International Cross Section Estimates of Demand for Use in the GTAP Model

Jeffrey J. Reimer

and

Thomas W. Hertel*

GTAP Technical Paper No. 23

* Reimer is Post-Doctoral Research Associate, Food System Research Group, Department of Agricultural and Applied Economics, University of Wisconsin, Madison, WI, USA. Hertel is Director, Center for Global Trade Analysis, and Professor, Department of Agricultural Economics, Purdue University, West Lafayette, IN, USA.

The authors thank Alan Powell, John Cranfield, Anita Regmi, and James Seale for comments on earlier drafts of this paper.

Abstract

The making of projections often requires an economy-wide perspective, and the estimation of consumer demands at the international level. In this paper, an implicit, directly additive demand system (AIDADS) is estimated using cross-country data on consumer expenditures from the International Comparison Program (ICP), and then from Global Trade Analysis Project (GTAP) data. The two data sets are found to produce results that are quite consistent despite their differing origins, and the fact that the former is based on consumer goods that embody wholesale/retail margins, while margin demands are treated separately in GTAP. Given the similarity of the results, the estimation based on GTAP data is favored because it is readily matched to input-output based production and trade data, and provides valuable new information concerning how aggregate margin expenditures are related to per capita income.

Table of Contents

I. Introduction

There is widespread demand for projections of economic activity, by sector, for purposes of strategic planning as well as policy analysis. When such forecasts are related to national energy demand, employment, or environmental quality, researchers are usually forced to take an economy-wide approach to modeling, which in turn requires specification of a complete system of consumer demands. By linking these estimates of demand behavior to production data based on input-output accounts, a researcher can then estimate the direct and indirect effects of changes in final uses on specific industries and commodities (Lawson, 1997). Linking demand behavior to production and trade data is also necessary for testing certain economic theories (e.g., Reimer and Hertel, 2003), as well as for understanding the process of economic development in general (Lluch, Powell, Williams, 1977). When such studies aim to determine global resource requirements, then an international demand system is required.

Unfortunately, specifying the demand parameters for a global model is a formidable challenge. One reason for this difficulty relates to the fact that there are few demand systems that are well behaved over the wide variation in per capita incomes inherent in a global model, let alone satisfactorily characterize demand behavior in such circumstances.[1] Another challenge stems from the fact that there are few publicly available data bases with information on per capita expenditures for multiple goods and countries. Perhaps the best known source of such data is the International Comparison Program (ICP), which was begun at the University of Pennsylvania and whose activities are currently coordinated by the World Bank. The ICP data have been used in numerous international demand studies, such as Theil and Clements (1987); Hunter and Markusen (1988); Theil, Chung, Seale (1989); Cranfield, Preckel, Eales, Hertel (2000); Regmi, Seale, Bernstein (2001); and Cranfield, Eales, Hertel, Preckel (2002).

Unfortunately, the ICP data pose a problem for researchers who need to match ICP-based demand estimates to production and trade information in data bases such as the Global Trade Analysis Project (GTAP), or the OECD Structural Analysis (STAN) data, which are based on input-output accounts (Dimaranan and McDougall, 2002; OECD, 2002). There are two primary reasons for this difficulty. The first is that production and trade data bases are generally evaluated in terms of producer prices, thereby excluding the wholesale/retail margins and transportation costs embodied in ICP consumer expenditures, which are evaluated at purchaser's prices. In theory, one should be able to reconcile consumption values with production values via use of a *margins matrix*, as in Lenzen (2000), Lawson (1997), Davis et al. (1997), and Ballard et al. (1985).[2] Such a matrix maps a portion of final goods expenditure to the wholesale/retail trade and transportation sectors. It thereby reflects the fact that to consume anything at the retail level requires consumption of the wholesaling, retailing, and transportation services which brought the product to the store. While margins matrices have been constructed and are available for certain, individual regions (e.g., ABS 1999a, for Australia; Lawson 1997, for the USA), they are quite difficult to construct (Piergiovanni and Pisani, 1998). The problems include issues such as collecting and compiling the large quantities of data that are

[1] Regarding the link between consumer demands and per capita income, an 1857 study by Prussian economist Ernst Engel may have been the first to explore the nature of this relationship. Using household data on 153 Belgian families, Engel made what is perhaps the first empirical generalization regarding consumer behavior: The proportion of total expenditure devoted to food declines as income rises. This hypothesis – now known as "Engel's Law" – has been verified in many subsequent studies, and suggests that consumer preferences tend to be non-homothetic. Classic studies in this area include Stigler (1954); Prais and Houthakker (1955); Lluch, Powell, and Williams (1977); Deaton and Muellbauer (1980); and Theil and Clements (1987).

