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Estimating GDP at the Parish (County) Level: An Evaluation of Alternative Approaches

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Executive Summary

- Gross Domestic Product or GDP was estimated at the parish (county) level to analyze the economic condition of parish economies, particularly rural parish economies that often are left out of economic analyses.

- GDP as estimated at the parish level in this analysis allows for comparing the relative returns of capital and labor for economic activity in rural regions that previous data such as employment, wages and earnings by themselves were not able to capture fully.

- When earnings data were disclosed, GDP was estimated using a ratio of state GDP to state earnings by sector multiplied by parish earnings by sector. This method was preferred because of the high correlation between state-level earnings and GDP data.

- When earnings data were not fully disclosed, this research found that the approach of estimating parish-level GDP using a ratio of state GDP to state employment by sector proved more accurate than the approach of using an earnings per employment ratio of contiguous counties.

- There was a shift in Louisiana parish GDP and employment growth rates. Between the periods 2001-2004 and 2004-2007, there was a shift among the parishes from having employment growth above and GDP growth below the corresponding state averages to having GDP growth above and employment growth below the corresponding state averages.

- The chemical, petroleum and coal products manufacturing sector and the mining sector proved to have both the highest GDP growth by parish industry for the period 2001-2007 and the highest percent of total parish GDP for the year 2007.

Introduction

Regional economists often are asked to provide data and analyses for regions smaller than a state. To accomplish this task, they acquire data from many sources, with varying levels of accuracy and disclosure. (Disclosure issues occur when data are withheld because providing them for a given firm in a given sector in a given region would disclose confidential information.)

The U.S. Bureau of Economic Analysis (BEA) publishes county-level earnings data (BEA Local Area Personal Income, 2008). The BEA, however, does not provide estimates for county-level gross domestic product (value-added) data. Given the pressure from many rural development officials for increased "value-added agriculture," there is a need to better identify the value-added contributions of specific county/parish industries.

The objective of this research is to augment previously applied methods with additional new methods so that gross domestic product (GDP) can be estimated at the county/parish level[1]. By estimating county-level GDP, we further analyze the economic condition of county economies, particularly rural county economies that often are left out of economic analyses. This type of county-level analysis can be used by local economic development boards and policymakers as they strive to have sustainable economic development in their region, particularly as it relates to workforce development and industrial recruitment and enhancement.

To develop estimates for GDP at the parish/county level, three different methodologies were examined. Estimates were developed and tested for accuracy using each of the methodologies. Parish-level statistics were then developed using the methodology that proved to be most accurate to examine economic activity and growth by major industries for each of the parishes.

[1] In the state of Louisiana, the term for a county is "parish."

Literature Review

Economic Activity Metrics

The ability to improve the standard of living for people in a region, state or nation is dependent on its ability to generate long-run economic growth, and, perhaps just as important, small changes in the growth of an economy over time can have very large effects on the standard of living in an area (Mankiw, 2009). The sources of economic growth include the availability of inputs (land, labor and capital) and the productive capacities of these inputs, which are influenced by both savings and consumption decisions and governmental policy. Consequently, understanding how those factors influence the economic activity and ultimately the standard of living in an area are of crucial importance to development economists, policymakers and regional planners.

There are several methods/metrics for measuring the economic activity (economic growth) of an area with each metric having its advantages and disadvantages. Certain metrics, however, provide a more comprehensive and informative snapshot than others. Some of the more commonly used metrics are employment, output, earnings and value-added (Andrews, 1954; Shaffer, Deller, and Marcouiller, 2004).

Employment is a clear and easily understood unit of measurement. Collection of employment data is relatively simple, and the data series over time generally are consistent and accurate (Shaffer, Deller, and Marcouiller, 2004). For example, the Census Bureau estimates employment annually for every county by industry (subject to disclosure rules). Companies such as Wholedata have supplemented such federal data sets with methods that estimate employment that could not be disclosed by the government (Isserman and Westervelt, 2006). Yet, employment as an economic metric is limited in its usefulness, since it does not take worker productivity or worker salaries into account (Andrews 1954; Shaffer, Deller, and Marcouiller, 2004). The economic effect of an increase of 50 jobs paying $30,000 is fundamentally different from the same number increase in jobs paying $120,000. In addition, seasonal and part-time employment typically is counted together in federal agency reports. By not recognizing these limitations in the analysis, incorrect inferences could be made. Finally, when considered intuitively, jobs are inputs into the production process, not an output of production.

A more desirable economic activity metric would be based on the value of the products or services being produced. *Output*, which is the value of the production of all industries in an economy, is an alternative economic metric[2]. The drawback to this measure is that it inflates the size of an economy since it does not subtract intermediate product sales among firms in its measurement, which leads to double counting (Shaffer, Deller, and Marcouiller, 2004). Double counting occurs when the value of an input is not subtracted from the value of a firm's output – thereby overestimating the size of the economy. For example, assume a parish or county's agricultural sector grows only corn and hogs and the total output value of each commodity is $1 million, resulting in a total parish/county agricultural output value of $2 million. The total value of the hogs is a function of the value of the inputs that are applied to grow the hogs. Assuming the hog producer purchases 100 percent of the corn produced by the corn farmers in the parish/county, then the $2 million agricultural output value for the county overestimates (double counts) the actual economic contribution of agriculture to the county by the value of the corn purchases by the hog producer.

The earnings metric does not suffer from double counting. It is defined as the labor and property earnings from current production. It includes wage and salary disbursements, supplements to wages and salaries and proprietors' income (BEA Local Area Personal Income, 2009). The problem with this metric is that it does not include taxes on production and imports (fewer subsidies) and does not include the components of gross operating surplus apart from proprietor's income. Taxes on production and imports net of subsidies represents the net transfer of the earned value of goods and services produced

[2] Output in agricultural data sets is approximately equal to gross farm value (Louisiana Summary: Agriculture and Natural Resources 2009) or Gross Farm Income (2009 Louisiana Agricultural Statistics) with a few exceptions.

in a regional economy that are paid (transferred) to various institutions of the economy. For most industries, taxes paid to the government are greater than the subsidies received, so not counting this value would underestimate a regional economy's overall activity. For an industry like agriculture that typically receives more subsidies than it pays in taxes, however, failing to make this adjustment would overestimate the region's economic activity by including unearned income. Since corporate forms of governance are a dominant business structure in most regions of the country, not including their operating surplus would further underestimate the region's economic contribution.

GDP

Gross domestic product (GDP) is considered a comprehensive measure of economic activity. In the United States, the Bureau of Economic Analysis uses three methods to measure GDP: the *expenditure* approach, the *value-added* approach and the *gross domestic income* approach (Landefeld, Seskin, and Fraumeni, 2008). The estimates generated by these methods are conceptually equal, but their estimates may vary slightly because of the different data sources and methods used in the estimation processes. Detailed definitions of each GDP method are presented in the next section.

Expenditure Approach

The *expenditure* approach generates final sales of domestic product to producers, and it is calculated by using the formula provided in Equation (1)

(1) $GDP=C+I+G+X-M$

where C = consumption, I = gross investment, G = government spending, X = exports and M = imports (Landefeld, Seskin, and Fraumeni, 2008). This is one of the most common definitions presented in introductory macroeconomics textbooks (Cramer, Jensen, and Southgate, 2001; Mankiw, 2009).

Value-Added Approach

Alternatively, the *value-added* approach estimates GDP for each industry by subtracting intermediate inputs from gross output (gross sales less changes in inventories) as described by Equation (2).

(2) $GDP = Gross\ output - Intermediate\ inputs$

where *Gross output* is defined as "the market value of an industry's production, including commodity taxes and an adjustment for inventories," and *intermediate inputs* are the value of the "goods or services that are used in the production process to produce other goods or services rather than for final consumption" (GDP by State, 2006). This approach focuses on the conceptualization that GDP measures only "new" value created in an economy and avoids the pitfalls of economic metrics such as output.

