2 ECONOMIC BASE MODELING OF HUB AND SPOKE GROWTH PATTERNS

"Economic Base Modeling to Test Growth Patterns"
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2.1 Introduction

This chapter presents an update of an economic base analysis of Appalachia's *distressed* and transitional (380 counties combined) counties using economic base theory which has been augmented to address possible spatial influences on a county's economic strength. This analysis was first conducted for the ARC (2000) by Smirnov-Smirnova to test whether distinct spatial growth patterns have a role to play in the performance of Appalachia's distressed, and near-distressed Transitional (153 counties at the time of the original analysis). The original study monitored employment growth performance (based on the strength of the regional employment multiplier) from 1992 through 1996. This update focuses on the period 1997 through 2002.

Summary of Original Research. In their "Assessment of the Economic-Bases of Distressed and Near-Distressed Counties in Appalachia," presented to the Appalachian Regional Commission (ARC) in 2000, Smirnov and Smirnova (hereafter referred to as S&S) use economic-base and location-quotient techniques to provide a detailed assessment and typology of 111 distressed and 42 near-distressed[1] counties in the Appalachian region in 1992 and 1996. The authors perform three key analyses to understand and assess the counties under study. First, they analyze the economic-base of distressed counties to identify their strengths and weaknesses and their potential for economic growth. The economic-base is defined as the collection of establishments in which the county specializes, where a county's employment in that industry is greater than the average for the rest of the country (i.e., it has an employment location-quotient greater than one).[2] Second, they identify the industrial-mix of economic-

[1] The ARC has since changed the terminology for the subset of transitional counties previously identified as *near-distressed* to *at-risk.*
[2] We will sometimes refer to the *economic-base* of a region as the *export-base*.

bases and regional spatial effects as important factors in shaping the regional economies of distressed and near-distressed counties. Third, they establish a typology for key parameters that characterize the economic potential of the economic-bases of distressed and near-distressed counties using regional employment multipliers and strength of spatial linkages; the latter measured by a spatial multiplier.

Based on their empirical analysis, S&S, identify several relationships and patterns that affect the economic development status in Appalachian counties:

- Within select types of economic-bases and specific classes of economic distress a strong relationship exists between the key parameters, such as population, employment, average wages, and per capita income of distressed and transitional counties. The S&S comparison of economic-bases between the distressed and near-distressed counties against the more prosperous economies in Appalachia reveals significant disparities in their key parameters.

- Regional employment multipliers show a direct (positive) relationship between the level of economic distress and the strength of the economic-base. In 1996, the average regional multiplier for distressed and near-distressed counties was 1.79, which is 11 percent lower than the average regional multiplier of 1.99 for all Appalachian counties. Distressed counties with higher values of regional multipliers tend to perform better and have higher economic growth potential than those with lower multiplier values.

- The industrial mix of the economic-bases of distressed and near-distressed counties is dominated by resource-oriented, technologically disadvantaged industries, many of which pay relatively low wages, have a low potential for growth of employment, and have little positive effect on local demand. The traditional components of Appalachia's industrial-mix are resource-oriented/extraction industries, such as coal-mining and agricultural production, where steady declines caused economic distress in affected counties. More dynamic and technologically advanced industries are virtually non-existent in the distressed areas of Appalachia.

- Spatial effects play an important role in shaping the economic-bases of all economies. The magnitude, direction, and scope of spatial effects for distressed and near-distressed counties differ from those of other counties in Appalachia. Distressed and near-distressed counties have very weak local and global economic linkages that lead to their limited economic opportunities and slow growth rates.

- The gap between distressed and prosperous counties in Appalachia is widening. On average, socio-economic parameters, such as population, employment, average wages, and per capita income of distressed and near-distressed counties, are growing at a substantially slower rate than they are in the rest of Appalachia. S&S identify four key characteristics as defining patterns of persistent self-reinforcing

economic distress: *(1)* small size of rural economies, *(2)* non-diversified economic-bases, *(3)* stagnant industrial mixes, and *(4)* weak spatial linkages.

Based on these patterns, S&S find that the economic growth potential differs among distressed and near-distressed counties. There are a total of 13 distressed and near-distressed counties (termed Type I) that have well-diversified economic-bases, strong spatial linkages, and their economic-growth potential is as strong as that of prosperous counties in Appalachia. The majority of these counties are perceived as potential hubs—regions that are capable of propagating economic growth in the neighboring regions. Also, 21 counties (termed Type II) are approaching a similar level of potential for economic growth. An important distinction is that these counties form 'tight spatial clusters'. These counties are likely to overcome economic distress and achieve a pattern of self-sustainable economic growth, however, their economic development initiatives have to be coordinated at the multi-county level. In total these 34 counties, with somewhat diversified economic-bases and some economic-growth potential, form spatial clusters, which highlights the need for policies and initiatives that promote closer economic ties between neighboring counties. Exhibits 2-1 and 2-2 identify the counties whose economies have been portrayed as functioning as a regional hub or regional spokes.

Exhibit 2-1. Potential Regional "Hubs" from among Select Appalachian Counties, Smirnov (2000)

Distressed and Near-Distressed Counties with Growth Potential as Regional Hubs (13 counties) – Type I	
Spatial linkages are strong, economic base is strong and well-diversified, the type of economic base is either service-based or non-specialized	
Distressed Counties	**Near-Distressed**
Scioto, OH *Fayette, PA Raleigh, WV Randolph, WV	*Talladega, AL *Allegany, MD *Belmont, OH *Guernsey, OH *Jefferson, OH Cumberland, TN Tazwell, VA Greenbrier, WV Marion, WV
* Counties with both strong exports and local inter-county spatial links; other counties are those with only strong, local inter-county spatial link.	

Exhibit 2-2. Potential Regional "Spoke" Economies from among Select Appalachian Counties, Smirnov (2000)

Distressed and Near-Distressed Counties with Potential Influence on Neighboring Counties (21) – Type II	
Spatial linkages are relatively strong, economic base is relatively strong and relatively well-diversified	
Distressed Counties	**Near-Distressed**
Bell, KY Breathitt, KY Floyd, KY Harlan, KY Johnson, KY Knox, KY Perry, KY Pike, KY Rowan, KY *Whitely, KY Alcorn, MS Monroe, MS Oktibbeha, MS *Athens, OH *Gallia, OH Wise, VA *Logan, WV Upshur, WV	Jackson, KY Greene, TN McMinn, TN
* Counties with both strong exports and local inter-county spatial links; other counties are those with only strong, local inter-county spatial link.	

Complementary industrial and labor market linkages among closely located counties, or clusters of counties, have substantial beneficial effects for all counties involved, enhancing competitiveness of local products and services, and creating a base for successful multi-county industrial clusters. Poor choice of the industrial mix to be promoted in one county might undermine economic opportunities in the neighboring counties.