[2] Some authors call this a "distribution", "bridge", or "transformation" matrix.

necessary, reconciling firm level data with national accounts data, inconsistencies among data sources, issues with under-reporting by firms, and concerns about the transparency and reliability of the many assumptions that inevitably have to be made. These difficulties are particularly acute when country coverage is extensive. A single margins matrix is unlikely to satisfactorily represent a broad mix of countries, given the vast international differences in technology and economic structure that prevail. Furthermore, it would be extremely expensive in terms of time and funding to construct margins matrices for the many countries for which such information is currently unavailable.

The second reason for the difficulty in linking ICP consumer data to production data is that the classification schemes are typically very different. For example, the ICP category "Medical Care" includes expenditures on "Services of Nurses" as well as "Therapeutic appliances and equipment", for which International Standard Industrial Classification (ISIC) categories (upon which GTAP and OECD STAN data are based) have no direct equivalents.

These compatibility issues have been exacerbated in the most recent version of the ICP data, which corresponds to the year 1996.[3] The problem relates to inconsistencies across regions in the way that the ICP data were collected and compiled (World Bank, 2002). For the data to be internationally comparable, it had to be aggregated from the original, base ICP categories (numbering in excess of 100), to a small number of categories (26 in the 1996 version). In general, the aggregation was carried out according to similarity in end use, meaning that expenditures on services were often combined with expenditures on physical goods. In contrast, production and trade data tend to be defined more nearly according to the factor used to produce them (e.g., labor-intensive activities tend to be distinguished from land- or capital-intensive activities). They also tend to have a small number of services categories, with a single category for wholesale/retail trade. Due to these issues, the most recent version of the ICP consumption data is even less compatible with production and trade data, than were earlier ICP versions.

Finally, we note that there is an overall, fundamental difference regarding the ICP definition of "actual total consumption of households" relative to that of production and trade data. In the ICP data this is given by: (a) Goods and services purchased by households, (b) Goods produced by households for their own consumption or received as remuneration in kind, and (c) Goods and services accruing to households free of charge or at a substantially reduced rate, financed by the government or non-profit institutions serving households (United Nations, 1992). In contrast, input-output based data generally include (a) and (c) in their definition of total consumption, but not (b). In other words, home production of food, for example, is left out of actual total consumption in these data, as is other non-market consumption activity.

One approach to dealing these sort of compatibility problems begins with the observation that (like the ICP data) some I-O based production and trade data sets also have information about per capita expenditures for a large number of countries. For example, the GTAP data contain information on consumption across 57 categories of goods and services, which for the purposes of demand system estimation, can be aggregated to a smaller number of categories that are representative of the consumption choices faced by households.[4] Over the past decade, GTAP data have gone through five public releases as well as extensive scrutiny by users, and their quality and usefulness are generally well regarded. If a global demand system could be satisfactorily estimated with these data, it would allow a researcher to bypass the severe mapping problems associated with the ICP data.

---

[3] Prior to the 1996 version, the most recent publically released ICP data are for 1985. These have been used, for example, in the Cranfield et al. (2000, 2002) studies.

[4] A producer category like "ferrous metals", which serves almost exclusively as an intermediate input, can be aggregated into a consumer category which primarily uses it, such as "manufactures/electronics".

Based on these observations, the primary objective of this study is to estimate a global demand system with 1997 GTAP per capita consumption expenditure data, and compare these results to those arising from estimation of this demand system using the more conventional ICP data. Should the estimation based on GTAP data be found to perform as well as the ICP-based estimation, this new demand system would prove to be a boon to researchers needing to reconcile consumer demand estimates with production and trade data.

The study begins by first outlining the demand system to be estimated (AIDADS), and providing description of both the ICP and GTAP data bases. In the course of describing the data, the reader is referred to appendices at the end of this study that describe the ICP terminology, and document several problems encountered with the 1996 ICP data, as well as how these problems were rectified.[5] Subsequent sections briefly describe aggregation and estimation issues, before turning to the demand system results. An additional appendix provides a GAMS program that enables readers to calculate GTAP-based expenditure elasticities for countries outside of the GTAP sample, or to make projections of consumer demand and future expenditure elasticities for those countries within the sample.

This study also contains the results of an additional AIDADS estimation exercise that may be of interest to readers. In this section, the demand system is again estimated with GTAP data, but this time to study the composition of *regional final demand* with respect to its three primary components: Consumption (*C*), Investment (*I*), and Government (*G*). In particular, this section determines whether the shares of these final demand components vary systematically with income. This exercise has a number of interesting applications. For example, it provides evidence concerning hypotheses about final demand expenditures such as Wagner's Law, which states that government has a tendency to grow at a faster rate than the rest of the economy (Islam, 2001). In turn, this exercise may be quite useful for future applied general equilibrium modeling. Consider that the GTAP applied general-equilibrium model, for example, employs the concept of a "regional household", which acts as a sort of regional clearinghouse regarding the allocation of regional expenditure. The exercise of this section will demonstrate that the behavior of such a regional household can be shown to systematically vary across the income spectrum.