Shafer, Deller, and Marcouiller (2004) define value-added as the final sales less the cost of materials purchased, which is a simplified version of the value-added definition of GDP. Value-added can be intuitively described as the value that a firm or entity adds to its inputs through processing. For instance, in the case of wood product manufacturing, one firm takes timber and produces lumber products, thereby adding value to the wood. Another firm takes the lumber and produces furniture, adding more value to the raw product. Even primary industries such as agriculture and mining create value-added products. Farmers add value by transforming inputs such as seed, fertilizer, soil and irrigation into a bushel of corn. Oil drillers use drilling tools and pipe to extract crude trapped beneath the ocean floor that would have very little value if it were to remain there.

Consequently, the value-added approach for calculating GDP allows for us to account for consumers that are now placing a higher value on produce coming from local areas and are therefore willing to pay a premium to obtain these goods (Loureiro and Hine, 2002). A growing number of studies have shown consumers' willingness to pay additional premiums for various attributes (Darby et al 2008; Lusk, Fields, and Prevatt 2008; Hand and Martinez, 2010). Even though the farm product itself may not have physically changed, consumer perception has, which transforms the produce from a homogeneous product into a heterogeneous product. What were once indistinguishable products have now increased in value through differentiation[3].

[3]The differentiated product model has a conceptual basis in the Dixit-Stiglitz model of monopolistic competition. This conceptual framework is one of the fundamental micro-level assumptions in two regional/macroeconomic models, Romer's endogenous growth model (Romer, 1990), and Krugman's New Economic Geography Models (Fujita, Krugman, and Venables, 1999).

Consumers, through their demand for local, organic and/or hormone free-products have created niche markets for farmers and have now added value on one or more of the aforementioned attributes they previously did not value. The value-added definition provides the opportunity of applying the GDP metric to measuring the creation of new value in a regional economy.

Income Approach

Finally, the *income* approach estimates GDP in terms of total domestic incomes earned. This method sums wages and salaries, supplements to wages and salaries, taxes on production and imports (less subsidies) and gross operating surplus (GDP by State, 2006). The formula is presented in Equation (3).

(3) *GDP = Wages and salaries + Supplements to wages and salaries + Taxes on production and imports – Subsidies + Gross operating Surplus*

In Equation (3), *wages and salaries* represents the wage and salary disbursements before deductions from the BEA state personal income (SPI) accounts, which have been adjusted to follow an accrual basis. *Supplements to wages and salaries* are made up of employer contributions to social insurance funds and other labor income. *Taxes on production and imports* is composed of federal excise taxes and customs duties, state and local sales taxes, property taxes (including residential real estate taxes), motor vehicle licenses, severance taxes and special assessments. *Gross operating surplus* consists of consumption of fixed capital, proprietor's income, corporate profits, nontax payments and business current transfer payments (net) (GDP by State, 2006). Due to data availability, this is the method used by the Bureau of Economic Analysis for calculating annual estimates of state-level GDP since 1963. Typically, the expenditure and value-added approaches are used only to calculate GDP at the national level.

In recent decades, GDP has gained widespread use as an economic metric due to its ability to provide comprehensive snapshots of economies at high levels of aggregation – at the national level, for example. It typically has been used in macroeconomic growth models such as the Neoclassical Growth Theory (Mankiw, Roemer, and Weil, 1992). As researchers tested these theories on large economic regions (nations), they desired to apply this knowledge to smaller, more localized areas to see if these theories held. Having substate GDP estimates would allow for testing of such neoclassical growth concepts as convergence rather than making assertions based on the analysis of larger geographic units. Since GDP includes the total gross operating surplus, it improves on the earnings metric by including both the proprietor and corporate operating surplus.

For Louisiana parishes, this attribute is important, as much of Louisiana's economic history has been dominated by large corporate employers in the natural extractive industries of oil and gas mining, petrochemical processing and forest product processing. Using earnings would be a suboptimal metric in those parishes with a greater proportion of corporate operating surplus because it would understate the relative proportion of returns distributed between capital and labor. The GDP metric does not have this limitation. Since many economic development planners in Louisiana work with natural resource extractive industries, it is important to understand the ratio of returns between capital and labor, since many of these natural resources are nonrenewable. The GDP metric provides that comparison tool when combined with wages.

Since the income and value-added definitions of GDP are conceptually equal and the income approach typically is applied for subnational estimates of GDP, this research develops a strategy for measuring value-added contribution at the county level (or "parish" level to be consistent with the terminology used in Louisiana) based on the income approach. This is the focus of the next section.

Methodology

Currently, the Bureau of Economic Analysis releases gross domestic product estimates for the national and state levels, and in recent years the agency has released these estimates at the metropolitan level. The metropolitan level statistics are calculated using a ratio of GDP to earnings. Earnings works well for this process because all components of earnings exist within GDP, with the exception that earnings uses a cash-flow basis for wages and salaries (when the money changed hands) and GDP uses an accrual basis for wages and salaries (when the money was accounted or expensed to the individuals). Therefore, earnings and GDP can be assumed to move together proportionally. Yet, this method of using earnings to estimate GDP cannot provide a complete set of estimates due to earnings data disclosure restrictions (when data are withheld because publishing them would disclose confidential earnings information). This is where our research seeks to contribute. The original concept for parish (county)-level GDP estimates was derived from the work of Baumgardner (2008), and the basis for our methodology is the metropolitan GDP estimation approach by BEA.

This research uses earnings and employment data to generate estimates of GDP by parish. Therefore, it is important to know how closely the earnings and employment data correlate with the GDP data. To decide which metric would be preferred, we evaluated the Pearson correlation coefficients using our state-level data sets. The correlation between earnings and GDP for the disclosed portions of the 61 GDP sectors for Louisiana overall is 0.7087 and is significant at the 1 percent level. In other words, the two metrics move together about 71 percent of the time. Although the correlation between GDP and employment is 0.3877 and is much lower than the correlation between earnings and GDP, it is still significant at the 1 percent level. It is no surprise earnings, instead of employment, so closely correlates with GDP, since earnings includes both compensation of employees, which is approximately 57 percent of national GDP, and noncorporate gross operating surplus. For employment, the correlation is smaller (only 39 percent), but the recent availability of detailed and fully disclosed parish-level employment statistics makes this metric very valuable, particularly when the earnings data are undisclosed.

Three methods are used to arrive at estimates for parish-level gross domestic product (GDP). The first method uses a ratio of state GDP to state earnings by sector, multiplied by the sector earnings at the parish level. Since, as previously stated, earnings data are a component of GDP data, the two measures of industry size would tend to fluctuate together. The first method, however, cannot be used comprehensively due to the earnings disclosure limitations for many sectors at the parish level and for a few sectors at the state level. The formula for the first method is:

$$GDP_{i,p,y} = \frac{GDP_{i,st,y}}{Earnings_{i,st,y}} \times Earnings_{i,p,y} \tag{4}$$

where p = parish; i = industry; st = state; and y = year.

The second method, the state productivity method, uses a ratio of state GDP to state employment by sector, multiplied by parish employment for each sector. This method provides estimates for every industry, but it assumes that worker productivity for each industry at the parish level exactly matches average productivity for that industry at the state level. The formula is presented in Equation (5):

$$GDP_{i,p,y} = \frac{GDP_{i,st,y}}{Employment_{i,st,y}} \times Employment_{i,p,y} \tag{5}$$

where all variables retain their specifications from Equation (4).

The third method is based on the concept that contiguous parishes (those parishes that are adjacent) will have similar earnings profiles (Manning, 1994; Qi and Chopping, 2007; Porter, 2008). For each parish industry, the disclosed earnings of all of the contiguous parishes are summed, and then the corresponding industry employment is likewise summed. The earnings total is then divided by the employment total to find the regional industry earnings to employment ratio that can then be applied to each parish.

