

# Urban Centers and Regional Economic Cohesion in Pennsylvania

by

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## **Abstract**

Dynamic correlations among Pennsylvania counties are estimated for employment and income in order to examine the comovement of county economies. The resulting correlations are used to construct regional economies centered on major urban areas consisting of counties displaying a high degree of economic cohesion. A notable finding is that the suburban Philadelphia counties comprise a cohesive regional economy separate from the city of Philadelphia, suggesting that regions containing several small urban centers are able to achieve the agglomeration economies usually provided by large cities.

# Urban Centers and Regional Economic Cohesion in Pennsylvania

Just how interdependent are urban and suburban economies?<sup>1</sup> Some see a close tie between the economic health of cities and suburbs and call for increased regional cooperation to address central city problems and improve overall conditions in the suburbs. Others argue that suburbs no longer need central cities, since the suburbs are self-sufficient and functionally independent. The academic literature tends to find a close correlation between urban and suburban economies. Richard Voith (1993) finds that accessibility to center-city Philadelphia is capitalized into suburban house values and that the value of center-city accessibility fluctuates with employment growth in Philadelphia. Voith (1998) also observes that income growth in large cities enhances suburban income growth but income growth in small cities has little effect on suburban economies. Edwin Mills (1990) detected a correlation between central city and suburban population growth. The results of William Goetzmann, Matthew Spiegel, and Susan Watcher (1998) suggest that city and suburban housing markets in California are closely linked. On the other hand, Peter Linneman and Anita Summers (1993) find that suburban employment growth is uncorrelated with employment growth in the central business district while William Bogart and William Frey (1999) document a shift in employment centers in the metropolitan Cleveland area from downtown to surrounding counties.

This paper takes a time series approach to the relationship between cities and suburbs. Urban centers and surrounding suburban counties that are strongly linked economically ought to display significant comovement of employment and income. This paper uses a measure of dynamic correlation among time series developed by Croux, Forni, and Reichlin (2001) to investigate the cohesion between urban and suburban economies in Pennsylvania.

Pennsylvania has two large cities, Philadelphia and Pittsburgh, as well as several smaller cities, making it ideal for examining the influence of both large and small urban centers on neighboring jurisdictions. Pennsylvania is composed of 67 counties. State population was 11,741,000 in 1969 and 12,286,107 in 2000. Philadelphia and Allegheny (which contains Pittsburgh) Counties accounted for 30 percent of the state population in 1969 and 23 percent in 2000. 70 percent of Pennsylvanians live in urban areas. The state capital, Harrisburg, is located in Dauphin County. While the state has experienced significant economic growth since 1969 at a rate close to that of the national economy, Pennsylvania has experienced a decline relative to neighboring states. The state's economy has become less diversified with the service sector increasing in importance. While manufacturing employment was nearly 31 percent of statewide employment in 1969 compared to 14 percent in 2000, service employment rose from 18 percent to 34 percent over the same period. For 2000, the health services and state and local government sectors together account for 19 percent of statewide total earnings. Pennsylvania has seen a divergence in income between the richest and poorest counties over the last 30 years (Latzko 2001).

The paper begins by considering whether counties comove more strongly with neighboring counties than with the state as a whole. After an affirmative answer is obtained, estimates of the employment correlation between urban centers and surrounding counties are used to construct cohesive urban/suburban regional economies in Pennsylvania. The resulting regions display the geographic scope of the economic influence of each of the state's urban centers. The most notable finding is that the Philadelphia suburbs form a cohesive regional economy that is not substantially correlated with the center city.

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<sup>1</sup> Bradbury, Downs, and Small (1980) and Mumphrey and Akundi (1998) discuss theories of the city suburb relationship.

## I. Dynamic Correlation and Geographic Proximity

Croux, Forni, and Reichlin (2001) define dynamic correlation as

$$(1) \quad \rho_{xy}(\lambda) = \frac{C_{xy}(\lambda)}{(S_x(\lambda)S_y(\lambda))^{1/2}},$$

