

Benchmark Estimates of 2002 Gross Domestic Product in
Guam

By

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This paper reports the result of research and analysis undertaken by Census Bureau staff. It has undergone a more limited review than official Census Bureau publications. This report is released to inform interested parties of current research and to encourage discussion of the results contained therein.

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Executive Summary

In June 2004, the U.S. Department of Interior, Office of Insular Affairs contracted the International Programs Center (IPC) of the U.S. Census Bureau to evaluate aggregate economic conditions in Guam. By agreement, the project was patterned after the research design developed in March 1999, when IPC produced a similar study entitled “*National Income Accounts in the Northern Mariana Islands.*” In operational terms, the design ensured that the best practice measurement methods employed by the U.S. Bureau of Economic Analysis (BEA) would be utilized, and that data found in the quinquennial 2002 Economic Census would be the primary source of information for making the economic evaluation.

The following report discusses how IPC molded those Census data into a credible five-year benchmark estimate of Gross Domestic Product (GDP). For those unfamiliar with the specialized terminology used in macroeconomics, the figures reported below comprise the base of a triangle of three measurements that are derived collectively from the National Income and Product Accounts (NIPA). In future tasks, we expect to develop the two remaining independent estimates of GDP based upon annual data sets. We expect to implement the income and expenditure methodologies to produce these companion estimates, and coordinate these results with the benchmark so that the NIPA triangle is complete and internally consistent.

On the basis of the information available to us, we estimate that partial GDP for the covered economic census industries is between \$1.927 and \$2.712 billion. Our best estimate of partial GDP, the “hybrid2”, is \$2.069 billion. The \$785 million range between the low and high estimates reflects the absence of complete data, the consequences of using simplifying assumptions, and the choice of measurement methodology. When the \$1.359 billion in value added originating in the excluded sectors of agriculture, government, airlines and private education is accounted for, total GDP rises to an estimated \$3.286 to \$4.071 billion. Based on an estimated population of 162,326 in 2002, this translates into per capita GDP varying between \$20,243 and \$25,079. Again, the best estimate of per capita GDP, the “hybrid 2”, is \$21,118. All of these figures fall between the 2002 thresholds for the upper middle (\$9,220) and high (\$27,590) income categories used by the World Bank.

Because these figures are GDP averages, they say nothing about the level of personal disposable income or its distribution. Moreover, these numbers do not distinguish between the living standards of Guam born residents, who are U.S. citizens, and foreign guest workers. At this point, firm conclusions about the welfare of individuals cannot be derived. Only future research can properly address this question. Finally, given what has been written about understated cost of goods sold (CGS) and imputed personal consumption expenditures, we conclude that the lower bound estimates are probably closer to the truth. Therefore the reader should exercise caution and err on the low side until the future reconciliation of GDP estimates based on annual income and expenditure data is undertaken and completed.

1. Introduction

When the NIPA project began in the Winter of 1998/Spring of 1999, there were significant questions about the adequacy of the available data sets for estimating Gross Domestic Product (GDP). The March 1999 report “National Income Accounts in the Northern Mariana Islands” dispelled that concern. The information found in the 1997 economic census and 1998 income and expenditure survey, coupled with auxiliary data sets, proved to be sufficient to develop a credible benchmark GDP estimate. Importantly, those GDP figures, disaggregated by industry sector, served as the foundation for the subsequent input-output analysis conducted by Dick Conway and Malcolm McFee Associates.

It has been five years since that original paper was written, and with the publication of the 2002 economic census, it is now time to produce similar estimates of GDP for Guam. During the intervening period, Rubin requested that several adjustments be made to the census questionnaire to gather more information. Given these revisions, Rubin felt he would be able to produce estimates that were more fully consistent with the methods employed by the Bureau of Economic Analysis (BEA). Notable additions to the 2002 questionnaire included broader industry coverage and greater detail on costs of goods sold (CGS). Unfortunately, there wasn't adequate time to make all of the requested revisions to the questionnaire, and baseline information on capital expenditures, and changes in inventory by stage of fabrication wasn't gathered. Even though these deficiencies won't be addressed until the 2007 Economic Census, the data sets, imperfect in some respects, are still more than adequate to produce estimates of GDP based upon standard value added methodology.

Using procedures similar to those employed in the 1999 paper, estimates of GDP discussed below will continue to be refined and developed in a manner consistent with standard economic accounting definitions. This means essentially implementing two simple algorithms:

- 1) aggregating value added originating in all sectors of the economy. In this instance, value added is defined as the difference between the dollar value of total output minus the dollar value of intermediate purchases, and alternatively
- 2) aggregating value added¹ alternatively defined as the sum of compensation, indirect business taxes and “other value added” (where the latter is basically equal to operating surplus plus depreciation).

With full and proper accounting, both methods will produce identical values. In either case, BEA considers these value added estimates of GDP to be the most complete and

¹ Or some variant thereof.

reliable of the three methodologies (value added, income, and final expenditure) available for calculating GDP.

This paper will proceed in four sections: data quality assessment, estimation of value added, sensitivity analysis, and final comments.

2. Initial Data Quality

To begin the analysis of value added, we first examined the microdata, record by record, for completeness and plausibility. Sales and payroll data presented no immediate problems. However, preliminary work on the census done by analysts in Company Statistics Division (CSD) showed that a significant number of respondents did not fully understand or failed to follow instructions for answering questions on intermediate purchases and CGS. Simple edit specification programs designed to detect outliers indicated that over ten percent of respondents failed to provide any data on intermediate purchases². In our follow-up, we found other instances in which the value of intermediate purchases was implausibly low or high³. Likewise, we found 739 records (twenty five percent of all businesses covered in the census) where employers failed to provide any class of customer data.

