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INDIANA BUSINESS REVIEW

Measuring the Economic Performance of Regions:

Creative Destruction and Economic Dynamism

Schumpeter's Gale is another term for Joseph Schumpeter's theory of creative destruction. The Great Recession sparked many to describe what was happening (the financial bust and bursting of the housing bubble) as "creative destruction" and that out of the economic chaos would come greater innovation spurred by entrepreneurs.

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From the Editor

Innovation and work are complementary themes in our summer issue. This isn't surprising, since both were authored by Tim Slaper, once an economist on the Joint Economic Committee for Congress and now happily for Indiana, economist and director of research for the IBRC in the Kelley School of Business. Tim tackles labor force churn and how it can be measured so that regions can hone in on their strengths and weaknesses.

An important complement to regional innovation is human capital (aka people with skills, training and education). Human capital can be measured by the types of occupations held, but the standardized and coded set of more than 1,000 occupation job titles doesn't really cut it when a region needs to identify significant skills surpluses or gaps in relation to a region's ability to innovate or desires to attract innovative industries or entrepreneurs. A new clustering of occupations has resulted in 34 clusters that allow a view of regional (or statewide) human capital and allows for easy translation to industry needs.

Measuring the Economic Performance of Regions: Creative Destruction and Economic Dynamism

Timothy F. Slaper, Ph.D.: Director of Economic Analysis, Indiana Business Research Center, Kelley School of Business, Indiana University

What drives the economic performance of a region or state, and how do we measure it? This article is first in a series that will explore how well Indiana's economic performance compares to other states in the union and what forces may account for that performance.

Concern over global competitiveness, industrial restructuring and slowing productivity growth has led to great interest in how these factors interrelate. Some researchers have emphasized technological and knowledge requirements that have changed, or even destroyed, the economic viability of a region's industries, firms and jobs. But then again, these changes also present the opportunity to create new industries, firms and jobs. This process, this "creative destruction," a term and concept introduced by the economist Joseph Schumpeter early last century, is the hallmark of a thriving and dynamic economy. The premise is that the incessant turbulence of an economy in motion can explain patterns of economic growth and change. As new products, process and production technologies, and organizational forms emerge and new markets are created, underlying dynamics disturb the previous steady state and stimulate the emergence of new, more competitive conditions.

The appeal of labor churn was highlighted in a recent *InContext* article.[1] A major takeaway from the article is that labor churn is an indicator that members of the workforce are bettering their employment situation. That is, workers move to more desirable and higher wage jobs. In the same way, churn, whether measured by new businesses being established or by existing businesses expanding their workforce, provides an indicator that the region is undergoing positive economic change.

For this reason, labor churn is an important indicator in the annual "State of the New Economy" report.[2] The Global Innovation Index also includes a measure for new business density.[3] The Bureau of Labor Statistics is also in the game with its "Entrepreneurship and the U.S. Economy" analysis that uses data tracking establishment births.[4]

Business dynamics in the form of entry and exit is the mechanism by which outdated ideas and industry practices are replaced by new and potentially revolutionary ones. This dynamic is at the heart of competition creating new industries, invigorating old ones and relegating inefficient practices to the pages of history. As such, exit and entry drive the growth and prosperity of individual firms, as well as the economy at large, and is a central focus of research in both economics and management. In particular, an expanding body of research focuses on the geographic dimension of entry and exit, the effect on the formation and growth of firms, and the associated implications for local and national economies.

Localized employment churn registered as job creation and destruction dynamics can account for variations in regional productivity, job creation and changes in the standard of living. Research suggests that employment turnover and replacement dynamics have a large and significantly positive effect on regional productivity growth independent of a variety of industrial restructuring processes that may occur at the same time.

Employment churn effects do not always exert a uniform influence on regional productivity performances, however. As the industrial belt turned to rust throughout the 1980s until the mid-1990s, job creation and destruction dynamics often canceled each other out as regions underwent industrial restructuring. Since the mid-1990s, however, the positive effects on regional productivity growth have been strong.

This article provides an investigation motivated by micro-level research on

"Localized employment churn registered as job creation and destruction dynamics can account for variations in regional productivity, job creation and changes in the standard of living."

firm-level entry and exit, expansion and contraction. As older, inefficient and marginally productive capital is destroyed, new, efficient and productive capital is created. This implies that productivity variability is likely linked closely to job reallocation, as workers matched with unproductive capital lose their jobs and new, more productive, couplings of labor and capital are made.

Churn can also signal entrepreneurial activity. The greater portion of establishments that are births, or the significance of employment gains due to new business formation, points to people taking risks to start businesses. It also measures, to a large degree, the adaptability of a region in responding to economic stress. Workers may lose their jobs due to competitive pressure from the next state or overseas. A flexible, resilient workforce would "adapt" rather than "die." The region would set forth to seize new business opportunities rather than hoping that an outside force—for example, an inbound relocating company—will provide their next paycheck.

A comparison of cross-sectional employment at two points in time enables the calculation of net employment growth: How many more or fewer jobs exist at the latter time period compared to the earlier time period? Thinking about how this net employment growth occurred, some establishments have expanded, some have contracted, and some establishments have either entered or exited the establishment landscape.