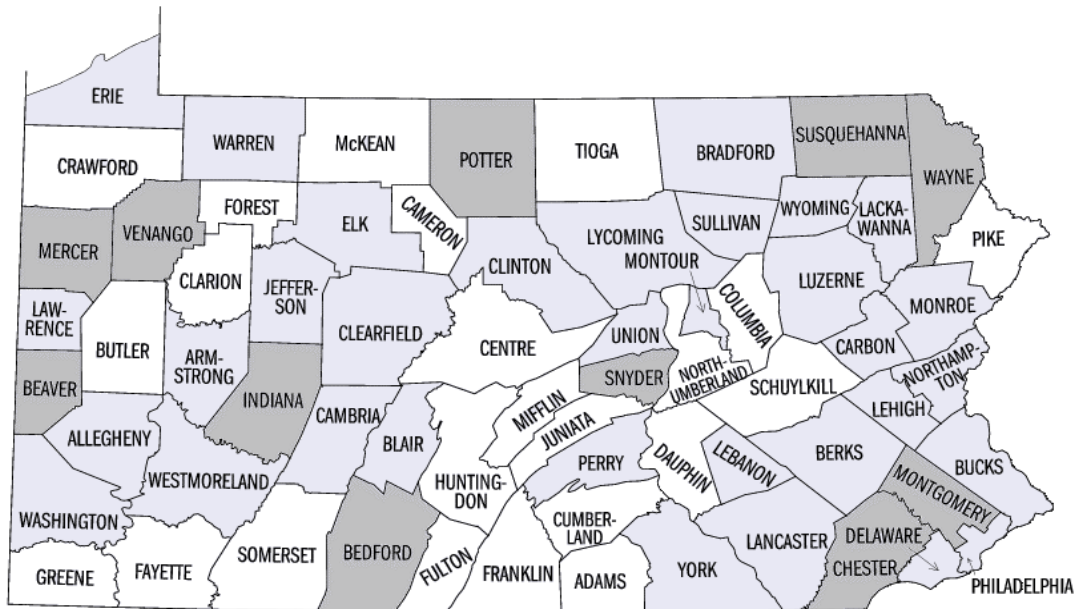
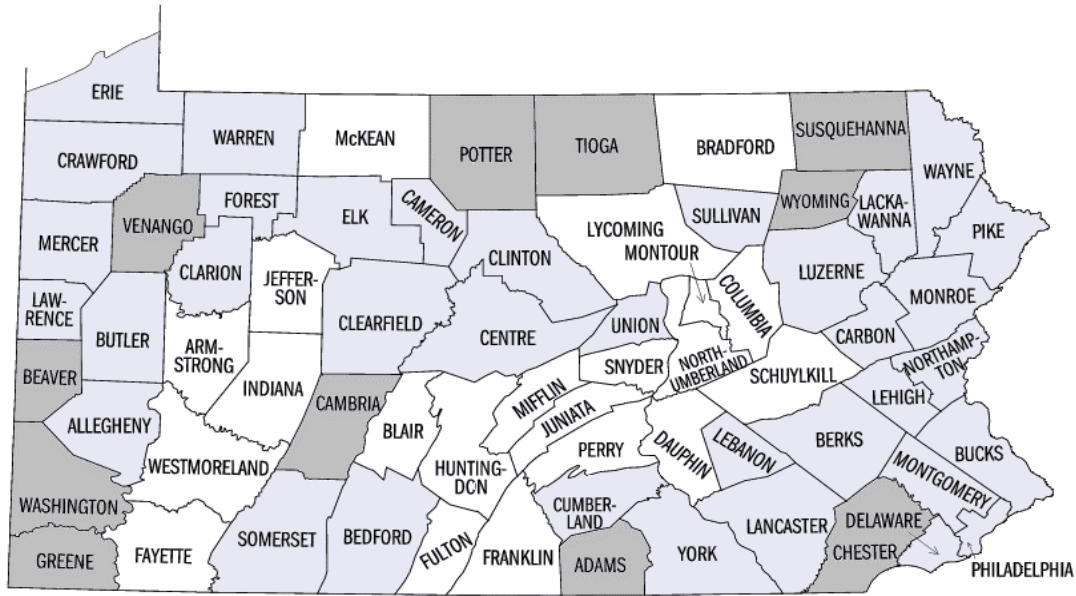
where  $S_x(\lambda)$  and  $S_y(\lambda)$  are the spectral density functions of time series  $x$  and  $y$  at frequency  $\lambda$  and

$C_{xy}(\lambda)$  is the cospectrum for series  $x$  and  $y$ . Dynamic correlation over the frequency band  $\Lambda_+ =$

$[\lambda_1, \lambda_2]$ ,  $0 < \lambda_1 < \lambda_2 < \pi$ , is

$$(2) \quad \rho_{xy}(\Lambda_+) = \frac{\int_{\Lambda_+} C_{xy}(\lambda) d\lambda}{\left( \int_{\Lambda_+} S_x(\lambda) d\lambda \int_{\Lambda_+} S_y(\lambda) d\lambda \right)^{1/2}}.$$

