FORUM EMPRESARIAL
Vol. 15, Núm. 1 • mayo 2010 / pp. 1-23

An Empirical Analysis of Employment and Wage Clusters in Puerto Rico: 1979-1999

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RESUMEN:
Este manuscrito propone un método para identificar conglomerados de empleo y nómina de economías regionales por sector económico. Exponemos cómo identificar conglomerados industriales utilizando como base el cálculo de los Cocientes de Localización, el Índice de Promedios Nacionales, e Índices de Empleo y Nómina, y un método para clasificar en tres categorías sus etapas de desarrollo: emergentes, maduros y declinantes. Aplicamos la metodología descrita en este informe para documentar la transición ocurrida en las regiones económicas de Puerto Rico de 1980 al 2000.

Palabras clave: conglomerados de empleo, conglomerados de nómina, economías regionales, cociente de localización.

ABSTRACT:
This paper proposes a method to identify employment and wage clusters for various sectors of a region's economy. The Location Quotient, the National Averages Index, and a local employment or wage index were estimated and used to identify industrial clusters and classify their development stage according to three categories: emerging, maturing and declining. An application of this methodology considering the Puerto Rican economy during the period 1980-2000 has allowed for documentation of regional shifts as a transition from manufacturing to service (postindustrial) industries was observed.

Keywords: employment clusters, wage clusters, regional economies, location quotient.

INTRODUCTION

Globalization has transformed the economies of the Caribbean region. The easing of trade restrictions, technological innovations, and the mobility of trade productive processes have led to a restructuring of Caribbean economies towards the development of a service sector (finance, tourism, entertainment and international trade). There have been two major transformations: (a) from agricultural export economies to assembly manufacturing (*maquiladoras*) and (b) from manufacturing to international services (Klak 1998, 2002; Pantojas-García 2001; Pantojas-García and Klak 2004). The impact of such a transformation on Caribbean economies has been significant, including the development of coastal regions at the expense of interior regions.

During the 1990's, Puerto Rico's economy shifted its dynamic axis from manufacturing to services. This transformation was documented initially by Pantojas-Garcia (1990) and was later confirmed by Dietz (2003). Such a transformation did not seem to have an impact on economic development strategies followed by the government of Puerto Rico, where the focus remained on the manufacturing sector. Only recently have political parties recognized the strategic shift caused by globalization, and have focused on reinventing Puerto Rico as a research and development center for new technologies and international services.

Academic literature on economic development has failed to produce an empirical profile on the spatial configuration of Puerto Rico's economic structure. Several relevant papers tend to describe or analyze the development process or specific aspects of economic problems using Commonwealth of Puerto Rico national account data and US Census aggregate statistics. The problems are typically presented following a hypothesis-testing format or an inductive historical "interpretive" perspective which tends to follow common themes in the literature and historical processes, often ignoring the spatial configuration of economic activity (Curet Cuevas 1976, 1986, 2003; Dietz 1989, 2003; Gutiérrez 2000; Irizarry Mora 2001; Martínez 1999; Pantojas-García 1990).

The following research report presents a methodology to identify and classify industrial clusters, with an application to Puerto Rico's economic-spatial configuration during the period 1979 to 1999. To identify employment and wage sectors, the Location Quotient, the Employment or Wage Index and the National Averages Index were calculated. Each of these indicators was estimated for all two-digit Standard Industrial Classification (SIC) sectors present in Puerto Rico's seventy-eight municipalities. Using beginning and end of period standardized employment and wage index values, we were able to classify industrial clusters as emerging, maturing and declining. The findings provide empirical confirmation of regional shifts in the Puerto Rican economy from manufacturing to service (postindustrial) industries.

Literature Review

Few studies have followed an inductive approach to analyze economic problems in Puerto Rico; these include Clark (1930), Diffie (1931), Bird (1950), Perloff (1950), Tobin (1976), and Kreps (1980). The two most recent reports on economic strategy have not been broadly based on empirical data, but rather on the advice of technical advisors and consultants: the Economic Advisory Council to the Governor of 1989, and the Economic Productivity Council of the Governor of 1994. Empirical studies on the economy seldom include any regional indicators of economic activity.

