests indicate that changes in real earnings cause changes in unemployment and not vice versa. To that end, the null hypothesis that output growth does not cause changes in $u$ is rejected for both measures of real output growth at the 1% significance level, while the null hypothesis that $u$ does not cause changes in real output growth cannot be rejected at the 5% significance level for both (the $p$-values are 0.09 for $RGMP_{MSA}$ and 0.15 for $RE_{MSA}$).

**TABLE 3**
**UNIT ROOT TESTS AND GRANGER CAUSALITY TESTS**

| **Unit Root Tests and Granger Causality Tests** | | | | | |
|---|---|---|---|---|---|
| | **$u$ (no constant nor trend, except I,P,S)** | **$RE_{MSA}$** | **$RGMP_{MSA}$** | | |
| **Im, Pesaran and Shin W-stat** | -5.34 (0.00) | -5.47 (0.00) | -2.57 (0.00) | | |
| **Levin, Lin & Chu t-test** | -3.17 (0.00) | -8.56 (0.00) | -8.91 (0.00) | | |
| **ADF – Fisher $\chi^2$** | 100.80 (0.00) | 130.30 (0.00) | 133.89 (0.00) | | |
| **Phillips Perron– Fisher $\chi^2$** | 46.02 (0.39) | 134.33 (0.00) | 130.56 (0.00) | | |
| **Lags** | 1 | 1 | 1 | | |
| **Obs** | 520 (550) | 545 (550 for PP) | 264 (286) | | |
| **Pairwise Dumitrescu Hurlin Panel Causality Tests for $RE_{MSA}$** | | | **Pairwise Dumitrescu Hurlin Panel Causality Tests for $RGMP_{MSA}$** | | |
| ***Null Hypothesis*** | **W-Stat** | **Prob** | **W-Stat** | **Zbar-stat** | **Prob** |
| **$g_Y$ does not homogeneously cause $\Delta u$** | 6.09 | 0.00 | 10.95 | 8.94 | 0.00 |
| **$\Delta u$ does not Granger Cause $g$** | 1.47 | 0.15 | 1.27 | -1.68 | 0.09 |
| **Lags** | 2 | | 2 | | |

## METHODOLOGY

The standard economic model of the Okun's law relationship is given by the change in the unemployment at time $t$, $\Delta u_t$, as a function of the output gap measured by deviations of output growth at time $t$, $g_{yt}$, from potential output growth, $g_{yn}$.

$$\Delta u_t = \beta(g_{yt} - g_{yn}) \tag{1}$$

Equation (1) indicates that unemployment will decrease when output grows above its potential rate and increase when output grows below its potential rate. Unemployment is constant when the output gap is zero, i.e., $g_{yt} = g_{yn}$. For our baseline model, we employ a common intercept with panel data for MSA $i$ at time $t$ is

$$\Delta u_{i,t} = \alpha + \beta_1 g_{yi,t} + \varepsilon_{i,t} \tag{2}$$

where $\alpha$ is the common intercept that is equivalent to $\beta g_{yn}$ from (1) and $\beta_1$ is equivalent to $\beta$ from (1) and $i$ represents the MSA ranging from $i = 1 \ldots 22$. The error term, $\varepsilon_{i,t}$, is assumed independent and identically distributed. We will refer to (2) as the *Common Intercept* model from which a common Okun's coefficient, $\beta_1$ is estimated. The common potential growth rate, $g_{yn}$, is given by $-\alpha/\beta_1$ from (2) as commonly done in the literature (see Altig, Fitzgerald, and Rupert (1997), Rudebusch (2000), and others).[6]

The second model employs the fixed effect (FE) structure with MSA-specific intercepts $\alpha_i$ which allows for MSA-specific potential growth rates, $g_{yn,i}$. The equation is

$$\Delta u_{i,t} = \alpha_i + \beta_1 g_{yi,t} + \varepsilon_{i,t} \tag{3}$$

where $\alpha_i$ is the MSA-specific fixed effect. We will refer to (3) as the *Fixed Effects* model for which each MSA's potential growth rate, $g_{yn,i}$, is derived by $-\alpha_i/\beta_1$.