This section examines whether the business cycles of counties that are geographic neighbors are more strongly correlated. The data analyzed is the natural log of the total full-time and part-time employment of each of the 67 counties in Pennsylvania for the years 1969 to 2000. The data is taken from the REIS database compiled by the Commerce Department. The series are twice differenced to remove the serial dependence. A Bartlett window with a span equal to 5 is used to produce the spectral density estimates. The ratio between the average dynamic correlation with neighboring counties and the average dynamic correlation with all counties is computed for each county. The ratio is calculated for both long-run frequencies, periods of six or more years, ( $\Lambda_+ = [0, \pi/3]$ ) and short-run frequencies ( $\Lambda_+ = [\pi/3, \pi]$ ). Figure 1 depicts the results. The shaded counties comove more strongly with their neighbors than with all Pennsylvania counties. A majority of counties do comove more strongly with neighboring counties. Most of these counties are located in the eastern and western portions of the state. Mid-state rural counties are less likely to be strongly correlated with nearby counties.



**Figure 1. The 67 Pennsylvania Counties Shaded by the Ratio between the Average Dynamic Correlation with Neighboring Counties and the Average Dynamic Correlation with All Counties at Short-Run (top) and Long-Run (bottom) Frequencies.**

## II. Constructing Regional Counties

Proximity does matter for economic correlation.<sup>2</sup> Pennsylvania counties tend to comove more strongly with their neighbors than with the rest of the state. These counties that are more strongly correlated with their neighbors are mostly clustered in the urbanized areas of the state. This suggests that urban centers may exert an influence on the economies of both neighboring suburban counties and distant suburban and rural counties. This section uses that supposition to construct regional economies centered upon the large cities in Pennsylvania in order to view the geographic scope of the influence of these urban centers.

This shift in perspective moves the analysis from the bivariate to the multivariate case. The dynamic correlation among more than two variables is the weighted average of the dynamic correlations between all possible pairs of series. Croux, Forni, and Reichlin (2001) name this cohesion. Cohesion at frequency  $\lambda$  is equal to

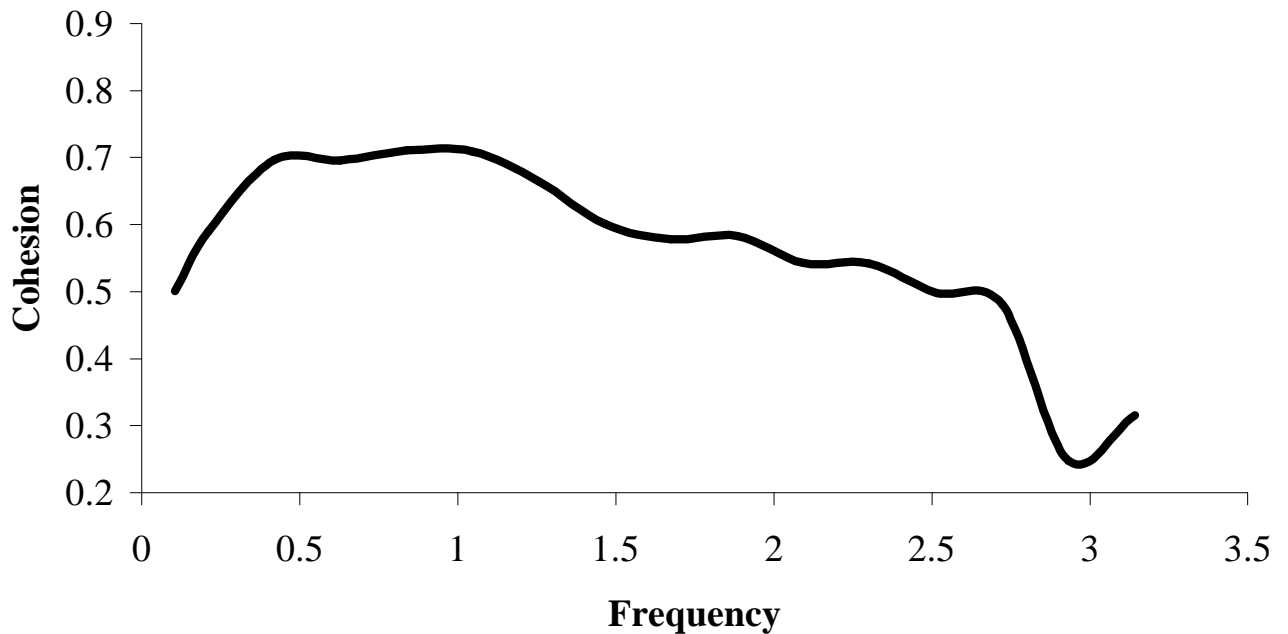
$$(3) \quad \text{coh}_x(\lambda) = \frac{\sum_{i,j} w_i w_j \rho_{xixj}(\lambda)}{\sum_{i,j} w_i w_j},$$

where  $w_i$  and  $w_j$  are nonnormalized positive weights. Within the frequency band  $\Lambda_+ = [\lambda_1, \lambda_2]$ , cohesion is given by

$$(4) \quad \text{coh}_x(\Lambda_+) = \frac{\sum_{i,j} w_i w_j \rho_{xixj}(\Lambda_+)}{\sum_{i,j} w_i w_j}.$$