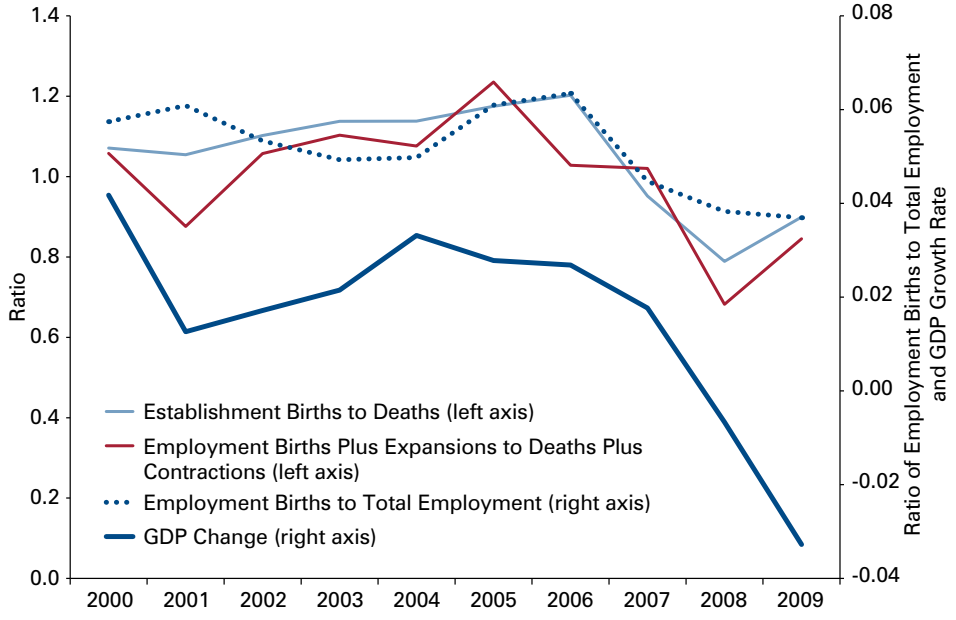
Net employment growth is the number of jobs created by expanding and opening establishments minus the number of jobs destroyed by contracting and closing establishments. The jobs created by expanding and opening establishments are referred to as job creation, and the jobs destroyed by contracting and closing establishments are referred to as job destruction. It should come as no surprise that net employment growth is the difference between employment gains that are associated with establishment births plus expansions and employment losses that are associated with establishment deaths and contractions.

Several measures for churn have been proposed, each with some theoretical rationale. For example, focusing on establishments, if one is to hold to the "creative destruction" view of economic dynamism, then one might propose a measure that adds establishment births to deaths (as a negative) and divides by the total number of all establishments. Or, if one wants to include all types of dynamic establishments that persist but are growing (creative) or shrinking (destruction), then one might add births, deaths, expansions and contractions together and divide by the total number of establishments. Arguably, if one were more interested in entrepreneurship, it is only establishment births as a proportion of all establishments that matter.

There are churn measures that focus on employment, not establishment, counts. One researcher summed both the absolute value of job creation and destruction together.[5] One could add the positive job gains from births and expansions and divide by the job losses due to deaths and contractions to derive a churn ratio. Then again, if one argues that it is the number of newly employed as a result of new business formation rather than the number of new businesses formed—as in the number of establishment births—then it is the employment gains associated with births that warrant one's attention.

The source of the churn statistics used in this analysis is the Business Dynamics Statistics data set from the U.S. Census Bureau.[6] The data are available at a two-digit industry detail and at the county level. More current churn statistics are available from the Bureau of Labor Statistics, but these data are only available at the state level and would not allow one to assess the churn dynamics of Indiana counties.[7] While researchers

FIGURE 1: Three Measures of Churn and GDP Growth for the United States, 2000 to 2009



Source: U.S. Census Bureau (establishments and employment) and Moody's (GDP chained 2005 dollars)

are always keen to get more detailed and granular data, the two-digit industry breakdown does allow one to note the structural differences across states and how different industries perform relative to one another.

This analysis was not intended to be exhaustive, so the three churn formulations that showed the greatest correlation with both economic growth—i.e., change in gross domestic product (GDP) in chained 2005 dollars—and employment growth were used to measure a state's economic dynamism. (It should come as no surprise that state GDP growth and state employment growth from 2000 to 2009 were strongly correlated: 0.82.)

Two of the three measures were employment churn:

1. Jobs gained from births and expansions divided by jobs lost from deaths and contractions (BX2DC)
2. Jobs gained from births divided by total employment (B2T)

The other measure was establishment-based:

3. Establishment births divided by establishment deaths (EB2D)

Figure 1 shows how U.S. GDP growth and churn metrics generally moved in the same direction from 2000 to 2009. While it may be too soon to tell from this Census data set (at the time of this writing the Census had not updated the data with more recent years), a similar data set compiled by the Bureau of Labor Statistics shows that the number of jobs created by births has been declining since the turn of the century.

Figure 2 shows that Indiana's B2T measure—the entrepreneurship measure—is below the national average. Florida and Texas outshine the national average considerably. The other states were selected to provide some geographic diversity. If the Great Lakes states were plotted, they would have followed the same pattern as Indiana—falling below the national average.

