

Diversity of Economic Activity for Metropolitan Areas in Puerto Rico: 1980-2000

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Introduction

Puerto Rico has experienced dramatic changes in its sectoral industrial composition during the latter half of the twentieth century. A majority of the research has focused on the rapid process of industrialization that took place as foreign investment grew in the export-oriented manufacturing sector. A question that does not seem to be as thoroughly researched in the literature is whether Puerto Rico's economy has undergone a process of deindustrialization after the oil crisis of the 1970's. Harrison (1982) has defined deindustrialization as a widespread, systematic disinvestment in a nation's basic productive capacity. Pantojas-Garcia (1990) and Dietz (2003) similarly suggest a move towards postindustrialization, but do not analyze deindustrialization as a process at the metropolitan level. An examination of shifts in employment by industrial sector would allow us to examine whether deindustrialization has occurred in Puerto Rico at the metropolitan level.

Changes in sectoral employment composition, however, may be indicative not only of deindustrialization processes, but also of industrial stability in a region. It is assumed that a more diversified economy is less susceptible to economic downturns because its product and employment depend on a variety of industrial sectors (Dissart 2003). In addition, industries in a diversified economy may benefit from cross-industry spillovers if they are located in the same region of influence. The following research will therefore use sectoral employment analysis with a dual purpose: assessing possible deindustrialization trends in Puerto Rico and estimating its levels of industrial stability and cross-industry spillovers.

Given that a large majority of economic activity takes place within Puerto Rico's metropolitan boundaries, the following research will explore changes in the sectoral composition of Puerto Rico's eight metropolitan areas during the last twenty years of the twentieth century. The metropolitan area concept is a statistical representation of the social and economic linkages between urban cores and outlying areas. The US Office of Management and Budget defines a metropolitan area as a core area containing a substantial population nucleus, together with adjacent communities having a high degree of economic and social integration with the core.

Each metropolitan area's sectoral employment figures will be examined to determine which economic sectors account for a majority of formal sector employment and those that have experienced the most employment growth during the study period. The resulting analysis will establish whether Puerto Rico's metropolitan economies have begun a process of deindustrialization.

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In order to establish a broader measure of variation in industrial structure, each metropolitan area's industrial composition will be analyzed to calculate estimates of local metropolitan area absolute diversity and relative diversity. Absolute diversity is a measure of the variety of formal sector employment present in a given metropolitan area, while relative diversity is obtained by comparing each metropolitan area's local employment structure with Puerto Rico's as a whole. The following research will also attempt to establish whether there is an association between these diversity trends and changes in manufacturing employment.

Diversion of capital from productive investment has generally not freed labor and capital from relatively unproductive uses to put them to work in more productive uses, as shown by various studies of workers who lose their jobs as a result of plant closings (Harrison 1982). Benería and Santiago (2001) have shown that workers displaced in the manufacturing sector are unable to recuperate financial losses as a result of displacement. From a policy perspective, it becomes necessary to measure the extent of deindustrialization in Puerto Rico and its possible future trends to gauge the impact of displacement on manufacturing workers. If deindustrialization has in fact occurred in Puerto Rico during the study period, the public sector may have to adjust its unemployment programs to accommodate what may be an increasing number of displaced manufacturing workers with skills that may not be transferable in the workplace.

2.0 Literature Review

Puerto Rico's rapid industrialization during the mid- twentieth century led to a significant transformation in the sectoral composition of the economy (Dietz 1986, Pantojas-Garcia 1990). Puerto Rico's economy since the 1950's has increasingly relied on industrial exports to the United States. In 1980, manufacturing GDP was \$5,323 million, or 36.8% of total GDP; by 2000, the figure had increased to \$27,442 million, or 43.5% of total GDP (Curet 2003). Such an increase could be partly due to financial manipulations, and may not necessarily represent production increases (Pantojas García 1997). These figures seem to point to the increasing importance of manufacturing during the study period. Since the proposed research focuses on the impact of deindustrialization on workers in metropolitan economies, the analysis will center on employment trends.

The focus on manufacturing activities in Puerto Rico, first labor intensive, and later capital intensive, had a significant impact on long-term industrial diversity and stability. If a region specializes in a small number of fast growing industries, rapid growth may be possible, but the region may be vulnerable to downturns in the industries in which it specializes (Dissart 2003). Puerto Rico's reliance in a federally legislated industrial incentive structure has led to an increased vulnerability resulting from the modification or elimination of such benefits.