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<sup>2</sup> And not just at the county level: Clark and van Wincoop (1999) find that within-country output correlations are larger than cross-country output correlations for the four largest European countries.



**Figure 2. Cohesion of the 67 Pennsylvania counties for county employment.**

Figure 2 shows the cohesion among all 67 counties at each frequency. The average level of employment over the period 1969-2000 is used to weight each county. County employment comoves most strongly in the long run. Cohesion across the entire frequency band equals 0.56.

10 Pennsylvania cities are large enough to possibly be considered urban centers: Philadelphia (2002 population, 1,585,600), Pittsburgh (369,900), Erie (108,700), Allentown (105,100), Scranton (81,800), Reading (78,400), Bethlehem (71,400), Lancaster (55,600), Harrisburg (52,400), and Altoona (51,400). No other cities have populations over 50,000. Although there are a number of smaller cities with populations between 15,000 and 50,000, these 10 cities are the starting points in the construction of regional economies. Members of an economic region must be geographic neighbors and must comove significantly more strongly than the state as a whole, that is, the cohesion among members of the regional economy must be substantially higher than the statewide cohesion of 0.56. Since the mean ratio between average

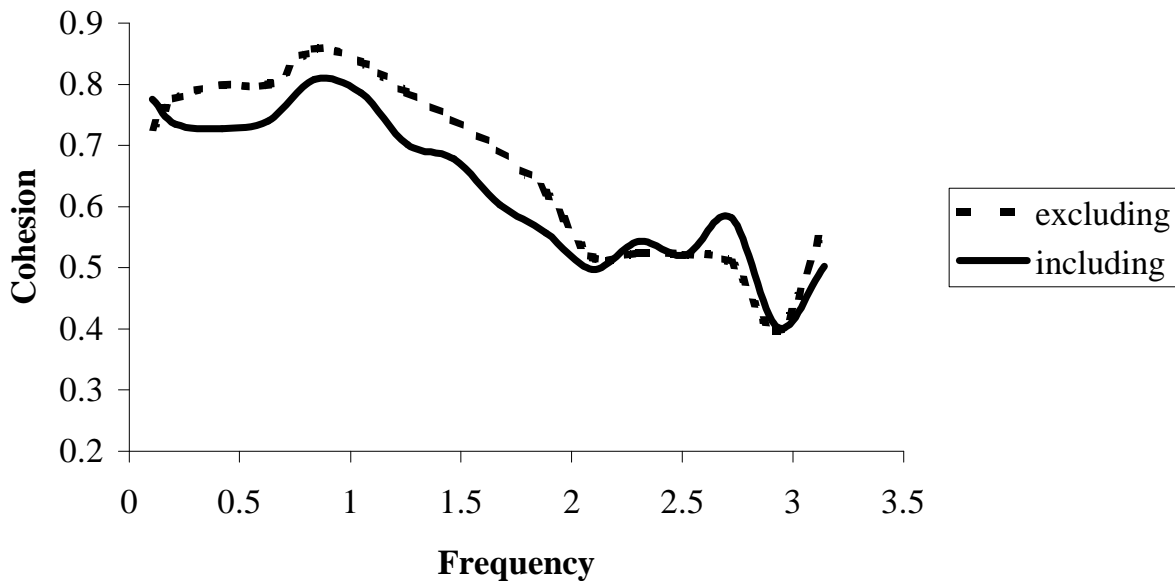
dynamic correlation with neighboring counties and average dynamic correlation with all counties is 1.15, a regional cohesion value greater than or equal to 0.64 is taken as substantially more cohesive than the state as a whole.

The procedure of constructing a cohesive regional economy is as follows: compute the cohesion among the urban center and all surrounding counties over the entire frequency band,  $\Lambda_+ = [0, \pi]$ , using equation (4). If the estimated cohesion is greater than 0.64, add the contiguous county with the highest bivariate dynamic correlation with the urban center and re-estimate the regional economic cohesion. Continue to add counties as long as the estimated cohesion is above the 0.64 threshold level.

