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# Fellows Address: Are Industry Clusters and Diversity Strange Bedfellows?

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# Fellows Address: Are Industry Clusters and Diversity Strange Bedfellows?

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**Abstract**

In this address, I review industry clustering and diversification strategies to compare and contrast their underlying foundations. The lack of consensus choice of one or the other for regional economic development strategies along with the recognition that in the dynamic process of development these two processes are related leads me to conclude that clusters and diversity need not be such strange bedfellows after all, and that a rational approach to economic development can leverage the strengths of each and offset weaknesses. I follow this discussion by introducing a cluster assessment diversification strategy (CADS) apparatus that can be used to measure existing cluster strength, to identify industrial strengths and deficit bottlenecks, and to explore the regional consequences of potential cluster diversification strategies.

Keywords: Industry clusters, Regional Industrial diversification, Input-output, Industry structure
JEL Classification: R30;C67;L16

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# 1 Introduction

The relationship between economic structure and economic performance has permeated regional science research from its very inception. From work developing Perroux's Growth Poles and economic spaces through Isardian industrial complexes and clusters to the views of Marshall and Jacobs on agglomeration concepts and economic diversity, the stage was set early for lively and continued debate over the nature of regional economic development, the dynamics of regional industrial structure, and regional growth and stability. For evidence of the unfaltering interest in this relationship, we need look no further than the three most recent SRSA conference programs in which, by my count, there were 11 papers with either industry clustering or diversification in their titles. In preparing for this address, I was able to identify fairly easily more than eighty similarly titled journal articles and a few dozen more related book chapters since 2000. The centrality of the topic to regional science is as clear as is the fact that an understanding of the relationships among economic structure and performance is elusive and incomplete.

For me these topics hold special interest because An Evaluation of Alternative Measures of Regional Industrial Diversity (Jackson, 1984) was my first regional science related publication, and many of my publications in the 30 years since those early days have explored different aspects of regional economic structure, structural change, and economic performance. My interests developed from a thorough grounding in industrial location theory, and an early realization that public sector regional economic development strategies were essentially the flip side of the coin from private sector application of location theory and location analysis.

Of course this realization also brings with it the question of whether any kind of development strategies focusing on specific industries is well advised, since private sector decisions are driven by location factors and also generally result in efficient allocations of factors of production. Mark Partridge, in his 2006 Presidential Address (Partridge, 2006), in Partridge and Olfert (2011) and again in his 2013 SRSA Fellows address (Partridge, 2013), cautioned strongly against picking winners as an approach to development. Likewise, Doug Woodward's 2013 Presidential Address also urged "caution regarding development incentives as a regional strategy ..." suggesting "that stronger agglomeration and cluster-based strategies are better suited to promote contemporary economic development," and the

literature is rife with other cautionary notes, including Neffke et al. (2011) whose empirical evidence suggests that "self-selection of industries into regions that host a substantial amount of related economic activities suggests there may be only limited justification for targeted industrial policy." (Neffke et al., 2011, p 261).

The general recognition of a need for caution, however, has not seemed to dampen enthusiasm for research probing the fundamental relationships that link regional economic structure and performance, relationships that lie at the heart of our understanding of regional economic systems and system dynamics.

Among the more striking developments of the last quarter century, of course, is the position of relative dominance to which industrial clustering approaches to regional development have risen. "Industry clusters have generated an extraordinary amount of interest in contemporary debates on regional economic development theory and praxis across a wide range of academic disciplines and policy circles" (Bekele and Jackson, 2006, p 2). Emphasizing clusters dominance over diversity, Desrochers and Sautet add that,

> "In the wake of the success of Michael Porter's cluster strategy and a long-held belief that the geographical specialization of economic activities is a desirable outcome of trade and the division of labor, regional development policy in the last two decades has heavily favored regional specialization at the expense of local economic diversity." (Desrochers and Sautet, 2008, p 826).

According to Stough, "The cluster concept is well known and often the basis for contemporary policy and practice in economic development" (Stough, 2015, p 223). Doug Woodward adds "... cluster initiatives form the basis for much of regional policy around the world" (Woodward, 2013, p 1). In his view, "the cluster approach is at the forefront of regional policy ... (and) ... has become an instrument included in state and local economic development toolboxes." (Woodward, 2013, p 18). Despite numerous critiques of various clustering constructs, (see e.g., Martin and Sunley (2003) or Yu and Jackson (2011)) "... the allure of cluster-based approaches to economic development policy remains strong." (Spencer et al., 2010, p 712).