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If economic diversity reduces volatility, a region wishing to reduce its vulnerability might pursue a diverse industrial mix as a desirable economic development goal (Sherwood-Call 1990). A diverse economy with different industries leads to employment gains in some, offset by losses in others. Malizia and Ke (1993) hypothesize that more industrially diverse areas lead to more stable economic growth, and less unemployment. An additional dimension that needs to be explained is the stability of individual industries; employment in unstable industries may also lead to economic instability.

If diversity is associated with economic stability, then a higher level of industrial diversity may be desirable. Layoffs would occur at different times, and affect a smaller portion of the work force at any time. There are exceptions, such as regions specializing in public administration and education, which are typically among the most stable of regional economies (Hackbert and Anderson 1975).

For diversity to work effectively in reducing unemployment, workers laid off in one industry should be able to find work in another local industry. Occupational diversity may result in more unemployment or instability due to difficulties reemploying heterogeneous workers (Malizia and Ke 1993).

Measures of diversity have also been used to conjecture the likely response of a region to fluctuations in extra regional or national business cycles. If a region's structure is like that of a nation, one might expect that, *ceteris paribus*, the region will respond to the business cycle in a manner similar to the nation as a whole (Hackbert and Anderson 1975). For example, a region with one or two major industries that relies substantially on exports (or the marginal propensity of other regions to import) may be very susceptible to large fluctuations in the local economy in response to extra regional business cycles (Wasylenko and Erickson 1978).

3.0 Methodology

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 establishment data is collected every year for each of Puerto Rico's 78 municipios, providing data up to the four-digit SIC level. We have selected as our study period 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 metropolitan deindustrialization may have occurred.

Metropolitan Statistical Areas have been selected as the unit of analysis because their geographical space is the location where a vast majority of industrial activity takes place in Puerto Rico, and also constitutes distinct labor markets. In addition, the presence of agglomeration economies associated with urban concentration or diversity is not only limited to central city areas but should also include surrounding suburban areas. Metropolitan areas therefore represent a more adequate unit of analysis than cities or municipios.

Since metropolitan area definitions depend mainly on variables such as commutation patterns and population density, boundary changes during a twenty-year period can be significant. To be able to compare sectoral composition patterns at the metropolitan level throughout the study period, one must therefore choose a particular boundary. End-of-period boundary definitions would have the advantage of representing the most recently observed commutation and density patterns in the regions for the study period, and would include any municipios incorporated into the metropolitan area. The following research will therefore use end-of-period, or 1999, US Office of Management and Budget definitions for metropolitan area boundaries.

Metropolitan industrial diversity has been estimated using two absolute measures, the Herfindahl and Entropy Indexes, and one relative measure, the National Averages Index^{*}. The Herfindahl Index measures both the spread and the relative importance of Metropolitan Area activities in different industries. It estimates diversity by calculating the inverse of the sum of the squared proportion of employment per industrial sector. A higher Herfindahl Index value would therefore represent a more diversified MA.

A second measure of metropolitan industrial diversity, the Entropy index, can be defined as a statistic that measures the deviation of a given distribution from complete concentration (minimum entropy) or dispersion (maximum entropy). The entropy index provides a reference point for the state of perfect diversity, where attention is focused on the variety of sectors, rather than the type of sectors (Siegel, Johnson and Alwang 1995). If a region's employment is concentrated in a single sector, the value of the entropy index equals 0. If regional employment were equally distributed among all sectors, then the entropy index would achieve its maximum value, the natural logarithm of all sectors.

The entropy measure is particularly useful because it allows comparisons across different regions and time periods. It provides reference points for the state of perfect diversity, where attention is not focused on the types of sectors. The entropy concept has proven to be extremely valuable as a measure of spatial distributions of socioeconomic variables, such as employment (Siegel, Johnson and Alwang 1995).

Wasylenko and Erickson (1978) have identified several problems that may arise when using the Entropy index. The measure might be incorrectly interpreted in the case of regions specializing in education and public administration, that are typically among the most stable of regional economies. In this case, a low entropy index would be estimated for a stable economy. In addition, the entropy index may indicate that a region is becoming more diverse over time, when the industrial structure of the region may be becoming less diverse when compared to the industrial structure of the national economy at each of the time periods (Wasylenko and Erickson 1978). The National Averages Index, a relative diversity index, allows for such comparisons of a region to the national economy.