Finally, each of the regional industry earnings ratios is multiplied by the parish's industry employment to get an estimate of earnings for each sector in the parish. These earnings estimates can be used when parish level earnings are not disclosed by BEA. The formulas are:

$$(6)\quad Estimated\_Earnings_{i,p,y} = \frac{\sum_{c=1}^{n} Earnings_{i,c,y}}{\sum_{c=1}^{n} Employment_{i,c,y}} \times Employment_{i,p,y}$$

$$(7)\quad GDP_{i,p,y} = \frac{GDP_{i,st,y}}{Earnings_{i,st,y}} \times Estimated\_Earnings_{i,p,y}$$

where c = contiguous parishes for a parish (p), and all other variables retain their prior specifications.

To estimate each of these equations, several data sources were used. All earnings data were obtained from the regional section of the Bureau of Economic Analysis website (BEA Local Area Personal Income, 2008). State-level GDP data also were obtained from the regional section of the BEA website (BEA Gross Domestic Product by State, 2008). Employment data for nonfarm industries came from the fully disclosed County Business Patterns (CBP) dataset created by Isserman and Westervelt (2006). Farm employment came from BEA (BEA State Area Personal Income, 2008). All data and results are for the parishes (counties) of the state of Louisiana for the years 2001-2007.

Identifying the Optimal Method

Gross domestic product was estimated for each industry in each Louisiana parish based on the following steps. In the first step, using Equation (4), GDP was estimated for each parish industry where the industry-level earnings data were available. We used the 61 industries from which GDP is provided for each state from the regional section of BEA (BEA Gross Domestic Product by State, 2008). This method was chosen because of the aforementioned high correlation between earnings and GDP at the state level. This method provided data for 48.83 percent of parish industries. The second step involved estimating GDP for the remaining 51.17 percent of parish industries by choosing between either the GDP productivity approach from Equation (5) or the regional contiguous earnings approach from Equations (6) and (7).

To determine which approach provided the best estimate of the unknown parish GDPs by sector, elements of the two estimation techniques were compared to the true parish industry earnings estimates for industries that were disclosed (approximately 49 percent of all parish industry earnings estimates). The first element was a ratio of state earnings to state employment multiplied by parish employment. The alternative element was the parish earnings estimate from the contiguous earnings approach.

The two estimation methods were evaluated for all seven years of data using pooled estimates and using Theil's coefficient of inequality (also known as the Theil's U Statistic). A pooled estimate represents the percentage difference between the summed estimated values and the summed observed values. Theil's coefficient is a frequently cited technique for comparing statistical estimates to corresponding observed values (Bliemel, 1973). Furthermore, as stated by Greene (2008), Theil's U is superior to other alternatives such as root mean square error due to its scale free structure. It is displayed below.

$$(8)\quad U = \frac{\left[\frac{1}{n}\sum_{i=1}^{n}(A_i - p_i)^2\right]^{1/2}}{\left[\frac{1}{n}\sum_{i=1}^{n} A_i^2\right]^{1/2} + \left[\frac{1}{n}\sum_{i=1}^{n} p_i^2\right]^{1/2}}$$

where i is the industry being examined, A_i represents the actual observation for industry i and P_i represents the predicted values for industry i. The results of the formula range from 0, which denotes a perfect forecast, to 1, which denotes maximum inequality, such as in a negative relationship.

Across all parishes, industries and years, the Theil coefficient for the state productivity method was 0.15. For the contiguous method, it was 0.64, as shown in Table 1. The total pooled estimate was -0.59 percent for the state productivity method and 14.77 percent for the contiguous method. Thus, as a whole, the state productivity method underestimated actual disclosed earnings by parish by approximately 1 percent, and the contiguous method overestimated the same disclosed earnings by around 15 percent.

Table 1.Comparison Across All Parishes, Industries and Years

	Theil	Pooled Estimate
State Productivity Method	0.15	-0.59%
Contiguous Method	0.64	14.77%

In particular, we believe some of the data limitations using the contiguous method led to its underperformance relative to the state productivity method. First, limitations in the number of disclosed earnings estimates for contiguous parishes may generate a contiguous earnings profile that is not an accurate estimate of the true earnings profile. Second, an urban contiguous parish may have a highly dissimilar productivity profile to neighboring rural parishes with establishments in the same industry, reducing the forecasting performance of the contiguous method.

Figure 1 displays Theil coefficients for eight categories, which summarize the industries defined by BEA. We aggregate 60 BEA earnings sectors into eight summary categories in the table. At this level of detail, the state productivity method provided a more accurate estimate for all categories except agriculture, forestry, fishing and related activities and wholesale and retail trade. The agriculture sector would be expected to display stronger regional similarity than statewide similarity in labor productivity because many crops are grown primarily in certain areas of the state (i.e., corn in the northeast, sugar in the south). Wholesalers and retailers would be assumed to have similar worker productivity among nearby parishes because the products being sold, the individuals being employed and the markets being served would be very similar. For both methods, the Theil coefficients indicate that estimates for the category of wholesale and retail trade come very close to the observed values. Continuing with the previous point, the industries contained in this category also would have similar worker productivity across the state.

Table 2 presents pooled estimates for the same major categories as Figure 1. Here, the state productivity method provides a much closer estimate for all categories than does the contiguous method. Again, the discrepancy between the magnitudes of the values is a result of the structuring of the method.

Figure 1. Theil Coefficients by Major Categories

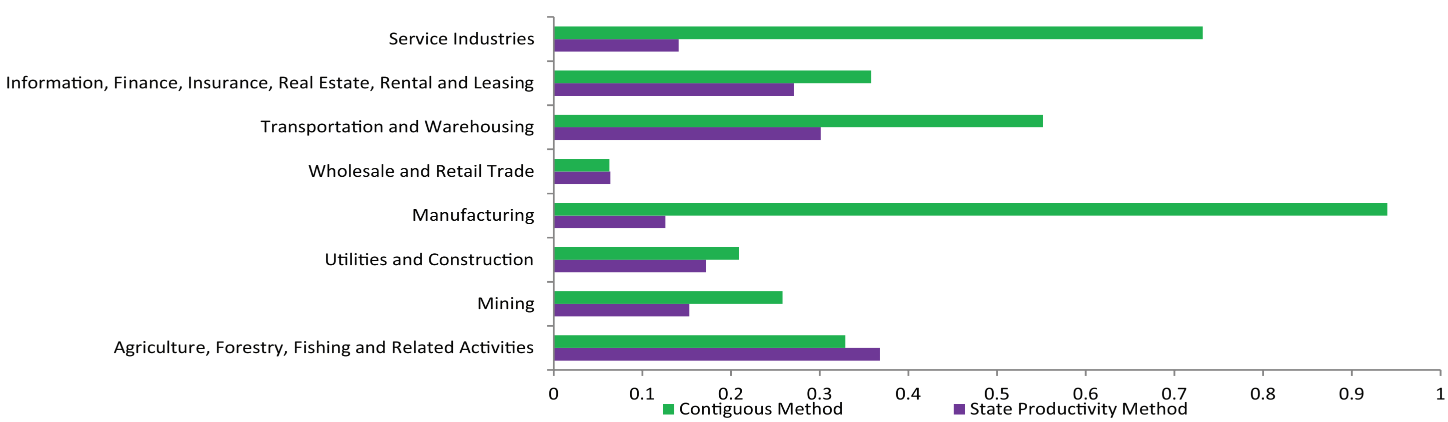
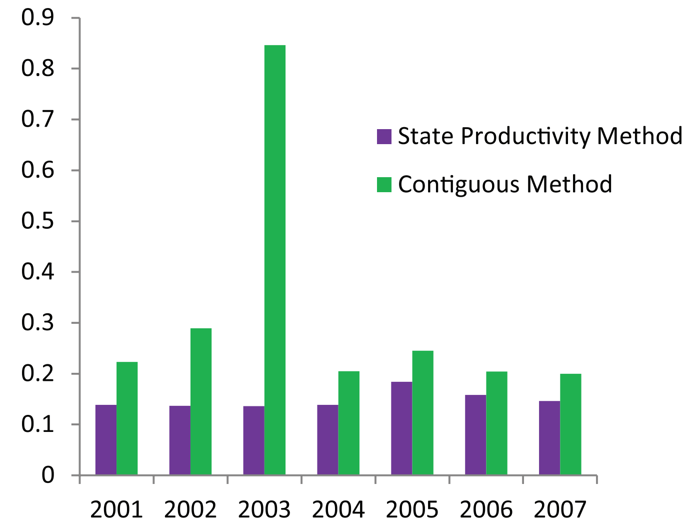