Update from the Spatially-augmented Export-base Analysis. The original analysis was updated for the Sources of Growth study using a more current set of data (years 1997, 2002) sourced from IMPLAN[3] and provided specifically for this task by the ARC. The analysis methodology is reviewed in the next section before presenting the findings for the 1997-2002 period. Additional information is provided in a separate Appendix document.

[3] IMPLAN ® is an economic-impact modeling system provided by the Minnesota IMPLAN Group, Inc. Industry-level data are developed primarily from County Business Pattern data and select REIS data totals

2.2 Export-base Analysis Methodology

S&S derive a spatial export-base model by applying the principle of demand-driven modeling to the two-level hierarchy of regional economy emanating from the county level (the first being the county itself, and the second being the county and its neighbors). This results in a three-sector economy with one non-basic sector and two basic sectors (serving local and global exports). They use a county's employment in export-designated industries relative to the entire United States as an indicator of its economic-base; and location-quotients to identify a county's export employment in an industry against the rest of the United States. Based on this model, they perform four key analyses:

- Strength of economic-base using regional employment multipliers
- Strength of spatial linkages
- Degree of diversification in the economy
- Classification of counties by growth potential

Strength of the Economic-base. S&S use a concept of Regional Employment Multipliers (REM) to measure the strength of the economic-base. REM is defined as the number of new jobs generated in the county's economy as a result of an additional job in the export-base sector. Higher REM values correspond to a stronger economic-base.

The classical export-base model establishes that the total employment in the county (X) is the sum of export-base employment (E) and non-base employment (L):

$$X = L + E \tag{1}$$

The critical assumption of the export-base model is that employment in the local sector is related only to the total employment in the county:

$$L = aX \tag{2}$$

Where (a) is the requirement coefficient, which denotes the demand for local services by the regional economy, and $0 < a < 1$.

Combining (1) and (2), we obtain:

$$X = \frac{1}{1-a} E \tag{3}$$

where the $\frac{1}{1-a}$ coefficient is the **Regional Employment Multiplier (REM)**, which

indicates how change in the export-base employment affects the regional economy, i.e., every additional job in the export-base sector creates a total of X jobs in the regional economy.

The standard export-base model analysis approach does not include spatial elements in the parameters of the model, *e.g.*, county location or socioeconomic environment. These assumptions limit the application of the model to the analysis of large geographical areas, such as states.

Strength of Spatial Linkages. S&S modified the export-base model to include spatial linkages to the neighboring counties and the rest of the world, based on a two-region model (Exhibit 2-3). The first region is represented by a county (County A). The second region is represented by the *expanded region of neighboring counties*, which comprises the county and its direct neighborhood of adjacent counties. The export base model for that region is similar to the single county case:

$$X^R = L^R + E^R \quad (4)$$

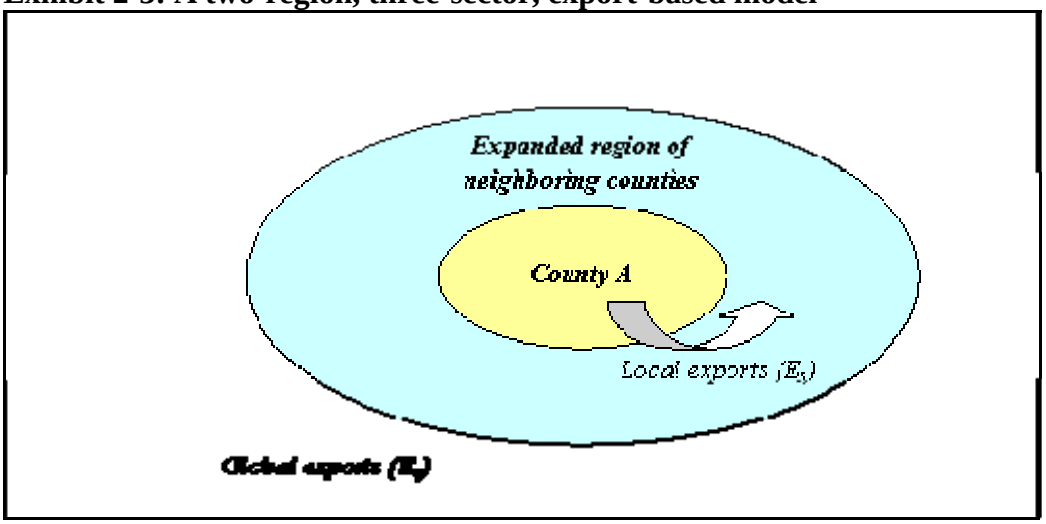
$$L^R = cX^R \quad (5)$$

Total employment in the context of this expanded region is related to the employment in the basic sector via the multiplier effect:

$$X^R = \frac{1}{1-c} E^R \quad (6)$$

The spatial export-base model implies no cross hauling within the aggregate multi-county region; i.e. a sector's product exported to the neighboring counties is not subsequently exported.

Exhibit 2-3: A two-region, three-sector, export-based model



Source: MIT Multiregional Planning Research Group.

This spatial export-base model links two levels of the regional hierarchy: (1) the

county model, and (2) the expanded region of neighboring counties model. Exports from a county comprise two components: local exports E_s (exports to the expanded region of neighboring counties) and global exports E_g (exports beyond the county and its neighborhood).

$$X = L + E_s + E_g \qquad (7)$$

where (X) is the sum of the export-base employment ($E = E_s + E_g$) and non-base employment (L); (E_s) is the portion of the export-base employment attributed to exports to the neighboring counties, and (E_g) is the portion of the export-base attributed to global exports (exports beyond neighboring counties).

This spatial export-based model leads to a three-sector economy, with a county's economy consisting of three sectors, one local non-basic sector and two basic sectors. We maintain the assumption of the classical export-based model that the employment in the local sector is related only to the total employment in the county:

$$L = aX \qquad (8)$$

County A's first basic sector is the sector that provides goods and services to the second basic sector in the expanded region. Assuming a linear relationship, we determine employment in this basic sector by:

$$E_s = bE^R = b(E_g + E_g^l)\,. \qquad (9)$$

where (E_g^l) is the size of the global export-base in the neighboring regions (counties), coefficient b (where $0 < b < 1$)[4] is a coefficient that indicates the requirement for employment tied to local export activities in the county and its spatial neighborhood.

The second basic sector is associated with goods and services supplied outside the expanded region. This assumption is a logical extension of the classical export-base model, which aims to explain employment in all sectors of the regional economy via

[4] The technical and economic bounds on the values of the coefficients: The bounds on the value of coefficient b are determined from practical considerations of model use. The lower bound b = 0 implies that all county exports are global, i.e. industrial mix of the county is identical to the industrial mix of the aggregated region. The upper bound, b = 1, still does not imply that all exports are local. However, high values of the coefficient b >=1 would have implied a "super-efficient" job-creation by global exports: one job created in the global export would have made a direct impact of equal or larger magnitude on the local exports. While technically this situation is possible, it simply suggests that the global export industry is a pass-through industry, which is instrumental, but not the reason, for the global exports. For example, if local export is generated by manufacturing in county A, and global exports is a shipping company in the neighborhood of county A, then the co-location of the two industries is driven by the demand on the manufacturing goods. High values of the coefficient b contradict the major economic assumption of the export-base model, which postulates the demand-driven economy. For this reason, any value of b close to 1, such as 0.8 or 0.9 should be taken as an indication of potential violation of model assumptions. (Communication from Smirnov, 1/30/2006)

the employment in the basic sector. In the case of the spatial export base model, it is a three-sector model: global export (basic-2) – local export (basic-1) – non-basic employment. Eventually, the employment in the second basic sector determines the employment in all other sectors.