^{*} See Appendix

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The National Averages Index is similar to the Location Quotient; it measures the square of the regional deviations from the national percentages of industrial categories. The National Average Index responds to the following hypothesis: the more similar a region's sectoral composition 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 industrial diversity would be (Dissart 2003). With the National Average Index, the region is optimally diversified when it mirrors the nation (Gilchrist and St. Louis 1991). The national industry mix provides a standard with which to measure a region's industrial structure. Puerto Rico's industrial structure would provide a reasonable standard for diversity given the present analysis. 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.

4.0 Results

4.1 Puerto Rico

A preliminary analysis of Puerto Rico's establishment employment by industrial sector shows signs of an emerging deindustrialization trend during the period. The following tables (1 and 2) list the five main industrial employment sectors in Puerto Rico for the years 1979 and 1999. Industries have been classified according to two-digit SIC codes, and sorted from highest to lowest employment levels.

Puerto Rico

Table 1

Principal Economic Sectors, 1979	
Puerto Rico	
Sector	Employment
Manufacturing (20--)	155,888
Retail trade (52--)	82,973
Services (70--)	81,102
Construction (15--)	31,599
Wholesale trade (50--)	29,568
Total Employment	381,130
Source: County Business Patterns	

Table 2

Principal Economic Sectors, 1999	
Puerto Rico	
Sector	Employment
Services (70--)	213,645
Retail trade (52--)	166,146
Manufacturing (20--)	151,266
Construction (15--)	61,637
Finance, insurance and real estate (60--)	45,470
Total Employment	638,164

The manufacturing sector has retained a similar amount of employees during the period 1979-1999. The lack of growth in this sector explains why it has dropped from the first position to the third. An analysis of employment by four-digit SIC indicates that, in 1999, chemicals continued to dominate this shrinking economic sector.

The services sector experimented a 163% increase during the period, and became by 1999 the most important sector in terms of employment. Both medical and business services were identified as the main service sectors in Puerto Rico by 1999. Retail was the next most important sector, showing 100% growth during the period. Construction continued to occupy the fourth position in terms of employment, increasing 95% during the period. Wholesale trade, initially in the fifth position, was substituted by a growing finance, insurance and real estate (FIRE) sector by 1999.

The increasing role of services and retail seemed to have a moderate positive impact on the diversity level of the island's actual economic structure. The Herfindhal Index for Puerto Rico as a whole seems to reflect an increase in diversity, even though the Entropy index did not reflect significant changes during the period.

4.2 The Metropolitan Areas

The following analysis examines changes in metropolitan industrial structure for the metropolitan areas under consideration: Aguadilla, Fajardo, Guayama, Mayagüez, Ponce, San Germán, San Juan and Yauco. For each of these regions, changes during the study period for the top five employment sectors will be examined, as well as changes in their local and relative diversity indexes.

A comparison of Islandwide 1979 and 1999 results shows that five of eight metropolitan areas have increased their local diversity levels. Four metropolitan areas do not present clear evidence of increased diversity: Guayama, Ponce, Mayagüez and San Juan. The National Average index results, which compare the metropolitan area's economic structure with Puerto Rico's, show fairly consistent results across regions. Six metropolitan areas show evidence of increasing similarity with Puerto Rico's overall structure, while only three metropolitan areas show a decreasing similarity: Mayagüez, Fajardo and Guayama.

Table 3
Metropolitan Area Indexes, 1979

Area Metro	Herfindahl	National Average	Entropy
Aguadilla	7.45	3.13	3.60
Fajardo	9.36	1.88	3.57
Guayama	6.71	3.11	3.83
Mayaguez	9.59	0.90	3.49
Ponce	25.73	0.84	5.15
San Germán	0.02	2.19	3.56
San Juan	15.53	0.04	5.43
Yauco	4.19	4.62	3.68

Table 4
Metropolitan Area Indexes, 1999

Area Metro	Herfindahl	National Average	Entropy
Aguadilla	19.20	2.79	4.92
San Juan	28.65	0.04	5.40
Mayaguez	48.65	0.93	3.08
Fajardo	14.32	3.01	5.03
Guayama	7.70	3.43	4.27
Ponce	22.58	0.57	5.19
San German	16.77	0.93	4.94
Yauco	17.86	1.45	5.30

4.2.1 Aguadilla

Table 5

Principal Economic Sectors, 1979	
Aguadilla Metropolitan Area	
Sector	Employment
Manufacturing (20--)	10,453
Retail trade (52--)	2,829
Services (70--)	1,641
Construction (15--)	486
Wholesale trade (50--)	401
Total Employment	15,810
Source:County Business Patterns	