To place the raw churn statistics in context and to ease comparison across states and industries, the churn metrics were converted into what may be called a "churn quotient" or CQ. In other types of regional analysis, the quotient concept is used to measure the concentration of something relative to the national average, for example, the concentration of employment in certain occupations.

In this case, the CQ measures the relative strength of the churn dynamic (of one of the three metrics) compared to the national average for that measure. A CQ greater than 1 shows a churn dynamic greater than the national average, while a CQ less than 1 shows less churn than the national average.

In terms of industry performance, manufacturing had EB2D values of less than 1 (even during the higher economic growth period of 2003-2007), showing that there were more establishment deaths than births over the period. Manufacturing's CQ is less than 1 as well, highlighting that churn in manufacturing is less than the average for other industries.

It is also interesting to note how some industries respond to economic cycles. In 2000, the ratio of construction births to deaths was about one. This value shot up to 1.3 in 2005 during the housing boom and plummeted to 0.5 in 2008 as the housing market imploded. Compared to other industries, the condition of the construction industry was truly dire during the Great Recession. In 2009, the construction CQ was 0.73. Only the manufacturing CQ was worse in that year.

The Great Recession was not as harsh for the education and health care/social assistance industries, at least based on the EB2D metric. The EB2D ratio for these never fell below 1.06, even in the teeth of the recession, and their CQs both averaged 1.21 from 2000 to 2009.

FIGURE 2: Births to Total Employment for the U.S., Indiana and Selected States, 2000 to 2009

Source: U.S. Census Bureau

There is an important caveat for these two industries, however, and an important point to be made about the need to use several metrics before one reaches any conclusions. Another churn measure, B2T (jobs from births to total employment), shows these two industries rival only manufacturing in terms of low CQs. The B2T, or proportion of jobs associated with establishment births compared to total employment, hovers, on average for all industries, around 0.055. Put another way, about 5.5 percent of jobs are attributed to establishment births in any given year. The construction and education services industries are less than half that (CQ = 0.45). Health care is about 70 percent of the national average B2T (CQ = 0.69). This makes sense. Health care and education employment growth is going to be a function of population growth. As it happens, fast-growing states like Florida and Texas exhibit CQs in the education and health care industries well above 1.0 for the B2T metric.

For the country as a whole, services are more entrepreneurial in terms of young firms generating new jobs. In terms of the B2T, six industries had a much greater new job dynamic than average:

1. Information
2. Finance and Insurance
3. Real Estate and Rental and Leasing
4. Professional, Scientific and Technical Services
5. Administrative, Support, and Waste Management and Remediation Services
6. Accomodation and Food Services

Table 1: Top 10 States and Indiana: GDP Growth and Industry Churn Quotients (Establishment Births to Establishment Deaths) for Select Industries, 2000 to 2009

State	GDP Growth Rank, 2000-2009	Employment Growth Rank, 2000-2009	Manufacturing Average CQ	Information Average CQ	Professional, Scientific and Technical Services Average CQ
North Dakota	1	6	1.29	0.86	1.13
Oregon	2	22	1.14	1.04	1.04
Wyoming	3	1	1.26	0.94	1.19
Utah	4	4	1.36	1.11	1.19
Idaho	5	10	1.27	1.10	1.21
South Dakota	6	15	1.39	0.99	1.04
Alaska	7	3	1.30	1.19	1.06
Texas	8	12	1.12	0.99	1.02
Nevada	9	2	1.26	1.13	1.13
District of Columbia	10	13	0.77	0.95	1.03
Indiana	45	49	1.02	0.98	0.99

Source: U.S. Census Bureau (establishments and employment) and Moody's (GDP chained 2005 dollars)

State Comparison

The last 15 years or so could not be considered the salad days for the Hoosier state. Even during the last period of national economic growth

Table 2: Top 10 GDP Growth States and Indiana: Industry Churn Quotients (Employment Associated with Births to Total Employment) for Select Industries, 2000 to 2009

State	GDP Growth Rank, 2000-2009	Employment Growth Rank, 2000-2009	Manufacturing Average CQ	Information Average CQ	Professional, Scientific and Technical Services Average CQ	Administrative, Support and Waste Management Services Average CQ
North Dakota	1	6	0.74	0.59	0.46	0.89
Oregon	2	22	1.05	0.94	0.86	0.85
Wyoming	3	1	1.14	0.43	1.03	0.90
Utah	4	4	0.89	1.26	1.35	0.96
Idaho	5	10	0.86	0.68	1.06	1.51
South Dakota	6	15	1.12	0.61	0.82	1.22
Alaska	7	3	0.29	0.29	0.57	0.85
Texas	8	12	1.26	1.21	1.20	1.15
Nevada	9	2	1.78	1.28	1.64	1.33
District of Columbia	10	13	0.18	0.41	0.77	0.88
Indiana	45	49	0.80	0.60	0.99	0.98

Source: U.S. Census Bureau (establishments and employment) and Moody's (GDP chained 2005 dollars)

TABLE 3: Top 10 GDP Growth States and Indiana: Industry Churn Quotients (Employment Associated with Births and Expansions to Deaths and Contractions) for Select Industries, 2000 to 2009