If the estimated cohesion among the urban center and all surrounding counties is less than 0.64, drop the county that is least correlated with the remaining counties and recalculate the cohesion. Continue to drop counties until the cohesion equals 0.64. Add any contiguous counties for which the subsequent estimated regional cohesion remains above 0.64.

#### A. Philadelphia

Philadelphia does not significantly comove with its suburban neighbors. Bivariate dynamic correlations between Philadelphia and nearby counties are Bucks 0.66, Chester 0.63, Delaware 0.51, Montgomery 0.55, Camden, New Jersey 0.48, Cumberland, New Jersey 0.45, and New Castle, Delaware 0.67. Cohesion among Philadelphia, Bucks, Chester, Delaware, Montgomery, and New Castle Counties equals 0.61, which is below the threshold of 0.64. The five suburban counties do form a cohesive economic region. The cohesion over the entire frequency band among Bucks, Chester, Delaware, Montgomery, and New Castle Counties is 0.64. Figure 3 plots the cohesion of employment for the suburban Philadelphia region including

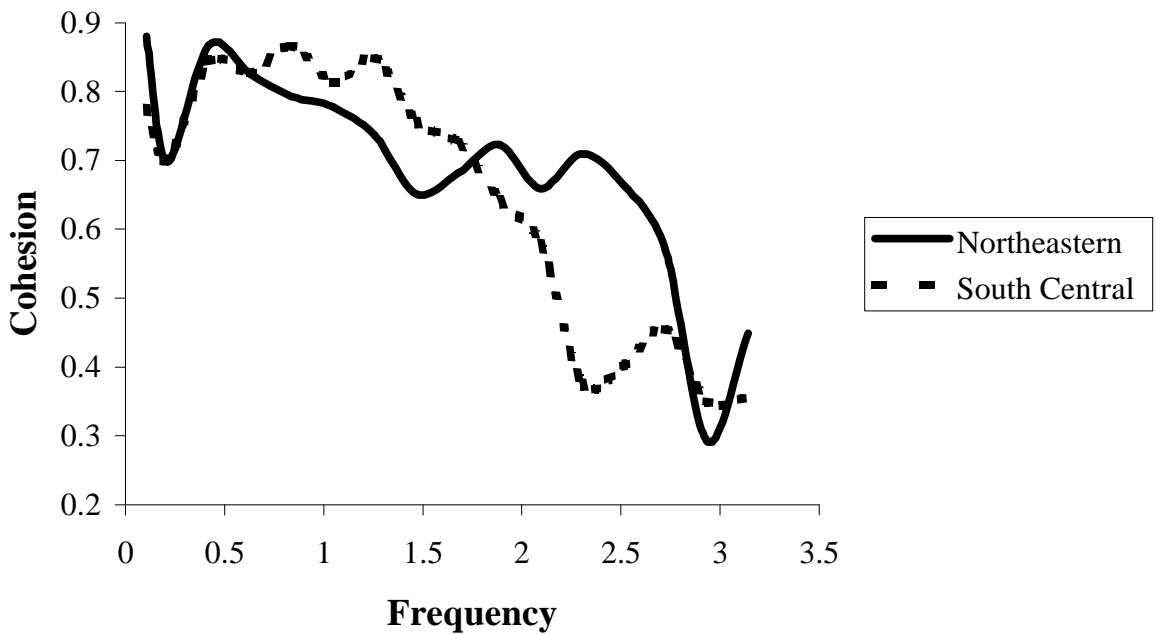
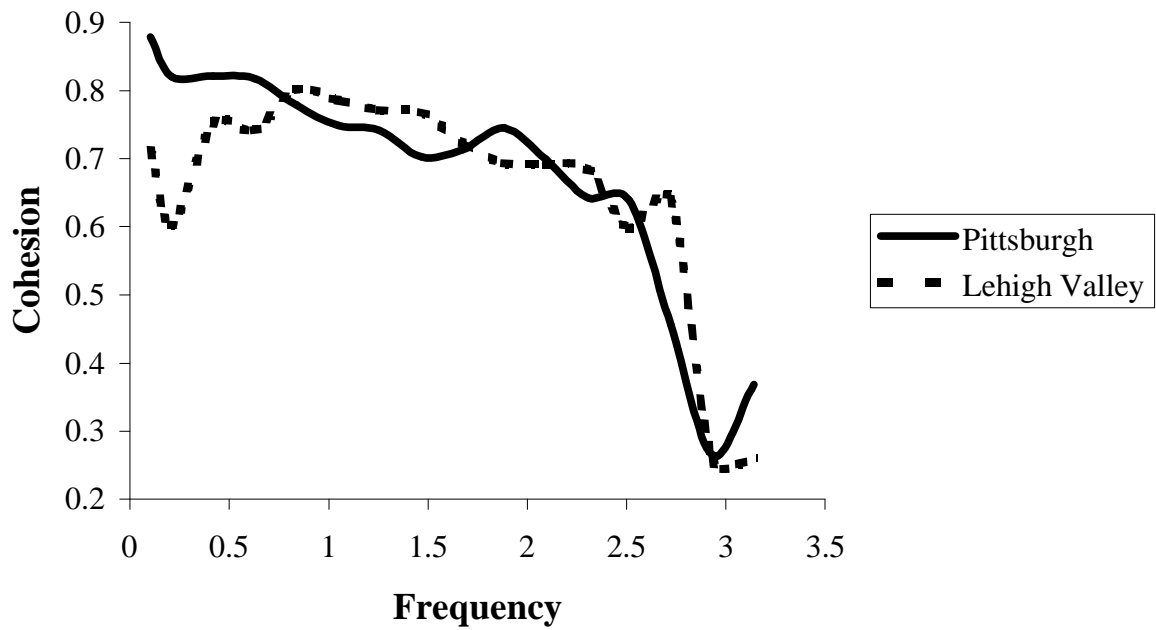