Table 2. Pooled Estimates by Major Categories

Category	State Productivity Method	Contiguous Method
Agriculture, Forestry, Fishing and Related Activities	0.12%	7.60%
Mining	-0.41%	-5.51%
Utilities and Construction	0.39%	10.26%
Manufacturing	-0.49%	15.72%
Wholesale and Retail Trade	-0.55%	-1.67%
Transportation and Warehousing	1.54%	19.57%
Information, Finance, Insurance,	-0.35%	19.82%
Real Estate, Rental and Leasing Service Industries	-1.30%	23.35%

Figure 2 displays Theil coefficients for the two methods across time. Again, the state productivity method is shown to be a more consistent estimator. In particular, if you examine the coefficient of variation (CV) for both methods, the CV for the contiguous method is more than six times as large as the CV for the state productivity method (0.75 versus 0.12). These results indicate the state productivity method has maintained its increased performance relative to the contiguous method throughout the evaluation time series.

Figure 2. Theil Coefficients by Years



Parish-level Analysis Using the GDP Estimates

The GDP and employment data were then analyzed at the parish-total level and the parish-industry level. The specific goals of this section of the research were to compare the growth rates of GDP and employment across all parishes and to determine which industries in a parish provided the greatest contribution to total GDP for a given parish.

We would assume that the GDP growth rate and the employment growth rate should increase or decrease at similar rates, since a booming economy would tend to increase both, and an economy in recession would tend to decrease both. Therefore, parishes that saw GDP growth and employment fall on opposite sides of the corresponding state averages are of interest. For those parishes that had both a GDP that exceeded the average GDP growth for Louisiana parishes and that experienced employment growth at a level less than the average for all Louisiana parishes, it may suggest that parish industries were likely moving toward a more capital-based operating structure. Therefore, productivity increased, but the owners of the firms (owners of the capital investment) primarily benefited. In contrast, a parish that had GDP growth that was lower than average GDP growth for all Louisiana parishes in conjunction with employment growth that exceeded average employment growth for all parishes might indicate the parish added jobs that paid below the state average salary in the previous year(s). Figure 3 displays how Louisiana's parishes were distributed in terms of the growth rates of GDP and employment.

Figure 4 displays how each parish's GDP growth rate and employment growth rate compares to the state average for the years 2001-2004. The majority of the parishes (43) saw growth rates similar to what would be expected, where both metrics were either above the state averages or below them. Of those parishes, 17 were metropolitan and 26 were nonmetropolitan.

Figure 3. Distribution for GDP and Employment Growth Rates for Louisiana Parishes for Years 2001-2007

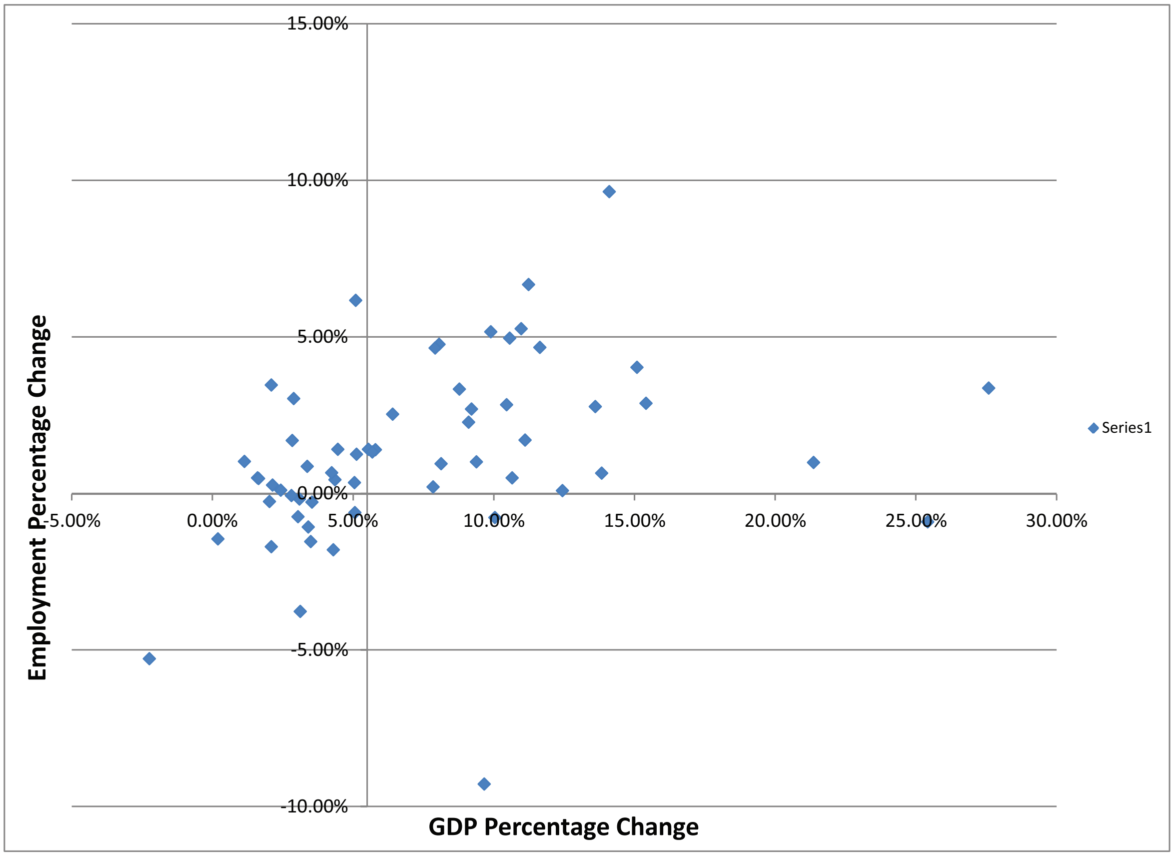


Figure 4. Parish GDP and Employment Growth Levels With Respect to the State Averages for Years 2001-2004