State	GDP Growth Rank, 2000-2009	Employment Growth Rank, 2000-2009	Manufacturing Average CQ	Information Average CQ	Professional, Scientific and Technical Services Average CQ	Administrative, Support and Waste Management Services Average CQ
North Dakota	1	6	1.52	1.42	1.11	1.08
Oregon	2	22	1.13	1.16	1.12	1.01
Wyoming	3	1	1.71	1.10	1.13	1.13
Utah	4	4	1.33	1.52	1.21	1.09
Idaho	5	10	1.19	1.21	1.25	1.13
South Dakota	6	15	1.72	1.67	0.99	1.12
Alaska	7	3	1.22	1.46	1.38	1.43
Texas	8	12	1.16	1.05	1.06	1.03
Nevada	9	2	1.46	1.14	1.09	1.19
District of Columbia	10	13	0.74	0.93	1.06	1.11
Indiana	45	49	1.02	1.01	1.01	1.05

Source: U.S. Census Bureau (establishments and employment) and Moody's (GDP chained 2005 dollars)

(from 2003 to 2008), the state only gained 80,000 jobs. On a relative GDP growth basis from 2000 to 2009, Indiana placed 45th; on a job growth basis, Indiana placed 49th. Manufacturing employment declined.

The churn statistics tell a similar story. **Table 1** presents the top 10 states in terms of GDP growth, along with Indiana. For the selected industries, Indiana was about average in terms of establishment birth to death rates. Had Indiana a large natural resource base (i.e., oil and gas), the outcomes would have been different. Several of the top 10 GDP growth states are in the Plains or West and have a recently booming natural resource sector.

But **Table 1** also shows that these states are not only strong in natural resources, but also saw above-average establishment formation in manufacturing and professional, scientific and technical services. Information establishment churn (this industry is considered important because it is one of the high-tech industries that are often viewed as driving innovation and growth) is not so closely aligned with economic growth for the top 10 states. All in all, the establishment churn metrics reflect the economic and employment growth in those states. (The industry CQs are tied to the U.S. industry churn metrics, not the overall average U.S. statistic for all industries as is the case for the state comparisons.)

Table 2 presents the same states, but shows a slightly different picture. In contrast to the relatively high ratio of new establishments formed in the selected industries (as in **Table 1**), the employment attributed to those many new firms are closer to the national average for manufacturing, with the exception of Nevada and (somewhat) Texas. Utah, Texas and Nevada can attribute a greater than average share of jobs associated with new firms in information and professional, scientific and technical services.

Administrative, support and waste management was included in **Table 2** because, for the nation as a whole, this industry's employment churn was well above the national industry average, even if its establishment churn was not. This suggested that the industry may have helped drive the above-average employment gains for the top 10 states, but as the table shows, the relative birth employment strength for the top 10 was mixed.

Table 3 presents the results of another, broader metric for churn, the one that includes expansions and contractions in older businesses. Almost without exception, the top 10 states had stronger CQ measures than the country as a whole for each of the selected industries. This may suggest that the robust job growth in these states is more attributed to older, well-established businesses rather than new start-ups. Put another way, it is the number of jobs attributed to expansions that account for the employment growth in these states. Considering both **Table 1** and **Table 3**, one might conclude that many new establishments in the top 10 are small and possibly frail, accounting for a small number of new jobs.

In terms of the experience for Indiana, the metrics register average to below average. Except for the well-below-average GDP and employment growth rates, the state is rather normal in terms of churn. The entrepreneurial measure of churn in **Table 2** shows a mixed picture for Indiana in the

selected industries—about average for the professional, scientific and technical services industry and the administrative, support and waste management industry, but below the national benchmark in manufacturing and information.

County Comparison

Given that this publication's focus is on Indiana, our attention turns to which Indiana counties have experienced the greatest creative destruction. **Table 4** lists the top 15 Indiana counties in terms of the average establishment births to deaths ratio, together with the 2009 rankings for both establishment births to deaths and jobs attributed to new business to total employment. The results are not unexpected, at least for the 2000 to 2009 average. Hamilton County has experienced relatively fast economic and population growth over the period and the EB2D ratio average is also the top of the state. Perhaps more interesting is that the churn readings can change dramatically from year to year. Given that the economy was in recovery mode, the 2009 rankings may reflect the relative stability of some counties over the creative destruction—more on the destruction side of the ledger during the Great Recession—of the traditionally more dynamic counties.

Table 4: Selected Churn Measures for the Top 15 Indiana Counties, 2000 to 2009

County	Establishment Births to Deaths, 2000-2009 Average	Rank of Establishment Births to Deaths, 2009	Rank of Employment Births to Total Employment, 2009
Hamilton	1.25	22	8
Hendricks	1.24	30	25
Vermillion	1.16	2	54
Newton	1.15	83	73
LaGrange	1.14	3	73
Hancock	1.11	60	42
Daviess	1.11	11	37
Johnson	1.10	66	35
Boone	1.09	38	13
Harrison	1.07	18	63
DeKalb	1.07	77	18
Union	1.07	1	73
Wells	1.06	24	56
Tippecanoe	1.06	9	21
Dubois	1.06	29	69

Source: U.S. Census Bureau

Conclusion

Establishment and employment churn are often used to measure the degree to which a region or state is undergoing economic "creative destruction," which is a mark of a thriving and dynamic economy. Several measures of churn were compared across states and these measures align well with the economic performance of states.