**Figure 3. Cohesion of the Suburban Philadelphia Region (Bucks, Chester, Delaware, Montgomery, and New Castle, Delaware Counties) Including and Excluding Philadelphia.**

and excluding Philadelphia County. The suburbs comove more strongly with one another at long-run, medium-run, and very short-run frequencies. The dynamic correlation over the entire frequency band between Suburban Philadelphia region and Philadelphia County is 0.70 while the correlation between the suburbs and the national economy is 0.89.

#### B. Pittsburgh

In contrast to Philadelphia, Pittsburgh, located in Allegheny County, does exert a substantial influence on neighboring counties. Bivariate dynamic correlations for employment with Allegheny County for nearby counties are 0.30 for Armstrong, 0.61 for Beaver, 0.70 for Butler, 0.58 for Fayette, 0.67 for Lawrence, 0.64 for Mercer, 0.51 for Washington, and 0.69 for Westmoreland. The cohesion for a Pittsburgh regional economy consisting of Allegheny, Beaver, Butler, Fayette, Lawrence, Mercer, and Westmoreland Counties is 0.65. The addition of



**Figure 4. Cohesion of the Pittsburgh, Lehigh Valley, Northeastern Pennsylvania, and South Central Pennsylvania Regional Economies.**

Washington County drops the cohesion to 0.62, excluding it from the regional economy. Figure 4 displays the cohesion of employment for the Pittsburgh and the other regions discussed below.

C. Erie

The cohesion of Erie and its two neighboring Pennsylvania counties, Crawford and Warren, is 0.61. There is no regional economy extending beyond Erie County in Northwestern Pennsylvania.

D. Allentown

The Lehigh Valley regional economy centered on Allentown is the most cohesive of any region in the state. The cohesion for Lehigh (which contains Allentown), Berks, Carbon, Monroe, Northampton, and Warren, New Jersey Counties equals 0.68. In addition to Allentown, this region includes Reading in Berks County and Bethlehem in Northampton County, giving the Lehigh Valley three highly correlated urban areas. The dynamic correlation over the entire frequency band between the Lehigh Valley and Philadelphia is 0.73. The correlation between the neighboring Lehigh Valley and Suburban Philadelphia regions is 0.87.

E. Scranton

The Northeastern Pennsylvania regional economy consists of Lackawanna, Luzerne, Bradford, Lycoming, Schuylkill, Sullivan, and Susquehanna Counties. The estimated cohesion among these counties is 0.65. In addition to Scranton, the region also contains two small urban centers, Wilkes-Barre (population 47,500) and Williamsport (31,900).



Figure 5 shows the eight regional urban/suburban economies in Pennsylvania, including the single county regions of Philadelphia, Erie, and Altoona. Each of the five multi-county regions contains several urban centers, both large and small. The Lehigh Valley region contains Allentown, Reading, and Bethlehem as well as Easton, which has a population of 26,300, and Phillipsburg, New Jersey (15,800). Northeastern Pennsylvania contains Scranton, Wilkes-Barre, and Williamsport plus Hazleton (24, 700) and Pottsville (16,600). Monroeville (29,200), New Castle (28,300), and Sharon (17,500) are part of the Pittsburgh regional economy. Lancaster, Harrisburg, York (42,200), Lebanon (24,800), and Carlisle (18,400) are the urban centers in the South Central region. Even the Philadelphia suburbs have several urban centers: Wilmington, Delaware (72,700), Chester (41,900), Norristown (30,700), Havertown (30,000), Pottstown (21,800), King of Prussia (18,400), and West Chester (18,000). The presence of multiple urban centers within a strongly cohesive regional economy suggests that several smaller urban centers are together able to achieve the agglomeration economies usually provided by large cities.