The next two models include the spillover effects that occur between MSAs. If labor markets among neighboring MSAs are relatively well-integrated, we would expect economic growth in one MSA to impact unemployment in neighboring MSAs. The extent of spatial dependence in unemployment is considered a function of labor migration and commuting.[7] Excluding parameters that capture these spatial effects from a model specification creates an omitted variable bias that can invalidate the other estimated parameters. It is commonly acknowledged that MSA unemployment and growth rates are not independent, but are *spatially dependent*, indicating unemployment and growth rates in one MSA are affected by those of neighboring MSAs. "Neighboring MSAs" may be located near or far geographically. Techniques in spatial econometrics are used to separate the local from the neighboring MSA output effects on local MSA unemployment.

Following LeSage (2014) who argues "most spatial spillovers are local" we assume the only important spatial spillovers impacting neighboring MSAs are local. *Local spillovers*, as opposed to *global spillovers*, do not involve endogenous feedback effects wherein a change in one MSA creates a sequence of adjustments in all sample MSAs that results in a new long-run steady state equilibrium unemployment and/or growth rate.[8] The local spillover is modeled as a spatial lag given by the matrix product of MSA $i$'s weight, $w_{i,j}$, and growth rate, $g_{yj,t}$. This term corresponds to the distance-weighted sums of output growth from the 21 neighboring MSAs (i.e., all MSAs excluding $i$) given by $\Sigma_{j=1}^{21} w_{i,j} g_{yj,t}$. The weight $w_{i,j}$ represents elements from the distance weighting matrix $W$ comprised of zero along the diagonals and normalized so that each row sums to one. That is, we define the element $w_{i,j}\ \forall\ i \neq j$ to be positive if MSA $i$ is a neighbor of MSA $j$, and zero otherwise. Two alternative weights are used. The first weights are computed as the inverse of the distance squared as measured from the center of the MSAs, $1/d^2_{i,j}$, where $d_{i,j}$ is the distance in miles between MSA $i$ and MSA $j$ for $i \neq j$; the second weighting scheme uses the inverse of the distance, $1/d_{i,j}$ for $i \neq j$. The normalization procedure implies the weights for $1/d^2$ are larger in size than the $1/d$ weights. These spatial considerations are incorporated into the final two models. They are panel *Spatial Lag of X* (*SLX*) models that account for spillovers by including the spatial average of neighbor $j$'s growth at time $t$, $w_{ij} g_{yj,t}$ as shown in (4)[9]

$$\Delta u_{it} = a_i + \beta_1 g_{yi,t} + \beta_2 \Sigma_{j=1}^{T} w_{i,j} g_{yjt} + \varepsilon_{it} \tag{4}$$

where $\varepsilon_{it} \sim N(0, \sigma_\varepsilon^2 I_N)$.[10]

With the inclusion of a spillover effect, Okun's coefficient is given by the derivative of unemployment to output growth from MSA $i$ and its neighbors $j$

$$\frac{\partial \Delta u}{\partial \beta_i} = \beta_1 + \beta_2 \Sigma_{j=1}^{21} w_{ij} \quad \text{or} \quad \frac{\partial \Delta u}{\partial \beta_i} = \beta_1 + \beta_2 \tag{5}$$

where $\Sigma_{j=1}^{21} w_{ij} = 1$ due to the normalization procedure in the weighting matrix. The partial derivative in (5) indicates the impact of output growth on changes in unemployment is comprised of $\beta_1$, a local MSA partial derivative, a direct effect, and $\beta_2$, a cross-partial derivative representing the local spatial spillovers to neighboring MSAs or indirect effect. Since the main diagonal elements of $W$ are zero and the rows sum to unity, we can interpret the coefficient $\beta_2$ as the (cumulative) cross-partial derivative. The sum of spillovers falling on all neighbors, $\beta_2$ denotes the average, or typical, spillovers where averaging takes place over all MSAs. Moreover, the OLS coefficient standard errors are unbiased which allows inferences about the magnitude and significance of local and spillover effects.