The addition of spatial interactions to regional export-base model introduces the concept of *regional neighborhood*. Regional neighborhood can be understood as the sphere of immediate economic influence of a county's economy. That influence is exerted via common infrastructure, economic linkages, shared labor pools, etc. Because most of these effects quickly decay with geographical distance, it is reasonable to assume initially that only cross-county border interactions affect neighboring counties. In this study, we use the physical contiguity criterion to define regional neighborhood.

This regional neighborhood is represented by the contiguity matrix. This is a matrix of zeros and ones, with an element S_{ij} equal to one if counties *i* and *j* are geographic neighbors. This denotes that these two counties may have close economic ties with each other and that their economic-bases are interdependent. In contrast, the element S_{ij} is equal to zero if two counties are not contiguous. The diagonal elements in the matrix are set to zero because our definition of global export excludes the county's output[5].

It should be noted that other neighborhood "constructs" could be used in this type of spatial modeling exercise. For example, a test of the hypothesis that the relationships among the different counties are a function of the cross-county trade flows rather than geographic adjacency would require generating a similar *spatial weights* matrix with elements S_{ij} equal to one if counties *i* and *j* pass a certain threshold of cross-county trade flows activity. Comparing the effect of the spatial linkages based on these two different notions of adjacency, would illustrate the relative strength of geographic neighborhood vs. trade flows on the economic influence exerted among these counties.

The principal distinction between the classical export-base model explained in Equations (1) and (2) and the modified spatial model explained in Equations (7), (8), and (9) is that for the latter, the export-base is segmented into two components and the "local" oriented export-base is linked directly to global export activities in the neighboring counties.

By combining Equations (7), (8), and (9), we obtain Equation (10):

$$X = \frac{1}{1-a}[b(E_g + E_g^l) + E_g] \qquad (10)$$

[5] For this updated analysis, the contiguity matrix was assembled using GeoDa[5]. The "Queen" concept from chess was chosen for calculating contiguity, which includes all the neighboring counties whether they are adjacent at a single point or have a common border with the county. This is in contrast to the "Rook" concept, which includes contiguous neighbors only if they share a border with the respective county.

which can be rearranged into Equation (11):

$$X = \frac{1+b}{1-a} E_g + \frac{b}{1-a} E_g^l \qquad (11)$$

Equation (11) is the reduced form of the spatial version of the export-base model. Both coefficients (*a*) and (*b*) are county-specific; however, in the case of the non-spatial version of the model, (a) alone would be the only parameter. Values of these parameters characterize the industrial mix of the regional economy at the aggregate level, based on the aggregation of NAICS-level estimates.

Two multipliers are important in this model. First, $\frac{1+b}{1-a}$ is the **Spatial version of the Regional Employment Multipliers (SREM)**, which denotes how much increase in employment in the county will occur from a unit increase in its global exports. The introduction of the spatial effects increases its value slightly from the value in the non-spatial version. The second multiplier $\frac{b}{1-a}$ measures the **Local Spatial Linkage (LSL)**, which indicates how much the employment in the county will increase as a result of a unit increase in the export-base employment in the neighboring counties.

Guided by this model, the Location Quotient (LQ) method[6] was used to calculate these multipliers. For each industry in a county, the LQ indicates the following: if the industry employs more (less) than the average in the reference area, which is the United States, we denote it as an export (local) industry. The LQ was also used to apportion the employment dedicated to export activities in an industry.

LQ values were computed for each of 85 industries in each of the 410 Appalachian counties and the U.S. (as the reference region) for 1997 and 2002.

In the spatial version of the export-base model, two regions are involved: one explicitly (the county in question) and one implicitly (the county's spatial neighbor(s) which includes itself). Building on this, we compute the local and global exports using the following process:

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[6] The LQ was calculated as follows:

$$LQ = \left(\frac{E_{ij}}{E_{in}}\right) \Big/ \left(\frac{E_j}{E_n}\right) \qquad (12)$$

where, E_{ij} is employment of industry j in county i ; E_{in} is total employment in county i; E_j is employment of industry j in the whole United States; E_n is total employment in the whole United States. If employment data are unavailable, an analyst can use output, value added, or some other data that is available for each county.

First, we compute export-base employment of the county in question (county A) using the location-quotient method, and export-bases of all its individual neighboring counties. Summing these numbers, we obtain an estimate of neighborhood's aggregate exports, E_T. This value represents the sum of all local and global exports from the county and its spatial neighbor(s).

Second, we compute the export-base of an aggregated region, i.e., the region composed of the county and its spatial neighbor(s) including any contiguous non-Appalachian counties, denoting the result as E_G. This number represents the export-base of the aggregated region, or from the perspective of county A, total global exports.

Third, we compute the ratio $(1-\frac{E_G}{E_T})$, which represents the **Total Spatial Linkages (TSL)**. This ratio is always a positive number between zero and one. Its value depends on the industrial mix of the economy of county A and that of its spatial neighbor(s). A small value for the TSL ratio indicates that the economy of a county and its spatial neighbors have similar economic-bases (*competing* substitutes) and have limited interactions with each other. At the limit, if these economies have an identical industrial mix, the TSL ratio will be equal to zero. The value of the TSL ratio is higher when the economy of the spatial neighbor(s) complements that of county A. At the limit, when these economies are perfect complements and the industrial mix of the aggregated economy is identical to the reference area, the TSL ratio will be exactly one.

Using the TSL ratio $(1-\frac{E_G}{E_T})$, we compute E_g and E_s for county A:

$$E_s = (1-\frac{E_G}{E_T})E \qquad (13)$$

$$E_g = \frac{E_G}{E_T}E \qquad (14)$$

where E is the export-based employment and is equal to the sum of E_g and E_s.

Degree of Diversification in the Economy. S&S measured the degree of diversification (or concentration) of employment in a county by the percent of total employment accounted for by the top five industries[7]. For example, in Bibb County, Alabama, the top five industries listed in Exhibit 2-4 employ 55% of the total labor force, indicating a 55% degree of diversification. A large number indicates a high

[7] Other measures of industrial diversification may be used to give a different picture, for example, comparing the concentration by sector to the concentration in the region as a whole or to a larger reference region like the United States. This measure is often used in many 'diversity indices' used in the analysis of ethnic and racial diversity in urban areas. For the purpose of this paper, we followed the same diversification index used in the S&S (2000) paper to enable cross-comparison of the results.

concentration of a few industries in the county, and a low number indicates a more diversified economy.