Others have observed both the tensions that exist between clustering and diversity, and the relationships among them. Desrochers and Sautet (2008, p 814) for example, concluded "that the regional setting most conducive to entrepreneurial activity is probably a diversified city made up of many specialized clusters, which is what most thriving cities have historically spontaneously evolved into." (Desrochers and Sautet, 2008, p 814). Indeed, according to Malizia and Feser, contrary to the view that diversity is defined by the absence of specialization, " Economic diversity is the presence of multiple specializations" (Malizia and Feser, 1999, p 92).

My intent today is to provide a bit of historical perspective, discuss cluster approaches and diversification strategies and measurement, and consider whether the two apparently competing forces might find ways to peacefully co-exist. A comprehensive review would fill volumes and I will undoubtedly neglect many important contributions, but I believe my remarks will identify a representative cross-section of current thought.

In the final canto of this address, I will present a measurement tool that I believe can be used to identify the normative structure of a cluster, as a reference for measuring cluster strength, and as the foundation for assessing the implications of the additions of new specializations as regions grow and diversify.

## 2 Economic Structure

### 2.1 Notable Precursors

The Growth Pole/Growth Center literature that built upon Francois Perroux's (1950) seminal contributions was among the earliest theoretical frameworks addressing industrial structure, and helped usher in cluster development approaches. The two related, but less than identical constructs, laid the groundwork for substantial conceptual development over the first quarter century of regional science research (e.g. Hansen, 1967; Darwent, 1969; Lasuen, 1969; Campbell, 1972; Parr, 1973; Beyers, 1974; Thomas, 1975). It also fueled a parallel effort focusing on the identification of key sectors, those propulsive growth pole industries whose activities stimulate greater than average activity of among industries in an economic system (early examples include (early examples include Rasmussen, 1956; Hirschman,

1958; Manne, 1963; Hazari, 1970; Schaffer, 1973; Schultz, 1977; Hewings, 1974; Beyers, 1976).

A second and often under-valued contribution to more sophisticated structural economic analysis methods is economic base theory (see e.g. Blumenfeld, 1955; Mattila and Thompson, 1955; Leven, 1956; Tiebout, 1956; Ullman and Dacey, 1960; Lane, 1966; Hewings, 1969; Leigh, 1970). The lack of regard for economic base theory and analysis might be due to its simplicity and the rise in popularity of more sophisticated and more highly disaggregated models of regional systems, but vestiges of its emphasis on the distinction between basic industries satisfying exogenous demand and those industries that support them can be seen in nearly all modern economic systems models.

## 2.2 Clusters

During its early decades, Regional Science scholars also began developing theories and methods for identifying and analyzing industrial cluster and complex concepts explicitly (Isard and Vietorisz, 1955; Isard and Schooler, 1959; Streit, 1969; Ghosh and Chakravarti, 1970; Czamanski, 1971, 1973, 1977; Roepke et al., 1974; Czamanski and Czamanski, 1977; Czamanski and Ablas, 1979; Norcliffe and Kotseff, 1980; Loviscek, 1982; O'hUallachain, 1984). Most of these studies were input-output (IO) based, and firmly established interindustry linkages and input output frameworks as essential tools for studies of economic structure.[1]

Substantial numbers of earlier contributions notwithstanding, few would dispute that the cluster approach to development really hit its stride at the confluence of Porter's contributions (1990; 1996; 2000; 2003) and Krugman's (1991; 1998) papers on the agglomeration and the New Economic Geography. From the 1990s onward, clusters have carved out a clear position of prominence - if not pre-eminence - in the regional economic development domain. "While the cluster strategy has been criticized on several counts, ... , it has nonetheless successfully overturned the previously prevalent diversification objective of most local development officials and established regional specialization as the preferred goal (Rosenfeld, 2001)" (Desrochers

[1] Though not focused directly on clustering, work building on Chenery and Watanabe (1958) focused on IO based economic system structural comparisons.

and Sautet, 2008, p 813).