## EMPIRICAL RESULTS

Table 4 shows model results using real earnings for output. Okun's coefficient ranges from -0.146 to -0.24 among the models, but only -0.22 to -0.24 for the different spatial lag models. Similarly, potential output ranges from 2.55 to 2.74 among the models, but only 2.69 to 2.74 for spatial lag models. In addition to greater parameter constancy, the spatial lag models explain about 10 percent more of the variation in unemployment changes than non-spatial models, as seen from the higher adjusted $R^2$ values and lower AIC values. All coefficients were significant at the one percent level except for the direct (self-MSA) effect, $\beta_1$, which was statistically insignificant for the inverse-of-the-distance fixed effects SLX and only significant at the 10% level for the inverse-of-the-distance-squared version. The regional spillover effect is between three and seven times the size of the direct MSA effect on unemployment. This is much larger than seen in Virginia (Periera (2015)) or the US overall (Kuscevic (2014)) which had estimated the regional effects to be about twice the direct MSA effects. The spatial lag model with the most predictive power and significant coefficient values at the 1% level is the inverse distance, SLX ($1/d$), model which predicts the average Florida MSA to have an Okun coefficient of -0.24 and a potential growth rate of 2.69. These are the nearly the same values as found with the fixed effects version of that SLX model.

Table 5 shows model results using RGMP for output. Okun's coefficient ranges from -0.124 to -0.22 among the models, but only -0.19 to -0.22 for the different spatial lag models. Similarly, potential output ranges from 1.73 to 2.48 among all models, but only 1.73 to 1.85 for spatial lag models. All coefficient values are significant at the one percent level. These results are quite similar to those of Table 4. The spillover effect is approximately 2 to 2.5 times the size of the local MSA effect on unemployment and thus is much closer to the effect found by Periera and Kuscevic. This result is expected as these authors also used RGMP for output. As with the real earnings data, the spatial lag model using RGMP with the most predictive power and significant coefficient values at the 1% level is the inverse distance model which predicts the average Florida MSA to have an Okun coefficient of -0.21 and a potential growth rate of 1.73. As with real earnings, these are the nearly the same values as found with the fixed effects version of that model.

**TABLE 4**
**REGRESSION RESULTS USING REAL EARNINGS**

| Dependent Variable: $\Delta u$ | | | | | | |
|---|---|---|---|---|---|---|
| | **Common Intercept** | **Fixed Effects** | **SLX ($1/d^2$)** | **SLX ($1/d$)** | **SLX with FE ($1/d^2$)** | **SLX with FE ($1/d$)** |
| **Intercept, $\alpha$** | $0.371^{***}$ | $0.41^{***}$ | $0.61^{***}$ | $0.63^{***}$ | $0.613^{***}$ | $0.63^{***}$ |
| $\beta_1$ | $-0.146^{***}$ | $-0.16^{***}$ | $-0.041^{***}$ | $-0.03^{***}$ | $-0.04^{*}$ | $-0.03^{*}$ |
| $\beta_2$ | | | $-0.181^{***}$ | $-0.21^{***}$ | $-0.181^{***}$ | $-0.20^{***}$ |
| **Okun's Coefficient** | -0.146 | -0.16 | -0.22 | -0.24 | -0.22 | -0.236 |
| **Potential growth rate** | 2.55 | 2.56 | 2.74 | 2.69 | 2.73 | 2.69 |
| **Adjusted $R^2$/AIC** | 0.23/3.15 | 0.22/3.19 | 0.34/3.0 | 0.35/2.97 | 0.32/3.06 | 0.33/3.04 |
| **Number of Obs.** | 550 | 550 | 550 | 550 | 550 | 550 |
| White period standard errors appear above. * Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level. | | | | | | |

