Benchmark Estimates of 2002 Gross Domestic Product

Commonwealth of the Northern Mariana Islands

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Executive Summary

In June 2004, the U.S. Department of Interior, Office of Insular Affairs awarded a contract to the International Programs Center (IPC) of the U.S. Census Bureau to evaluate aggregate economic conditions in Guam. All parties agreed that the project's objective was to produce estimates of Gross Domestic Product (GDP), and that the scope of work would embrace the essential elements of the research design found in the March 1999 IPC 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 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 $752.6 and $966.9 million. The $214 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 $142.4 million in value added originating in the excluded sectors of agriculture and government is accounted for, total GDP rises to an estimated $895.0 to $1,109.3 million. Based on an estimated population of 75,066 in 2002, this translates into per capita GDP varying between $11,923 and $14,778. These figures fall between the 2002 thresholds for the upper middle ($9,220) and high ($27,590) income categories used by the World Bank.

For comparison purposes, our original paper on the CNMI estimated that GDP in 1997 was between $854.8 and $1,007.1 million. On a per capita basis, this is equivalent to $13,406 to $15,974 in GDP. Thus, over the five-year period, it would appear that the nominal amount of goods and services available to each resident fell by at least 7.5 to 11.1 percent. We say "at least" since the cost of living has not been factored in. In short, economic conditions as of December 31, 2002 were probably not as good as they were when the previous economic census was taken. Outside information validates this impression given what is known about the negative impact of the September 11 terror attack on tourist industry revenues in specific, and employment and payrolls in general.

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 CNMI 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 COGS 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 revisit and update those calculations. 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 (COGS). 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 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.
2) aggregating value added[1] 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 reliable of the three methodologies (value added, income, and final expenditure) available for calculating GDP.

[1] Or some variant thereof.

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 the 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 COGS. Simple edit specification programs designed to detect outliers indicated that over ten percent of respondents failed to provide any data on intermediate purchases[2]. In our follow-up, we found other instances in which the value of intermediate purchases was implausibly low or high[3]. Likewise, we found 170 records (fifteen 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 U.S. Input-Output (I-O) table. Rubin first made the assumption that for any given 4-digit North American Industry Classification System (NAICS) industry, the technology underlying production (reflected by input structure) was similar in the U.S. and CNMI[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 respondent P/S ratio was then compared to the corresponding parameter range for the

[2] The magnitude of underreporting can be captured by the Intermediate Purchase/Final Sales ratio (P/S). According to our rough estimates, the fraction of firms reporting a "0" P/S was 14 percent, where the percent is computed as sales of "0" responders divided by total industry sales of all responders. If the P/S threshold is set at 10 percent, the fraction of industry sales rises to 44 percent.

[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 CNMI machinery and equipment imports from countries like the U.S. and Japan. In addition, CNMI 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 "Census" versus 1997 "I-O "). 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).

relevant 2-digit NAICS industry group in the I-O table[5]. 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 CNMI 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 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 reported intermediate purchases from final sales[6]. The resulting estimate, raw value added (RVA), serves as the initial estimate and strawman for subsequent work. This initial estimate is juxtaposed against a second estimate (ValueAdded1), where intermediate purchases have been adjusted to correct for the outliers detected in the data quality assessment exercise. We format the presentation of both estimates of value added according to the aggregate industry sectors covered in the 2002 Economic Census with some modification[7]. 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 CNMI economic census, but the needed corrections probably don't alter the end result by more than five percent.

[7] "Information" is separated from "Professional….", "Apparel" is separated from "Manufacturing", and "Education is moved from "Professional.." to "Other".