One concept of relevance to the identification of the configuration of an industrial sector is the cluster. Clusters are often described as analytical instruments in the explanation of growth patterns, employment dynamics, technological progress and competitiveness. Various authors have discussed clusters from the perspective of accumulation of technological capability (Cumbers and MacKinnon 2004; Simmie 2004), while others have focused on the changes in space of external economies and agglomerative externalities (Friedland, Palmer and Stenbeck 1990; Phelps 2004). A third area of research in the cluster literature is the growth process of a cluster (Brenner and Weigelt 2001; Isaksen 2004; Todtling and Trippl 2004).

Preissl & Solimene (2003) points to clusters as seen in spatial perspective, defining these as groups of firms or actors in close proximity. Feser (1998) focuses on measurement issues that play a critical role in identifying the presence of clusters or the potential for cluster development. He identifies six analytical techniques used to identify the presence and strength of a cluster in a particular region: expert opinion, location quotients, trade-based input-output analysis, innovation-based input-output analysis and surveys. We propose a cluster definition and classification scheme that is fundamentally spatial in nature, uses readily available annual census data, and can be applied to any region where similar data is collected on a regular basis.

METHODS

In this research report a cluster is defined as an agglomeration of industries defined by the concentration of employment and wages (as measured by the Location Quotient, National Average and Local Employment or Wage Index) in geographic proximity. Geographic proximity is defined as municipalities that share borders. Such a definition provides for an initial identification of wage and employment regional clusters. Since these purely empirical approaches to cluster identification tend to overlook the nature of cluster life cycles, we developed a measure that would provide an indication of whether the cluster is growing or diminishing in size, using employment and wage growth as a proxy for cluster evolution.

All descriptive industrial structure analysis, including index estimation, was based on one and two-digit Standard Industrial Classification (SIC) data published in the US Census Bureau's County Business Patterns (CBP). CBP employment and wage data is collected every year for each of Puerto Rico's seventy-eight municipalities, all counties in the United States and equivalent subdivisions in its territories, providing data up to the four-digit SIC level. The study period was selected as the last twenty years of the twentieth century (1979-1999), thus excluding the recession period caused by the oil crisis in the 1970's, and focusing on the subsequent period where the shift from manufacturing to international services occurred. Municipalities have been selected as the unit of analysis because they represent

the smallest units for which two-digit SIC employment and wage data was consistently available.

The Puerto Rico Department of Labor and Human Resources (DLHR) also collects employment and wage data up to the four-digit SIC level. To test the robustness of the results obtained with CBP data, a second set of clusters was identified with DLHR two-digit SIC data. Analysis with this secondary source of data included selected end of period industrial sector employment and wage activity since DLHR data was only available for the end year of the study period.

Employment and wage concentration has been estimated using one local measure of economic concentration (LC), the employment or wage index, as well as two comparative measures, the National Averages Index and the Location Quotient (LQ). All index values have been standardized to facilitate the interpretation of results and allow comparisons across regions and time periods. The LC is provided by the following equation:

$$LC = \sum_{i=1}^{n} X_i^2$$

where Xi is sector i's share of employment or wage and N is the number of sectors in the region.

The Location Quotient is a ratio of employment or wage shares: the regional industry's share of total regional employment or wages is compared to the national industry's share. A quotient higher than one is an indication of a high degree of specialization in economic activities, which may be an indication of comparative advantage (Wolfe 2003). Given the acceptance and use of this index in the literature, a standardized index with a value greater than zero will be required to identify regional clusters. It should be noted that Location Quotients do not point to links between sectors; other methods may be necessary for this purpose. LQ is provided by the following equation:

$$LQ = \sum_{i=1}^{n} \frac{\frac{X_{MI}}{X_{MT}}}{\frac{X_{PRI}}{X_{PRT}}}$$

where X_{MI} is the ith's sector share of employment or wage in the municipality, X_{MT} represents total employment or wage in the mu-

nicipality, X_{PRI} is the ith's sector share of employment or wage in Puerto Rico (the aggregate), and X_{PRT} is the total employment or wage figure for Puerto Rico.