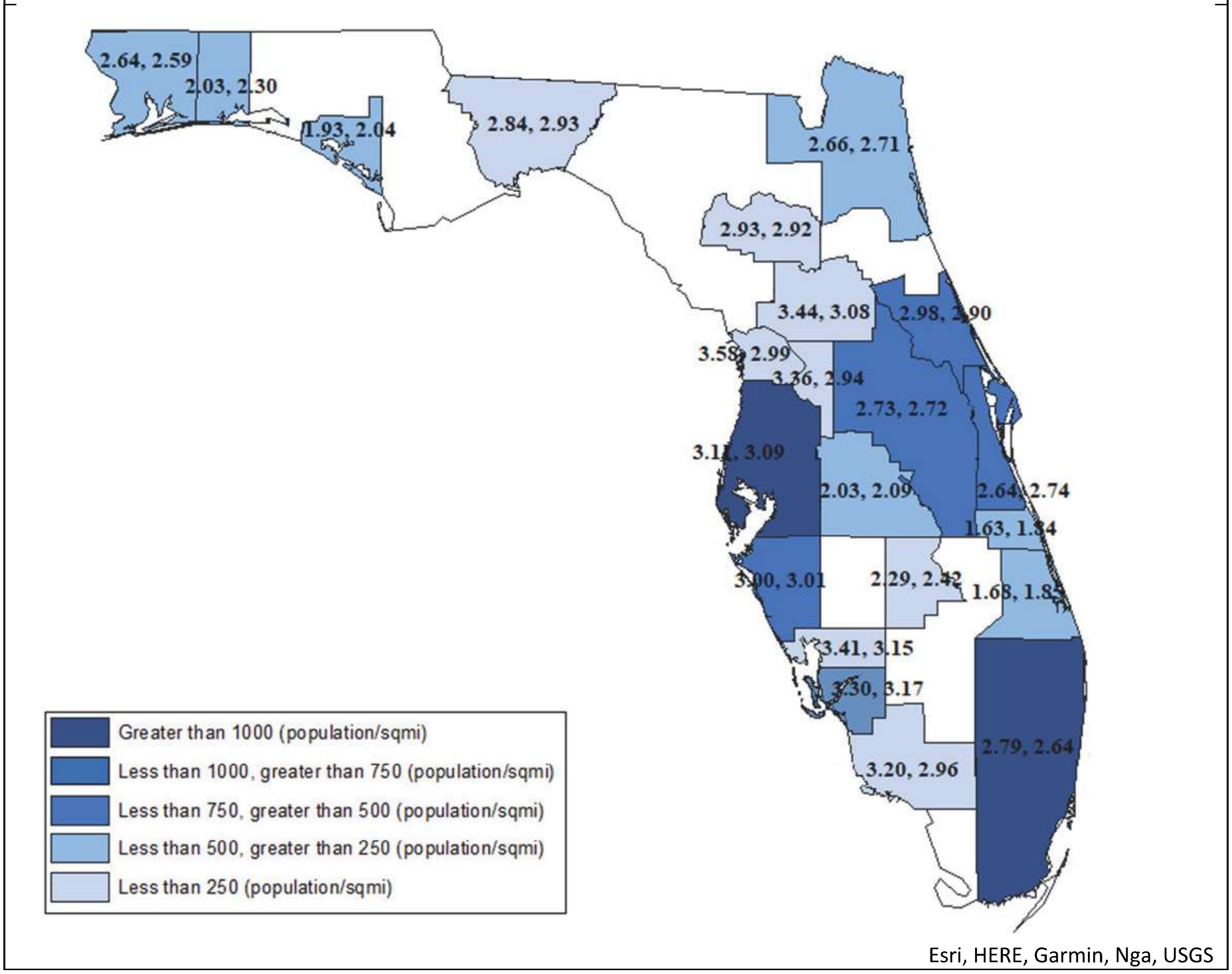
**TABLE 5**
**REGRESSION RESULTS USING RGMP**

| Dependent Variable: $\Delta u$ | | | | | | |
|---|---|---|---|---|---|---|
| | **Common Intercept** | **Fixed Effects** | **SLX ($1/d^2$)** | **SLX ($1/d$)** | **SLX with FE($1/d^2$)** | **SLX with FE ($1/d$)** |
| **Intercept,$\alpha$** | $0.307^{***}$ | $0.32^{***}$ | $0.35^{***}$ | $0.37^{***}$ | $0.36^{***}$ | $0.375^{***}$ |
| $\beta_1$ | $-0.124^{***}$ | $-0.13^{***}$ | $-0.10^{***}$ | $-0.08^{***}$ | $-0.1^{***}$ | $-0.086^{***}$ |
| $\beta_2$ | | | $-0.09^{***}$ | $-0.13^{***}$ | $-0.09^{***}$ | $-0.13^{***}$ |
| **Okun's Coefficient** | -0.124 | -0.13 | -0.19 | -0.21 | -0.19 | -0.22 |
| **Potential growth rate** | 2.48 | 2.45 | 1.85 | 1.73 | 1.84 | 1.74 |
| **Adjusted $R^2$/AIC** | 0.19/3.54 | 0.14/3.66 | 0.21/3.52 | 0.22/3.50 | 0.16/3.64 | 0.17/3.63 |
| **Number of Obs.** | 308 | 308 | 308 | 308 | 308 | 308 |
| White period standard errors appear above. ** Significant at the 5% level, *** Significant at the 1% level | | | | | | |

Figure 1 below shows the individual potential growth rates for all 22 Florida MSAs as estimated from the two FE SLX models with real earnings. While Table 5 shows the mean potential growth rate is 2.73 for the inverse-of-the-distance-squared model and 2.69 for the inverse-of-the-distance model, Figure 1 indicates the individual MSA rates vary widely. Specifically, the inverse-of-the-distance-squared model potential rates range from 1.63 to 3.58, while the inverse-of-the-distance model ranges from 1.84 to 3.09. Potential growth rates are shown to be slightly higher on average for more urban than rural MSAs, where "urban" is measured by density (population per square mile).