To get a more thorough understanding of these deficiencies, Rubin expanded the CSD search for outliers using a set of special purpose parameters he created based on the ratio of intermediate purchases to final shipments (P/S) found in the 1997 US Input-Output (I-O) table. Rubin first made the assumption that for any given 4-digit NAICS industry, the technology underlying production (reflected by input structure) was similar in the U.S. and Guam.⁴ Moreover, in the absence of rapid technological change and uneven bursts of inflation at the producer price level, this ratio was assumed to be fairly stable over the intracensal period (1997-2002). With this understanding for each 4-digit NAICS record in the census, the observed raw P/S ratio was then compared to the corresponding

² The magnitude of underreporting can be captured by the Raw Intermediate Purchase/Final Sales ratio (P/S). According to our rough estimates, the fraction of firms reporting a “0” P/S was 21 percent, where the percent is computed as sales of “0” responders divided by total industry sales of all responders.

³ At the high end, intermediate purchases exceeded final sales. This can occur in the short run if a high fraction of output remains unsold and is entered into inventory. In the long run, it is not sustainable and will cause the firm to go bankrupt.

⁴ Finding identical production technique is highly unlikely. If anything, technology is more advanced in the U.S. Nevertheless, technological convergence is promoted by the substantial volume of Guam machinery and equipment imports from countries like the U.S. and Japan. In addition, Guam data reflect five years worth of “catch-up” since some of the underlying capital investment decisions captured in the Census figures correspond to machinery of a more recent vintage (2002 versus 1997). Even if the technology (as measured by capital/labor coefficients) is substantially different, intermediate input structure for homogeneous products should be quite similar. These intermediates are far more important than the level of technique for estimating value added, especially if the focus is on the primary measurement algorithm (see section 3.1 below).

parameter range for the relevant 2-digit NAICS industry group in the I-O table⁵. If the observed ratio fell outside the I-O range, the value was considered an outlier. Rubin replaced each outlier value with the mean P/S ratio from the corresponding entry in the I-O table at the 4-digit NAICS.

The assessment of data quality does not end with analyzing intermediate purchases because estimating value added is not the only goal of the benchmark exercise. To produce a fully consistent set of national income and product accounts, it is also necessary to begin the coordination of annual estimates of GDP with the five-year (census) estimates. That coordination is based, in part, on the magnitude and plausibility of the estimate of personal consumption expenditures (PCE).

In the U.S., BEA calculates benchmark PCE from the census data on sales by class of customer. Subsequent estimates of annual PCE are then derived from the benchmark by applying growth rates from the survey data on retail trade and services. To be consistent with BEA methodology, the first step in this exercise begins with the calibration of the Guam class of customer data.

Rubin's review of the class of customer data found that more than 10 percent of respondents provided no disaggregation whatsoever. Moreover, there were instances where the class of customer percentages summed to less than 100. With this much missing information, it was clear that any estimate of PCE derived from the census would be biased downward, so a simple imputation strategy was devised. First, for those records where "0" class of customer data was provided, the mean estimate of the household share from "100" percent responders at the analogous 2-digit NAICS industry level was imputed. Second, in those instances where the class of customer percentages summed to less than 100 and there were no household sales, the residual was assumed to be the household share if it fell within the inter-quartile range for household shares in the analogous 2-digit NAICS industry respondent sample. If the residual fell outside the inter-quartile range, the midpoint of the latter was taken as the preliminary household estimate, and the summation of all class of customer percentage data was then scaled up to equal 100 percent. Third, in those instances where the class of customer percentages summed to less than 100 and there were household sales, that household percentage was scaled up by the reciprocal of the total percentage of reported sales across all classes of customers.

⁵ The U.S. Input-Output table reports summary data on final shipments and intermediate purchases at the 4-digit NAICS industry level. There is no detail on variation within any given NAICS industry. Nevertheless, variation in the purchase to shipment ratio can be approximated if one moves to a higher level of aggregation. Specifically, subsets of this data can be assembled to form a 2-digit umbrella industry grouping which corresponds to the macro industries identified in the economic census. The minimum and maximum values of the 4-digit NAICS purchase to shipment ratios contained within this subset determine the range of acceptable values at the 2-digit industry level. Of course, there is an implicit assumption here that *inter-industry* variation at the calculated 2-digit level is greater than or equal to *intra-industry* variation at the 4-digit level. While we cannot prove that this is true, if technology is relatively homogeneous within any given 4-digit industry, then crossing product lines and technologies to move to higher levels of aggregation will create, ipso facto, more variation than would be observed in any given compilation of common 4-digit enterprises.

3. Estimation of Value Added

3.1. “Sales minus Purchases” Algorithm (Covered Industries)

The simplest method for calculating value added in the industries covered by the census (all economic agents except those in agriculture and government) is to subtract raw intermediate purchases (P) from final sales⁶. The resulting estimate, raw value added (RVA), serves as the initial point of departure and strawman for subsequent work. This first estimate is juxtaposed against a second estimate (ValueAdded1), where raw intermediate purchases have been adjusted by a factor P' that corrects for the outliers detected in the data quality assessment exercise. The revised figure for intermediate purchases is referred to as IP, where $IP = P + P'$. We format the presentation of both estimates of value added according to the aggregate industry sectors covered in the 2002 Economic Census with some modification⁷. All figures are reported in thousands of nominal 2002 dollars.