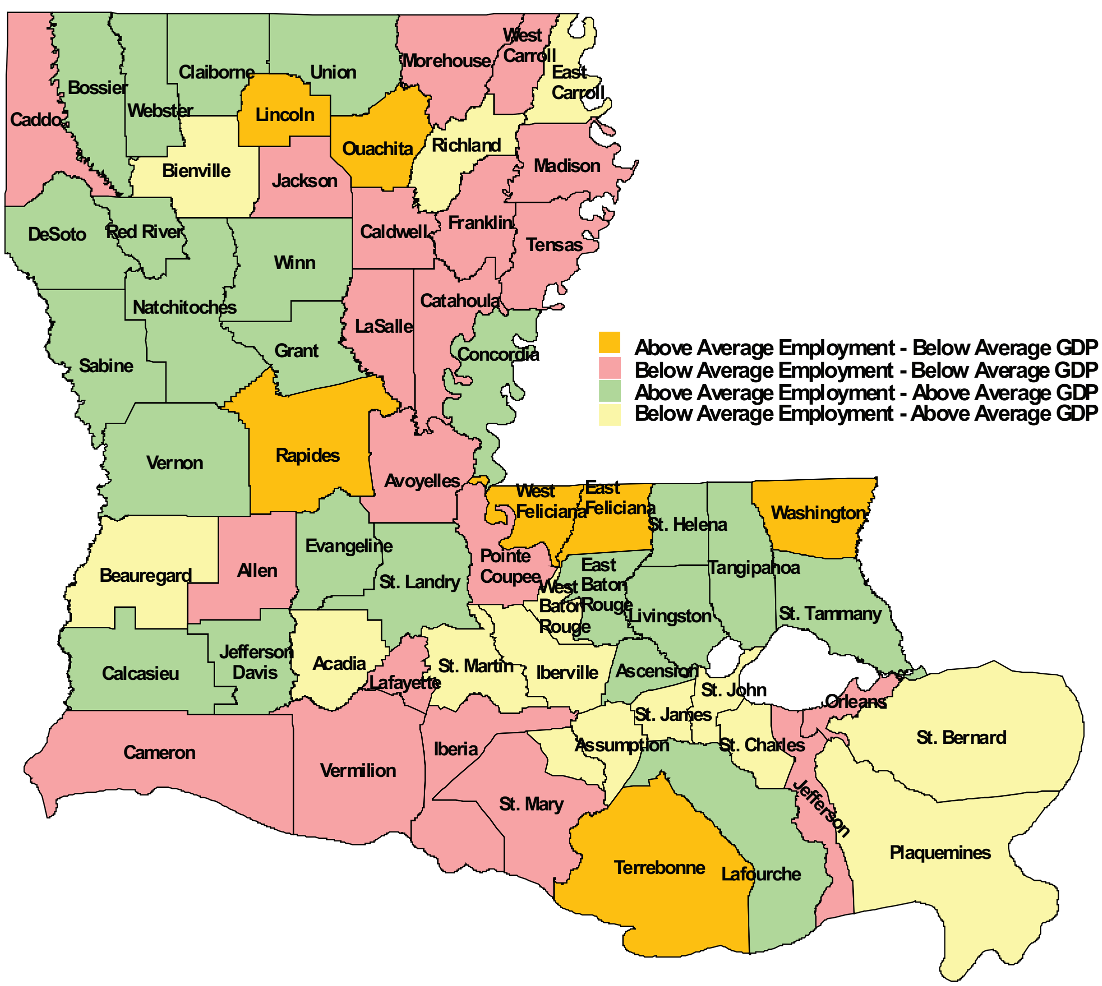
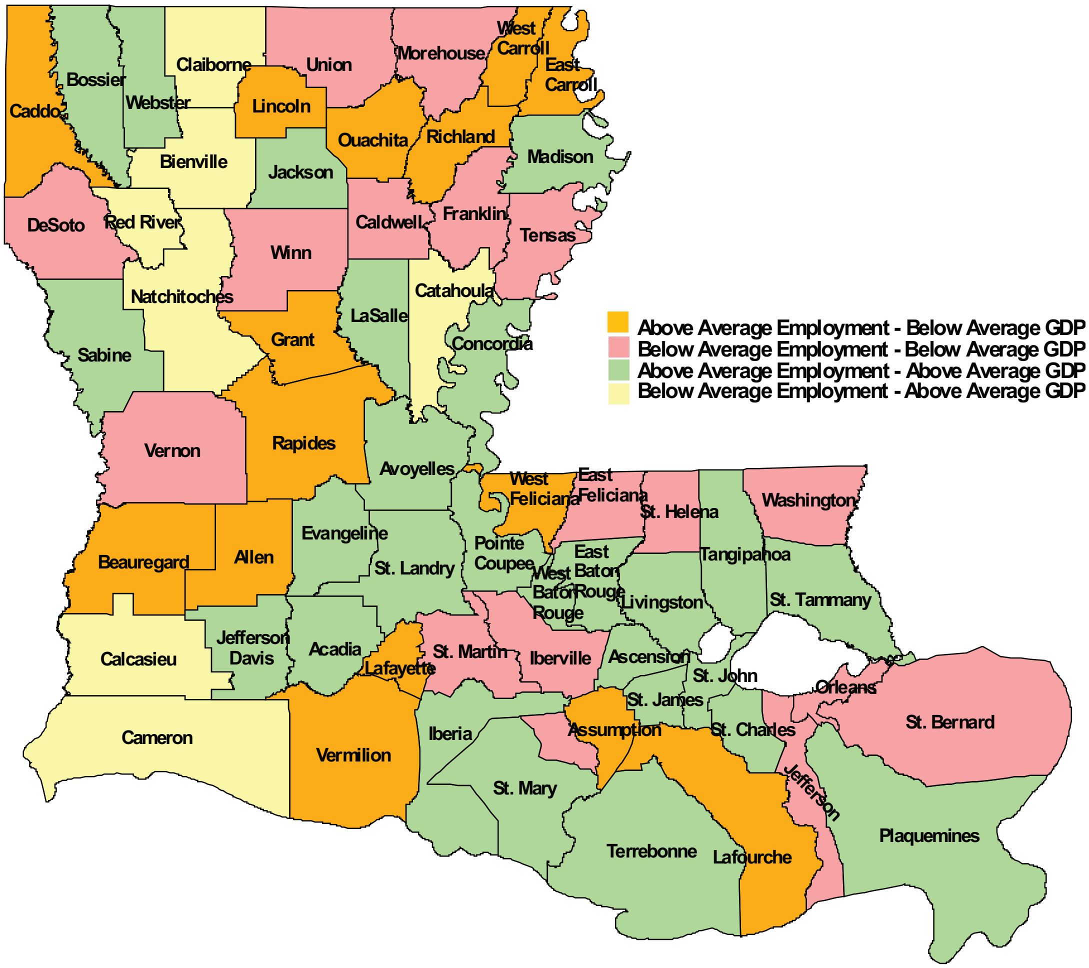


Figure 5. Parish GDP and Employment Growth Levels With Respect to the State Average for Years 2004-2007



For the years 2004-2007, the dynamics of the parishes changed – as displayed in Figure 5. The largest category was still those parishes with above average GDP and above average employment, but the top left and bottom right categories switched places in order of size. Three parishes (Assumption, Beauregard and East Carroll) switched to having greater average employment growth and lower average GDP growth relative to statewide averages. While this might suggest the labor force is gaining a greater percentage of GDP relative to owners of capital, it may also mean these economies are creating a large number of low-paying jobs in sectors that have low GDP to output ratios. It should be further noted that in both times, output prices could also be contributing to GDP growth. Given that employment is measured in jobs and not wages, in industries with rapidly rising output prices, it can be ambiguous whether the increased GDP returns are being distributed to capital or labor without more detailed wage analysis.

An industry-level analysis of parish GDP also was conducted to determine which sectors provided the greatest contribution to each parish's GDP. For this analysis, 61 BEA industry sectors were aggregated into 11 summary sectors. Details of this aggregation are provided in Appendix A. Table 3 displays the number of occurrences that a certain parish summary sector had the highest percentage of total 2007 GDP for that parish or had the highest growth rate from 2001-2007 for that parish. The chemical, petroleum and coal products manufacturing sector and the mining sector dominated both categories. Government represented the highest percentage of total GDP for individual parishes but never represented the highest growth rate. The food and fiber system and information and other services appeared in both categories. The all other manufacturing sector often had the highest growth rate but never the highest percentage of total GDP for a parish.

Table 3. Identification of Highest Contributing Sectors

Sector With Highest Percent of 2007 GDP for Each Parish	
Sector Name	**Number of Times This Sector Was a Parish's Largest Sector**
Mining	17
Government	16
Chemical, Petroleum and Coal Products Manufacturing	11
Food and Fiber System	11
Wholesale and Retail Trade	4
Transportation and Utilities	2
Information and Other Services	2
Finance, Insurance and Real Estate	1

Sector With Highest GDP Growth Rate From 2001 to 2007 for Each Parish	
Sector Name	**Number of Times ThisSector Had the Highest Growth Rate**
Chemical, Petroleum and Coal Products Manufacturing	28
Mining	20
All Other Manufacturing	6
Food and Fiber System	4
Education and Health Care Services	3
Information and Other Services	2
Construction	1

These results suggest Louisiana continues to be dominated by primary (agriculture and mining sectors) and secondary (manufacturing) sectors with a strong public sector (government) influence. These results also suggest, however, that the government sector is not the dominating growth sector for Louisiana parishes in this decade. Instead, it is traditional private sector primary and secondary industries that are the dominant growth sectors. For a full ranking by size of the 11-parish industry summary categories for the year 2007, see Appendix B. Aggregate GDP by parish by year can be found in Appendix C. Flat files containing GDP by industry by parish estimates from 2001 through 2007 are available from the authors by request.