The National Averages Index (NA) is similar to the Location Quotient in that it allows for a comparison of national and regional employment and wage concentration. It measures the square of the regional deviations from the national percentages of industrial categories. The national industry mix provides a standard with which to measure a region's industrial structure. The National Average Index responds to the following hypothesis: the more similar a region's composition by sector is to that of the nation's, the more stable it should be relative to other regions (Siegel, Johnson and Alwang 1995). The greater the sum of the deviations, the greater the industrial specialization or the lower the level of industrial diversity (Dissart 2003). With the National Average Index, the region is optimally diversified when it mirrors the nation (Gilchrist and St. Louis 1991). Even though this index might indicate that it would be ideal for a region to emulate the nation, in some cases, this policy implication may not be correct. The National Averages Index is provided by the following equation:

$$NA = \sum_{i=1}^{n} \frac{(X_i - \overline{X})^2}{\overline{X}_i}$$

where Xi is the ith's sector share of employment or wage in the municipality, $\overline{X}$ is the average municipality's employment or wage share, and $\overline{X_i}$ is the share of employment or wage in sector i considering Puerto Rico as a whole.

The procedure followed for cluster identification consists of an examination of standardized index values during the study period. For both the start and end years, the fifteen industrial sectors that generate the most employment and wages in Puerto Rico have been identified using two-digit SIC data.

For an employment or wage cluster to be identified, each of two or more contiguous municipalities must have a standardized Location Quotient and at least one additional standardized index value greater than zero. Clusters were also identified according to three categories: emerging, maturing or declining. An emerging cluster

is one that has been identified only at the end year. A maturing cluster is one that was identified both at the beginning and end year, but its geographic area increased or remained the same during the study period. A declining cluster was defined if one of two alternative criteria was met; either the cluster was identified only during the beginning of the study period, or it was identified during both the beginning and end years, but a decrease in its territorial extension was observed.

Results

Puerto Rico's Top Employment and Wage Sectors: 1979-1999

In order to better understand the dynamics of cluster formation and decline in Puerto Rico, it is important to examine the importance and ranking of the major industrial sectors in terms of employment and payroll. Tables I and II identify the ranking and share of the top ten industrial employment and wage sectors in Puerto Rico for the study period.

The top five employment sectors in Puerto Rico's economy during the initial time period (1979) were as follows: Apparel and Other Finished Products, Food and Kindred Products, General Contractors and Operative Builders, Electronics, and Health Services. In contrast, the main employment sectors in 1999 were ranked as follows: Business Services, Health Services, Eating and Drinking Places, Chemicals and Allied Products, and General Contractors and Operative Builders. It is clear that during the intervening twenty-year period, services became an increasingly important component of the Puerto Rican economy, occupying three of the top five 1999 employment rankings, while manufacturing became increasingly unimportant. The Apparel sector dropped in the rankings from first to fifteenth, and Electronics similarly decreased from fourth to tenth. Food and Kindred Products, initially second in the rankings, no longer appeared in the top ten end year employment rankings.

Table I. Puerto Rico's Fifteen Top Employment Sectors: 1979 and 1999

	1979				1999			
Ranking	SIC Code	SIC Description	Employment	Share of total (%)	SIC Code	SIC Description	Employment	Share of total (%)
1	2300	Apparel and other textile products	39014	8.93%	7300	Business services	60595	8.41%
2	2000	Food and kindred products	19203	4.40%	8000	Health services	49577	6.88%
3	1500	General contractors and operative builders	17859	4.09%	5800	Eating and drinking places	40728	5.65%
4	3600	Electronic and other electric equipment	17833	4.08%	2800	Chemicals and allied products	36393	5.05%
5	8000	Health services	17774	4.07%	1500	General contractors and operative builders	31285	4.34%
6	2800	Chemicals and allied products	16522	3.78%	5400	Food stores	26740	3.71%
7	5400	Food stores	16510	3.78%	8200	Educational services	25881	3.59%
8	7300	Business services	16081	3.68%	5300	General merchandise stores	25710	3.57%
9	5100	Wholesale trade-nondurable goods	15231	3.49%	5100	Wholesale trade-nondurable goods	20974	2.91%
10	5000	Wholesale trade-durable goods	13928	3.19%	3600	Electronic and other electric equipment	20236	2.81%