Exhibit 2-4: Example of Degree of industry diversification

County FIPS, Name	Industry	Rank	Employment
01007 Bibb County, Alabama			
	92 Government & non NAICs	1	1,216
	230 Construction	2	621
	113 Forestry & Logging	3	324
	321 Wood Products	4	312
	814 Private households	5	307
	Industry Diversification (Percent of employment in top five industries):		55%

Source: MIT Multiregional Planning Research Group.

Classification of Counties by Growth Potential. S&S divided the counties into four groups based on the values of spatial regional employment multipliers (SREM) and local spatial linkages (LSL). In Exhibit 2-5, we define the criteria for the county typology, and in Exhibit 2-6, we illustrate this classification system. In the Appendix, we include the numerical thresholds used for the classification for 1997 and 2002 evaluation.

Exhibit 2-5: County Typologies

Type	Definition	Criteria
Type I	Counties with a strong economic-base, i.e., spatial regional employment multipliers (SREM) in top quartile, AND strong local spatial linkages (LSL).	SREM in top quartile **and** LSL in top half
Type II	Counties with strong local spatial linkages and a relatively strong economic-base relative to Appalachian counties, i.e., spatial regional employment multiplier in second quartile.	SREM in second quartile **and** LSL in top half
Type III	Counties with either a weak economic-base, i.e., spatial regional employment multipliers being less than the median, OR weak local spatial linkages	SREM in bottom half **or** LSL in bottom half (excluding Type IV)
Type IV	Counties with a weak economic-base, i.e., spatial regional employment multiplier in bottom quartile, AND weak local spatial linkages.	SREM in bottom quartile **and** LSL in bottom half

Source: Smirnov and Smirnova (2000).
SREM = Spatial Regional Employment Multipliers; LSL = Local Spatial Linkages

Exhibit 2-6: Calculations of County Typology

SREM LSL	Top quartile *75%*	Second quartile *median*	Third quartile *50%*	Bottom quartile *25%*
Top half *Median*	**Type I**	**Type II**	**Type III**	**Type III**
50% **Bottom half**	**Type III**	**Type III**	**Type III**	**Type IV**

Source: MIT Multiregional Planning Research Group; based on Smirnov and Smirnova (2000).
SREM = Spatial Regional Employment Multipliers; LSL = Local Spatial Linkages

Data Methodology. While there are several sources of public and private employment data for the county-level economies, this updated analysis relies upon a current IMPLAN data set provided specifically for this analysis through the ARC. The data set covers all the 410 Appalachian counties as well as 137 contiguous non-Appalachian countries for 1997 and 2002. It covers 85 industries in each county, using the three-digit North American Industrial Classification System (NAICS) classification[8].

There are substantial methodological differences in the nature of data sets used in this report and the 2000 S&S study, which relied upon *Clean* CBP & REIS data sets:

- The IMPLAN data set is based on industry-level data with an algorithm to estimate suppressed data points, while the CBP data is the aggregate of establishment-level data (with data suppression issues). The result is slightly different notion of an 'industry' in both data sets.
- Each data set uses a different level of industry aggregation.
- IMPLAN uses NAICS codes, while CBP data used for the initial study was in terms of SIC codes.

Additional data issues are presented after the current analysis' results are compared to the original findings by Smirnov.

[8] This data set does not include the inter-industry trade relationship or the county-to-county trade flows. These data would be useful in getting a deeper and more detailed understanding of the cross-county and inter-industry dynamics using techniques like input-output analysis. Some of these additional data sets may be available commercially, but were not available for this study.

2.3 Overview of the Results

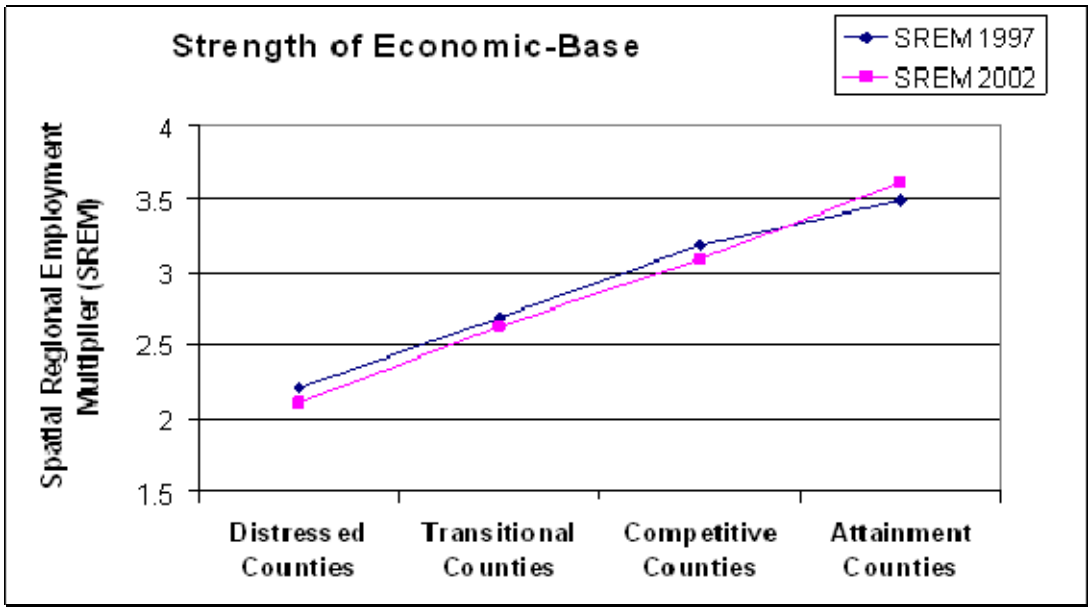
Using Structured Query Language (SQL), the following four indices from the Smirnov analysis were recomputed for each Appalachian county for 1997 -2002:

- Strength of economic-base using regional employment multipliers
- Strength of spatial linkages
- Degree of diversification in the economy
- Classification of counties by growth potential

Strength of the Economic-Base. The Spatial Regional Employment Multiplier (SREM) indicates the strength of the economic-base by measuring the number of new jobs generated in the county's economy as a result of an additional job in the export-base sector. To compare the SREM across the different types of economic-attainment counties, we calculate the average SREM for groups of counties based on their ARC designated economic status.