Conclusion

Generating gross domestic product estimates was determined to be important to analyzing a local region because GDP was shown to be a more comprehensive economic activity metric than the other economic metrics applied in the past and because the estimates of GDP represent the value-added activity that has occurred in a region, as opposed to a summation of all activities.

Therefore, this research sought to develop a method for estimating parish-level GDPs. When earnings data were disclosed, the preferred method of generating GDP estimates was used. This method was preferred because of the high correlation between state-level earnings and GDP data.

When earnings were not disclosed, this research sought to find a means to assign estimates for the missing data. Two methods were analyzed, a statewide labor productivity approach and a contiguous parish earnings approach. The statewide labor productivity approach generally was found to be more accurate. This result is attributed to the contiguous method being weighted by larger, more urban parishes, which were dissimilar in regional productivity to their rural parish counterparts in the same industry. Using Theil coefficients, where a value of 0 is a perfect forecast and a value of 1 is maximum inequality, the state productivity method had a value of 0.15 and the contiguous method had a value of 0.64 when both were compared to the disclosed earnings data. In addition, when all of the estimates were pooled (summed), the state productivity method underestimated the total by -0.62 percent compared to the contiguous method, which overestimated the total by 14.85 percent.

One particular limitation of this research is whether GDP is the most appropriate measure of economic well-being. For example, the OECD notes that while GDP is the best indicator available on a timely basis, it should not be used as the only indicator of economic well-being. Further, it is not alone in their criticism of GDP as a measure of economic well-being and/or social welfare (Economist, 2006; van den Bergh, 2009).

Since GDP is an aggregate measure of income, when it is used to measure GDP on a per capita basis, it is unable to account for income distribution (van den Bergh, 2009). Consequently, if income is distributed relatively unequally, opportunities for personal development also will be.

This was observed in this study as the variation in the GDP estimates was driven a majority of the time by the statewide average industrial productivity (GDP per employee) for each industry. If industrial productivity for a given sector in a given parish varied greatly from the statewide average, this would reduce forecast accuracy.

A third limitation of GDP is that it is a measure of the size of an economy and consequently it does not necessarily represent the best measure of the economic well-being of the people in the economy. For example, GDP ignores leisure time (happiness), income inequality and the quality of environment, all of which affect the well-being of the citizens of an economic entity (Hamilton, 1994; Moulton, 2004; Economist, 2006; Boyd, 2007; Boyd and Banzhaf; 2007; van den Bergh, 2009). The development of environmental/green accounting units (i.e., how does the environment contribute to social welfare and how do you measure the depletion of natural resources) has received considerable attention in recent years (Hamilton, 1994; Economist, 2006; Boyd, 2007; Boyd and Banzhaf; 2007; van den Bergh, 2009). Green GDP measurement should be of particular interest to the citizens and policymakers of Louisiana because of the state's abundant natural resources.

A final limitation, and one that will continue for future studies in this area, is that such studies require very detailed data to be provided by the federal government (earnings) and the private sector (Wholedata employment estimates). Should these data sources become unavailable (or less detailed) in the future, estimating county-level GDP using the methods contained here will be limited.

One area for further research would be to find additional ways to use the GDP data to analyze parish-level finances, whether through cross-sectional or time-series analyses. Another area would be to find some way to revise the contiguous parish method, which would not be as easily weighted toward the data coming from urban parishes.

In conclusion, this research developed a method for estimating GDP at the parish level, an area often left out of traditional economic analyses but one that is of crucial importance given the devastating effects the recent economic and environmental crises have had on parishes, particularly in Louisiana. Moreover, agricultural economics and rural communities recently were designated a program area as part of the Agriculture and Food Research Initiative (AFRI), a competitive grant program to provide funding for fundamental and applied research, education and extension to address food and agricultural sciences. Under this program area, two priority topics were identified that would greatly benefit from these parish-level GDP estimates: first, entrepreneurship and small business development, and second, rural development.

Now that there is an established method for measuring economic productivity in a parish or county economy, policymakers and development boards have a tool at their disposal that will help them identify those sectors that are most responsible for generating economic activity in their areas. Consequently, economic and industrial policy constructed by community planners and policymakers will become much more focused on strengthening their comparative advantages. For example, policy and development initiatives will concentrate on workforce enhancement in those sectors that are crucial to a parish's economic growth, attracting industries that are either downstream or upstream from these sectors and/or attracting other companies in the same sector via the benefits of economies of agglomeration.

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Appendix A. Bridge Table Between the 11 Industry Summary Categories and the 61 GDP Sectors

Summary Category Code	Summary Category Name	GDP Code	GDP Sector Name
1	Food and Fiber System	4	Crop and animal production (farms)
1	Food and Fiber System	5	Forestry, fishing and related activities
1	Food and Fiber System	14	Wood product manufacturing
1	Food and Fiber System	26	Food product manufacturing
1	Food and Fiber System	27	Textile and textile product mills
1	Food and Fiber System	28	Apparel manufacturing
1	Food and Fiber System	29	Paper manufacturing
1	Food and Fiber System	76	Food services and drinking places
2	Mining	7	Oil and gas extraction
2	Mining	8	Mining, except oil and gas
2	Mining	9	Support activities for mining
3	Transportation and Utilities	10	Utilities
3	Transportation and Utilities	37	Air transportation
3	Transportation and Utilities	39	Water transportation
3	Transportation and Utilities	40	Truck transportation
3	Transportation and Utilities	41	Transit and ground passenger transportation
3	Transportation and Utilities	42	Pipeline transportation
3	Transportation and Utilities	43	Other transportation and support activities
3	Transportation and Utilities	44	Warehousing and storage
4	Construction	11	Construction
5	All Other Manufacturing	15	Nonmetallic mineral product manufacturing
5	All Other Manufacturing	16	Primary metal manufacturing
5	All Other Manufacturing	17	Fabricated metal product manufacturing
5	All Other Manufacturing	18	Machinery manufacturing
5	All Other Manufacturing	19	Computer and electronic product manufacturing
5	All Other Manufacturing	20	Electrical equipment and appliance manufacturing
5	All Other Manufacturing	21	Motor vehicle, body, trailer and parts manufacturing
5	All Other Manufacturing	22	Other transportation equipment manufacturing
5	All Other Manufacturing	23	Furniture and related product manufacturing
5	All Other Manufacturing	24	Miscellaneous manufacturing
5	All Other Manufacturing	30	Printing and related support activities
5	All Other Manufacturing	33	Plastics and rubber products manufacturing