Table II. Puerto Rico's Fifteen Top Payroll Sectors: 1979 and 1999

	1979				1999			
Ranking	SIC Code	SIC Description	Payroll	Share of Total (%)	SIC Code	SIC Description	Payroll	Share of Total (%)
1	2300	Apparel and other textile products	209334	6.15%	7300	Business services	834360	6.47%
2	2800	Chemicals and allied products	208494	6.12%	4800	Communication	454816	3.53%
3	2000	Food and kindred products	165976	4.87%	6000	Depository institutions	430059	3.33%
4	3600	Electronic and other electric equipment	164294	4.82%	8000	Health services	812496	6.30%
5	5100	Wholesale trade-nondurable goods	151772	4.46%	8200	Educational services	418225	3.24%
6	5000	Wholesale trade-durable goods	147352	4.33%	8700	Engineering and management services	363962	2.82%
7	1500	General contractors and operative builders	116515	3.42%	5000	Wholesale trade-durable goods	485921	3.77%
8	8000	Health services	108282	3.18%	5100	Wholesale trade-nondurable goods	520766	4.04%
9	7300	Business services	107391	3.15%	1500	General contractors and operative builders	432499	3.35%
10	5400	Food stores	87485	2.57%	2800	Chemicals and allied products	1133212	8.78%

Payroll rankings also reveal dramatic changes during the study period. The Apparel and other Finished Products sector, first in 1979, was no longer among the top ten sectors by the end of the study period, when the Business Services occupied the top position. Chemicals & Allied Products decreased from second to tenth, and its ranking was occupied in 1999 by the rising Communications sector. As in the case of the Apparel sector, Food and Kindred Products decreased from third to no longer placing among the top ten, and its initial position was occupied by Depository Institutions by the end of the study period. The Electronics sector similarly decreased from its initial fourth position, and was substituted by the Health Services sector by the end of the study period. Wholesale Trade (non-durables) rounded the top five in 1979, and only decreased to eighth position by 1999, when its beginning of period position was occupied by the Educational Services sector.

EMERGING, MATURING AND DECLINING CLUSTERS IN PUERTO RICO: 1979-1999

An emerging cluster is one that was initially identified at the end of the study period (1999). As seen in table III, sixteen emerging employment and twenty-one wage clusters were identified, mostly found in the service and manufacturing sectors of the economy. The retail sector was not presented in the findings because initial mapping of its clusters exhibited several widespread clusters all over the Island, not showing concentration centers for this activity. The methodology applied in this research is better suited for all other sectors where the spatial-temporal relationship between cluster formation and population growth is not as strong.

The presence of the manufacturing sector was significant, with four employment clusters including a total of 40,110 employees in the Electronics, Chemicals and Allied Products (two clusters for this sector), and Apparel sectors. Their regional distribution shows that all but one manufacturing cluster were located outside the capital, San Juan, where the Island's main port and airport are located. Such a decentralized distribution of manufacturing activity is partly due to local income tax exemptions which varied according to municipality location, generally favoring those furthest away from San Juan. A second factor which seems to be critical for the location of some Chemi-

cal industries was the presence of aquifers. According to interviews with key manufacturing managers, the presence of an independent source of water was critical in the formation of the Barceloneta-Manatí cluster in the North Coast.

The growth of services was evident, given the formation of two Business, two Health and one Educational Services employment cluster containing a total of 94,369 employees. Centralization of services in San Juan was evident, given the presence of a cluster for each of the three service types in the capital city.

Wage clusters also reveal a prevalence of service clusters. Manufacturing presence was limited to only two Chemicals clusters, both outside the San Juan area, with a combined wage of $362,400,000 (in 1999 dollars). Eleven of the twenty-four wage clusters represented the business, health, education, and engineering, accounting, research and management service fields, accounting for $591,726,000 (in 1999 dollars). Only one of these eleven clusters included San Juan, so there seems to be a significant decentralization of service wage concentration.