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

	Total Sales	Total Reported Purchases	Adjusted Purchases	Value Added1	Raw Value Added
Other	100,968	74,795	38,965	62,003	26,173
Repair and Maintenance Services	15,510	3,530	6,405	9,105	11,980
Food Services	53,353	12,557	25,767	27,586	40,796
Accommodations	143,834	41,552	49,045	94,789	102,282
Arts, Entertainment etc.	29,316	9,147	10,395	18,921	20,169
Health Care and Social Assistance	15,568	1,433	5,178	10,390	14,135
Professional, Business Services etc.	134,687	26,020	43,718	90,969	108,667
Finance, Insurance and Real Estate	69,105	15,739	25,084	44,021	53,366
Information	48,486	2,380	22,509	25,977	46,106
Rental and Leasing Services	12,142	5,007	3,633	8,509	7,135
Transportation and Storage Services	58,361	13,293	24,955	33,406	45,068
Retail	312,384	46,921	121,837	190,547	265,463
Wholesale	122,634	22,050	41,173	81,461	100,584
Apparel	639,357	122,619	402,656	236,701	516,738
Construction	50,008	28,524	28,263	21,745	21,484
Manufacturing	26,417	8,556	15,621	10,796	17,861
Total	**1,832,130**	**434,123**	**865,204**	**966,926**	**1,398,007**

Note that the correction for outliers reduces total value added from $1.398 billion to $967 million or by 31 percent. Nevertheless, even the scaled back $967 million estimate is probably too high given the unexpectedly large amount of calculated value added originating in retail trade, wholesale trade, and information services. These discrepancies

are brought into sharp relief by comparing U.S. ratios for compensation per dollar of value added to the same ratios for the CNMI. In the U.S. I-O table, compensation accounts for 60 percent of retail trade value added, 56 percent of wholesale trade value added, and almost 60 percent in information and data processing. The corresponding figures from the CNMI Economic Census are approximately 18[8], 13, and 30 percent respectively. Such figures are not credible because they imply profit margins that are improbably high- more than 300[9] 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[10] [11]. Simple algorithms first converted Census reported payroll to

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[8] For Retail Trade, the 18 percent figure is based on compensation of $33,415,000 and value added (value added1) of $190,547,000. 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 CNMI'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 CNMI will be biased downward by the simple application of U.S. I-O table P/S ratios.

[9] If the estimate of Retail VA1 were accurate, then to preserve the equality of VA1 and VA3 there would have to be an upward adjustment in " OVA" equal to the difference in the initial value added estimates (190,547 – 91,497 = 99,050). With this revision, the sum of operating surplus and depreciation (OVA) would rise from 11.7 percent as a fraction of sales (36,656/312,384) to 43.4 percent (135,706/312,384).

[10] 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.

[11] Even though U.S. and CNMI pay rates and benefits are probably quite different, for all census enumerated industries combined, both regions have similar compensation to total sales (output) ratios: 29 percent (U.S.) versus an estimated 24 percent (CNMI). Given that sales as a multiple of the CIF-adjusted value added1 is 2.308 (1,832,130/ 793,885) in CNMI and 1.903 (12,825,699/6,644,775) in the U.S., simple arithmetic indicates that the unmeasured ratio of compensation to value added in CNMI (.5613) is virtually identical to 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 CNMI parameters should not bias summary estimates of GDP (measured as value added). See footnote 9 for the assumed CIF markup rate.

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. 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 Added2
Other	17,740	1.1695	20,747	0.256517	80,879
Repair and Maintenance Services	3,144	1.136828	3,574	0.491097	7,278
Food Services	12,180	1.140905	13,896	0.672303	20,670
Accommodations	35,095	1.147958	40,288	0.492959	81,726
Arts, Entertainment etc.	6,418	1.146269	7,357	0.490638	14,994
Health Care and Social Assistance	3,666	1.166912	4,278	0.726114	5,891
Professional, Business Services etc.	34,080	1.138793	38,810	0.66077	58,735
Finance, Insurance and Real Estate	11,879	1.168881	13,885	0.216795	64,047
Information	6,650	1.168832	7,773	0.788264	9,861
Rental and Leasing Services	2,796	1.139018	3,185	0.316874	10,050
Transportation and Storage Services	13,816	1.173276	16,210	0.653521	24,804
Retail	29,309	1.140091	33,415	0.602174	55,491
Wholesale	8,820	1.165999	10,284	0.562161	18,294
Apparel	177,781	1.18444	210,571	0.637421	330,348
Construction	11,276	1.165207	13,139	0.801866	16,385
Manufacturing	6,925	1.183256	8,194	0.481189	17,029
Total	**381,575**		**445,605**		**816,482**

Not surprisingly, compensation-based calculations of value added reduce the estimates for Retail Trade, Wholesale Trade and Information by millions of dollars ($210, $63 and $36 million respectively). When positive offsets in other industries are included, the final figure for industry wide value added falls from $967 to $816 or by an additional 16 percent.