Table 6

Principal Economic Sector, 1999	
Aguadilla, Isabela, San Sebastian Metropolitan Area	
Sector	Employment
Manufacturing (20--)	16,184
Retail trade (52--)	8,301
Services (70--)	5,340
Construction (15--)	1,722
Finance, insurance and real estate (60--)	948
Total Employment	32,495
Source: County Business Patterns	

Aguadilla's four most important sectors, manufacturing, retail, services and construction, have retained their ranking during the study period, but their growth rates have varied significantly. Manufacturing, the most important sector in terms of employment, grew 55% from 1979 to 1999, while the remaining three sectors increased at more rapid rates (193% to 254%).

The Aguadilla metropolitan area did show significant dependence on the manufacturing sector, as evidenced by the unusual employment growth in this category. An analysis using four-digit SIC level data reveals that the four largest industrial employment categories by 1999 were manufacturing-related (instruments, electronics, leather and industrial machinery). Finance, insurance and real estate substituted wholesale trade as the fifth most important employment sector of the economy during this period, a trend that was also observed for Puerto Rico aggregate data.

Diversity indexes point to two emerging trends during the twenty-year period. Aguadilla's economy has become increasingly like Puerto Rico's in terms of relative diversity, as evidenced by the 11% decrease in the National Averages Index. An examination of the corresponding index levels (2.79 in 1999), however, indicates that even though both economic structures have grown increasingly similar, the difference between the two is still significant. Locally, index estimations point to a metropolitan economy with increasing diversity. Both the Herfindhal and Entropy Indexes increased from 1979 to 1999. Even though the main employment sectors remained mostly unchanged during the period, it seems that sectoral composition in the metropolitan economy has become increasingly diversified.

4.2.2 Fajardo

Table 7

Principal Economic Sectors, 1979	
Fajardo Metropolitan Area	
Sector	Employment
Manufacturing (20--)	2,639
Retail trade (52--)	1,231
Services (70--)	899
Construction (15--)	181
Wholesale trade (50--)	130
Total Employment	5,080
Source: County Business Patterns	

Table 8

Principal Economic Sectors, 1999	
Fajardo Metropolitan Area	
Sector	Employment
Retail trade (52--)	3,228
Services (70--)	3,098
Manufacturing (20--)	2,698
Transportation and public utilities (40--)	389
Construction (15--)	349
Total Employment	9,762
Source: County Business Patterns	

Fajardo experienced significant sectoral changes from 1979 to 1999. The stagnation of the manufacturing sector during the twenty-year period is evidenced by its decrease in sectoral employment rankings from first to third. Nevertheless, manufacturing was still important in 1999, as shown by the presence of a large industrial machinery and equipment sector, and apparel and other textile products. It was the retail and service sectors that grew rapidly to provide additional employment in the area, becoming the two most important economic sectors in 1999. Construction dropped to the fifth position, while wholesale was substituted by transportation in the top five. The Fajardo metropolitan area did show an increasing dependence on the tourism sector. A 1999 analysis of sectoral employment at the four-digit SIC level revealed that hotels and other lodging places and eating and drinking places were the two main industrial sectors of the area.

Fajardo is a metropolitan area that has grown increasingly less like Puerto Rico's aggregate structure. Its shift towards greater specialization in tourism during the period, reflected indirectly through services and retail growth, has led to greater concentration levels than those observed in Puerto Rico's economic structure as a whole. Local diversity indexes, however, did show that internal economic changes have led to increasing diversity in the region. Both the Herfindhal and the Entropy indexes increased

during the period 1979-1999, pointing to greater diversity as a result of a deindustrialization process in the region.

4.2.3 Guayama

Table 9

Principal Economic Sectors, 1979	
Guayama Metropolitan Area	
Sector	Employment
Manufacturing (20--)	3,295
Retail trade (52--)	1,182
Services (70--)	606
Wholesale trade (50--)	283
Finance, Insurance, and real estate (60--)	223
Total Employment	5,589
Source: County Business Patterns	

Table 10

Principal Economic Sectors, 1999	
Guayama Metropolitan Area	
Sector	Employment
Manufacturing (20--)	5,401
Retail trade (52--)	2,898
Services (70--)	2,302
Finance, insurance and real estate (60--)	466
Construction (15--)	257
Total Employment	11,324
Source: County Business Patterns	

The Guayama metropolitan area exhibited an industrial employment structure similar to Aguadilla's. By 1999, manufacturing continued to be the main source of employment, while retail and services continued to play an important role. 1999 Employment rankings by four-digit SIC data indicated that chemicals, rubber and instruments provided 4,800 jobs in the region. Health services were also of particular importance, providing 1,335 positions in the area. Wholesale trade was no longer part of the top five industries, while construction employment gained more importance in the area. Finance, insurance and real estate continued to play an important role, ranking fourth by 1999.