Although a consensus cluster definition has been somewhat elusive, there are commonalities across the cluster literature, and researchers seem to "know them when they see them." The following characteristics appear often:

- Sectoral specialization and comparative advantage,
- Interindustry interdependencies in buyer-supplier relationships,
- Co-location among related cluster industries leading to denser interindustry linkages and lower transaction costs
- Industry-specific knowledge spillovers from more intense interactions
- Productivity gains from specialization and labor market pooling

Despite a lack of clear consensus, Rocha concludes that "clusters have three necessary or defining dimensions: geographical proximity, an interfirm network, and an inter-organisational or institutional network" (Rocha, 2004).

## 2.3 Cluster measurement

We should acknowledge at the outset that cluster measurement based solely secondary data will almost surely fall short of identifying anything more than the potential for the kinds of dialogue and communications networking that Deller (2012) identifies as part of the definition of clusters. "A common weakness of most of the existing approaches is that they do not incorporate collaboration among cluster participants. (Reid et al., 2008, p 346). Rocha and Sternberg define agglomerations as "clusters without networks." (Rocha and Sternberg, 2005, p 268). The suggestion is that agglomerations are necessary but not sufficient conditions for clusters. In this sense, cluster measures based on secondary data alone might more appropriately be called agglomeration measures, but to maintain consistency with the literature, we will continue to use cluster measure in this exposition.[2]

[2] See Parr (2002) for a comprehensive review and clarification of agglomeration concepts.

Dozens of methods have been proposed for identifying clusters (Bekele, 2007). The industry complex and cluster literature listed earlier identifies a large number of mostly IO based candidate measures. Kelton et al. (2008) used a common approach to identifying NAICS clusters following the Feser and Bergman (2000) cluster stipulations that "for two industries, A and B, to be considered part of the same cluster, they must be linked in one of the following four ways:

- A buys directly or indirectly from B;
- A sells directly or indirectly to B;
- A and B have similar purchase patterns from other industries; or
- A and B have similar sales patterns to other industries (Kelton et al., 2008, p 307).

Both Kelton et al. (2008) and Feser and Bergman (2000) identify clusters using these dimensions by applying correlation analyses to national input-output data. More recent contributions to the cluster measurement literature are Titze et al. (2011) use of qualitative IO to identify clusters (MFA - minimal flow analysis) and Deller's 2012 approach to filling the industrial gaps in regional industrial structure using IO methods as a foundation.

Delgado et al. (2014) have recently published an NBER report that provides extensive detail on the Harvard cluster mapping program methodologies. According to their website, "Strong clusters are defined as those where the location quotient, i.e. the cluster's relative employment specialization, puts them into the leading 25% of regions across the U.S. in their respective cluster category."[3] The characteristics of the LQ are well known, of course, with LQ values exceeding 1.0 indicating that an industry's concentration in the study region is greater than its concentration in the reference region.[4]

There is an interesting parallel between the LQ and Balassa's Index of Revealed Comparative Advantage RCA (Balassa, 1965), which tends to be

[3] `http://www.clustermapping.us/content/cluster-mapping-methodology` accessed March 21, 2015.

[4] Rocha and Sternberg use firm concentrations instead of employment concentrations to avoid cases of strong influence of big firms in the agglomeration indicator. ((Rocha and Sternberg, 2005, p 279).

better known to the international trade community than to regional science. The RCA is based on export proportions rather than employment proportions, but like the RCA, LQs reveal concentration. Concentration might in turn reveal comparative advantage, or it might reveal how the geographic distribution of demand structures depends on the distribution of other industry sectors in and outside the region. High employment or production levels will not necessarily equate to comparative advantage, but they certainly do reveal concentration and viability of the industry in the analysis region, hence they are certainly candidates for inclusion in regional clusters. Indeed, industries with a region's highest LQ might well be the cluster anchors, those industries that form the central focus for industry clusters, often the industries that lend their names to the regional cluster (e.g., the steel cluster, the biomedical cluster, the chemical manufacturing cluster, etc.)