Indiana's economic performance from 2000 to 2009 was below the national average (with state rankings in the mid to high 40s). These rankings were also reflected in the state's overall churn indicator rankings, even if a couple of industries tracked with the national averages. In short, the churn statistics did not mislead. Relatively speaking, the churn metrics do not show Indiana to be as dynamic as other states. The churn metrics also did not mislead in terms of the more dynamic counties in the state.

The industry detail of the churn measures can provide some insight into the sources of a state's dynamism. The natural resource feeding frenzy has driven the performance of many Plains and Western states, but there may be more to their motor for economic growth than meets the eye. How it is that many of these same states have been shown, based on their churn metrics, to have a relatively dynamic manufacturing sector warrants further investigation. There may be state policies or other forces that helped them bolster their economic growth. If time and resources allow, look for an exploration into how those forces may affect a state's economic performance in future *Indiana Business Review* issues. ■

Notes

1. Timothy Zimmer, "Understanding the Benefits of Workforce Churn," *InContext*, January-February 2014, www.incontext.indiana.edu/2014/jan-feb/article3.asp.
2. Information Technology and Innovation Foundation, "The 2012 State New Economy Index: Benchmarking Economic Transformation in the States," December 2012, www2.itif.org/2012-state-new-economy-index.pdf.
3 Soumitra Dutta and Bruno Lanvin, eds., "The Global Innovation Index 2013: The Local Dynamics of Innovation," www.globalinnovationindex.org/userfiles/file/reportpdf/GII-2013.pdf.
4. See www.bls.gov/bdm/entrepreneurship/entrepreneurship.htm.
5. Y. Lee and D. A. Hicks, "Schumpeterian Churn Dynamics and Regional Productivity Performance," *International Business & Economics Research Journal* 2 (2011).
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Clustering Occupations

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Which is more important: what we do or what we make?

Which does one hear more about: skills gaps or industry gaps? Know this, if one were to type in "industry gap" in Google, one of the top matches is "industry skills gap." Given that occupations embody knowledge and skills, it may well be that "what we do" is more important.

A region's occupational mix may be at least as important as a region's industrial mix in driving economic performance. Indeed, several years ago, this publication showed that the reason Indiana lagged the nation in terms of personal income was that the state's occupation mix did not reflect the nation's mix.[1] Many occupations were over-represented in the Hoosier state while others were under-represented.

Many economic development practitioners (EDPs), as well as policymakers and analysts, are familiar with industry constructs and analysis (the Standard Industrial Code was around from the late 1930s until being replaced with the North American Industrial Classification System in the mid-1990s), but are not as familiar with occupational constructs and analysis. Although it was developed in the late 1970s, the Standard Occupational Classification (SOC) system did not really get the attention it deserved until the 1990s.

Why consider occupation clusters? Isn't the full list of 923 detailed occupations better for an EDP to understand a region? Why cluster occupations when there are established broader aggregates of 23 occupation groups, or families, as defined by the Bureau of Labor Statistics (BLS) and O*NET? Detailed analysis does require the full set of occupations, but distilling 923 occupations into 34 clusters—as presented below—allows one to view a region's occupation profile, or human capital, in one view. Moreover, occupation clusters are superior to job families because occupation clusters are in closer alignment with the types of industries those occupations inhabit.

The purpose of creating and using occupation clusters as well as industry clusters is to develop an additional dimension for analyzing and describing a regional economy.

This methodology is different from the methods commonly used to categorize industry clusters. Identification of industry clusters involves tracing value-chain relationships between industries and businesses (that is, businesses that buy and sell things to each other that they need in order to process and produce products). The occupational mix of a region is based on the BLS occupational employment survey (OES) that is used to determine industry staffing patterns. Staffing patterns are a list of the occupations employed within a particular industry.

One would not be far off the mark to say that the regional presence of industries largely indicates the region's occupational mix. And the reverse is largely true as well. A region's occupational mix largely implies the type of industries in greatest concentration in the region. That said, there may be cases for which this does not hold. A generic drug manufacturer may have a materially different staffing pattern than a boutique pharmaceutical manufacturer. The Indiana Business Research Center (IBRC) estimates county-specific occupation counts using staffing patterns and adjusts the occupation estimates using region-specific OES results published by BLS.[2]

The IBRC recently performed occupational cluster analysis to continue a research effort to develop a web-based database and analytical framework that would enable EDPs, policymakers and researchers to better understand their region or state. Occupation clusters have the advantage of compressing important information about the detailed occupation definitions (which total 923 in the SOC vintage used here) to make analysis more manageable. The goal is to help users:

> *"The 34 occupation clusters allow one to view a region's occupation profile, or human capital, in one view."*

- Understand their local workforce and educational situation within the broader regional economic development context
- Understand the associated knowledge and skills that will help local and regional stakeholders to bridge the gap between workforce and economic development when constructing a regional economic development strategy
- Diagnose how well-positioned the region and its communities are to participate effectively in a knowledge-based economy
- Determine a region's strengths and weakness in terms of knowledge and skills

Analyzing industry concentration, we posit, overshadows occupation

concentration for EDPs and policymakers. Why this is the case when occupations embody the knowledge, skills, and training of the individuals who work for businesses and industries is anybody's guess. In contrast to simply using educational attainment to measure a region's human capital, occupation cluster analysis can offer a deeper understanding into the talent of the regional workforce. Given that globalization is increasingly making borders irrelevant in terms of the movement of talent and human capital, occupation cluster analysis—or perhaps one should call it "human capital cluster analysis"—is particularly valuable.