Appendix A. Continued

Summary Category Code	Summary Category Name	GDP Code	GDP Sector Name
6	Chemical, Petroleum and Coal Products Manufacturing	31	Petroleum and coal products manufacturing
6	Chemical, Petroleum and Coal Products Manufacturing	32	Chemical manufacturing
7	Wholesale and Retail Trade	34	Wholesale trade
7	Wholesale and Retail Trade	35	Retail trade
8	Information and Other Services	46	Publishing including software
8	Information and Other Services	47	Motion picture and sound recording industries
8	Information and Other Services	48	Broadcasting and telecommunications
8	Information and Other Services	49	Information and data processing services
8	Information and Other Services	58	Professional and technical services
8	Information and Other Services	62	Management of companies and enterprises
8	Information and Other Services	64	Administrative and support services
8	Information and Other Services	65	Waste management and remediation services
8	Information and Other Services	72	Performing arts, museums and related activities
8	Information and Other Services	73	Amusement, gambling and recreation
8	Information and Other Services	75	Accommodation
8	Information and Other Services	77	Other services, except government
9	Finance, Insurance and Real Estate	51	Federal Reserve banks, credit intermediation and related services
9	Finance, Insurance and Real Estate	52	Securities, commodity contracts, investments
9	Finance, Insurance and Real Estate	53	Insurance carriers and related activities
9	Finance, Insurance and Real Estate	54	Funds, trusts and other financial vehicles
9	Finance, Insurance and Real Estate	56	Real estate
9	Finance, Insurance and Real Estate	57	Rental and leasing services and lessors of intangible assets
10	Education and Health Care Services	66	Educational services
10	Education and Health Care Services	68	Ambulatory health care services
10	Education and Health Care Services	69	Hospitals and nursing and residential care facilities
10	Education and Health Care Services	70	Social assistance
11	Government	79	Federal civilian
11	Government	80	Federal military
11	Government	81	State and local

Appendix B. Estimated Parish GDP Rankings by Industry for 2007

Parish Name	FIPS	Food and Fiber System	Mining	Transportation and Utilities	Construction	All Other Manufacturing	Chemical, Petroleum and Coal Products Manufacturing	Wholesale and Retail Trade	Information and Other Services	Finance, Insurance and Real Estate	Education and Health Care Services	Government
Acadia	22001	9	1	8	7	11	10	2	4	5	6	3
Allen	22003	4	9	8	5	10	11	3	2	7	6	1
Ascension	22005	10	6	8	5	11	1	4	3	2	9	7
Assumption	22007	1	2	3	9	5	11	6	8	10	7	4
Avoyelles	22009	2	10	8	7	9	11	3	4	5	6	1
Beauregard	22011	2	10	9	7	11	1	5	6	3	8	4
Bienville	22013	2	1	5	10	8	11	3	7	6	9	4
Bossier	22015	9	3	10	7	11	8	4	2	5	6	1
Caddo	22017	10	1	8	11	6	9	4	2	7	5	3
Calcasieu	22019	10	8	9	6	11	1	3	2	5	7	4
Caldwell	22021	4	9	7	8	10	11	2	3	6	5	1
Cameron	22023	11	1	4	6	10	2	3	7	8	9	5
Catahoula	22025	1	7	2	9	11	10	4	6	5	8	3
Claiborne	22027	3	1	4	8	11	10	5	7	9	6	2
Concordia	22029	1	3	5	10	11	9	4	6	8	7	2
DeSoto	22031	2	1	5	8	10	11	4	6	7	9	3
East Baton Rouge	22033	9	11	8	6	10	2	5	1	4	7	3
East Carroll	22035	1	9	8	11	10	7	3	4	5	6	2
East Feliciana	22037	8	9	7	10	2	11	3	5	6	4	1
Evangeline	22039	9	8	5	11	10	7	4	3	6	2	1
Franklin	22041	1	11	6	8	10	9	3	7	5	4	2
Grant	22043	3	10	4	5	11	9	2	6	7	8	1
Iberia	22045	9	1	6	7	5	11	4	3	2	10	8
Iberville	22047	3	8	5	6	11	1	7	4	9	10	2
Jackson	22049	1	2	5	9	10	11	4	8	7	6	3
Jefferson	22051	10	4	8	9	6	11	1	3	2	5	7
Jefferson Davis	22053	9	4	8	10	6	11	1	2	5	7	3
Lafayette	22055	8	1	9	10	7	11	4	2	3	5	6
Lafourche	22057	10	3	2	9	8	11	6	4	1	7	5
LaSalle	22059	6	1	7	8	10	11	3	4	5	9	2
Lincoln	22061	6	8	10	9	7	11	2	4	5	3	1
Livingston	22063	7	11	9	5	2	10	3	4	6	8	1

Appendix B. Continued

Parish Name	FIPS	Food and Fiber System	Mining	Transportation and Utilities	Construction	All Other Manufacturing	Chemical, Petroleum and Coal Products Manufacturing	Wholesale and Retail Trade	Information and Other Services	Finance, Insurance and Real Estate	Education and Health Care Services	Government
Madison	22065	3	11	8	10	9	1	4	5	7	6	2
Morehouse	22067	1	8	7	9	11	10	2	6	4	5	3
Natchitoches	22069	2	11	7	10	3	4	6	5	8	9	1
Orleans	22071	8	1	5	11	9	10	6	2	4	7	3
Ouachita	22073	6	11	8	9	7	10	2	1	3	5	4
Plaquemines	22075	9	1	3	8	10	2	5	7	6	11	4
Pointe Coupee	22077	4	9	1	8	10	11	3	6	5	7	2
Rapides	22079	7	11	10	9	8	6	4	2	5	3	1
Red River	22081	2	1	4	9	10	11	5	7	8	6	3
Richland	22083	4	11	8	9	3	10	1	7	6	5	2
Sabine	22085	1	7	6	10	9	11	3	4	5	8	2
St. Bernard	22087	10	3	6	2	11	1	4	5	8	9	7
St. Charles	22089	9	11	2	6	10	1	3	4	7	8	5
St. Helena	22091	2	11	4	10	6	3	9	5	7	8	1
St. James	22093	3	11	6	10	4	1	2	7	8	9	5
St. John	22095	11	8	4	9	5	1	2	3	7	10	6
St. Landry	22097	8	9	4	10	11	1	3	7	5	6	2
St. Martin	22099	4	1	10	8	11	9	3	6	2	7	5
St. Mary	22101	10	1	7	8	2	9	6	5	3	11	4
St. Tammany	22103	9	6	8	7	10	11	1	2	3	5	4
Tangipahoa	22105	5	11	6	9	10	8	2	4	3	7	1
Tensas	22107	1	6	7	10	9	11	3	4	5	8	2
Terrebonne	22109	10	1	8	9	2	11	4	5	3	6	7
Union	22111	1	4	7	9	10	11	3	6	8	5	2
Vermilion	22113	5	1	8	7	10	11	2	6	3	9	4
Vernon	22115	6	10	8	7	9	11	3	2	4	5	1
Washington	22117	2	4	8	9	10	11	3	5	6	7	1
Webster	22119	5	1	11	8	4	7	2	9	3	10	6
West Baton Rouge	22121	9	3	2	5	6	1	4	8	10	11	7
West Carroll	22123	2	10	7	4	9	11	3	8	6	5	1
West Feliciana	22125	3	9	1	7	10	11	5	4	6	8	2
Winn	22127	1	2	9	10	11	7	4	3	8	6	5