Guayama is one of the metropolitan areas that has shown the least change in local and comparative diversity index levels during the study period. The National Average index grew only 10%, indicating that the difference in MA and Puerto Rico aggregate

structures slightly increased during the period. The index level in 1999, 3.4, points to the fundamental differences in the structure of both economies. Local diversity indexes consistently reflect increasing diversity in Guayama, though the changes are modest. The Herfindhal and Entropy indexes grew 15% and 11%, respectively, during the study period. These small changes in the employment structure may be due to Guayama's continuing industrialization during the study period. Furthermore, the changes observed in retail and services were not as significant as in other metropolitan areas.

4.2.4 Mayagüez

Table 11

Principal Economic Sectors, 1979	
Mayagüez Metropolitan Area	
Sector	Employment
Manufacturing (20--)	10,867
Retail trade (52--)	4,624
Services (70--)	3,280
Construction (15--)	1,046
Wholesale trade (50--)	978
Total Employment	19,996
Source: County Business Patterns	

Table 12

Principal Economic Sectors, 1999	
Mayagüez Metropolitan Area	
Sector	Employment
Manufacturing (20--)	8,873
Services (70--)	8,627
Finance, insurance, and real estate (60--)	2,185
Whole trade (50--)	781
Transportation and public utilities (40--)	375
Total Employment	20,841
Source: County Business Patterns	

Even though manufacturing has remained the most important employment sector, it decreased by 18% during the study period. The services and finance sectors provided much of the new employment during the period; the service sector alone grew 152%. The four-digit SIC ranking shows that food processing, particularly the tuna industry in this case, was still the most important employment sector in 1999, followed closely by business and health services. One of the two large tuna-processing facilities, Star Kist, closed shortly after the end of the study period. Chemicals and allied products and eating and drinking places were also included in the top five four-digit SIC industries.

4.2.5 Ponce

Table 13

Principal Economic Sectors, 1979	
Ponce Metropolitan Area	
Sector	Employment
Manufacturing (20--)	12,815
Services (70--)	6,885
Retail trade (52--)	6,173
Construction (15--)	2,294
Wholesale trade (50--)	1,817
Total Employment	29,984
Source: County Business Patterns	

Table 14

Principal Economic Sectors, 1999	
Ponce Metropolitan Area	
Sector	Employment
Services (70--)	14,917
Retail trade (52--)	11,836
Manufacturing (20--)	9,061
Construction (15--)	4,552
Finance, Insurance and real estate (60--)	2,117
Total Employment	42,483
Source: County Business Patterns	

Manufacturing employment in Ponce decreased by 29% during the twenty-year study period. The sectors that grew to play a greater role in employment in the area were services and retail, which in 1999 were ranked first and second in the area. Construction continued to be an important contributor to the area, and the FIRE sector grew to displace wholesale trade in the fifth position. An analysis of rankings by four-digit SIC employment sectors revealed that, by 1999, manufacturing did not seem to be as significant as in other metropolitan areas. Instruments and related products occupied a lower position than health and business services, which were the two largest employment sources. General contractors and general merchandise stores were also listed as major employment categories.

Ponce's economic structure was already quite similar to Puerto Rico's aggregate structure by the beginning of the study period. The National Average Index decreased, indicating that Ponce's economy had grown increasingly similar during the twenty-year period.

The Herfindhal and Entropy indexes did not point to significant changes in local industrial diversity. Even though Ponce had deindustrialized during the study period, this structural change does not seem to have affected local diversity patterns, but may be consistent with increasing similarities with Puerto Rico's aggregate economic structure.