At first glance, the most likely estimate of GDP in the covered sectors of industry would thus appear to lie in the $816 - $967 million range. This is probably the wrong 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 thirteen of the sixteen industries, this produces sensible results, and corresponds to $668,941,000 in value added. Nevertheless, the standard algorithm does not produce defensible estimates for Retail Trade, Wholesale Trade, and Information. So, to complete the initial picture, we use a hybrid mix of calculations, and replace the faulty numbers with the revised-compensation-based estimates of $83,646,000. The end result is GDP totaling $752,587,000, a figure which falls outside of the range defined by the application of the two value added algorithms[12]. 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 and "other value added". Information to implement this algorithm is available from Table 2 (compensation), the Single Audit Report (indirect business taxes), and the U.S. Input-Output table (other value added scaling factors. See Appendix 1). Application of these methods produces an estimate of value added ($859.3 million) midway between the "hybrid 1"and upper limit.

[12] This "hybrid 1" $752.6 million dollar estimate is very close to the CIF-adjusted value added1estimate. Inclusion of the 20 percent CIF markup reduces the original value added1 estimate from $966.9 million to $793.8, a figure which is basically five percent above the hybrid. Refer footnote 9.

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

	Total Sales	Compensation	Other Value Added/Sales	Other Value Added	Indirect Business Taxes	Value Added3
Other	100,968	20,747	0.367609	37,117	6,925	64,789
Repair and Maintenance Services	15,510	3,574	0.252407	3,915	1,064	8,553
Food Services	53,353	13,896	0.102245	5,455	3,659	23,010
Accommodations	143,834	40,288	0.260572	37,479	9,865	87,632
Arts, Entertainment etc.	29,316	7,357	0.295761	8,671	2,011	18,039
Health Care and Social Assistance	15,568	4,278	0.184455	2,872	1,068	8,218
Professional, Business Services etc.	134,687	38,810	0.154987	20,875	9,238	68,923
Finance, Insurance and Real Estate	69,105	13,885	0.257601	17,802	4,740	36,427
Information	48,486	7,773	0.057739	2,800	3,326	13,899
Rental and Leasing Services	12,142	3,185	0.429058	5,210	833	9,228
Transportation and Storage Services	58,361	16,210	0.172372	10,060	4,003	30,273
Retail	312,384	33,415	0.117344	36,656	21,426	91,497
Wholesale	122,634	10,284	0.10768	13,205	8,411	31,900
Apparel	639,357	210,571	0.122364	78,234	43,852	332,657
Construction	50,008	13,139	0.068137	3,407	3,430	19,976
Manufacturing	26,417	8,194	0.160831	4,249	1,812	14,255
Total	**1,832,130**	**445,606**		**288,005**		**859,274**

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, wholesale

trade and information services sectors. According to SNA guidelines, the preferred method for calculating value added in these industries is a two-step procedure[13]. Initially, gross margin on sales 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 (COGS); however, an approximation to this measure can be calculated as a residual based on total reported sales, total reported purchases[14], estimated compensation, indirect business taxes and estimated "other value added". Using the standard accounting identities for a merchandising firm, COGS equals: sales – reported purchases-compensation - other value added (profit plus depreciation) – indirect business taxes. For the three industries under consideration, value added (ValueAdded4) following SNA definitions is equal to $137,296,000. When these replacement estimates are used, total GDP rises to $806,237,000 (see previous discussion on p.12, section 3.2). This estimate is referred to as "hybrid 2".

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

	Total Sales	Total Reported Purchases	Compensation	Other Value Added	Indirect Business Taxes	Estimated Cost of Goods Sold	Value Added4
Information	48,486	2,380	7,773	2,800	3,326	32,207	13,899
Retail	312,384	46,921	33,415	36,656	21,426	173,966	91,497
Wholesale	122,634	22,050	10,284	13,205	8,411	68,684	31,900
Total	**1,832,130**	**434,123**	**445,605**	**288,005**	**33,163**	**274,857**	**137,296**

3.4 Estimates of Value Added in Non-covered Industries

The economic census does not cover GDP originating in agriculture or government. To account for value added in these missing sectors, two additional data sets are employed: the Census of Agriculture and administrative records from the Department of Finance. Analysis of the agriculture data indicates that this omitted sector is quite small. There are identified sales of $2,287,407, selected purchases of $483,030, and payroll of $660,891. The simple "sales minus purchase" algorithm produces a value added estimate that might be on the order of $1,804,377. Alternatively, reported compensation scaled by the

[13] SNA is an acronym for the United Nations *System of National Accounts*.