## 2.4 Diversity

The benefits of regional industrial diversity have long been advanced. According to Chinitz, "Large areas are more diversified than small areas. Diversified areas exhibit more stability in their growth because their fortunes are not tied to the fortunes of a few industries." (Chinitz, 1961, p 281). The first of these two assertions is consistent with the Ullman and Dacey's subsequent development of the Minimum Requirements (MR) approach to estimating a region's economic base. Among other things, and without tying economic base models directly to IO, the MR reflects the fact that as regions grow, whether centered on cluster anchors or not, the incomes of workers will result in higher levels of demand for service and support activities, resulting in greater diversity by definition.

Unlike the Marshallian externalities[5], both Chinitz (1961) and Jacobs (1969) considered a diversity of industries to be "a breeding ground for new ideas and innovations because diverse industry bases in the city stimulate inter-industry knowledge transfers." (Koo, 2007, p 997). Hence, both clustering and diversity can promote knowledge spillovers, they simply arise via different mechanisms. Derochers and Sautet reinforce the spillover benefits of diversity, "it is likely that a more diversified environment will increase the probability of combining existing skills and resources in different configurations by offering a greater number and variety of problems

[5] Sometimes these are referred to as MAR externalities for Marshall (1890), Arrow (1962) and Romer (1986).

to be solved, as well as a much wider pool of expert knowledge and other useful resources to develop new solutions." (Desrochers and Sautet, 2008, p 827).

Aside from the benefits of knowledge spillovers, of course, are the advantages that arise from avoiding situations in which a region's economy might be overspecialized in a single industry. Should an industry on which a large portion of a region's industry be dependent suddenly turn downward, the region's entire economy is at risk and might suffer substantially. The Cleveland and Pittsburgh steel economies are well known examples. This is the argument simplified as "not placing all of a region's employment eggs in a single industrial basket."

Other benefits to diversity can be more subtle. Chinitz (1961) identifies possible advantages of multiple small firms over large single-plant firms that might arise from areas like capital markets. Small local entrepreneurs might be more likely to invest surplus capital - e.g., start new businesses - locally than would the corporate owners of large plants. "Given an equivalent array of investment opportunities at home, the surplus capital of the multiplant industry is more likely to "leak" out to other areas." (Chinitz, 1961, p 286-7) . He adds that wage levels are often influenced by dominant industries to the disadvantage of other regional industry. These observations along with Renski's finding that "higher industrial diversity reduces the hazard rates of new firms in five of the eight study industries" (Renski, 2011, p 490) serve to suggest the broader array of motivations for regional diversification.

## 2.5 Diversity measurement

Diversity has been the primary focus of numerous studies, and has been used as one among sets of independent variables in more general studies, yet there have been only a small number of diversity measures. Several of the simpler measures have been used for comparison and largely as points of reference. These would include the ogive, where diversity corresponds to each of N industries having 1/N of the employment (or output, or income, depending on data availability), and the squared or absolute deviation from national average industrial shares. The rationale for the national average measures is that - at least in developed economies - national economies are themselves considered to be diverse. Other proxies include the industry

mix component of shift-share analysis, which also implicitly reflects the norm of the national industry distribution. Some studies have also used the percent of employment in durable goods manufacturing as a proxy for a region's reliance on export income, though the direct relationship to diversity is less clear here given that durable goods manufacturing in a region might itself be specialized or diversified.[6]

Among the more intriguing approaches to measuring diversity - and guiding diversification - is the Portfolio Variance (PV) measure adapted from the finance literature (Conroy, 1972, 1974, 1975; Barth et al., 1975; Jackson, 1984; Siegel et al., 1994; Sherwood-Call, 1990, *inter alios)*. With this measure, industrial concentrations of employment are seen as the regions portfolio of assets, and the PV measure "reflects the structural composition of region's economy in terms of intra-and intersectoral employment covariation. ... The measure represents a departure from normative measures by accounting for intraregional intersectoral employment relationships which may be related to factor endowments." (Jackson, 1984, p 105). In this way, it avoids the "mistake of pursuing a one-size-fits-all solution" against which Koo would later caution. (Koo, 2007, p 1008)

Two diversity measures that seem to have found widespread acceptance in the regional science and economics literature are based on entropy (e.g. Wasylenko and Erickson, 1978; Kort, 1981; Trendle, 2006; Bishop, 2008) and the Herfindahl-Hirschman Index (e.g. Diamond and Simon, 1990; Simon, 1988; Malizia and Ke, 1993; Izraeli and Murphy, 2003; Lall and Chakravorty, 2005; Mizuno et al., 2006; Chiang, 2009; Fu et al., 2010). To me this seems somewhat surprising, since both are essentially naïve measures of dispersion, and are divorces conceptually from any notions of regional comparative advantage, geographically variant demand, or interindustry linkages. The norm here is essentially that of the simpler and often-dismissed ogive measure.