Global integration has diluted many regional competitive advantages. Many factors of production are increasingly low-cost, be it labor, land, transportation, communications or commodities. Technological know-how knows no national borders. Given this leveling of costs across countries, a region's best chance to differentiate itself is with its brainpower: the education, knowledge, skills and know-how of its workforce.

Markusen and Barbour (2003) emphasized that both industries and occupations are important for understanding complex and changing regional economies, and they have suggested that economic development strategists look into occupation targeting in addition to industrial targeting. They note that whereas industry targeting includes a wish list of industries that regions want to have, occupation targeting could benefit a wide array of the industries that are built around similar occupations.

As an example, they cite engineers in the southern California aerospace/defense industry clusters who found employment opportunities (and the opportunity to create innovations) in other southern California industries, such as sportswear and sports equipment using exotic materials developed for defense and aerospace.

In later work, Barbour and Markusen (2007) noted the limitations of publicly available data for occupation analysis and proposed to develop an occupation structure for state and metropolitan areas by using the national industry-by-occupation matrix. A major finding was that certain occupations in high-tech industries were distributed quite differently in some metropolitan areas, even when the regions shared a similar industry mix.

One can attribute at least four characteristics to an industry cluster:

1. Geographically bounded concentration of similar, related, or complementary businesses
2. Active channels for transactions and communications among these businesses
3. Shared and specialized infrastructure, labor markets or services
4. Common competitive opportunities and threats

Just as an industry cluster is defined as a collection of industries that are similar or interdependent in certain ways, an occupation cluster shares many similar characteristics.

Feser (2003) and Koo (2005) refined the cluster concept to occupations by including knowledge characteristics of the individual occupations and developing knowledge-based occupation clusters. Feser proposed that these clusters could not only describe the local labor pool, but also serve as inputs in explanatory models of regional growth and change.

The IBRC occupation cluster analysis relies heavily on Feser's (2003), Koo's (2005) and Nolan et al's (2011) previous efforts. That said, Nolan's knowledge-based clusters account for only half of the labor force. As a result, the IBRC extended the analysis to include what is here called the "skill-based" occupations that were not the focus of these earlier works. After all, not all regions are suitable for development strategies that focus on high-tech, knowledge-intensive occupations. Additionally, to be valuable to EDPs, one needs to embrace developmental strategies that seek to capitalize on existing local and regional skills and expertise.

"In contrast to simply using educational attainment to measure a region's human capital, occupation cluster analysis can offer a deeper understanding into the talent of the regional workforce."

One of the building blocks in this study was to identify and categorize occupations into clusters based on the Occupational Information Network–Standard Occupational Classification (O*NET-SOC) system. Occupation clusters are groups of occupations that share similar knowledge, skills and other characteristics, such as formal education levels, training, wage levels and availability of benefits.[3]

O*NET also places an occupation in one of five "job zones." A job zone is a group of occupations that are similar in terms of the education, experience and on-the-job training

Table 1: Knowledge-Based Occupation Clusters

Cluster Number	Knowledge-Based Cluster Titles	Number of Occupations in Cluster	Job Zone Average
01	Arts, Entertainment and Broadcasting Specialists and Management	26	4.2
02	Engineering, Architecture and Related Disciplines	49	4.1
03	Finance, Legal, and Real Estate	22	4.2
04	Health Care: Life and Medical Scientists	18	4.7
05	Health Care: Medical Practitioners and Scientists	29	5.0
06	Health Care: Nurses and Specialized Care Delivery	25	4.5
07	Health Care: Therapy, Counseling and Rehabilitation	13	4.7
08	Information Management and Computing	24	4.2
09	Managerial, Sales, Marketing and Human Resources	27	4.2
10	Mathematics, Statistics, Data Analysis and Accounting	13	4.5
11	Natural Sciences and Environmental Management	40	4.4
12	Postsecondary Education and Knowledge Creation	25	5.0
13	Primary, Secondary and Vocational Education, Remediation and Social Services	29	4.1
14	STEM and Applied Science Technicians	41	3.0
15	Transportation, Logistics and Planning	14	4.1

Source: Indiana Business Research Center

that people need to do the job. Job Zone 1 includes occupations that require little preparation (e.g., parking lot attendants, counter clerks or dishwashers). Job Zone 2 occupations usually require at a minimum a high school diploma, plus some vocational training or job-related coursework. At the other end of the spectrum, Job Zone 5 occupations require advanced communication and organizational skills, as well as specialized knowledge. Job Zone 5 occupations include lawyers, aerospace engineers, physicists and surgeons.