Appendix C. Aggregate Estimated GDP Values (in Dollars) by Parish, 2001-07

Parish	2001	2002	2003	2004	2005	2006	2007
Acadia	753,799,504	812,074,863	910,144,264	987,663,957	1,006,791,949	1,291,869,933	1,380,089,655
Allen	358,298,507	371,254,987	379,320,658	398,892,798	395,594,733	464,306,794	472,526,324
Ascension	2,346,994,421	2,768,890,292	2,695,081,471	3,092,708,761	3,297,394,126	3,988,667,177	4,473,867,709
Assumption	258,081,911	317,788,787	315,513,338	377,342,207	372,836,640	407,600,186	395,247,678
Avoyelles	528,617,074	553,681,547	519,223,705	514,156,994	530,302,043	595,872,222	679,000,419
Beauregard	463,195,615	537,148,947	657,664,273	614,956,110	654,493,761	728,948,923	706,958,417
Bienville	214,386,178	219,628,176	254,521,242	306,656,419	333,847,335	337,779,887	634,224,492
Bossier	2,396,545,867	2,546,557,267	2,894,848,254	3,178,867,585	3,290,020,876	4,548,097,363	4,286,302,740
Caddo	9,625,168,840	9,185,025,490	10,462,689,119	11,695,586,282	12,143,067,909	14,397,393,300	12,384,950,162
Calcasieu	6,115,737,510	6,582,406,530	7,597,472,071	8,977,309,149	11,975,265,102	11,468,497,906	11,744,790,165
Caldwell	130,358,020	138,247,255	143,284,189	139,348,430	147,886,747	152,770,104	154,535,614
Cameron	246,053,376	185,380,902	211,524,945	245,156,999	244,438,116	280,329,619	342,231,847
Catahoula	167,961,831	120,973,470	149,726,690	168,082,023	171,213,472	188,183,791	236,944,617
Claiborne	241,771,751	289,249,873	264,275,801	311,317,595	329,741,703	468,881,946	416,551,105
Concordia	235,207,148	259,334,321	322,086,791	360,975,380	374,976,382	468,192,966	508,705,743
DeSoto	407,955,508	400,920,883	471,012,358	555,898,770	521,130,755	588,151,956	602,742,634
East Baton Rouge	15,118,016,873	15,808,020,080	17,156,582,477	18,911,420,275	20,674,801,716	23,554,161,471	24,515,474,361
East Carroll	106,603,323	95,509,213	126,513,038	132,512,883	131,210,930	143,042,993	166,426,486
East Feliciana	259,024,514	250,245,886	359,636,272	293,669,633	312,981,991	340,727,069	364,781,868
Evangeline	301,909,968	335,954,568	378,221,098	403,640,185	474,633,740	506,819,258	546,969,524
Franklin	287,782,399	288,440,459	297,867,357	320,000,466	320,073,925	337,711,920	378,156,817
Grant	140,630,667	149,989,604	193,997,371	197,711,985	191,883,543	227,046,460	244,347,006
Iberia	1,886,191,768	1,879,388,608	2,065,967,044	2,253,578,787	2,705,932,215	3,521,573,395	3,682,420,626
Iberville	1,261,417,415	1,553,315,947	1,475,201,887	1,934,748,745	2,245,379,038	2,239,086,553	2,368,076,588
Jackson	281,654,244	281,590,775	248,113,824	279,322,189	264,593,045	295,950,717	390,157,545
Jefferson	14,838,776,957	15,817,543,554	16,193,488,578	17,473,739,297	18,446,566,692	19,356,942,394	21,027,094,608
Jefferson Davis	338,082,945	385,386,064	480,264,989	491,645,751	468,497,373	555,896,862	631,099,279
LaSalle	377,502,832	237,895,179	259,561,896	309,643,042	299,547,561	521,095,347	508,820,579
Lafayette	9,507,860,651	8,790,997,164	9,744,724,219	10,730,758,066	11,616,860,527	13,793,393,706	16,532,327,877
Lafourche	1,978,764,357	2,073,689,153	2,317,464,571	2,424,480,049	2,640,863,321	3,027,564,787	3,381,194,104
Lincoln	896,984,522	955,042,415	972,105,809	1,065,802,061	1,106,978,968	1,331,833,521	1,331,784,893
Livingston	790,694,513	908,411,311	1,029,043,576	1,149,361,373	1,252,529,914	1,378,647,417	1,550,644,477

Appendix C. Continued

Parish	2001	2002	2003	2004	2005	2006	2007
Madison	151,421,597	148,785,025	198,883,723	175,457,299	254,062,719	294,708,750	324,630,398
Morehouse	437,512,914	456,703,533	509,343,252	511,006,453	516,668,291	569,373,998	576,912,392
Natchitoches	750,065,074	760,801,473	831,473,874	998,164,489	1,086,831,683	1,222,850,541	1,307,366,769
Orleans	25,058,380,137	22,852,425,754	24,021,333,517	26,448,090,749	27,319,925,778	23,253,116,144	25,405,343,285
Ouachita	4,608,703,166	4,560,632,233	4,832,010,180	5,222,834,617	5,239,545,208	5,754,458,028	5,767,532,946
Plaquemines	1,697,112,961	1,565,901,356	2,105,590,916	2,606,480,063	3,059,323,570	3,112,798,833	3,471,983,688
Pointe Coupee	338,477,037	338,998,489	339,559,787	397,303,816	376,263,497	438,270,121	534,342,093
Rapides	3,124,784,385	3,259,990,732	3,339,616,006	3,798,796,524	3,995,036,937	4,278,807,122	4,592,073,405
Red River	146,898,395	132,525,929	168,644,442	197,676,008	211,689,550	243,013,101	331,193,131
Richland	264,346,273	284,557,739	319,226,400	330,878,489	343,816,660	395,524,912	403,764,431
Sabine	308,849,937	315,283,439	347,719,164	408,547,027	416,292,518	425,236,206	408,184,750
St. Bernard	1,099,866,910	1,158,654,988	1,748,394,909	2,179,673,109	3,240,482,467	2,195,536,138	2,035,033,061
St. Charles	2,088,871,456	2,793,117,792	3,216,367,698	4,287,646,049	5,542,868,019	5,226,048,827	5,583,413,930
St. Helena	101,198,326	103,772,367	103,879,509	142,650,507	123,371,276	136,504,059	154,771,395
St. James	516,846,065	665,690,164	771,063,806	1,338,628,486	2,402,318,408	2,411,415,492	1,963,844,661
St. John	902,767,912	1,034,894,825	1,401,351,796	1,680,850,381	2,378,747,982	2,385,879,912	2,808,145,527
St. Landry	1,114,191,682	1,202,194,613	1,448,132,369	1,511,734,110	1,721,390,925	1,823,574,753	2,216,740,159
St. Martin	488,853,593	533,650,972	639,556,517	742,469,970	695,332,751	794,479,609	935,588,244
St. Mary	2,354,250,084	2,139,657,416	2,120,256,719	2,210,627,075	2,424,832,256	2,820,656,268	3,236,585,792
St. Tammany	3,438,784,046	3,911,764,877	4,322,924,131	4,817,214,056	5,469,129,688	5,945,976,422	6,681,227,101
Tangipahoa	1,675,070,307	1,836,028,474	1,906,318,554	2,209,228,050	2,323,436,269	2,736,040,564	2,894,765,757
Tensas	74,995,917	59,200,983	92,446,268	87,028,685	96,801,654	88,397,418	104,153,111
Terrebonne	4,288,924,268	3,150,910,374	3,788,495,230	3,540,668,870	7,183,009,990	11,360,316,300	9,573,546,544
Union	208,959,323	264,166,253	261,609,928	313,623,171	300,413,537	279,102,972	307,877,977
Vermilion	1,092,649,023	975,622,265	1,092,482,766	1,256,944,655	992,421,044	990,658,981	1,495,670,352
Vernon	1,071,612,024	1,150,746,474	1,242,472,345	1,363,765,681	1,406,255,501	1,605,456,660	1,683,530,627
Washington	594,905,755	616,459,300	668,502,555	711,314,326	774,651,946	779,698,395	798,629,770
Webster	709,402,899	716,273,482	866,926,102	961,630,377	1,159,771,236	1,291,506,665	1,290,166,545
West Baton Rouge	808,282,676	846,040,570	1,031,828,484	1,143,631,842	1,449,285,232	1,526,735,522	1,719,840,858
West Carroll	128,290,012	125,688,958	149,318,500	143,669,411	147,716,836	159,149,717	182,163,618
West Feliciana	496,464,302	554,244,216	550,882,474	579,147,672	574,806,379	629,338,439	680,739,171
Winn	288,230,535	284,631,363	305,244,903	372,663,737	401,164,043	370,331,187	363,792,555

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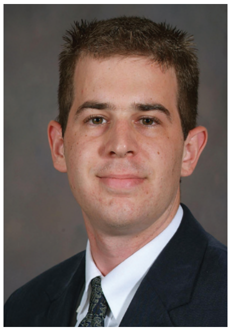

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