[14] Our analysis of the Census questionnaire and the individual data records in the industrial sectors under review strongly suggests that these numbers are the operating expenses on materials, utilities, warehousing etc. The sum of these reported purchases (P1) along with the unknown COGS (P2) conceptually equals the summary category intermediate purchases used in the first value added algorithm. By definition, value added estimated from sales and intermediate purchases must equal value added estimated from factor costs. Thus S-P = C + OVA + IBT. Substituting P1 +P2 for P implies that unknown P2 = S – P1 – C – OVA – IBT.

associated parameters from the I-O table suggests a figure of $3,001,962. Clearly, this latter figure is impossible unless there are price controls in effect which artificially depress the value of sales. Therefore we accept the $1.8 million figure as the maximum for value added given that purchases are "selected" rather than comprehensive.

Government payroll and fringe benefits in CNMI were approximately $121,028,922 in CY2002. If the CNMI compensation to value added scalar[15] is identical to that in the U.S. at the state and local level, then value added in this sector totals $140,617,877.

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 $610,667,000 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.

If CNMI GDP for the economic census industries is between $752.6 and $966.9 million, and if value added in agriculture and government is $142.4 million, then total GDP is in the range of $895.0 to $1,109.3 million. 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 CNMI are 55.0 or 68.2 percent depending on whether the high or low GDP estimate is used as the denominator. As a result, if the $610.7 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.

[15] 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 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.

[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 57.9 to 71.8 percent of GNI.

Table 5. 2002 Estimated Personal Consumption Expenditures ($000)

Number of Establishments	Sales & Receipts	Value of sales to HH customers	NAICS 4-digit industry code
1276	1,832,130	610,667	0000 CNMI Total
		9,221	01 Health care and social assistance
		5,702	02 Repair and maintenance services
		128,329	03 Accommodations
		37,359	04 Food services
		69,427	05 Information/professional/business services
		21,434	06 Transportation and storage services
		250,229	07 Retail
		7,336	08 Wholesale trade
		6,277	09 Manufacturing
		3,885	10 Construction
		28,774	11 Finance, insurance, real estate
		8,240	12 Rental and leasing services [not real estate]
		34,454	13 Other kinds of business or activity

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 . In the first instance, data extracted from tax records could potentially allow us to replace the synthetic numbers with company reported figures on purchases and cost of goods sold. Unfortunately, as of this writing, queries of the tax base have not provided fully consistent results. So, for the time being we limit ourselves to the second issue: examining the implications of replacing the U.S. benefit scalars with compensation data specific to the CNMI.

An unpublished study sheds light on the value of benefits in CNMI. Our conclusion is that with the exception of the transportation and garment industries, the use of U.S. scalars will produce an upward bias in the GDP estimates. Nevertheless, when **all** industries are summed, the combined impact on value added is less than $10,000,000 regardless of the choice of estimating algorithm. Given the range of value added

estimates, this is roughly one percent of GDP, a figure well within the "noise" in the data, and certainly not a cause for concern.

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. According to CNMI administrative records, beginning and ending year inventory in 2002 differed by $488,000 or 0.4 percent. 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 $752.6 and $966.9 million. The $214 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 $142.4 million in value added originating in the excluded sectors of agriculture and government is accounted for, total GDP rises to an estimated $895.0 to $1,109.3 million. Based on an estimated population of 75,066 in 2002, this translates into per capita GDP varying between $11,923 and $14,778. These figures fall between the 2002 thresholds for the upper middle ($9,220) and high ($27,590) income categories used by the World Bank.