4.2.6 San Germán

Table 15

Principal Economic Sectors, 1979	
San German Metropolitan Area	
Sector	Employment
Services (70--)	4,045
Manufacturing (20--)	3,650
Retail trade (52--)	1,759
Construction (15--)	497
Finance, Insurance, and real estate (60--)	172
Total Employment	10,123
Source: County Business Patterns	

Table 16

Principal Economic Sectors, 1999	
San German Metropolitan Area	
Sector	Employment
Manufacturing (20--)	4,725
Retail trade (52--)	3,807
Services (70--)	3,057
Construction (15--)	1,301
Finance, insurance and real estate (60--)	266
Total Employment	13,156
Source: County Business Patterns	

San Germán is the only municipio where manufacturing grew to become the most important employment sector by the end of the study period. By 1999, both services and retail continued to occupy two of the top three employment positions; retail grew 116%, while the service sector decreased 24%. Construction and finance retained their position in the employment rankings, showing modest increases during the period. Four-digit SIC employment rankings show that, within the manufacturing sector, apparel and other textile products and electronics and other equipment provided the most employment by 1999. Health services, eating and drinking places, and general contractors and operative builders were also important end-of-period employment sources.

San Germán's local economy also grew increasingly diverse and similar to Puerto Rico's economic structure. Both the Herfindhal and the Entropy indexes point to growth in local diversity. Perhaps the increasing importance of manufacturing employment has contributed to the greater variety of industries in the area. Increasing local diversity may have also made San Germán's economic structure more similar to that observed in Puerto Rico during the study period. The National Average Index was initially quite high, and decreased in value 74% by 1999.

4.2.7 San Juan

Table 17

Principal Economic Sectors, 1979	
San Juan Metropolitan Area	
Sector	Employment
Manufacturing (20--)	102,119
Services (70--)	64,194
Retail trade (52--)	61,460
Construction (15--)	26,803
Wholesale trade (50--)	25,491
Total Employment	280,067
Source: County Business Patterns	

Table 18

Principal Economic Sectors, 1999	
San Juan Metropolitan Area	
Sector	Employment
Services (70--)	172,488
Retail trade (52--)	121,646
Manufacturing (20--)	96,613
Construction (15--)	47,289
Finance, insurance and real estate (60--)	38,546
Total Employment	476,582
Source: County Business Patterns	

San Juan is the largest metropolitan area in Puerto Rico; two-thirds of Puerto Rico's municipios (51 of 78) are part of this region. As in other metropolitan areas, a reduction in manufacturing employment (5%) was observed during the study period. By 1999, services and retail became the top two sectors in the area, providing nearly half of total employment. Construction had retained its fourth position in the rankings, and wholesale trade was substituted by finance, insurance and real estate as the fifth most important employment sector. A ranking of employment sectors by four-digit SIC shows

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that business and health services were the top two sectors in 1999, accounting for nearly half of total employment in the San Juan metropolitan area. Chemicals was the only manufacturing sector represented in the top five positions. Apparel and electronics, originally present in the 1979 top five rankings, was no longer present by 1999. Eating and drinking places employment occupied the third position, and the general contractors and operative builders sector completed the 1999 top five employment sources.

San Juan's economic structure was the most similar to Puerto Rico's as a whole, probably because it contained nearly two-thirds of all municipios in Puerto Rico. The National Average Index value of 0.04, the lowest for any metropolitan area, is indicative of such similarities.

San Juan's local economy seems to have grown increasingly diverse during the study period, though the evidence on local diversity is not very strong. The Herfindhal Index showed an increase, while the Entropy index did not change significantly. It is possible that the deindustrialization process has not altered San Juan's economic diversity patterns significantly.

4.2.8 Yauco

Table 19

Principal Economic Sectors, 1979	
Yauco Metropolitan Area	
Sector	Employment
Manufacturing (20--)	3,028
Retail trade (52--)	1,840
Wholesale trade (50--)	371
Services (70--)	336
Construction (15--)	265
Total Employment	5,840
Source: County Business Patterns	

Table 20

Principal Economic Sectors, 1999	
Yauco Metropolitan Area	
Sector	Employment
Retail trade (52--)	2,097
Services (70--)	1,879
Construction (15--)	1,573
Manufacturing (20--)	1,046
Finance, insurance and real estate (60--)	411
Total Employment	7,006
Source: County Business Patterns	

Yauco is one of the more recently defined metropolitan areas. The trend of manufacturing employment loss observed in other metropolitan areas is repeated, but in this case the reduction observed (65%) was significant. Retail and services grew to occupy the top two positions by 1999, providing more than half of total employment in the area. Construction employment grew and continued to be important, occupying the fourth position in 1999, and wholesale trade was once again substituted by finance, insurance and real estate employment. Four-digit SIC rankings indicate that, within manufacturing, chemicals, food and kindred products, and furniture and fixtures, present in 1979, were no longer in the top five employment categories by 1999. By then, special trade contractors provided nearly a third of all employment in the area, and health services, food stores, heavy construction and eating and drinking places occupied the remaining four positions. A diversified economy was evident, where services were particularly important, and manufacturing secondary, unlike several other metropolitan areas.