⁶ The BEA definition of value added is somewhat more complex. More precisely, one should use shipments and other receipts **plus** changes in finished goods and “work in progress” inventories rather than final sales. The latter information is not contained in the economic census, but the needed corrections probably don't alter the end result by more than five percent.

⁷ “Rental and Leasing” is combined with “Other” to preserve non-disclosure.

Table 1. 2002 Value Added Estimates by Industrial Sector (\$000)

	Total Sales	Raw Intermediate Purchases (P)	Intermediate Purchases (IP)	Value Added ¹	Raw Value Added (RVA)
Retail, Leasing and Other	69,163	12,037	19,141	49,333	57,126
Repair and Maintenance Services	98,815	16,426	42,017	56,798	82,389
Food Services	273,576	60,412	137,472	136,104	213,164
Accommodations	356,096	96,204	124,418	231,678	259,892
Health Care and Social Assistance	233,640	44,313	88,025	145,615	189,327
Professional, Business Services etc.	317,116	137,974	111,512	205,604	179,142
Finance, Insurance and Real Estate	595,689	533,839	240,024	355,655	61,850
Information	82,726	11,818	32,671	50,050	70,908
Transportation and Storage Services	420,649	136,919	205,211	215,438	283,730
Retail	1,250,439	218,973	495,616	754,823	1,031,466
Wholesale	515,868	74,023	169,537	346,331	441,845
Construction	261,641	106,256	145,608	116,033	155,385
Manufacturing	116,410	39,950	67,917	48,483	76,454
Total	4,591,828	1,489,150	1,879,169	2,711,945	3,102,678

Note that the correction for outliers reduces total value added from \$3.103 billion to \$2.712 billion or by 12.5 percent. Nevertheless, even the scaled back \$2.712 billion estimate is probably too high given the unexpectedly large amount of calculated value added originating in retail and wholesale trade. These discrepancies are brought into sharp relief by comparing U.S. ratios for compensation per dollar of value added to the same ratios for Guam. In the U.S. I-O table, compensation accounts for 60 percent of retail trade value added, and 56 percent of wholesale trade value added. The

corresponding figures from the Guam Economic Census are approximately 18.5⁸ and 14.3 percent respectively. Such figures are not credible because they imply profit margins that are improbably high- as much as 400 percent greater than those in the corresponding U.S. industry. Random noise in the data cannot explain away the problem. Economists know that industrial activity in the trade sectors is largely confined to the re-packaging/re-selling of already produced items. Without significant processing, value added must be dominated by intermediary service type functions whose costs are primarily wage and salary driven. Under these circumstances, further downward adjustment of value added seems warranted.

3.2. Scaled Compensation Algorithm (Covered Industries)

The method discussed below is actually a variant of the factor cost approach (see section 3.3). However for ease of exposition and narrative continuity, it is introduced here.

Prior experience with the 1997 CNMI Economic Census uncovered a similar problem with inflated sectoral estimates. Rubin's 1999 paper concluded that the reporting industries failed to net out the cost of goods resold properly, resulting in understated intermediate purchases and upwardly biased value added. To correct the problem, Rubin refrained from using intermediate purchases altogether, and resorted to the standard fallback position in which estimates of value added are based solely on scaled compensation data^{9 10}. Simple algorithms first converted Census reported payroll to compensation, and then compensation, to value added. Specifically, Rubin used survey data on the value of fringe benefits to scale up payroll to compensation. Likewise, parametric ratios from the U.S. I-O table, representing compensation per dollar of value added, allowed him to complete the conversion from compensation to value added.

⁸ For Retail Trade, the 18.5 percent figure is based on compensation of \$139,838,000 and value added (value added1) of \$754,823,000. Given that the suspected inflation of the value added estimate is not a miscalculation, it may have a simple explanation based on patterns of international trade. A large fraction of intermediate purchases in the U.S. purchases (including goods for resale) are from domestic producers. By way of contrast, virtually all of Guam's intermediate purchases (including goods for resale) are imported. If cost, insurance and freight (CIF) account for as much as 20 percent of final purchase price, estimates of intermediate purchases in Guam will be biased downward by the simple application of U.S. I-O table P/S ratios.

⁹ Justification for this move is straightforward: most economists consider payroll data to be reliable because tax law mandates accurate collection and reporting. Moreover, research supports the belief in fairly stable empirical relationships between compensation and value added.

¹⁰ Even though individual U.S. and Guam pay rates and benefits are probably quite different, there are ways to test the realism of the assumption that benefit scalars are identical for all census enumerated industries combined. We find that both regions have similar compensation to total sales (output) ratios: 29 percent (U.S.) versus an estimated 21.3 percent (Guam). Given that sales as a multiple of the CIF-adjusted value added1 is 1.965 (4,591,828/2,336,825) in Guam and 1.930 (12,825,699/6,644,775) in the U.S., simple arithmetic indicates that the unmeasured ratio of compensation to value added in GUAM (.4176) is perhaps 26 percent lower than the known ratio in the U.S. (.5623) In turn, this implies that using U.S. compensation to value added ratios to proxy the unknown Guam parameters will bias summary estimates of GDP (measured as value added) downward by this same percentage or by nearly \$682 million. From table 2, Value added 2 is given as 1,969,331; dividing this latter figure by 0.74266 yields an "unbiased" estimate of 2,651,712. See footnote 8 for the assumed CIF markup rate.

Analogous techniques are employed to produce the ValueAdded2 estimates reported in Table 2.below.