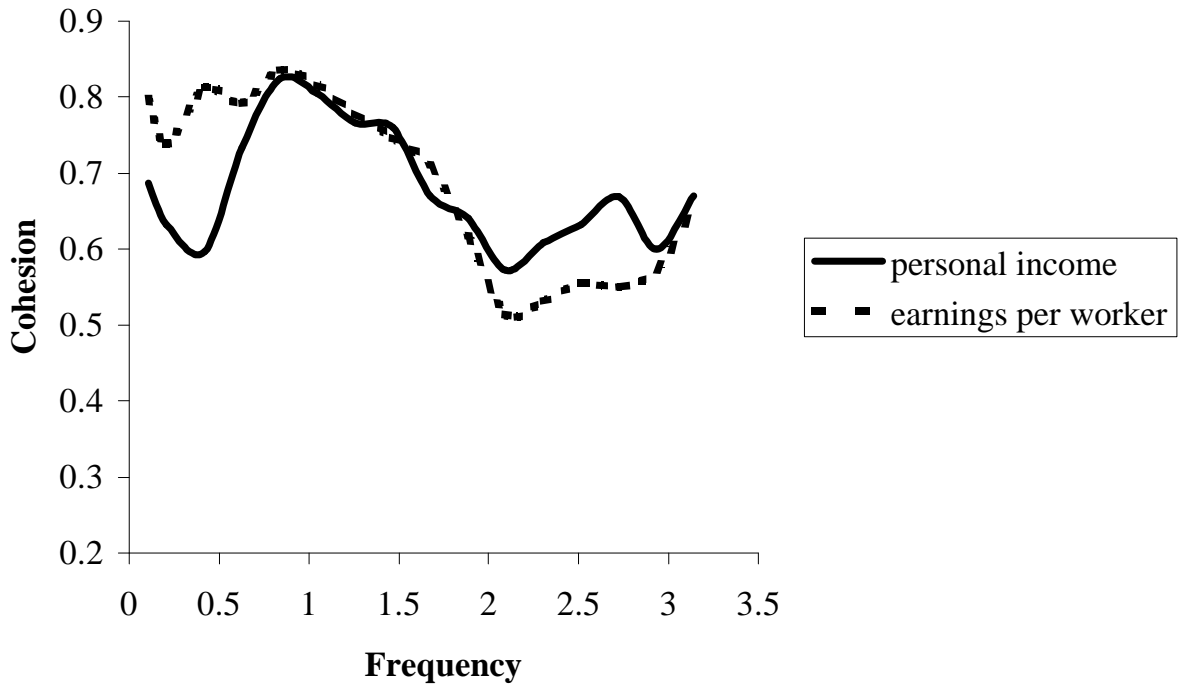
The main assumption underlying the city/suburban interdependence hypothesis is that large cities supply greater opportunities for agglomeration economies, which are the benefits that accrue from having many businesses in close proximity. The basic principle behind agglomeration economies is that concentration of industry makes doing business more efficient by providing firms with access to specialized business services and by reducing transportation and communication costs. It appears that a grouping of small cities in close proximity can also provide agglomeration economies.

### III. Cohesion of Income

To check the sensitivity of the results to using employment to proxy county economies, two measures of income were analyzed, personal income and total earnings per worker. The ideal income measure is not available: a county-level version of gross domestic product. The personal income accounts reported by the Commerce Department's Bureau of Economic Analysis assign income to the county in which the owner of the inputs resides not to the county in which the income was earned. But if people work in one county and live in another or if people own capital in other counties, then personal income is not an accurate indicator of county economic activity. For instance, Cumberland County received 15,418 commuters from Dauphin County in 1990 while sending there 20,963 commuters, and nearly 60,000 Delaware County residents worked in Philadelphia County with an even larger number of Philadelphia commuters coming from out of state (Pennsylvania State Data Center). Also, personal income includes transfer payments. Personal income may not be a reliable measure of county-level economic activity because it includes both unearned income and income earned outside the county.