Nolan et al (2011) focused on job zones 3, 4 and 5, with the view that these knowledge-based occupations drive innovation. Fair enough for the purposes of their study, but our goal was to expand the focus.

Data on the knowledge level, type of skills and the extent of training for each occupation (KST) were the basis for our clustering procedure. Abilities, as in the common formula "knowledge, skills and abilities" (KSA), in contrast to knowledge and skills, were not found to differentiate between occupations very well. Following Feser, Koo and Nolan et al, we used the Ward agglomerative hierarchical clustering algorithm to identify and categorize occupations into clusters.

Ward's clustering algorithm is commonly used to determine cluster patterns in large multivariate data sets. It minimizes variation based on the differences in measurements for KST within a cluster. One potential weakness of Ward's clustering algorithm is that the clustering process is sensitive to overly influential observations that "pull" the cluster "center" away from other occupations that would have minimized variances within a particular cluster. Rather than removing the so-called "outliers" from the clustering process, the results were reviewed for consistency and reasonableness. In several cases, occupations were reassigned based on the knowledge component or the industry alignment of the occupation. For example, morticians were shifted from the medical professions to the knowledge-based personal services occupations. As a result, there is a small element of subjectivity and evaluation in the construction of the clusters.

The results of the cluster analysis are presented based on whether the cluster is knowledge-based or skill-based. **Table 1** presents the clusters that are dominated by higher levels of specialized knowledge.

The table also shows the average job zone for the cluster. Except for STEM-related technicians (cluster 14), the clusters average more than 4 on a 5 point scale. In the case of STEM-related technicians, these occupations tend to use specialized or specific knowledge domains, even if the level of education for these occupations may not be as extensive as engineers, computer scientists or financiers.

Table 2 presents the skill-based clusters. In this set of clusters, there are several clusters that support knowledge-based clusters. For example, cluster 21 is "Financial, Legal and Inspection Services, Support." These occupations would tend to work at the same firms as those in cluster 3, "Finance, Legal, and Real Estate." The same can be said of the "Administration and Office Support" cluster supporting the work of managers (cluster 9), finance (cluster 3) or university professors

TABLE 3: Descriptive Statistics for Two-Digit Families of Occupations

2-Digit Family SOC Code	Family of Occupations	Number of Occupations in Family	Family Maximum Job Zone	Family Minimum Job Zone	Family Average Job Zone
11	Management	47	5	3	4.0
13	Business and Financial Operations	46	4	2	3.7
15	Computer and Mathematical	29	5	3	4.0
17	Architecture and Engineering	61	5	2	3.7
19	Life, Physical, and Social Science	59	5	3	4.4
21	Community and Social Service	14	5	4	4.5
23	Legal	8	5	3	4.3
25	Education, Training, and Library	58	5	3	4.6
27	Arts, Design, Entertainment, Sports, and Media	43	4	2	3.3
29	Health Care Practitioners and Technical	83	5	2	4.2
31	Health Care Support	17	3	2	2.6
33	Protective Service	28	4	1	2.7
35	Food Preparation and Serving Related	16	3	1	1.5
37	Building and Grounds Cleaning and Maintenance	8	3	1	1.9
39	Personal Care and Service	32	4	1	2.4
41	Sales and Related	22	4	1	2.7
43	Office and Administrative Support	61	4	1	2.3
45	Farming, Fishing, and Forestry	17	4	1	1.9
47	Construction and Extraction	59	3	1	2.0
49	Installation, Maintenance, and Repair	54	3	1	2.6
51	Production	109	3	1	2.2
53	Transportation and Material Moving	52	4	1	2.3

Source: Indiana Business Research Center

families have occupations that range from Zone 1 to Zone 4.

Table 3 presents some descriptive statistics of the job zones and occupation counts for occupation families, while **Table 4** presents these data for the occupation clusters.

Probably the best reason that occupation clusters are superior to job families is that the occupation clusters are in closer alignment with a type of industry (broadly defined). For example, the management occupations family from BLS and O*NET ranges from business executives to power plant managers to logistics managers to food service managers to clinical research coordinators. The latter occupation appears in the "health care: life and medical scientists" cluster, while logistics managers fall in the "transportation, logistics and planning"cluster.

Thus, in a way, occupation clusters allow one to see an additional dimension of a region's human capital—not just occupations, but also how those occupations may be deployed in industry. ■

Notes

1. Timothy F. Slaper and Ryan A. Krause, "Occupational Hazard: Why Indiana's Wages Lag the Nation," *Indiana Business Review*, Spring 2010, www.ibrc.indiana.edu/ibr/2010/spring/article1.html.
2. See The Regional Labor Mix tool at www.hoosierdata.in.gov/mix/mix_menu.aspx.
3. O*NET-SOC is developed under the sponsorship of the U.S. Department of Labor's Employment and Training Administration and is the nation's primary source of occupational information. The O*NET-SOC taxonomy includes hundreds of occupations, with each occupation including information on 33 different knowledge variables.