**FIGURE 1**
**MSA POTENTIAL GROWTH RATES USING REAL EARNINGS**

Potential growth rates appear in the order: SLX with FE ($1/d^2$) and SLX with FE ($1/d$)




## CONCLUSION

Incorporating spatial effects into a standard Okun model has shown that Okun's coefficient ranges from -0.22 to -0.24 at the MSA level in Florida using real earnings and -0.19 to -0.22 using real GMP. Thus, every one percentage point increase in the output growth rate causes a 0.19 to 0.24 percentage point decrease in unemployment. Finding similar coefficient values for two different time series over different (overlapping) time periods, gives us greater confidence in the validity of these estimates. Moreover, these values are well within the range found in the literature cited above with Kuscevic (2014) estimating a -0.176 for US MSAs and Periera (2014) estimating -0.36 for Virginia. Spillover effects contribute significantly to the Okun coefficient; they comprise two-thirds of the total effect in the real earnings data and one-half of the total effect in the real GMP data. These finding suggest Florida MSAs have highly-integrated labor markets, showing MSA unemployment is highly dependent on neighboring labor market conditions.

The estimated values of Okun's coefficient are used to derive the potential real output growth rate which averages approximately 2.69 using real earnings data and 1.73 using real GMP. These estimates may serve local policymakers as a benchmark to which they can compare their MSA's actual output growth. These potential growth rates are revealed to be slightly higher on average for the more-densely populated MSAs, which may corroborate other studies showing economic dynamism is higher in urban areas compared to rural.

## ENDNOTES

1. See Connaughton and Madsen (2009, 2012), Freeman (2000), Anselin and Sergio (2010), and Kuscevic (2014).
2. Real earnings have been used as a proxy for real economic activity, and thus RGMP, in other studies such as Latzko (2002) and Metcalf (2012).
3. We also conduct a Fisher-type test based on the *p* values from the individual Augmented Dickey-Fuller unit root test statistics. The number of lags selected is based on the Bayesian information criteria.
4. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality. The Granger Causality tests show an *F*-statistic in parentheses.
5. The conceptual framework of hysteresis is provided in Blanchard and Summers (1987) and unit root testing procedures are detailed in Cuestas and Gil-Alana (2011).
6. Two other prominent methods exist for calculating potential output: the production function, or growth accounting, method and the Dynamic Stochastic General Equilibrium, or DSGE, model. For a review see Mishkin (2007).
7. Molho (1995) suggests that labor migration and commuting are the two economic reasons behind the observed spatial dependence in the unemployment rate in the UK.
8. In many ways, Florida is an ideal state in which for this analysis. States create different fiscal policies which can influence location and decisions. Given Florida is a peninsula and that its major MSAs are far from other state borders, impacts from neighboring state policies are less likely to influence the analysis. We expect, therefore, intra-state spillover effects to overwhelm any inter-state effects. Only the geographies of Hawaii and Alaska provide greater insularity.
9. The term *spatial lag of X* model or *SLX* indicates the model contains spatial (not temporal) lags of the independent or *X* variables of neighboring home characteristics as explanatory variables.
10. It is important to note that even if the true errors exhibited spatial dependence – i.e., $\square_{it} = \square W \square_{ij} + \square_t$ where $\square_t \sim N(0,\square_{\square}^2)$ – the *SLX* estimates would be unbiased, but they would be inconsistent. In fact, incorporating spatial errors into a model (known as a *spatial Durbin error model, SDEM*) yields the same partial derivative for Okun's coefficient. LeSage (2014) states that *OLS provides consistent estimates of the parameters if the spatial correlation occurs only through the error term (SDEM model) or exogenous characteristics (SLX model).* In both cases standard errors are inconsistent.

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