The overall goal of this study, therefore, is to demonstrate that GTAP expenditure data (in conjunction with the AIDADS demand system, to be discussed below) are quite useful for the estimation of international demand behavior. It is hoped that the analyses presented below will stimulate further applications of the GTAP expenditure data by researchers, and strengthen current efforts to update and improve the GTAP data base.

II. The AIDADS Demand System

It is assumed there is a single, representative private consumer in each country, whose preferences are identical to those of every other country's representative consumer. As such, issues related to aggregation over individual consumers are assumed away, which is necessary given the data available to us. Moreover, it is assumed that tastes are internationally identical – at least at a fairly aggregated level. This is an assertion for which Clements and Chen (1996) find strong empirical support.

With regard to choosing an appropriate demand system for estimation, first observe that there are several which could feasibly provide a basis for estimating consumer demands at the international

[5] The newly refined 1996 ICP data that are developed in this paper are available upon request.

level. We select among these by sifting through the various demand system characteristics that are desirable in this context. To begin, features such as ease of estimation, parsimonious parameterization, and the imposition of the economic restrictions of adding up, homogeneity, and symmetry are desired. Furthermore, the utility function underlying the demand system should be not homothetic, which eliminates the possibility that consumers adjust their purchasing behavior as their income changes. This requirement rules out forms such as the Homothetic Constant Elasticity of Substitution (HCES) and Cobb-Douglas. Additionally, the income consumption path should not be forced to be linear. In other words, the demand system should allow for more than just quasi-homotheticity, which severely limits the amount of demand response that is possible across the income spectrum (Deaton and Muellbauer, p. 145). This rules out the Linear Expenditure System (LES).[6] Another desirable feature is that the demand system be well-behaved across a substantial range of per-capita income. This consideration rules out the Almost Ideal Demand System (AIDS) and Working Preference Independence model, since the budget shares in these models can stray outside the unit interval under moderately large variations in per capita expenditure (Rimmer and Powell, p. 1614), and we will estimate using data from countries that span the world income spectrum.[7]

One demand system that possesses all of these desired properties is AIDADS (An Implicitly Directly Additive Demand System). Developed by Rimmer and Powell (1996), AIDADS is a generalization of the LES that allows for non-linear income consumption paths, while maintaining a parsimonious parameterization of preferences. AIDADS also has the advantage of being an effectively globally regular demand system. In a comparison test with four other demand systems (QUAIDS, QES, AIDS, and LES), AIDADS performed exceptionally well, particularly in situations where there are widely varying income levels (Cranfield et al., 2002).[8] A possible disadvantage of AIDADS for some purposes is that it imposes implicit direct additivity, thereby limiting the range of substitution that is possible across goods. This feature is not critical to this study, however, since the goods represented correspond to relatively broad, aggregated categories, as opposed to narrowly defined ones. Instead of devoting more parameters to substitution responses, AIDADS captures a rich array of Engel effects by adding $N - 1$ income response parameters beyond that which is used by the LES, where N is the total number of goods. Therefore, the total number of parameters to be estimated is $3N + 1$.

Rimmer and Powell (1996) derive the following system of budget share equations for AIDADS:

$$w_n^c = \frac{p_n^c \gamma_n}{M^c} + \left(\frac{\alpha_n + \beta_n e^{u^c}}{1 + e^{u^c}} \right) \left(1 - \frac{\mathbf{p}'\boldsymbol{\gamma}}{M^c} \right) ,$$

[6] Another drawback of the LES is that its income elasticities are highly counterintuitive, since for necessities they always increase with income, while for luxury goods they always decrease with income.

[7] The AIDS demand system and variants of the Working model also have the disadvantage that they possess only local curvature properties, if they satisfy concavity at all.

[8] This is because AIDADS is a rank 3 demand system, according to Lewbel's (1991) definition. Rank 1 demands are are independent of income, and therefore the most restrictive. Rank 2 demand systems do not force the Engel curve through the origin. Rank 3 (i.e., full rank) demand systems are the least restrictive, allowing for non-linear Engel responses.

where w_n^c is the share of good *n* in country *c*'s private household consumption; γ_n, α_n, and β_n are unknown parameters to be estimated; u^c is utility[9]; M^c is per-capita expenditure on private household consumption in country *c*; p_n^c is the price of good *n* in country *c*; and $\mathbf{p}$ is the vector of goods prices. The term γ_n reflects the subsistence level of good *i* that all countries must consume. The term $\mathbf{p}'\boldsymbol{\gamma}$ represents the minimally sustainable per-capita expenditure in any country, and $[M^c - \mathbf{p}'\boldsymbol{\gamma}]$ is discretionary income. The following parametric restrictions are used to ensure well-behaved demands: $0 \le \alpha_n,\ \beta_n \le 1$ for all *n*, and $\sum_n \alpha_n = \sum_n \beta_n = 1$. The regularity conditions of consumer theory are satisfied in the price-income space for which discretionary income is strictly positive. Note that in the special case that $\alpha_n = \beta_n$ for all goods *n*, only the constant β_n is left in the marginal budget share term, and AIDADS is equivalent to LES. Further description of AIDADS will be provided in later sections, when its estimation and the results are discussed.