Table III. Emerging Clusters, as Evidenced by the Location Quotient, the Employment and Wage Index & the National Average Index

SIC Code	SIC Description	Employment Clusters	Wage Clusters	Employment and Wage Clusters
15	General Contractors and Operative Builders	-	4	-
17	Special Trade Contractors	4	2	1
23	Apparel and Other Finished Products	1	-	-
28	Chemicals and Allied Products	2	2	1
36	Electronics and Other Electronic Equipment	4	-	-
48	Communications	-	1	-
60	Depository Institutions	-	1	-
73	Business Services	2	5	1
80	Health Services	2	2	-
82	Educational Services	1	2	-
87	Engr., Acct., Res. & Mgmt. Services	-	2	-

Maturing clusters were initially identified at the beginning and end of the study period, maintaining or increasing their territorial extension. Two employment clusters were identified for each of the following sectors: General and Specialized Contractors, Manufacturing and Wholesale Trade (see Table IV). Both manufacturing clusters represented labor-intensive, high employment sectors: Food & Kindred Products, and Apparel and Other Finished Products. Wage data revealed the presence of only three maturing clusters. One of the clusters represented the Chemicals and Allied Products sector, and the remaining two represented the Wholesale Trade sectors.

As expected, all maturing clusters but one (representing the Chemicals and Allied Products sector) were located in the San Juan metropolitan area, historically the center of trade in Puerto Rico. In all cases, their geographic extension increased during the twenty year period. While employment in the General and Specialized Contractors cluster increased only 9.4% during the study period, labor-intensive manufacturing grew at a much faster rate of 286%. An examination of wages reveals that Chemicals and Allied Products was the fastest growing sector, with a 219% growth (in 1999 dollars) during the study period. In comparison, Wholesale Trade Durables cluster wage totals grew 71%, while Non-Durables cluster wages increased at a faster rate of 117%.

Table IV. Maturing Clusters, as Evidenced by the Location Quotient, the Employment and Wage Index & the National Average Index

SIC Code	SIC Description	Employment Clusters	Wage Clusters	Employment and Wage Clusters
15	General Contractors and Operative Builders	1		
17	Special Trade Contractors	1		
20	Food and Kindred Products	1		
23	Apparel and Other Finished Products	1		
28	Chemicals and Allied Products		1	
50	Wholesale Trade – Durable Goods	1	1	1
51	Wholesale Trade – Non-Durable Goods	1	1	1

Declining sectors were identified according to two alternative criteria; either the cluster was identified only at the beginning of the study period, or the cluster was identified in 1979 and 1999, but its geographic area decreased. Four declining wage and employment clusters were found in the manufacturing sector; two in the labor intensive Apparel and Other Finished Products, and two in the capital intensive Electronics sector (see Table V). These sectors have been described as "footloose" industries.

While four Electronics employment clusters emerged, two declined. Similarly, while one Apparel employment cluster emerged and a second one matured, two declined. Even though there was some evidence of emerging and maturing employment clusters in these "footloose" industries, an examination of wages only pointed to new and growing activity in the Chemicals and Allied Products sector.

Contrary to the geographic pattern observed with maturing clusters, all declining clusters but one (a wage cluster representing depository institutions) were located outside the San Juan area. As seen in the table indicating the top fifteen employment sectors, Apparel provided the highest level of total sector employment at the beginning of the study period. The two declining Apparel and Other Finished Products clusters were located in the Northwest and Central regions of Puerto Rico, and provided employment to 8,315 workers, and wages of approximately $41.5 million (in 1999 dollars). By comparison, the two declining Electronics clusters employed 4,398 persons, and paid wages of approximately $38.2 million (in 1999 dollars).

Table V. Declining Clusters, as Evidenced by the Location Quotient, the Employment and Wage Index & the National Average Index

SIC Code	SIC Description	Employment Clusters	Wage Clusters	Employment and Wage Clusters
23	Apparel and other finished products made from fabrics and similar materials	2	2	2
36	Electronics and Other Electronic Equipment	2	2	2
60	Depository Institutions	0	1	0