For comparison purposes, our original paper on the CNMI estimated that GDP in 1997 was between $854.8 and $1,007.1 million. On a per capita basis, this is equivalent to $13,406 to $15,974 in GDP. Thus, over the five-year period, it would appear that the nominal amount of goods and services available to each resident fell by at least 7.5 to 11.1 percent. We say "at least" since the cost of living has not been factored in. In short, economic conditions as of December 31, 2002 were probably not as good as they were when the previous economic census was taken. Outside information validates this impression given what is known about the negative impact of the September 11 terror attack on tourist industry revenues in specific, and employment and payrolls in general.

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 CNMI 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 COGS 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.

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	0.1914919	0.5125279	0.3750688
1120	Animal products	1.171251495	0.3708193	0.8509767	0.0763318
1130	Forestry and logging products	1.119961373	0.2044177	0.4990055	0.3687654
1140	Fish and other non-farm animals	1.119961373	0.1532087	0.447338	0.409838
1150	Agriculture and forestry support services	1.119961373	0.9172788	0.4595745	0.0230549
2110	Oil and gas	1.163378408	0.1830656	0.5994245	0.2517028
2121	Coal	1.189054726	0.4954605	0.5379911	0.1335135
2122	Metal ores	1.212925852	0.5294009	0.5670794	0.1565155
2123	Nonmetallic minerals	1.171833299	0.4761356	0.4543849	0.2577472
2130	Mining support services	1.170872237	0.6743442	0.5756449	0.084972
2211	Electric power	1.193114814	0.2033462	0.3754867	0.3890399
2212	Natural gas distribution	1.193114814	0.3038349	0.6714919	0.1272735
2213	Water and sewage treatment	1.193114814	0.3355574	0.3500855	0.3964294
2301	New residential construction	1.165206872	0.7546677	0.6323585	0.0825979
2302	New nonresidential construction	1.165206872	0.8975616	0.5163929	0.0408427
2303	Maintenance and repair construction	1.165206872	0.8577883	0.6017215	0.0473191
3110	Food products	1.17762435	0.4823521	0.7585239	0.1178935
3121	Beverage products	1.17762435	0.233352	0.6156313	0.1786777
3122	Tobacco products	1.270292208	0.0877838	0.4482253	0.3596247
3130	Yarn, fabrics, and other textile mill products	1.17305218	0.8260566	0.7438856	0.0377674
3140	Non-apparel textile products	1.184439686	0.6007447	0.6713745	0.1259711
3150	Apparel	1.184439686	0.6374208	0.6509395	0.1223638
3160	Leather and allied products	1.175091193	0.6519795	0.6951636	0.1006966
3210	Wood products	1.177399406	0.6906114	0.7146356	0.0743245
3221	Pulp, paper, and paperboard	1.169359502	0.4983126	0.6560709	0.1644889
3222	Converted paper products	1.169359502	0.6574777	0.6979449	0.0933626
3230	Printed products	1.169359502	0.7174159	0.570011	0.1127035

NAICS	Industry	Compensation (Benefits) Scale Factor	Compensation/Value Added	Intermediate Purchases/Final Shipments	Other Value Added/Final Shipments
3240	Petroleum and coal products	1.220271733	0.3463597	0.8895674	0.061855
3251	Basic chemicals	1.205944103	0.4197562	0.7338329	0.1379247
3252	Resins, rubber, and artificial fibers	1.190686389	0.4159569	0.7417698	0.1348933
3253	Agricultural chemicals	1.205944103	0.222071	0.6780095	0.2340952
3254	Pharmaceuticals and medicines	1.193134638	0.2745384	0.6142272	0.2602751
3255	Paints, coatings, and adhesives	1.193134638	0.4036489	0.6844475	0.1712114
3256	Soaps, cleaning compounds, and toiletries	1.193134638	0.1852337	0.5906615	0.3190926
3259	Other chemical products	1.205944103	0.4494844	0.644962	0.1840128
3260	Plastics and rubber products	1.190686389	0.6229667	0.6214377	0.1345773
3270	Nonmetallic mineral products	1.192499127	0.5210948	0.5425182	0.2076444
331A	Primary ferrous metal products	1.218746802	0.7018621	0.7466756	0.066702
331B	Primary nonferrous metal products	1.218746802	0.7886668	0.8294275	0.0268541
3315	Foundry products	1.196572993	0.8347816	0.5970295	0.0576246
3321	Forgings and stampings	1.196572993	0.6559157	0.5728948	0.1405804
3322	Cutlery and hand tools	1.196572993	0.5506777	0.4961614	0.2194913
3323	Architectural and structural metal products	1.196572993	0.6064477	0.5574596	0.1675696
3324	Boilers, tanks, and shipping containers	1.196572993	0.6406962	0.6820695	0.1077916
332A	Ordnance and accessories	1.196572993	0.6336928	0.4696823	0.1646407
332B	Other fabricated metal products	1.196572993	0.6402092	0.5068607	0.1703987
3331	Agriculture, construction, and mining machinery	1.166165215	0.58189	0.679293	0.1269978
3332	Industrial machinery	1.166165215	0.6661386	0.6207785	0.1197645
3333	Commercial and service industry machinery	1.166165215	0.6930836	0.6663159	0.0956688
3334	HVAC and commercial refrigeration equipment	1.166165215	0.666493	0.6673024	0.1029242
3335	Metalworking machinery	1.166165215	0.8054476	0.5092158	0.0873188
3336	Turbine and power transmission equipment	1.166165215	0.5298862	0.6225982	0.1725252