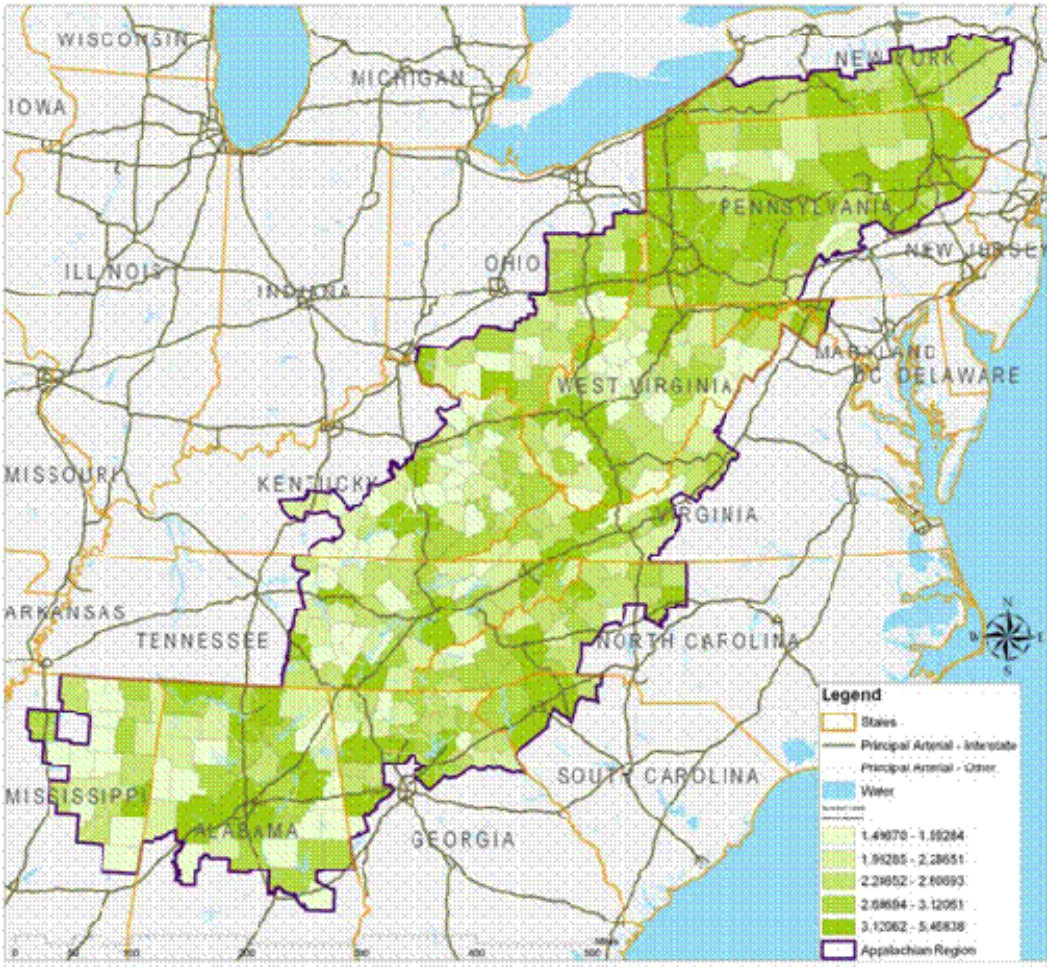
By examining these aggregate results for the Appalachian region (Exhibits 2-7 and 2-8), we identify two clear trends. First, there is a very limited (3%) difference between the SREM values across all counties between 1997 and 2002. Second, the SREM values increase linearly from the distressed counties to the attainment counties, indicating an increasing effect of the economic-base industries in the higher attainment counties. For example, in 2002, a new job in an export-based industry produced, on average, 2.1 jobs in a distressed county, compared to 3.6 jobs in an attainment county – a 58% difference.

Exhibit 2-7: Strength of economic-base* by ARC Economic Status Class



SREM = spatial regional employment multiplier; Source: MIT Multiregional Planning Research Group

Exhibit 2-8: **Mapped Distribution of the 2002 spatial regional employment multipliers (SREM)**



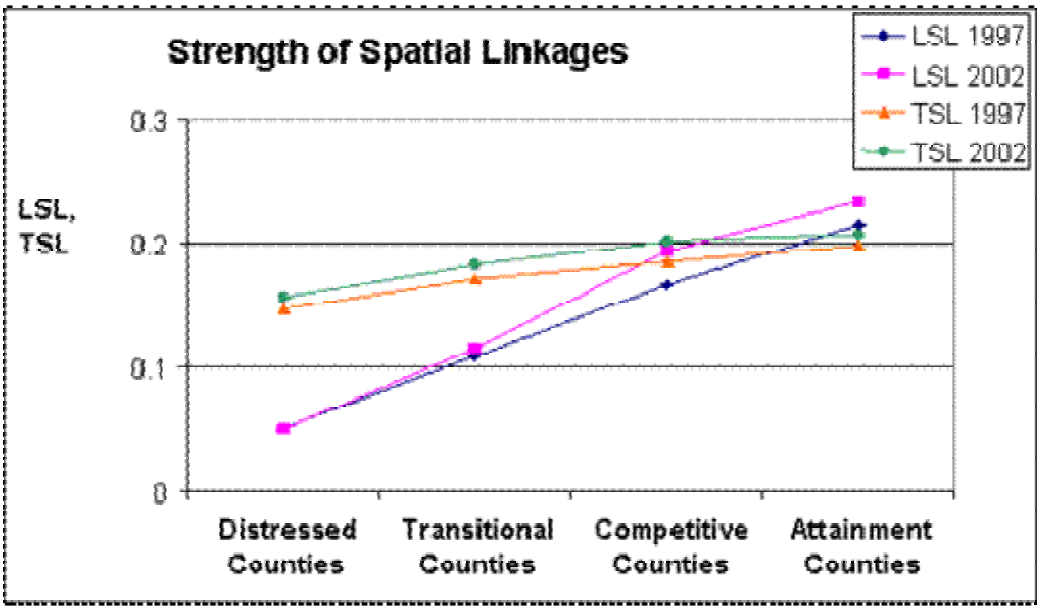
Source: MIT Multiregional Planning Research Group.

However, it is hard to specify the direction of the causality in this relationship. It could be that counties with industries that have higher SREM values have better opportunities for additional growth, as the export activity spurs forward and backward linkages. It could also be that counties that are economically developed have a more advanced and diversified economy such that the exporting firms can maximize local sourcing, rather than importing them from other counties. (The Appendix contains the complete SREM values for each of the 410 Appalachian counties for 1997 and 2002.)

Strength of Spatial Linkages. **"Local Spatial Linkage (LSL)"** is a measure of how much employment in a county will increase as a result of a unit increase in the export-base employment in the neighboring counties (Equation 11). LSL values (Exhibit 2-9 and 2-10) are significantly higher in competitive and attainment counties, compared to the distressed and transitional counties. This indicates that a county has higher

economic linkages with neighboring counties. For example, in 2002, LSL = 0.05 in distressed counties, compared to LSL = 0.23 in attainment counties. Higher LSL values suggest that neighboring economies are more integrated and, therefore, more responsive to economic policies. This may be a result of the local geography, where attainment counties may contain residential neighborhoods next to an industrial county, where the impact of jobs in the industrial county trickles down to the neighboring suburban residential county.