Yauco has also shown a pattern similar to that evidenced in San Germán and Aguadilla. The local economy, although initially quite different from Puerto Rico's economic structure, became increasingly similar by the end of the study period. Local diversity increased, as evidenced by both the Herfindhal and Entropy indexes. Yauco's deindustrialization process could also be associated with increasing local diversity and increasing similarities with Puerto Rico's overall economic structure.

5.0 Conclusions

A majority of Puerto Rico's metropolitan areas have deindustrialized during the last twenty years of the twentieth century. Fajardo, Mayagüez, Ponce, San Juan, Yauco, and Puerto Rico as a whole experienced manufacturing employment losses during this period. Only Aguadilla, Guayama, and San Germán did show gains in manufacturing employment. It is possible that, along with the complete elimination of US IRS section 936 tax benefits after 2005, manufacturing employment losses could increase in terms of magnitude and geographical extent.

An increase in metropolitan manufacturing employment coincided with an increase in local diversity in Aguadilla, Guayama and San Germán. In the remaining metropolitan areas, where manufacturing employment decreased during the period, either increases in local diversity were also observed, or inconclusive results were obtained. Overall, metropolitan diversity increased regardless of changes in manufacturing employment.

A majority of metropolitan economies have also become more like the overall Puerto Rican economy in terms of sectoral employment diversity. Aguadilla, Ponce, San Germán and Yauco grew increasingly similar to the Puerto Rican aggregate during the study period, while Fajardo, Mayagüez and Guayama, grew increasingly dissimilar. Once again, there is no clear trend associating changes in manufacturing employment and relative diversity.

Local and relative diversity measures do not answer various important questions, such as what constitutes an optimal diversity pattern, nor do they establish a causal relationship between economic diversification and economic development policy variables (Hackbert and Anderson 1975). To ascertain these relationships, a measurement of diversity indices is necessary, but not sufficient.

Other areas that require further exploration may include an analysis of the character of individual industries with respect to the size of firms, their growth rates and degrees of instability, the types of labor they employ and the interrelationships among them. The San Juan metropolitan area can also be subdivided into smaller areas to understand its internal changing dynamics of industrial structure.

Puerto Rico's deindustrialization trend is expected to have continued up to the present due to the impact of the gradual elimination of US IRS Section 936 during a ten-year period (1995 to 2005). Along with a reduction of manufacturing employment in a majority of metropolitan areas, the number of displaced manufacturing workers with non-transferable skills will most likely continue to increase, and the public sector will have to adjust its policies directed at unemployment alleviation. Because many of their skills are non-transferable, workers can benefit from acquiring new skills to help them adapt to a rapidly changing economic structure where knowledge and technology are becoming increasingly important.

References

- Attaran Mohsen. 1986. Industrial diversity and economic performance in U.S. areas. *California State University. Bakersfield California*. 44-54.
- Benería, Lourdes and L. Santiago. 2001. The Impact of Industrial Relocation on Displaced Workers. *Economic Development Quarterly* 15: 229-224.
- Board, John, and Charles Sutcliffe. 1991. Risk and income tradeoffs in regional policy: A portfolio theoretic approach. *Journal of Regional Science* 31: 191-210.
- Bradshaw, Ted K., and Edward J. Blakely. 1999. What are third “wave state” economic development efforts? From incentives to industrial policy. *Economic Development Quarterly* 13: 229-224.
- Brewer, H. L. 1985. Measures of diversification: predictors of regional economic instability. *Journal of Regional Science* 25:463-70.
- Brewer, H. L., and Ronald L. Moomaw. 1985. A note on population size, industrial diversification, and regional economic instability. *Urban Studies* 22: 349-54.
- Brown Deborah J. and Jim Pheasant. 1985. A sharpe portfolio approach to regional economic analysis. *Journal of Regional Science* 25: 51’63
- Bureau of the Census, *County Business Patterns*, US Department of Commerce, Washington, DC, 1979.
- Bureau of the Census, *County Business Patterns*, US Department of Commerce, Washington, DC, 1999.
- Curet, E. 2003. *Economía Política de Puerto Rico: 1950 a 2000*. San Juan: Ediciones M.A.C.
- Dietz, J. 1986. *Economic history of Puerto Rico: Institutional change and capitalist development*. Princeton: Princeton University Press.
- Dietz, J. 2003. *Puerto Rico: Negotiating development and change*. Boulder: L. Rienner.
- Dissart, J. C. 2003. Regional Economic Diversity and Regional Economic Stability: Research Results and Agenda. *International Regional Science Review* 26: 423-446.
- Doeringer, Peter B., and David G. Terkla. 1995. Business Strategy and cross industry clusters. *Economic Development Quarterly* 9: 225-37.
- Feser Edward J. 1998. Enterprises, external economies, and economic development. *Journal of Planning Literature* 12: 283-302