Table 2. 2002 Value Added Estimates by Industrial Sector (\$000)

	Payroll	Scalar	Compensation	Compensation/Value Added	Value Added 2
Retail, Leasing and Other	13,567	1.145205	15,537	0.137950	112,628
Repair and Maintenance Services	20,823	1.137794	23,692	0.506144	46,809
Food Services	77,662	1.140905	88,605	0.672303	131,793
Accommodations	90,961	1.147958	104,419	0.492959	211,821
Health Care and Social Assistance	76,087	1.168044	88,873	0.833573	106,617
Professional, Business Services etc.	120,032	1.135193	136,260	0.578562	235,514
Finance, Insurance and Real Estate	94,755	1.173111	111,158	0.249087	446,262
Information	20,844	1.167468	24,335	0.426584	57,045
Transportation and Storage Services	80,031	1.152856	92,264	0.665036	138,736
Retail	122,655	1.140091	139,838	0.602174	232,222
Wholesale	42,522	1.162536	49,433	0.562161	87,935
Construction	54,131	1.167554	63,201	0.814704	77,575
Manufacturing	32,173	1.195605	38,466	0.455899	84,374
Total	846,243		976,081		1,969,331

Not surprisingly, compensation-based calculations of value added reduce the estimates for Retail Trade and Wholesale Trade by millions of dollars (\$523 and \$258 million respectively). When positive offsets in other industries are included, the final figure for industry wide value added falls from \$2.712 to \$1.969 billion or by an additional 27 percent.

At first glance, the most likely estimate of GDP in the covered sectors of industry would thus appear to lie in the \$1.969 - \$2.712 billion range. This may be an overly strong conclusion to draw. From a methodological point of view, our strong preference is to use the standard algorithm (final sales minus intermediate purchases) for calculating value added and keep all calculations on a common footing. For eleven of the thirteen industries, this produces sensible results, and corresponds to \$1,610,791,000 in value added. Nevertheless, the standard algorithm does not produce defensible estimates for Retail Trade and Wholesale Trade. So, to complete the initial picture, we use a hybrid mix of calculations, and replace the suspect numbers with the revised-compensation-based estimate of \$432,211,000¹¹. The end result is GDP totaling \$2,043,002,000 a figure which falls just above the lower limit of the range defined by the application of the first two value added algorithms. This estimate is referred to as “hybrid 1”.

3.3 Factor Cost Algorithm (Covered Industries)

The second definitive method for calculating value added involves summing compensation, indirect business taxes (IBT) and “other value added”(OVA). Information to implement this algorithm is available from Table 2 (compensation), the Single Audit Report (IBT), and the U.S. Input-Output table (OVA scaling factors. See Appendix 1). Given the dominant role of compensation in this approach and the one discussed in section 3.2, it is not surprising that the calculated value “addeds” are nearly identical: \$1.927 vs. \$1.969 billion. Nevertheless, we prefer the full factor cost estimates presented below to the previous scaled compensation numbers because the addition of IBT increases the percentage of measured as opposed to scaled value added. Again, the caution expressed above about the range of GDP estimates still appears to be well founded.

¹¹ The revised compensation based estimate of value includes a 35 percent correction for upward bias in the U.S compensation to value added scalar. See footnote 11.

Table 3. 2002 Value Added Estimates by Industrial Sector (\$000)

	Total Sales	Compensation	Other Value Added/Sales	Other Value Added (OVA)	Indirect Business Taxes (IBT)	Value Added³
Rental, Leasing and Other	69,163	15,537	0.4497058	31,103	2,609	49,249
Repair and Maintenance Services	98,815	23,692	0.264267	26,114	3,727	53,533
Food Services	273,576	88,605	0.102245	27,972	10,319	126,896
Accommodations	356,096	104,419	0.260572	92,789	13,432	210,640
Health Care and Social Assistance	236,640	88,873	0.1190162	28,164	8,926	125,963
Professional, Business Services etc.	317,116	136,260	0.263916	83,692	11,962	231,914
Finance, Insurance and Real Estate	595,689	111,158	0.317654	189,223	22,470	322,851
Information	82,726	24,335	0.190209	15,735	3,120	43,190
Transportation and Storage Services	420,649	92,264	0.119796	50,392	15,867	158,523
Retail	1,250,439	139,838	0.117341	146,728	47,167	333,733
Wholesale	515,868	49,433	0.10768	55,549	19,459	124,441
Construction	261,641	63,201	0.06172	16,149	9,869	89,219
Manufacturing	116,410	38,466	0.116676	13,582	4,391	56,439
Total	4,591,828	976,081		777,192	173,206	1,926,591

The use of the factor cost algorithm, in conjunction with the earlier results, suggests yet another possibility for calculating replacement value added in the retail trade and wholesale trade sectors. According to SNA guidelines, the preferred method for calculating value added in these industries is a two-step procedure¹². Initially, gross margin on sales (GM) is calculated, and then intermediate purchases, exclusive of goods for resale, are netted out. Obviously, the Census does not contain accurate data on cost of goods sold (CGS); however, an approximation to this measure can be calculated as a residual if we accept the VA3 estimate of GDP originating in these sectors as parametric,

¹² SNA is an acronym for the United Nations *System of National Accounts*.

and then work through a series of accounting definitions. First note that $GM = IP + VA$ (VA3). Data for the right hand side of the equation come from Tables 1 and 3. Next, apply the residual formula for calculating CGS: $CGS = \text{Total Sales (TS)} - GM$. Fidelity to the accounting standard is assured since $TS - CGS = GM = IP + VA$. For the two industries under consideration, value added (ValueAdded4) following SNA definitions is equal to \$458,174,000, while CGS is estimated to be \$642,980,000. When these replacement figures are used, total GDP rises to \$2,068,965,000. This new estimate is referred to as “hybrid 2.” See previous discussion on p.11, section 3.2.