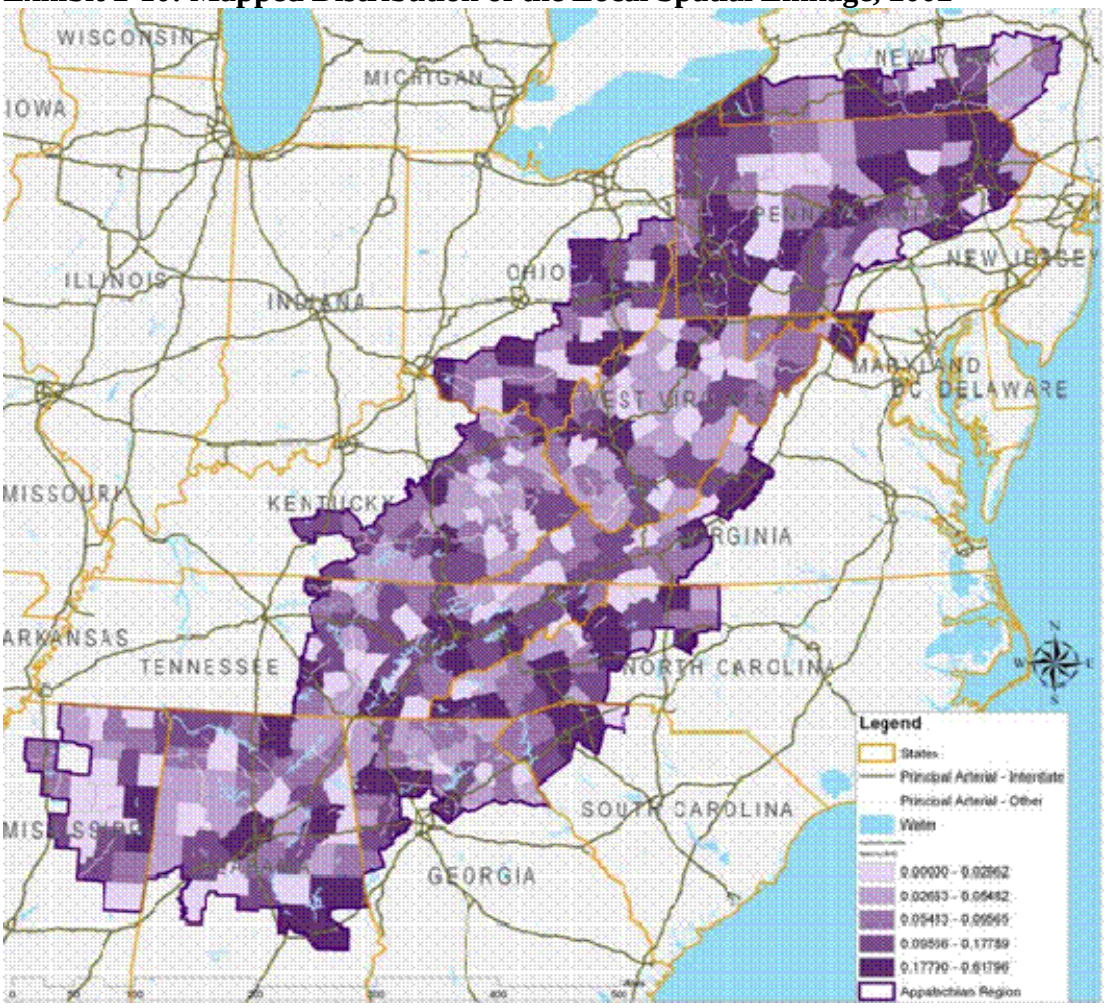
Exhibit 52-9: Strength of local spatial linkages (LSL) and total spatial linkages (TSL), 1997 and 2002



Source: MIT Multiregional Planning Research Group.

Total Spatial Linkage (TSL) is a measure of the similarities/differences in the industrial mix between a county and its spatial neighbor(s). TSL is a positive number between zero and one. A high TSL value indicates that the economy of the county is different and complements that of its spatial neighbor(s). A small value for TSL indicates similar economic-bases between the county and its spatial neighbors where they have limited interactions among each other (substitutes). TSL values (Figures 5.5) are higher for attainment counties indicating more complementarities with their spatial neighbors, compared to distressed counties that have more similarities with their spatial neighbors, indicating less potential for economic integration. For example, in 2002, TSL = 0.21 for attainment counties, compared to 0.16 for distressed counties.

Exhibit 2-10: Mapped Distribution of the Local Spatial Linkage, 2002



Source: MIT Multiregional Planning Research Group.

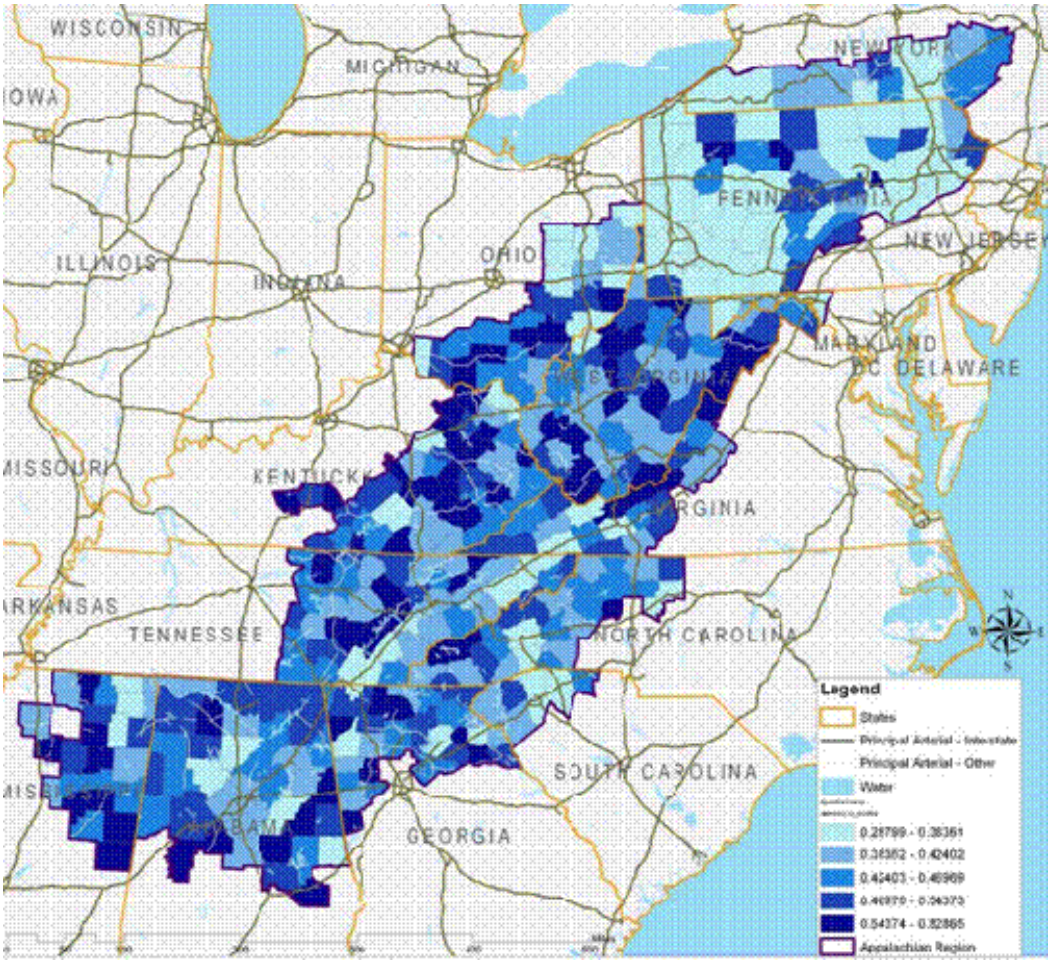
Degree of Diversification in the Economy. The degree of diversification or concentration of employment in a county is measured by the percent of total employment in the county tied to the top five industries. For 2002, 42% of the employment in the competitive and attainment counties was concentrated in the top five industries (Exhibits 2-11 and 2-12). However, the transitional and distressed counties had more concentration, with 45% and 53%, respectively. These values have changed little between 1997 and 2002, except for distressed counties, in which the concentration in the top five industries increased by 6.9% from 0.494 to 0.528. The industrial concentration in distressed and transitional counties indicates more vulnerability to cyclical recessions in these individual industries. Most of the distressed and transitional counties have small economies, where these top industries often represent a small number of establishments with large employment (Smirnov and Smirnova 2000), thus the impact of factory closures or relocation can significantly affect employment in the county economy.