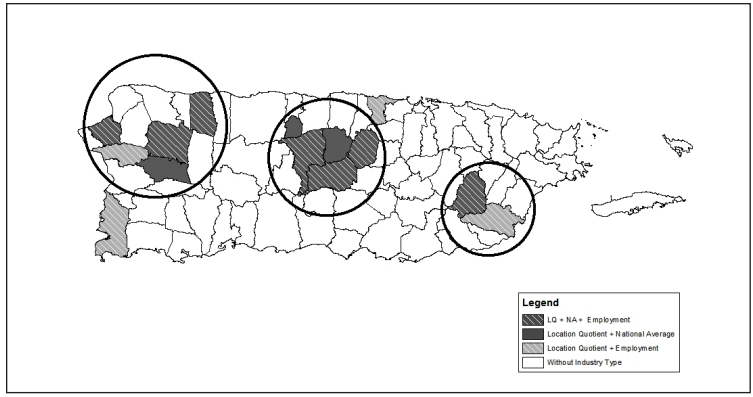
DECLINING EMPLOYMENT AND WAGE CLUSTERS: THE APPAREL AND TEXTILE PRODUCTS SECTOR

Two sectors have been selected for further analysis given their drastic emergence and decline during the study period: Apparel and Other Finished Products and Business Services. Four maps will be shown for each sector, two showing the initial presence of employment and wage clusters in Puerto Rico, and two showing the final configuration of both types of clusters.

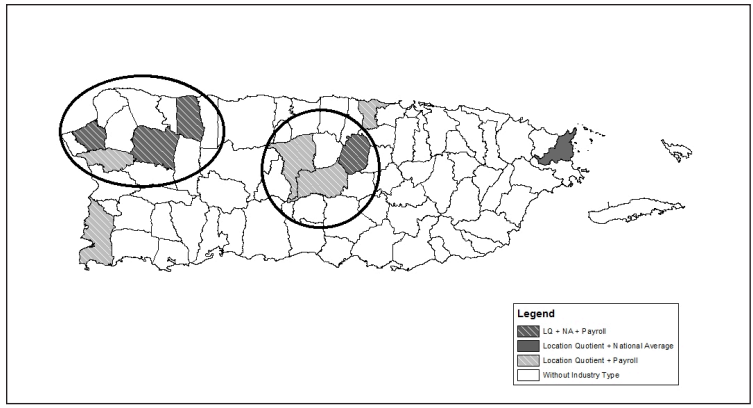
Apparel and Other Finished Products was the top ranked employment sector at the beginning of the study period. It provided employment to more than 39,000 workers, with an 8.9% share. By the end of the study period, this sector dropped to the fifteenth place in the rankings, its employment reduced to 17,656. In 1979, the Apparel and Other Finished Products employment clusters covered a significant portion of Puerto Rico's territory (see Map I). Three classifications of municipality clusters were identified in each map, and described on their legend as follows: 1) the standardized Location Quotient and National Average Index are both greater than zero; 2) the standardized Location Quotient and the Employment Index are both greater than zero; and 3) the standardized Location Quotient, National Averages and Employment Index are all greater than zero.

Three clusters were identified in 1979; all were located along a development axis that extended from the Northwest to the Southeast. Twelve municipalities in total composed these three clusters. An examination of wage clusters in 1979 shows the strength of the Northwest and Central Region Apparel activity (see Map II); even though a smaller number of municipalities constituted these two clusters, their existence shows the importance of this sector in the regional economies as an employment and wage generator.

Map I. Apparel and Other Finished Products Employment Clusters in 1979



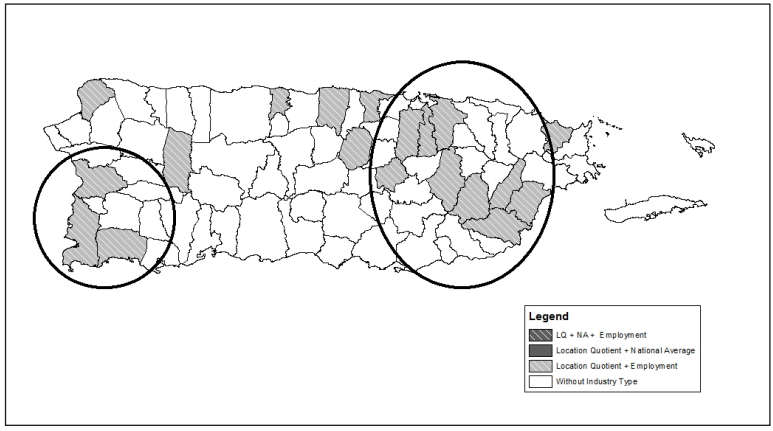
Map II. Apparel and Other Finished Products Wage Clusters in 1979