It would be an understatement to suggest that no consensus has developed regarding the relationship among diversity and economic performance. Wagner and Deller (1998) suggest that the principal causes of the empirical inconsistency include the use of highly aggregated data sets, theoretically poor measures of diversity and overly simplistic statistical

[6] See e.g., Jackson (1984) for a more comprehensive discussion of these diversity measures, and of various issues that accompany choice of measure in application.

methods. They respond to this criticism by putting forward an IO based "density" measure as a step toward the incorporation of interindustry linkages in diversity studies.

## 2.6 Some Comments on Regional Dynamics

In his early contributions, Chinitz asks us to think about how changes in one industry might impact its region's suitability as a location for other industries. He falls just short of identifying an interesting paradox for those who tie structure to performance too strongly. Namely, should an anchor industry in a region suffer a sharp decline, the region by most measures would as a direct consequence become more diversified, though certainly not better off. He goes on to note that "The region will then become more diversified in its old age, so to speak. What then? Do we correct for the increased diversification? Does it open up new opportunities to the region?" (Chinitz, 1961, p 282)

Studies of regional industrial structure focusing on the dynamics of regional systems are increasing in number, many of which are in the context of clusters. For example, Stough (2015) has begun to focus on cluster life cycles in the context of entrepreneurship and regional economic development. Trippl and Todtling (2010) suggest that because of the life cycles of industries and regions, "old industrial regions can, in fact, be regarded as a prime example of the negative side of clustering."[7] They identify three types of cluster renewal strategies, including "diversification into established industries that are new for the region", (p. 209) suggesting that this path "opens up new directions of development, broadening the economic base of the regional economy." They go on to discuss both "the emergence of clusters in established industries, that are new for the region" (p 209) and cluster-based renewal based upon sectoral diversification activities of home grown firms moving into new sectors. (Trippl and Todtling, 2010, p 209-210).

Consistent with evolutionary reasoning, Neffke et al. (2011) has observed that regional diversification emerges "as a strongly path-dependent process. Regions diversify by branching into industries that are related to their current industries." (p. 261). He adds that new growth paths in regions do not start from scratch but are strongly rooted in the historical

[7] Martin and Sunley (2003) provide a thorough critique of industry clusters along these and other lines.

economic structure of a region. He also points to the loss of the entire textile and wood industry clusters in the Linköping region as an example of a situation in which "the exit of one industry can set a cascading sequence of exits into motion, leading to the departure of complete technological clusters" (Neffke et al., 2011, p 261).

In terms of dynamics, Malizia and Feser's observations are particularly astute, "The economic diversity of a city can be defined in reference to its specializations. As additional relatively independent specializations colocate, the area becomes more diverse. Economic diversity is the presence of multiple specializations." (Malizia and Feser, 1999, p 92).

## 3 Analytics

With the exception of the national average measure, which implicitly assumes that all regions' industrial structures should replicate the national distribution of industry activity, and the portfolio variance diversity measure, virtually all measures of industrial diversity are standard measures of dispersion. This is true of entropy-based measures, ogive measures, and the well-known Herfindahl-Hirschman index. Although there are some theoretical justifications for the notion of diversity for diversity's sake, everything we know about location theory, historical inertia, infrastructure, localization economies, and more would suggest the ideal distribution of activity would vary by region, reflecting regional comparative advantages, historical cluster development, local comparative advantages, etc.