Table 4. 2002 Value Added Estimates for Selected Service Sectors (\$000)

	Total Sales (TS)	Cost of Goods Sold (CGS)	Gross Margin (GM)	Raw Intermediate Purchases (P)	Purchase Adjustment (P')	Intermediate Purchases (IP)	Value Added 4
Retail	1,250,439	421,090	829,349	218,973	276,643	495,616	333,733
Wholesale	515,868	221,890	293,978	74,023	95,514	169,537	124,441
Total	1,766,307	642,980	1,123,327	292,996	372,157	665,153	458,174

3.4 Estimates of Value Added in Non-covered Industries

The economic census does not cover GDP originating in agriculture, government, certified carrier air transportation and private education at the elementary through high school levels. To account for value added in these missing sectors, three additional data sets are employed: the Census of Agriculture, administrative records from the Department of Finance and BLS survey data. Analysis of the agriculture data indicates that this omitted sector is quite small. There are identified sales of \$4,197,680, selected purchases of \$782,904, and payroll of \$669,125. The simple “sales minus purchase” algorithm produces a value added estimate that might be on the order of \$3,414,776. Alternatively, reported compensation scaled by the associated parameters from the I-O table suggests a figure of \$3,984,900. Because of our stated preference for using pure algorithms (3.1 or 3.3), we accept the \$3.4 million figure as the maximum for value added, with the caveat that purchases are “selected” rather than comprehensive.

Government payroll and fringe benefits in Guam were approximately \$1,012,414,007 in CY2002¹³. If the Guam compensation-to-value added scalars are identical to those in the U.S. at the federal, state and local levels, then value added in this sector totals \$1,243,578,197.¹⁴

¹³ Actually, the federal government data are for FY 2002. When the FY 2003 data become available, this estimate will be updated.

¹⁴ US data for 2001 indicates that GDP originating in Federal Government was \$396.2 billion, while State and Local Government produced \$885.1 billion. Given that compensation in these sectors was \$300.3 and \$761.8 billion respectively, compensation as a percent of GDP is 0.76 for the federal government and 0.86

**Table 5. Estimated 2002 Government Compensation and Value Added
(\$2002 = 100)**

	Benefit multiplier	Wages	Benefits	Compensation	Value added in government
Government of Guam					
Line Agencies		141,598,496	34,522,495	176,120,991	204,626,791
Department of Education		159,624,407	32,708,324	192,332,731	223,462,458
Autonomous Agencies		174,768,903	41,863,905	216,632,808	251,695,587
U.S. Federal Government					
<i>military</i>					
civilian		56,447,000		85,196,836	
active+inactive military (aim)		193,448,000		298,777,106	
scalar civilian	1.509324436				
scalar aim	1.544482786				
total benefits+salary				383,973,942	506,594,992
<i>non-military</i>					
scalar	1.509313977	28,724,000		43,353,535	
total benefits+salary				43,353,535	57,198,370
Total Government Compensation				1,012,414,007	
Total Government Value Added					1,243,578,197

Sources: Government of Guam: 2003. *Current Employment Report (September 2003)*; *Guam Economic Review*. Volume 25, No.4.; *Statement of Wages and Benefits CY 1999-2003*; Department of Education 2004. *Statement of Wages and Benefits CY 1999-2003*, U.S. Census Bureau 2003. *Consolidated Federal Funds Report: FY 2002 (Detailed Federal Expenditure Data-GUAM)*.

Finally, based on BLS data reporting average wages and total employment, total wages paid out in air transportation and private education are estimated at \$53,368,179 and \$17,202,392 respectively. Assuming that the respective industries pay benefits equal to 21.39 and 20 percent¹⁵ of total compensation for airline workers and educators

for the state and local components. See: Survey of Current Business December 2002, appendix pages D-31, D-34 Tables B.3 and B.7.

¹⁵ Benefits for airline workers come from the U.S. scalars reported in Appendix 1. Benefits for private educators are assumed to be equal to those paid to public school educators (20 percent). Source: Department of Education Statement of Wages and Benefits.

respectively, total compensation equals as \$85,426,677. Application of the relevant scalars produces value added paid in these industries of an additional \$111,924,032.

Summarizing across all non-census covered industries, total value added could be as much as \$1,358,917,005. When this figure is added to the value added originating in the covered industry, total GDP rises to an estimated \$3.286 - \$4.071 billion.

3.5 Class of Customer Imputation and Calibration of the Range of GDP Estimates

Based on the group average imputation methods discussed at the end of section 2, there could be as much as \$1,805,484,000 in household personal consumption expenditures resulting from sales by firms and enterprises represented in the economic census. While this figure is somewhat speculative, it does have testable implications.

Based upon what we know about typical island economies, PCE as a fraction of Gross National Income (GNI)¹⁶ is rarely below 60 percent or above 70 percent. The corresponding figures for Guam are 44.3 or 54.9 percent depending on whether the high or low GDP estimate is used as the denominator. As a result, if the \$1.805 billion estimate is in fact accurate, the **lower** GDP estimate would be more consistent with the stylized facts about the known structure of final expenditures in the insular areas.

¹⁶ We are assuming that GDP and GNI are identical in magnitude. In fact, GNI could be as much as five percent less than GDP. If foreign owned companies repatriate the vast bulk of their profits as is the case in American Samoa, then this would suggest PCE shares ranging from 46.7 to 57.8 percent of GNI.