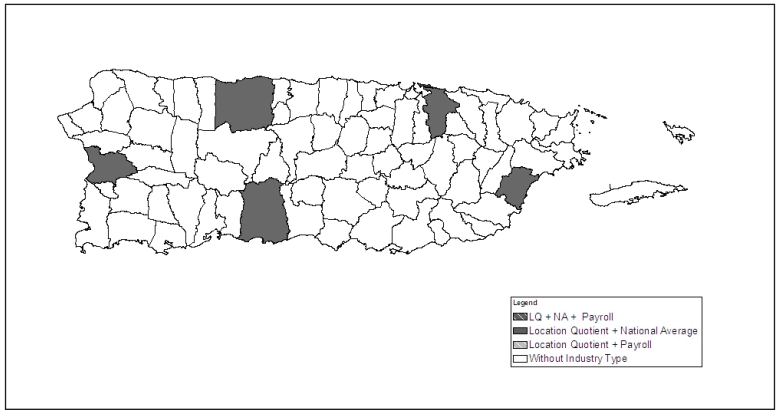
By 1999, a redistribution of the Apparel and Other Finished Products sector is apparent (see Map III). The Northwest-Southeast axis has been replaced by two distinct clusters on opposite sides of Puerto Rico. The Central and Northwest clusters, which accounted for 8,315 jobs, declined, and a smaller three-municipality cluster with 3,716 employees emerged along the Southwest Coast. The maturing Southeast cluster expanded to include seven additional municipalities, and its employment increased 185% during the study period, from 2,167 to 6,173 jobs.

The 1999 wage cluster map showed a significant transformation in the sector's wage activity; the two previously existing clusters disappeared by the end of the study period. The only remaining wage concentrations were found in the traditional metropolitan population centers, such as San Juan, Ponce and Mayagüez. The findings confirm that the loss in regional Apparel wage concentration was greater than the decrease in regional employment concentration.

Map III. Apparel and other Finished Products Employment Clusters in 1999



Map IV. Apparel and Other Finished Products Wage Clusters in 1999



The Emerging Employment and Wage Clusters: Business Services

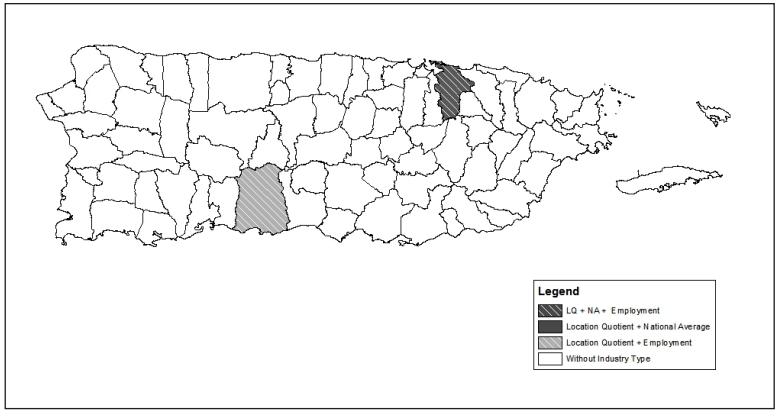
The Business Services sector has been chosen to represent emerging cluster activity given its rise to the top position in terms of employment and wage share during the study period. The Business Services sector not only rose in the employment rankings from eighth to first during the study period, but also its employment share increased 4.7%. Wage activity demonstrated similar growth, from ninth to first in the rankings, increasing its share by 3.3% (in 1999 dollars).

All retail, finance and service sector activity has traditionally concentrated in the capital region. One notable exception is the business services sector. At the beginning of the study period, Business Services employment was concentrated not only in San Juan, but also in Ponce, the largest population center in the South Coast (see Map V). Wage activity was similarly concentrated not only in San Juan, but also in Aguadilla, a municipality in the Northwest Region (see Map VII). No clusters were initially identified, since concentration was limited to these three municipalities.