Indeed, and in agreement with Koo's (2007) assertion that "the kind of industry mix a regional economy has should be a starting point for any policy discussion on regional economic development" (Koo, 2007, p 1008), it would be logical to look closely at a region's existing industrial structure to identify revealed comparative advantages in order to assess potentials for development. Theoretical arguments in favor of developing industry clusters are persuasive, but so too are arguments in favor of diversifying to hedge against downturns in industries of regional over-reliance. A small region might be able to support only a single industry cluster, or perhaps no cluster at all. But as regions grow, they may be able to support not only one, but multiple clusters. A compromise solution, then, might be to follow a cluster strategy by first identifying and developing an anchor industry with revealed regional comparative advantage, then moving next

to identify a second industry with regional comparative advantage in a counter-cyclical industry to serve as anchor for a second cluster. If the region is large enough, or as it continues to grow, additional clusters could be added in similar fashion. With the right tools, clustering and diversity can be reassessed periodically.

An orthogonal strategy would be to identify a set of diverse regional industries with revealed comparative advantage and use those industries to identify industries whose development would best support the input requirements of the clusters they anchor.

### 3.1 A Proposed Method

What would be the characteristics of an analytical tool that would support the analysis of existing industry structure and that could support the development of strategies for selecting new specializations into which to diversify? Such a tool would

1. Identify distributions of industries needed to support regional structures with one or more clusters,
2. Incorporate interindustry linkages,
3. Be adaptable to specific regional industry structures,
4. Distinguish between endogenous and exogenous demand,
5. Facilitate a comparison between existing regional structures and normative structures, and
6. Support simulations based on hypothetical industry specific expansion of the regional economy.

Where should we look for such a tool?

> The natural inclination of a scientist when confronted with a new problem is to try to solve it with old tools. When he is finally convinced that the old tools will not do the job, he retreats to his shop to fashion some new tools. (Chinitz, 1961, p 279)

Checking our old tools, then, a reasonable foundation would seem to be the IO framework. The need to distinguish between endogenous and exogenous demand in an input-output system evokes the net multiplier approach of Oosterhaven and Stelder (2002). The computation of net multipliers rests on an equation system wherein RHS final demands by industry are adjusted using the relationships among endogenous and exogenous demands to reflect only the exogenous portion of final demand. Net multipliers have been proposed for use in identifying the relative importance of different regional industries and are argued to be free of the double counting issues that accompany gross multipliers. However, the values of net multipliers in potential anchor sectors depend upon an already fixed economic structure. The ratios of endogenous to exogenous demand for each industry are a function of the specific regional mix of industries, irrespective of any normative structures.

A related thread of IO research that adds extraction methods for identifying key sectors and the importance of an industry or industries to a regional economy Dietzenbacher and Lahr (2013); Temurshoev and Oosterhaven (2014), including Temurshoev's (2010) extensions to the identification of optimal sector groupings. The identification of key sectors or critical groupings might be useful starting points, but these and related methods produce results that depend on specific current regional industrial structures and therefore relate to current realities rather than potential structures.

What we need is a cluster assessment and diversification strategy (CADS) apparatus that we can use to

(a) Select an industry or set of industries from a study region to be the anchors of one or more clusters,

(b) Specify activity levels for these anchors,

(c) Determine the necessary industrial distribution of supporting industries to fully support these anchors at these production levels,

(d) Assess the sufficiency of the anchor industry or industries for supporting the selected clusters, and

(e) Evaluate the implications of diversifying into new specializations.

Objective (a) selecting an anchor or anchors, can be achieved by any number of methods. Identifying the best approach will be left to future research. For current purposes, we will simply adopt the location quotient approach, appealing to its relationship to Balassa's Index of revealed comparative advantage. Likewise, for identifying a supporting industrial structure, the current activity level(s) in terms of employment and output will serve to establish a comprehensive distribution of supporting industries.

To identify the input requirements for supporting our anchors, we can partition the IO accounting framework according to anchor and non-anchor industries.[8] Mathematically, let

$$\begin{bmatrix} q_r \\ \hline q_s \end{bmatrix} = \left[\begin{array}{c|c} A_{rr} & A_{rs} \\ \hline A_{sr} & A_{ss} \end{array}\right] \begin{bmatrix} q_r \\ \hline q_s \end{bmatrix} + \begin{bmatrix} f_r \\ \hline f_s \end{bmatrix} \tag{1}$$