Exhibit 2-11: Average values for Industry Diversification, by County economic-status

Economic-Status	1997	2002	Percentage Change (1997-2002)
Distressed	0.494	0.528	6.9%
Transitional	0.437	0.451	3.2%
Competitive	0.431	0.424	-1.5%
Attainment	0.422	0.425	0.6%

Source: MIT Multiregional Planning Research Group

Exhibit 2-12: Mapped Distribution of County-level Industry diversification in Appalachia, 2002



Source: MIT Multiregional Planning Research Group.

Classification of Counties by Growth Potential. Based on the results for 2002, the ARC county distribution among the S&S typology (Exhibit 2-13 and 2-14) is overall consistent with the economic development status of the counties, e.g., a large number of the distressed and transitional counties are classified as Type III and Type IV, while most of the competitive and attainment counties are classified as Type I and Type II. We can use this classification to help identify counties that could serve as "anchors" or "hubs" for a regional economic development strategy, e.g., Type I counties that are distressed (1) and transitional (81) have strong employment multipliers and local spatial linkages.

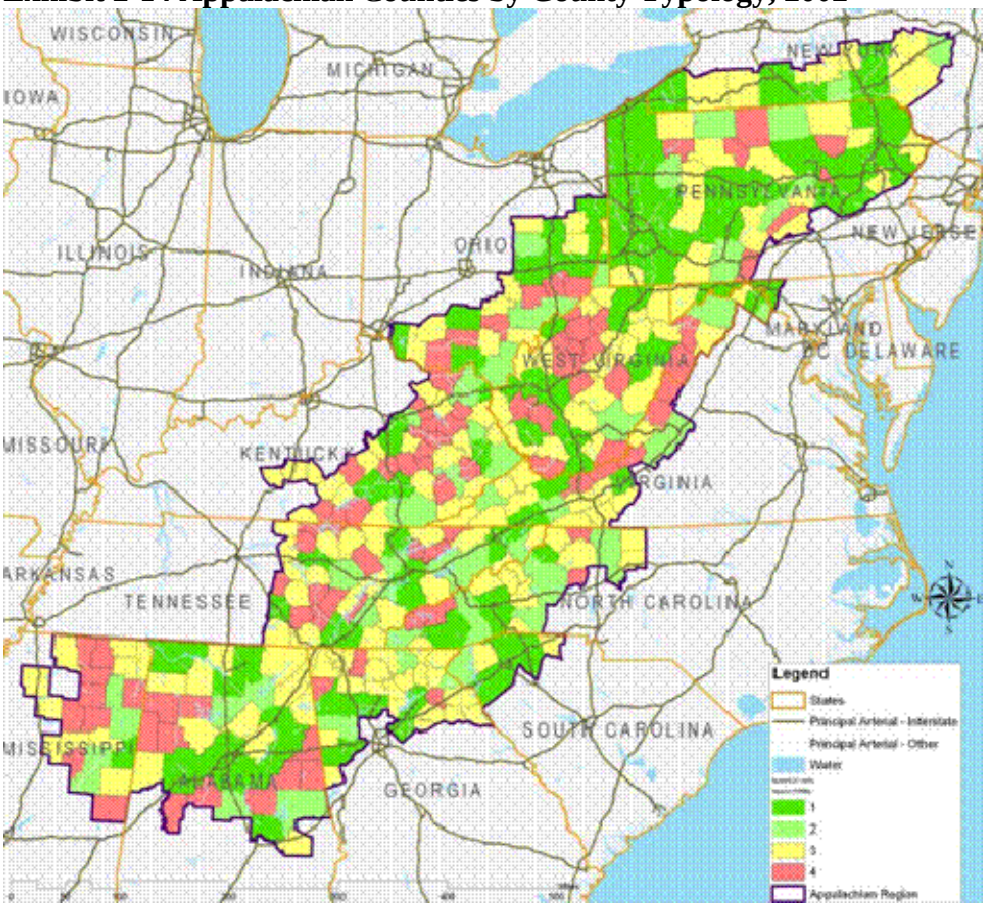
The transitional counties are more numerous than the set of distressed Appalachian counties and exhibit more heterogeneity (i.e., spread across the different types) in the composition of economic-base and therefore display a broader reaction to economic stimuli. Type I and II transitional economies are more likely to respond favorably to economic growth in the neighboring counties. In contrast, Type III and IV transitional and distressed counties will have less benefit. This suggests two policy implications. First, if officials target Type I and II counties for investments, they are likely to obtain a favorable growth response. Second, the overall effect in Appalachia of local initiatives will be higher for counties that are surrounded by Type I or II counties; and limited in the case of counties surrounded by Type III and IV counties, because all the linkages lead to outside-of-the-region interactions.

Exhibit 2-13: Appalachian Counties by S&S Typology and Economic Status

Economic Status	Type I	Type II	Type III	Type IV
Distressed	1	9	32	35
Transitional	81	52	118	52
Competitive	12	2	6	2
Attainment	5	1	2	0

Source: MIT Multiregional Planning Research Group.

Exhibit 2-14 Appalachian Counties by County Typology, 2002



Source: MIT Multiregional Planning Research Group.