Table 6. 2002 Estimated Personal Consumption Expenditures (\$000)

Number of Establishments	Sales & Receipts	Value of sales to HH customers	NAICS 4-digit industry code
2927	4,591,828	1,805,484	0000 Guam Total
	233,640	225,971	01 Health care and social assistance
	98,815	45,271	02 Repair and maintenance services
	356,096	51,685	03 Accommodations
	273,576	114,569	04 Food services
	399,842	137,236	05 Information/professional/business services
	420,649	46,341	06 Transportation and storage services
	1,250,439	696,496	07 Retail
	515,868	11,356	08 Wholesale trade
	116,400	7,613	09 Manufacturing
	261,641	35,719	10 Construction
	595,689	407,296	11 Finance, insurance, real estate
	69,163	25,931	12 Rental and leasing services [not real estate], and Other

4. Sensitivity Analysis and Other Qualifications

The above analyses are somewhat speculative. They contain synthetic estimates of intermediate purchases and compensation which are not based entirely on information contained within the 2002 Economic Census. Both situations are remediable since there are additional data sets which could further substantiate the assumptions used in the analysis. Data extracted from tax records could potentially allow us to replace the synthetic numbers with company reported figures on purchases, cost of goods sold and payroll as a fraction of total compensation. Unfortunately, as of this writing, queries of the tax base have not been made.

Finally, to make our analysis more consistent with BEA practice, we address the issue of reconciling the Census and BEA definitions of value added. The former focuses solely on final shipments and intermediate purchases, while the latter is more inclusive and includes an entry for inventory change. Currently we have no information on beginning and ending inventories. However, based upon previous analyses of the CNMI data and the 1997 Puerto Rico Economic Census, we believe that inventory change is less than 3

percent of final shipments and could be as low as 0.4%¹⁷. In our opinion, this correction factor is within the “noise” in the data and can therefore be ignored.

5. Final Comments

On the basis of the information available to us, we estimate that partial GDP for the covered economic census industries is between \$1.927 and \$2.712 billion. Our best estimate of partial GDP, the “hybrid2”, is \$2.069 billion. The \$785 million range between the low and high estimates reflects the absence of complete data, the consequences of using simplifying assumptions, and the choice of measurement methodology. When the \$1.359 billion in value added originating in the excluded sectors of agriculture, government, airlines and private education is accounted for, total GDP rises to an estimated \$3.286 to \$4.071 billion. Based on an estimated population of 162,326 in 2002, this translates into per capita GDP varying between \$20,243 and \$25,079. Again, the best estimate of per capita GDP, the “hybrid 2”, is \$21,118. All of these figures fall between the 2002 thresholds for the upper middle (\$9,220) and high (\$27,590) income categories used by the World Bank.

Because these figures are GDP averages, they say nothing about the level of personal disposable income or its distribution. Moreover, these numbers do not distinguish between the living standards of Guam born residents, who are U.S. citizens, and foreign guest workers. At this point, firm conclusions about the welfare of individuals cannot be derived. Only future research can properly address this question. Finally, given what has been written about understated cost of goods sold (CGS) and imputed personal consumption expenditures, we conclude that the lower bound estimates are probably closer to the truth. Therefore the reader should exercise caution and err on the low side until the future reconciliation of GDP estimates based on annual income and expenditure data is undertaken and completed.

¹⁷ See: *Benchmark Estimates of 2002 Gross Domestic Product in the Commonwealth of the Northern Mariana Islands*. p.16.

**6. Appendix 1: Critical Economic Ratios Derived from U.S. Input-Output Accounts
and Other Official U.S. Statistics**

NAICS	Industry	Compensation (Benefits) Scale Factor	Compensation/Value Added	Intermediate Purchases/Final Shipments	Other Value Added/Final Shipments
1110	Crop products	1.171251495	0.191491853	0.512527917	0.375069
1120	Animal products	1.171251495	0.37081931	0.850976656	0.076332
1130	Forestry and logging products	1.119961373	0.204417656	0.499005497	0.368765
1140	Fish and other non- farm animals	1.119961373	0.153208676	0.447337963	0.409838
1150	Agriculture and forestry support services	1.119961373	0.917278764	0.459574468	0.023055
2110	Oil and gas	1.163378408	0.183065561	0.599424524	0.251703
2121	Coal	1.189054726	0.495460537	0.537991079	0.133513
2122	Metal ores	1.212925852	0.529400872	0.567079362	0.156516
2123	Nonmetallic minerals	1.171833299	0.476135551	0.454384943	0.257747
2130	Mining support services	1.170872237	0.674344155	0.575644884	0.084972
2211	Electric power	1.193114814	0.203346246	0.375486651	0.38904
2212	Natural gas distribution	1.193114814	0.303834909	0.671491932	0.127274
2213	Water and sewage treatment	1.193114814	0.335557351	0.35008554	0.396429
2301	New residential construction	1.165206872	0.754667675	0.632358525	0.082598
2302	New nonresidential construction	1.165206872	0.897561625	0.516392886	0.040843
2303	Maintenance and repair construction	1.165206872	0.857788342	0.601721464	0.047319
3110	Food products	1.17762435	0.482352079	0.758523938	0.117893
3121	Beverage products	1.17762435	0.233351982	0.615631341	0.178678
3122	Tobacco products	1.270292208	0.08778382	0.448225324	0.359625
3130	Yarn, fabrics, and other textile mill products	1.17305218	0.826056636	0.743885621	0.037767
3140	Non-apparel textile products	1.184439686	0.600744688	0.671374466	0.125971
3150	Apparel	1.184439686	0.637420824	0.650939476	0.122364
3160	Leather and allied products	1.175091193	0.651979482	0.695163635	0.100697
3210	Wood products	1.177399406	0.690611364	0.714635637	0.074325
3221	Pulp, paper, and paperboard	1.169359502	0.498312624	0.656070881	0.164489
3222	Converted paper products	1.169359502	0.657477697	0.697944927	0.093363
3230	Printed products	1.169359502	0.717415882	0.570010959	0.112704
3240	Petroleum and coal products	1.220271733	0.346359746	0.889567384	0.061855