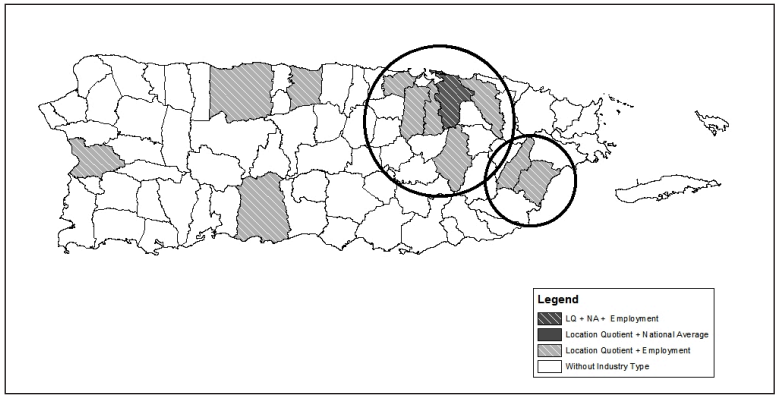
In 1999, Ponce did not develop into a cluster; no adjoining municipalities exhibited the required employment levels (see Map VI). The San Juan cluster emerged with 44,999 employees, and included five additional municipalities in its metropolitan region. In addition, a new cluster with 2,811 places of employment was also formed in the Southeast. This last cluster coincided with the formation of the Chemicals and Allied Products sector in the same region, so there is a possibility of a strong association between these clusters. A later phase of this research will focus on the Chemicals clusters and their relationship to other industrial sectors in the region.

An examination of the end of period Business Services wage clusters shows the magnitude and spread of service activity throughout the Island (see Map VIII). The activity observed in Aguadilla grew significantly to include two other municipalities, and there are two additional clusters in the Southwest and Northeast. There is also significant activity in San Juan and the Central Region. A total of 34 municipalities have shown higher than average Business Services wage activity, confirming wide regional diffusion of this top ranked sector.

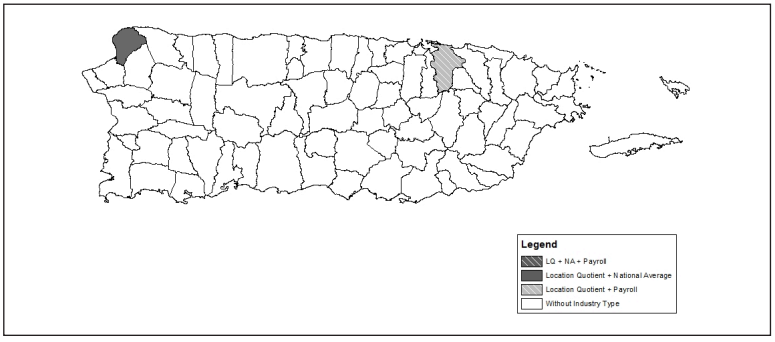
Map V. Business Services Employment Clusters: 1979



Map VI. Business Services Employment Clusters: 1999



Map VII. Business Services Wage Clusters: 1979



Map VIII. Business Services Wage Clusters: 1999

Conclusions

We were able to use a cluster identification methodology that diminishes data requirements on the respondent, just requiring a measure of employment and/or wages at the national level and a local level. Its application in the context of the US and Latin American countries is relatively simple; all that is needed is a measure of employment and/or wages by economic sector. The methodology is useful not only to identify the location of regional clusters, but also to initially classify them according to their maturity.

An examination of the emergence and decline of clusters points towards the regional diffusion of post industrialization. Clearly, segments of labor intensive industries such as apparel and food processing have been partially displaced by "postindustrial industries" or knowledge-intensive industries such as chemical and allied products, where pharmaceutical industries are the leading group. Pharmaceuticals, however, have a heavy financial and marketing component in Puerto Rico given the tax advantages of section 936 of the U.S. Internal Revenue Code, repealed in 1996 and ending in December 2005. The diffusion of clusters outside the San Juan area was not limited to manufacturing, but also included construction, wholesale, and service activity. The dispersion observed in these sectors pointed to aggressive post industrialization along Puerto Rico's productive regions outside the San Juan metropolitan area.

The cluster identification and classification methodology in this research report is intended to provide an initial mapping tool to researchers interested in economic cluster activity, identifying regions of employment and wage concentration and providing a measure of the cluster's maturity. There are numerous additional methods that can be used to further refine this definition. A second stage of this research would focus on examining the previously identified Chemicals sector clusters by means of qualitative methods, including interviews with managers in cluster pharmaceutical firms. To further refine the spatial definition of cluster presented in this report, the focus would shift to the identification and analysis of forward and backward linkages with other firms within and outside the pharmaceutical industry cluster.

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