be a partitioned system where $q$ is an appropriately dimensioned outputs vector where $r \geq 1$ is the number of anchor industries and $s$ is the number of support industries. The values in $q_r$ are set to the observed anchor industry output values (demand for which is revealed). $A$ is a partitioned, household endogenous matrix of direct technical coefficients, and $f$ is a partitioned vector of exogenous final demands. Households are endogenous to provide for a comprehensive assessment of support industries in the spirit of economic base theory.[9] The solutions for supporting sector output $q_s$ and constrained sector final demand are:

$$q_s = (I - A_{ss})^{-1}(A_{sr}q_r + f_s) \tag{2}$$

Equation (2) includes the $f_s$ term for the sake of completeness, but since our solution is in search of a normative distribution where exogenous demand for non-cluster anchor sectors is zero by definition, the second RHS term reduces to $A_{sr}q_r$. Because equation (2) uses technical and not regional trade coefficients, the requirements from supporting sectors are technical requirements, independent of regional structure. They represent the direct and indirect supporting sector output required to support anchor industry production.

[8] Davis and Salkin (1984) developed a parallel version of this framework to estimate the economic impacts of industry-specific supply constraints.

[9] A Type I model could be used, although the interpretation would now exclude the induced income production requirements.

Note the solution in equation (2) depends on the number and production levels of all anchor industries, which will be identified by the analyst based on conditions in the region and the quantitative identification of comparative advantages. Larger regions would be expected to be able to support more and more diverse clusters, and indeed, would already have diversified into them (Malizia and Feser, 1999).

Having identified supporting sector output levels, the exogenous demand for anchor industries' output can be determined by the relationship in equation (3), the remainder of anchor output is required to satisfy endogenous demand of other anchors and support industries. Any negative values of $f_r$ would indicate that the targeted level of anchor industry output is insufficient in terms of fully satisfying system requirements.

$$f_r = (I - A_{rr})q_r - A_{rs}q_s \tag{3}$$

Each industrial distribution derived from this approach provides a normative reference against which a region's actual industrial structure can be compared, satisfying methodological objectives (c) and (d). Overages reflect industries that are able to satisfy additional endogenous or exogenous demand, and deficits might form the basis for exploring import substitution possibilities subject to other location theoretic concerns. Note that industries that are ill-suited to the study region for location theoretic or other reasons can be included in the anchor industry partition, with values corresponding to region-specific supply constraints.

Objective (e), evaluating the implications of diversifying into new specializations, can be reached by treating the formulation as the basis for evaluating alternative scenarios. Future research will identify optimal approaches to identifying the number and types of diverse specializations for regions of given size, complexity, centrality, etc. Other research will relate measures based on this method to regional economic growth, stability, and development. I hope the this paper has lain a foundation for the development of what will be a wide range of future research that can support a more comprehensive understanding of the relationship between economic structure and economic performance.

# 4 Conclusion

In this address, I have identified a number of key dimensions of industry clusters and industrial diversification that suggest strongly that these two need not be strange bedfellows, but instead might well be very supportive partners. I developed a tool and a CADS procedure that can be used first to identify a normative distribution of industries, then to assess a region's industrial structure relative to that norm. The implications for the region of diversifying into new clusters also can be anticipated using the proposed tool.

Note that the proposed method is designed to inform the planning and development process, not to strictly prescribe. The CADS apparatus need not be used in the context of a planned economy to be of value. Its application can identify existing strengths and gaps or bottlenecks in the regional economy - in terms of supply deficits; it can be used as a standard against which the existing distribution of industrial activity can be measured; and it can be used to identify the distributional implications of diversifying into new industry clusters, all of which will can lead to more rational economic development decisions.

Chinitz (1961) wrapped up his essay in this way:

> I said we need new tools in regional analysis. I am prepared to modify that statement in favor of this one. We need to make better use of some old tools which we have not yet applied very extensively to regional analysis.(Chinitz, 1961, p 289)

My final message in this address is to note that in this modern era of electronic search and ease of access to the literature, it is rare that entirely new conceptual tools are developed. While it might be tempting for today's scholars to privilege recent contributions under the assumption that surely the more recent literature is state of the art, there is an abundant body of knowledge that with more or less extension and adaptation can be put to very profitable use, but all too often earlier contributions to today's solutions are overlooked. With due attention to earlier contributions, those golden nuggets can be mined, refined and prove even more valuable today than when they were first discovered.

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