NAICS	Industry	Compensation (Benefits) Scale Factor	Compensation/Value Added	Intermediate Purchases/Final Shipments	Other Value Added/Final Shipments
3339	Other general purpose machinery	1.166165215	0.6589121	0.5912471	0.1310743
3341	Computer and peripheral equipment	1.181523039	0.7219024	0.8394994	0.035959
334A	Audio, video, and communications equipment	1.181523039	0.520275	0.6362625	0.1669876
3344	Semiconductors and electronic components	1.181523039	0.4012167	0.514061	0.2834121
3345	Electronic instruments	1.181523039	0.7198607	0.5515421	0.1183562
3346	Magnetic media products	1.181523039	0.5591392	0.5810228	0.1787626
3351	Electric lighting equipment	1.181523039	0.58159	0.6251259	0.1491654
3352	Household appliances	1.181523039	0.6344796	0.7134098	0.0970661
3353	Electrical equipment	1.181523039	0.6554614	0.6271797	0.1208034
3359	Other electrical equipment and components	1.181523039	0.552385	0.6216681	0.1613415
3361	Motor vehicles	1.276135009	0.528298	0.8438382	0.0685525
336A	Motor vehicle bodies, trailers, and parts	1.276135009	0.8264697	0.7254636	0.0422484
3364	Aerospace products and parts	1.203714318	0.7639638	0.6521786	0.0771443
336B	Other transportation equipment	1.203714318	0.7576037	0.6499214	0.0802297
3370	Furniture and related products	1.179597433	0.6694649	0.5760372	0.1342077
3391	Medical equipment and supplies	1.166690816	0.5432352	0.4941897	0.2235625
3399	Other miscellaneous manufactured products	1.193134638	0.6367094	0.6164057	0.1279211
4200	Wholesale trade	1.165999361	0.5621609	0.3306932	0.1076797
4A00	Retail trade	1.140091194	0.6021739	0.3930115	0.117341
4810	Air transportation	1.213903255	0.8095548	0.6333568	0.0209804
4820	Rail transportation	1.353387709	0.6683403	0.4460505	0.166297
4830	Water transportation	1.196734986	0.5476973	0.7554239	0.0846802
4840	Truck transportation	1.209858997	0.5914051	0.5193631	0.1877114
4850	Transit and ground passenger transportation	1.175449473	0.6155399	0.3541367	0.204639
4860	Pipeline transportation	1.180540541	0.4526318	0.691465	0.1262567
48A0	Sightseeing transportation and transportation support	1.170221305	0.736129	0.5121239	0.102912
4920	Courier and messenger services	1.170221305	0.6710513	0.3410448	0.213436
4930	Warehousing and storage	1.209858997	0.7448205	0.3170207	0.1448189
5111	Newspapers, books,	1.163857996	0.4265843	0.4288924	0.3184626