2.4 Uses and Limitations of the Findings

This analysis provides some useful insights into the development potentials of the distressed and transitional counties based on their export-base. However these indices should not be used in a vacuum when making county-level policy decisions or investment allocations. This section points to some of the strengths and limitations of the methods and data under-pinning this analysis which can serve to both (a) assist users of this report in interpreting the spatial economic-base implications for their county(ies) of interest, and (b) guide future follow-up work that may utilize a similar methodology.[9]

Strengths of the Economic-Base Model. The computed indices may be useful at the aggregate level to provide a picture of the economic capabilities in the Appalachian

[9] This section benefited significantly from comments from Luc Anselin, Lisa Petraglia, Karen Polenske, Oleg Smirnov, and Glen Weisbrod.

region. By examining the results of this analysis in comparison with the results of the original S&S analysis, we can highlight three key points that illustrate the strength of this approach. First, the quantitative characteristics of the counties did not change significantly from 1997 to 2002. Second, when we do a back-of-the-envelope comparison of the county typology for some counties between the original S&S computations for 1996 and the 2002 computations done for the present study, we find limited change in how a county is rated Type I through IV. This is an indication of both the consistency of the methodology despite the change in data sources and aggregation, and it also shows that there was little change in the Appalachian counties during that period. However, we would need to conduct a systematic comparison between the results of the two analyses to confirm this point. Third, the current results when applying the S&S typology may explain some of the differences between attainment and distressed counties vis-à-vis their economic-bases and spatial linkages.

Limitations of this Analysis. The use of this analysis should be guided by the limitations of the theory, methodology, and data.

- **Economic-Base Model** - In general, the key limitation of the economic-base model is its sensitivity to definitional issues in the computation. Analysts using the economic-base model must make two theoretical assumptions: (1) the reference region is a closed-economy, i.e., all economic activities happen within the region, and there is no trade activity between the reference region and outside the region; (2) all counties throughout the region have identical productivity and consumption levels (Kim 1995).

  For the first assumption, we use the United States as our reference region, assuming that all U.S. export/import activities happen within the country, and no one county exchanges goods with areas outside of the United States. The United States was chosen as the reference area in this study in order to compare Appalachian counties with other U.S. counties in terms of their economic-base performance. However, this may have limitations in counties (Appalachian or not) that have significant exports to areas outside of the United States.

  For the second assumption, we assume that, throughout the United States, labor productivity as well as consumers' tastes and expenditure patterns, and households' income levels are identical. This assumption implies evenly distributed demand and supply of each product in proportion to the population within the reference area.

- **Location-Quotient (LQ) Method** - LQ is a useful technique to identify export-based industries in a region; however, its accuracy depends on many factors including the reference area and level of data aggregation.

  First, for the **reference area**: we performed the same analysis twice using *all of Appalachia* and then the United States as the reference areas, and noticed a significant difference in the LQ values. This difference would trickle down

through the computations, and would produce a different picture for the export-based industries. Although the results may remain similar across different time periods if the same computation method is used, analysts need to be careful in the interpretation of the results in either case.

Second, for the **level of data aggregation**: we use three-digit NAICS codes (85 industries) to calculate the LQs and identify export sectors. In theory, the results may vary depending on what data level of industrial classification an analyst uses to calculate the LQs. Using data at a more disaggregated level (larger number of industrial sectors), tends to produce more 'accurate' results.[10] For example, with an analysis at the three-digit NAICS code level, a researcher will not detect some detailed export-based industries due to aggregation bias; but, at a four-digit level of analysis, one or two sub-sectors may appear as export sectors. However, when we compare the county-level aggregate outcomes and the resulting county typology from the S&S paper with the current results, there are no significant *ordinal* changes in the relationships among the counties (the ranking and typology), yet *cardinal* differences do exist, i.e., differences in the values of the LQs and multipliers.

- **Spatial Linkages Concept.** Spatial linkages, as computed in this analysis, provides limited resolution as to the role of cross-sector linkages (input-output accounts would illuminate key inter-industry relationships capitalized upon in a county). Nor can one explicitly identify the role that a county's personal income (predominantly made up of wage earnings) plays in the strength of the spatial linkages when household fulfill their demands for goods and services. It is also important to keep in mind that the terms *multiplier* and *linkage* represent different concepts than those terms connote in traditional input-output analysis.

- **County Classification.** While the S&S county classification (Type I through IV) is a useful tool to avoid the variations in multiplier values due to the use of different data sets, two issues limit the usefulness of this classification. First, the two dimensions used in the county classification (SREM and LSL) are not orthogonal, i.e., they are correlated (SREM = (1/1-a) + LSL). The use of orthogonal dimensions is required for effective classification. Second, the classification does not take into account the standard error of the multiplier values. This would affect counties on the borderline between different types.

- **Data Issues and Comparability of Results.** Since the current analysis used a different source of data than the one used in the 2000 S&S report (IMPLAN vs. *Clean* CBP/REIS data), there are issues with the comparability of the results. These issues stem from the different levels of aggregation in the establishment/industry data sets. Specifically one is limited in making a direct comparison of individual values for multipliers for county-industry pairings. To reliably overcome this and be able to make comparisons of the results between the

[10] Consequently, using more aggregated data tends to produce higher values for the regional multipliers.

two analyses comparative ranking among the different counties/industries can be used. In doing so there is a strong correlation of the county classification results between the two reports, indicating a robustness of the results of the analysis at the aggregate level, despite the difference in the level of data aggregation, time period, industrial classification (SIC vs NAICs), and data source. This comparison also highlights the limited change in the (relative) economic structure in the Appalachian counties over the past decade.

Applying the Results of this Analysis. Given the strengths and limitations of this analysis, we describe different approaches to make use of this analysis in the field and the potential for future research studies that would build on this analysis.

First, using this analysis, we can create profiles for each county, highlighting the multipliers, the top industries, and the typology. However, the local county community cannot take solitary action based on these profiles since by definition they reflect the influences of neighboring counties. A second approach would be to use this analysis for a cross-county comparison to understand the relative characteristics of these counties. This may be useful to understand the relationships between economic attainment and the parameters computed in this analysis, e.g., the industry diversification or concentration, or the regional linkages. A third approach is to use the county typology to identify potential "growth hubs" at the regional level. This is similar to what S&S use in their paper (see Exhibit 5.1 above), where they identify counties with strong spatial linkages and economic-base as potential agents for triggering regional growth in their neighborhood. A fourth approach in using this analysis is to identify possible counties or groups of counties for future case studies to examine the spatial forces at work on each county in a neighborhood.

The most important point to emphasize in using such an analysis at the individual county level is that it is not unusual that the computed figures would vary from the reality in the individual counties. This is due to several factors in the data collection, measurement errors, aggregation effects, and assumptions embedded in the computation process. When using these results in individual counties, an analyst needs to do a "reality check" to ensure that the results are not anomalies. A reality check should turn up consistency with existing economic changes/transactions. This becomes crucial when communicating these results to local communities, or when using them for county-level decisions.

2.5 References

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