- Gilchrist, Donald A., and Larry V. St. Louis. 1991. Directions for diversification with an application to Saskatchewan. *Journal of Regional Science* 31: 273-89.
- Hackbart Merlin M., and Donald A. Anderson. 1975. On measuring economic diversification. *Land Economics* 4: 374-378.
- Harrison, B. and B. Bluestone. 1982. *The deindustrialization of America: plant closings, community abandonment, and the dismantlement of basic industry*. New York: Basic Books.
- Isard, Walter, Iwan J. Azis, Matthew P. Drennan, Ronald E. Miller, Sydney Saltzman, and Erik Thorbecke. 1998. Methods of interregional and regional analysis. *Regional Science Studies Series*. Aldershot, England: Ashgate.
- Lande Paul S. 1994. Regional industrial structure and economic growth and instability. *Journal of Regional Science* 34: 343-360
- Malizia Emil E. and Shanzi Ke. 1993. The Influence of economic diversity on unemployment and stability. *Journal of Regional Science* 33: 221-235
- Pantojas-García, E. 1990. *Development strategies as ideology: Puerto Rico's export-led industrialization experience*. Boulder: Lynne-Rienner.
- Sherwood-Call, Carolyn. 1990. Assessin regional economic stability: A portfolio approach. *Economic Review (Federal Reserve Bank of San Francisco)*: 17-26.
- Siegel, Paul B., Jeffrey Alwang, and Thomas G. Johnson. 1994. Toward and improved portfolio variance measure of regional economic stability. *Review of Regional Studies* 24: 71- 86.
- Siegel Paul B., Thomas G. Johnson, and Jeffrey Alwang. 1995. Regional Economic Diversity and Diversification. *Growth and Change* 26: 261-284
- Wagner, John E., and Steven C. Deller. 1998. Measuring the effects of economic diversity on growth and stability. *Land Economics* 74: 541-56.
- Wasylenko Michael J., and Erickson Rodney A.1978. On measuring economic diversification:Comment. *Land Economics* 54: 106-109

APPENDIX

Industrial diversity has been estimated using two absolute measures, the Herfindahl Index H and the Entropy Index, and one absolute measure, the National Averages Index. The Herfindahl Index measures both the spread and the relative importance of Metropolitan Area activities in different industries. It measures diversity by adding the squared proportion of employment per industrial sector. The following equation describes the Herfindahl Index:

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

where X_i is sector i 's share of employment and N is the number of sectors in the region. The index takes into account the relative importance of the Metropolitan Areas' industrial employment diversity. A higher Herfindahl Index value represents a more diversified MA in terms of employment.

Entropy can be defined as a statistic that measures the deviation of a given distribution from complete concentration (minimum entropy) or dispersion (maximum entropy). The following equation describes the entropy index:

$$E = -\sum_{i=1}^N X_i \ln X_i$$

where X_i is the sectoral share of employment and N is the number of sectors. If a region's employment is concentrated in a single sector, the value of the entropy index equals 0. If regional employment were equally distributed among all sectors, then the entropy index would achieve its maximum value, or the natural logarithm of all sectors.

The National Averages Index is similar to the Location Quotient; it measures the square of the regional deviations from the national percentages in industrial categories. The National Average Index responds to the following hypothesis: the more similar a region's sectoral composition is to that of the nation's, the more stable it should be relative to other regions (Siegel, Johnson and Alwang 1995). The following equation describes the National Average Index:

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

where X_i is the i th's sector share of employment in the region, and \bar{X}_i is the national average sectoral share of employment in sector i . The greater the sum of the deviations, the greater the industrial employment specialization or the lower the industrial employment diversity (Dissart 2003). With the National Average Index, the region is optimally diversified when it mirrors the nation (Gilchrist and St. Louis 1991).