NAICS	Industry	Compensation (Benefits) Scale Factor	Compensation/Value Added	Intermediate Purchases/Final Shipments	Other Value Added/Final Shipments
	and directories				
5112	Software	1.139017614	0.4625512	0.3339335	0.3471143
5120	Motion pictures and sound recordings	1.172372248	0.4332018	0.5824925	0.2112663
5131	Radio and television broadcasting	1.172372248	0.8235473	0.6654608	0.0523236
5132	Cable networks and program distribution	1.172372248	0.3335077	0.530328	0.2816567
5133	Telecommunications	1.192934172	0.3430455	0.4418455	0.2660133
5141	Information services	1.192934172	0.5734303	0.403023	0.2376237
5142	Data processing services	1.192934172	0.5890563	0.3421489	0.2596896
52A0	Monetary oversight and credit intermediation	1.184085116	0.3490832	0.291006	0.4360915
5230	Securities, commodity contracts, investments	1.118434935	0.7613362	0.4455803	0.1075615
5240	Insurance carriers and related services	1.177468547	0.6394297	0.498527	0.142226
5250	Funds, trusts, and other financial vehicles	1.149142622	0.6326954	0.9280793	0.0110404
5310	Real estate	1.156334606	0.0961274	0.3042988	0.5046845
5321	Automotive equipment rental and leasing	1.139017614	0.2266818	0.3012713	0.4916939
532A	Consumer goods and general rentals	1.139017614	0.4013199	0.3080004	0.3741862
5324	Machinery and equipment rental and leasing	1.139017614	0.2631157	0.2437209	0.5256531
5330	Rights to non-financial intangible assets	1.139017614	0.0122868	0.0357013	0.8657313
5411	Legal services	1.135718758	0.5650606	0.2777899	0.3085856
5412	Accounting and bookkeeping services	1.139017614	0.6281311	0.2681958	0.2660694
5413	Architectural and engineering services	1.139017614	0.6168493	0.2943357	0.2641494
5414	Specialized design services	1.139017614	0.4543283	0.3532254	0.3361163
5415	Computer systems design and related services	1.139017614	0.784348	0.3547105	0.1295346
5416	Management and technical consulting services	1.139017614	0.5119754	0.2878363	0.3419917
5417	Scientific research and development services	1.139017614	0.8860754	0.3569982	0.066885
5418	Advertising and related services	1.139017614	0.5335697	0.3573892	0.2890181
5419	Other professional and technical services	1.139017614	0.2064875	0.3173924	0.5229651

NAICS	Industry	Compensation (Benefits) Scale Factor	Compensation/Value Added	Intermediate Purchases/Final Shipments	Other Value Added/Final Shipments
5500	Management of companies and enterprises	1.139017614	0.8682304	0.2960229	0.0740314
5613	Employment services	1.139017614	0.8692275	0.0920309	0.1142502
5615	Travel arrangement and reservation services	1.139017614	0.7007657	0.4618873	0.1451232
561A	All other administrative and support services	1.139017614	0.5794556	0.3201325	0.2711463
5620	Waste management and remediation services	1.139017614	0.4943694	0.4738822	0.2218259
6100	Educational services	1.153614193	0.8913795	0.4193278	0.0604877
6210	Ambulatory health care services	1.169380993	0.7087345	0.3138793	0.1944022
6220	Hospital care	1.169380993	0.9714039	0.4497268	0.012356
6230	Nursing and residential care	1.169380993	0.8679594	0.3735079	0.0752124
6240	Social assistance	1.154444748	0.8302508	0.4508546	0.0866164
71A0	Performing arts, spectator sports, and museums	1.146269242	0.6074772	0.4650702	0.1679325
7130	Amusements, gambling, and recreation	1.146269242	0.4854634	0.3222725	0.298187
7210	Accommodations	1.14795755	0.4929594	0.3299977	0.2605724
7220	Food and beverage services to customer order	1.140905329	0.6723027	0.5125204	0.1022446
8111	Automotive repair and maintenance	1.134672599	0.4923747	0.4712431	0.2293621
811A	Electronic, commercial, and household goods repair	1.140766116	0.488792	0.3739577	0.3024712
8120	Personal and laundry services	1.124811819	0.441397	0.3915163	0.315125
813A	Religious, grant-making, and social advocacy	1.098823141	0.9995842	0.3366344	0
813B	Civic, social, professional and similar organizations	1.098823141	0.9961645	0.5326934	0
S001	Federal Government enterprise services	1.52319617	0.9032248	0.2052129	0.0769157
S002	State and local government enterprise services	1.24181173	0.6471111	0.5146917	0.1627786

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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