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Table 2: Skill-Based Occupation Clusters

Cluster Number	Skill-Based Cluster Titles	Number of Occupations in Cluster	Job Zone Average
16	Administration and Office Support	27	2.0
17	Artisans, Craftsman, Designers, including Performance	22	2.6
18	Attendants and General Services	19	1.6
19	Construction Trades	37	1.9
20	Facility, Plant and Large Equipment Operators and Technicians	41	2.0
21	Financial, Legal and Inspection Services, Support	33	2.8
22	Food Preparation and Service	16	1.4
23	Health Care: Therapists, Technicians and Aides	37	2.8
24	Machinists and Skilled Operators and Tenders	22	2.6
25	Managers and First-Line Supervisors	24	2.6
26	Mechanics and Repair Technicians	55	2.7
27	Media, Web Development and Programming	16	2.9
28	Personal Services	16	2.8
29	Production Operators and Tenders	43	2.0
30	Production, General	34	1.7
31	Safety, Security and Emergency	33	3.0
32	Sales, Agents, Brokers and Customer Relations, Support	14	2.5
33	Transportation Equipment Operators	23	2.2
34	Transportation, Logistics and Dispatch, Support	16	1.9

Source: Indiana Business Research Center

(cluster 12), depending on the nature of the firm, school or office.

Table 1 and **Table 2** also show the number of occupations in a cluster. The distribution is not even, and it is here that the "science" of the clustering algorithm meets the "art" of deciding the number of clusters. One can decide how many clusters to have ahead of time, but if one decided that 25 clusters was the right number, one may find some odd bundling of occupations. This is especially true for the skill-based occupations that are in the lower job zones because "skills" as O*NET defines and collects data for are more evenly distributed across the general population and occupational landscape. If one limited the number of clusters to 25, for example, it is likely that attendants would be grouped with food preparation and general (unskilled) production workers.

Why use the above occupation clusters, in contrast to the full list of 923 occupations or the 23 occupation groups or families? While important for more detailed analysis, grasping a region's occupation profile or human capital in one view is better done with a more compressed set of categories.

The downside to the 23 job families of the SOC codes used by BLS is that a job family can be as few as eight occupations—as is the case for both the legal occupations family and the cleaning and maintenance occupations family—or as many as 109 occupations in the production occupations family. The range of job zones for a job family can be relatively wide as well. Several service-type job

For the detailed occupations in each cluster, see the appendix at www.ibrc.indiana.edu/ibr/2014/summer/appendix.xlsx.

"Occupation clusters allow one to see an additional dimension of a region's human capital—not just occupations, but also how those occupations may be deployed in industry."

TABLE 4: Descriptive Statistics for Occupation Clusters

Cluster Number	Occupation Cluster	Number of Occupations in Cluster	Cluster Maximum Job Zone	Cluster Minimum Job Zone	Cluster Average Job Zone
01	Arts, Entertainment and Broadcasting Specialists and Management	26	5	4	4.2
02	Engineering, Architecture and Related Disciplines	49	5	4	4.1
03	Finance, Legal, and Real Estate	22	5	4	4.2
04	Health Care: Life and Medical Scientists	18	5	4	4.7
05	Health Care: Medical Practitioners and Scientists	29	5	5	5.0
06	Health Care: Nurses and Specialized Care Delivery	25	5	3	4.5
07	Health Care: Therapy, Counseling and Rehabilitation	13	5	4	4.7
08	Information Management and Computing	24	5	4	4.2
09	Managerial, Sales, Marketing and Human Resources	27	5	4	4.2
10	Mathematics, Statistics, Data Analysis and Accounting	13	5	4	4.5
11	Natural Sciences and Environmental Management	40	5	4	4.4
12	Postsecondary Education and Knowledge Creation	25	5	4	5.0
13	Primary, Secondary and Vocational Education, Remediation and Social Services	29	5	3	4.1
14	STEM and Applied Science Technicians	41	3	2	3.0
15	Transportation, Logistics and Planning	14	5	4	4.1
16	Administration and Office Support	27	3	1	2.0
17	Artisans, Craftsman, Designers, including Performance	22	3	1	2.6
18	Attendants and General Services	19	2	1	1.6
19	Construction Trades	37	2	1	1.9
20	Facility, Plant and Large Equipment Operators and Technicians	41	3	1	2.0
21	Financial, Legal and Inspection Services, Support	33	3	2	2.8
22	Food Preparation and Service	16	3	1	1.4
23	Health Care: Therapists, Technicians and Aides	37	3	2	2.8
24	Machinists and Skilled Operators and Tenders	22	3	2	2.6
25	Managers and First-line Supervisors	24	3	2	2.6
26	Mechanics and Repair Technicians	55	3	1	2.7
27	Media, Web Development and Programming	16	3	2	2.9
28	Personal Services	16	3	2	2.8
29	Production Operators and Tenders	43	2	2	2.0
30	Production, General	34	3	1	1.7
31	Safety, Security and Emergency	33	4	2	3.0
32	Sales, Agents, Brokers and Customer Relations, Support	14	3	2	2.5
33	Transportation Equipment Operators	23	3	1	2.2
34	Transportation, Logistics and Dispatch, Support	16	3	1	1.9

Source: Indiana Business Research Center

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