The Bureau of Economic Analysis also tracks "total earnings by place of work". This attributes income to the county in which it was earned. Total earnings include wages and salaries, other labor income, contributions for social insurance, and proprietors' income. It excludes dividends, interest, rent, and transfer payments. Total earnings divided by total full and part-time employment yields total earnings per worker.

Figure 6 shows the cohesion of all 67 counties for the two income measures over the period 1969-2000. The variables are in log form and are twice differenced to render them



**Figure 6. Cohesion of the 67 Pennsylvania counties for county personal income and total earnings per worker.**

stationary. Counties are weighted by personal income and by employment for the estimates of personal income and total earnings per worker cohesion, respectively. The state as a whole is much more cohesive for both measures of income than for employment. Table 1 compares the income and employment cohesion estimates over the entire frequency band for each economic region. All five of the regional economies constructed in the previous section are more cohesive for personal income than the state as a whole. However, only the South Central region is substantially more cohesive for earnings per worker than the state as a whole. Two regions, Suburban Philadelphia and the Lehigh Valley, are actually slightly less cohesive than the state for earnings per worker.

**Table 1**

**Cohesion Estimates by Region**

The table reports the income and employment cohesion estimates over the entire frequency band for the state as a whole and for each economic region.

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	<u>Employment</u>	<u>Personal Income</u>	<u>Earnings per Worker</u>
State of Pennsylvania	0.56	0.67	0.65
Suburban Philadelphia	0.64	0.76	0.63
Pittsburgh	0.65	0.69	0.69
Lehigh Valley	0.68	0.74	0.63
Northeastern Pennsylvania	0.65	0.81	0.69
South Central Pennsylvania	0.64	0.84	0.80

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Neighboring counties excluded from the regions constructed in the previous section were included in re-estimates of regional income cohesion in order to see whether their inclusion results in a higher estimated cohesion. Looking at income, however, changes the composition of only one region. The inclusion of Washington County, excluded from the Pittsburgh regional economy due to its very low employment correlation with neighboring counties, slightly increases the estimated regional cohesion for both personal income and total earnings per worker. The Suburban Philadelphia region remains more cohesive when Philadelphia is excluded: 0.76 versus 0.66 for personal income and 0.63 versus 0.61 for earnings per worker.

IV. Cohesion of Metropolitan Statistical Areas

Pennsylvania contains six multi-county Metropolitan Statistical Areas as defined by the Office of Management and Budget.<sup>3</sup> These six MSA's do not coincide with the economic

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<sup>3</sup> There are also eight single county MSA's in Pennsylvania, including Erie and Altoona. The Sharon MSA is part of the Pittsburgh region constructed above. York and Lancaster are included in the South Central Region. Reading is in the Lehigh Valley region. The Williamsport MSA is included as part of the Northeast region. State College is not an urban center.

**Table 2**

**Cohesion Estimates by MSA**

The table reports the income and employment cohesion estimates over the entire frequency band for the state as a whole and for each multi-county Metropolitan Statistical Area in Pennsylvania as defined by the Federal Office of Management and Budget.

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	<u>Employment</u>	<u>Personal Income</u>	<u>Earnings per Worker</u>
State of Pennsylvania	0.56	0.67	0.65
Philadelphia	0.55	0.67	0.63
Allentown-Bethlehem-Easton	0.68	0.73	0.59
Scranton-Wilkes-Barre-Hazleton	0.65	0.87	0.69
Harrisburg-Lebanon-Carlisle	0.37	0.84	0.74
Johnstown	0.57	0.82	0.70
Pittsburgh	0.62	0.69	0.70

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regions identified in this paper. MSA's consist of those counties most closely economically and socially integrated around a central city. Table 2 shows the estimated employment and income cohesions for each MSA over the frequency band  $\Lambda_+ = [0, \pi]$ , with the state of Pennsylvania provided for reference. Only the Allentown-Bethlehem-Easton MSA is substantially more cohesive for employment than Pennsylvania as a whole. Several MSA's are substantially more cohesive for personal income, but none are substantially more cohesive for earnings per worker.

V. Summary

This paper used time series data to estimate dynamic correlations among Pennsylvania counties for employment and income in order to examine the comovement of county economies. Counties tend to comove more strongly with neighboring counties than with the state as a whole. The resulting correlations are used to construct five multi-county and three single county regional economies centered on major urban areas consisting of counties displaying a high

degree of economic cohesion. A notable finding is that the suburban Philadelphia counties comprise a cohesive regional economy separate from the city of Philadelphia. Each of the five multi-county regions contains several large and small urban areas, suggesting that regions containing several small urban centers are able to achieve the agglomeration economies most often provided by large cities.

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