NAICS	Industry	Compensation (Benefits) Scale Factor	Compensation/Value Added	Intermediate Purchases/Final Shipments	Other Value Added/Final Shipments
3251	Basic chemicals	1.205944103	0.419756204	0.73383285	0.137925
3252	Resins, rubber, and artificial fibers	1.190686389	0.415956862	0.741769761	0.134893
3253	Agricultural chemicals	1.205944103	0.22207097	0.678009533	0.234095
3254	Pharmaceuticals and medicines	1.193134638	0.27453843	0.614227223	0.260275
3255	Paints, coatings, and adhesives	1.193134638	0.403648889	0.684447523	0.171211
3256	Soaps, cleaning compounds, and toiletries	1.193134638	0.185233657	0.590661526	0.319093
3259	Other chemical products	1.205944103	0.449484443	0.644962005	0.184013
3260	Plastics and rubber products	1.190686389	0.622966687	0.621437741	0.134577
3270	Nonmetallic mineral products	1.192499127	0.521094784	0.542518217	0.207644
331A	Primary ferrous metal products	1.218746802	0.70186208	0.746675553	0.066702
331B	Primary nonferrous metal products	1.218746802	0.788666805	0.829427488	0.026854
3315	Foundry products	1.196572993	0.834781628	0.597029478	0.057625
3321	Forgings and stampings	1.196572993	0.655915663	0.572894805	0.14058
3322	Cutlery and handtools	1.196572993	0.550677737	0.496161371	0.219491
3323	Architectural and structural metal products	1.196572993	0.606447697	0.557459573	0.16757
3324	Boilers, tanks, and shipping containers	1.196572993	0.640696159	0.682069491	0.107792
332A	Ordnance and accessories	1.196572993	0.633692823	0.469682301	0.164641
332B	Other fabricated metal products	1.196572993	0.640209178	0.506860656	0.170399
3331	Agriculture, construction, and mining machinery	1.166165215	0.581889974	0.679293032	0.126998
3332	Industrial machinery	1.166165215	0.666138592	0.620778482	0.119764
3333	Commercial and service industry machinery	1.166165215	0.693083644	0.666315871	0.095669
3334	HVAC and commercial refrigeration equipment	1.166165215	0.666492965	0.667302358	0.102924
3335	Metalworking machinery	1.166165215	0.805447552	0.50921575	0.087319
3336	Turbine and power transmission	1.166165215	0.529886222	0.622598174	0.172525

NAICS	Industry	Compensation (Benefits) Scale Factor	Compensation/Value Added	Intermediate Purchases/Final Shipments	Other Value Added/Final Shipments
	equipment				
3339	Other general purpose machinery	1.166165215	0.658912114	0.591247076	0.131074
3341	Computer and peripheral equipment	1.181523039	0.721902444	0.839499365	0.035959
334A	Audio, video, and communications equipment	1.181523039	0.520274991	0.636262499	0.166988
3344	Semiconductors and electronic components	1.181523039	0.401216703	0.514060969	0.283412
3345	Electronic instruments	1.181523039	0.719860703	0.551542086	0.118356
3346	Magnetic media products	1.181523039	0.559139249	0.581022842	0.178763
3351	Electric lighting equipment	1.181523039	0.581589958	0.625125894	0.149165
3352	Household appliances	1.181523039	0.634479567	0.713409841	0.097066
3353	Electrical equipment	1.181523039	0.655461402	0.627179749	0.120803
3359	Other electrical equipment and components	1.181523039	0.552384964	0.621668142	0.161341
3361	Motor vehicles	1.276135009	0.528297991	0.843838242	0.068552
336A	Motor vehicle bodies, trailers, and parts	1.276135009	0.826469713	0.725463617	0.042248
3364	Aerospace products and parts	1.203714318	0.763963812	0.652178553	0.077144
336B	Other transportation equipment	1.203714318	0.757603695	0.649921445	0.08023
3370	Furniture and related products	1.179597433	0.669464879	0.576037248	0.134208
3391	Medical equipment and supplies	1.166690816	0.543235151	0.494189691	0.223562
3399	Other miscellaneous manufactured products	1.193134638	0.636709446	0.616405713	0.127921
4200	Wholesale trade	1.165999361	0.562160851	0.330693202	0.10768
4A00	Retail trade	1.140091194	0.602173886	0.393011466	0.117341
4810	Air transportation	1.213903255	0.809554799	0.633356775	0.02098
4820	Rail transportation	1.353387709	0.668340323	0.446050518	0.166297
4830	Water transportation	1.196734986	0.547697258	0.755423934	0.08468
4840	Truck transportation	1.209858997	0.591405126	0.519363128	0.187711
4850	Transit and ground passenger transportation	1.175449473	0.615539865	0.354136718	0.204639
4860	Pipeline transportation	1.180540541	0.452631829	0.691464992	0.126257
48A0	Sightseeing transportation and transportation support	1.170221305	0.736128961	0.512123939	0.102912

NAICS	Industry	Compensation (Benefits) Scale Factor	Compensation/Value Added	Intermediate Purchases/Final Shipments	Other Value Added/Final Shipments
4920	Courier and messenger services	1.170221305	0.671051341	0.341044792	0.213436
4930	Warehousing and storage	1.209858997	0.744820503	0.317020672	0.144819
5111	Newspapers, books, and directories	1.163857996	0.426584275	0.42889239	0.318463
5112	Software	1.139017614	0.462551154	0.333933451	0.347114
5120	Motion pictures and sound recordings	1.172372248	0.433201773	0.582492529	0.211266
5131	Radio and television broadcasting	1.172372248	0.823547305	0.665460845	0.052324
5132	Cable networks and program distribution	1.172372248	0.33350772	0.530327951	0.281657
5133	Telecommunications	1.192934172	0.343045522	0.441845503	0.266013
5141	Information services	1.192934172	0.573430277	0.40302295	0.237624
5142	Data processing services	1.192934172	0.589056272	0.342148913	0.25969
52A0	Monetary oversight and credit intermediation	1.184085116	0.34908317	0.291005967	0.436091
5230	Securities, commodity contracts, investments	1.118434935	0.761336194	0.445580325	0.107562
5240	Insurance carriers and related services	1.177468547	0.639429706	0.498526978	0.142226
5250	Funds, trusts, and other financial vehicles	1.149142622	0.632695427	0.928079316	0.01104
5310	Real estate	1.156334606	0.096127413	0.304298763	0.504684
5321	Automotive equipment rental and leasing	1.139017614	0.226681783	0.301271287	0.491694
532A	Consumer goods and general rentals	1.139017614	0.401319896	0.308000408	0.374186
5324	Machinery and equipment rental and leasing	1.139017614	0.263115717	0.243720899	0.525653
5330	Rights to non-financial intangible assets	1.139017614	0.012286816	0.035701331	0.865731
5411	Legal services	1.135718758	0.565060553	0.277789909	0.308586
5412	Accounting and bookkeeping services	1.139017614	0.628131062	0.268195849	0.266069
5413	Architectural and engineering services	1.139017614	0.616849294	0.294335652	0.264149
5414	Specialized design services	1.139017614	0.454328348	0.353225361	0.336116
5415	Computer systems design and related services	1.139017614	0.78434796	0.354710478	0.129535

NAICS	Industry	Compensation (Benefits) Scale Factor	Compensation/Value Added	Intermediate Purchases/Final Shipments	Other Value Added/Final Shipments
5416	Management and technical consulting services	1.139017614	0.511975371	0.287836252	0.341992
5417	Scientific research and development services	1.139017614	0.886075359	0.356998173	0.066885
5418	Advertising and related services	1.139017614	0.533569714	0.35738915	0.289018
5419	Other professional and technical services	1.139017614	0.206487533	0.317392357	0.522965
5500	Management of companies and enterprises	1.139017614	0.868230387	0.296022912	0.074031
5613	Employment services	1.139017614	0.86922752	0.092030934	0.11425
5615	Travel arrangement and reservation services	1.139017614	0.700765654	0.461887268	0.145123
561A	All other administrative and support services	1.139017614	0.579455617	0.320132538	0.271146
5620	Waste management and remediation services	1.139017614	0.494369421	0.473882163	0.221826
6100	Educational services	1.153614193	0.89137945	0.419327812	0.060488
6210	Ambulatory health care services	1.169380993	0.708734495	0.313879301	0.194402
6220	Hospital care	1.169380993	0.971403886	0.449726785	0.012356
6230	Nursing and residential care	1.169380993	0.867959446	0.373507855	0.075212
6240	Social assistance	1.154444748	0.83025078	0.450854607	0.086616
71A0	Performing arts, spectator sports, and museums	1.146269242	0.607477186	0.465070171	0.167932
7130	Amusements, gambling, and recreation	1.146269242	0.485463422	0.322272503	0.298187
7210	Accommodations	1.14795755	0.492959397	0.329997695	0.260572
7220	Food and beverage services to customer order	1.140905329	0.672302655	0.512520402	0.102245
8111	Automotive repair and maintenance	1.134672599	0.492374733	0.471243147	0.229362
811A	Electronic, commercial, and household goods repair	1.140766116	0.488791956	0.373957722	0.302471
8120	Personal and laundry services	1.124811819	0.441397038	0.391516257	0.315125
813A	Religious, grantmaking, and social advocacy	1.098823141	0.999584155	0.336634428	0

NAICS	Industry	Compensation (Benefits) Scale Factor	Compensation/Value Added	Intermediate Purchases/Final Shipments	Other Value Added/Final Shipments
813B	Civic, social, professional and similar organizations	1.098823141	0.996164545	0.532693447	0
S001	Federal Government enterprise services	1.52319617	0.903224827	0.20521294	0.076916
S002	State and local government enterprise services	1.24181173	0.647111067	0.514691692	0.162779

Table sources:

Compensation Benefits Scale Factor: author's calculation from data in: U.S. Bureau of Economic Analysis.2004 *Table B.7. Compensation and Wage and Salary Accruals by Industry*, www.bea.gov/bea/ARTICLES/2002/12December/D-pages/1202Dpg, accessed July 22, 2004.

For all other critical ratios, the source is the author's calculations from data in: U.S. Bureau of Economic Analysis.2004 *1997 Industry by Industry Total Requirements after redefinition at the detailed level (Table8)*, http://www.bea.gov/bea/dn2/i-o_benchmark.htm, accessed July 22, 2004.

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