III. International Comparison Program Data

In this section, the background, characteristics, and present status of the International Comparison Program (ICP) data are described. Section 4 of the study will provide similar discussion of the Global Trade Analysis Project (GTAP) data. The origins of the ICP can be traced back to researchers working at the University of Pennsylvania in the late 1960s (Kravis, Heston, and Summers, 1975). Since that time the general objective of the ICP has been to develop internationally consistent price and quantity comparisons across countries regarding the components of GDP. Although these international comparisons could be made with respect to structure of production (i.e., GDP could be decomposed by industrial category), the ICP makes international comparisons via expenditure category breakdowns: household consumption (*C*), capital formation (*I*), government consumption (*G*), and net exports (United Nations, 1992). There is often a large amount of detail within these categories. Indeed, the number of household expenditure categories exceeds 100 in some versions of the ICP data. Another important characteristic is that the ICP data encompass many developing nations, in addition to those which are highly industrialized. Features such as these make the ICP data well suited to the study of international demand patterns.

A central feature of the ICP framework is its use of Purchasing Power Parity (PPP), a concept that can be traced back to sixteenth century work by Spanish scholars, and is widely used in the international finance literature (Daniels and VanHoose, 1999). A PPP rate is a certain type of exchange rate that compares the cost of a common basket of goods in two countries. In ICP terminology, a PPP rate indicates the amount of Local Currency Units (LCUs) needed to purchase a bundle of goods that is identical in quality and quantity to what can be bought with one unit of a base country's currency. Advocates of the PPP approach point to its several advantages over the alternative of conventional exchange rates for the study of international consumption patterns. First of all, PPPs do not fluctuate over time to the degree that conventional exchange rates do. PPP rates are also less likely to overstate poverty in developing countries, since PPPs allow for the fact that services may be cheaper there. Additionally, the ICP produces PPP rates that are specific to the individual components

[9] It may be seem unusual to see utility in this function. In principle one could obtain uncompensated demands (and budget shares) that depend solely on prices and expenditure by substituting out utility, but this cannot be done analytically. The estimation process, documented in Cranfield et al., involves solving for utility numerically and making the necessary substitution.

of a highly refined decomposition of GDP. A conventional exchange rate, in contrast, provides but a single conversion factor for all goods and services.

Several recent international demand studies, such as Cranfield et al. (2000, 2002), have employed the 1985 version of the ICP data. These "Phase IV" data have information specific to 113 commodities and 64 countries, and are the most recent ICP release to have been widely distributed. While more recent versions of the ICP data exist, they have not been made widely available due to concerns about quality. Some of the problems may be traced back to a lack of funding, resulting in limited data collection in some parts of the developing world. Another issue has been the European Union's desire to impose the "fixity principle", which has created structural problems in some versions of the ICP data (Seale, 1998).[10]

In response to these problems, the World Bank, International Monetary Fund, and United Nations sponsored an independent review of the ICP project in the late 1990s. Consultant Jacob Ryten (1999) found the ICP's purpose to be important and timely, but acknowledged that there were significant financial and organizational obstacles facing the project, and made suggestions for improving the project's ability to generate credible and usable data. Fortunately for international demand analysts, a new round of the ICP has been launched with more resources and new organization. Unfortunately, this round will not yield new data for demand research until at least 2005 (World Bank, 2002).

Meanwhile, versions of the ICP data based on the efforts of the 1990s do exist. For example, the World Bank has made a data set corresponding to the year 1996 available to interested researchers.[11] These data have been compiled in such a way to eliminate the concerns about quality in previous versions. Although some inconsistencies were encountered in preliminary examination of these data, it was possible to ascertain the source of these problems, and make the necessary adjustments (these are described in Appendix B). The resulting data now appear to be quite refined. For example, aggregate values are quite consistent with corresponding data from the World Bank's World Development Indicators (WDI), as well as GTAP data regarding household consumption. Additionally, it will later be seen that these data produce very credible estimates when used to estimate AIDADS.

The 1996 ICP data obtained for this study have complete information for 114 countries, the most ever made available. As indicated earlier, however, there is a major disadvantage to these data, since household consumption is decomposed into only 26 commodities, instead of the original decomposition of more than 100 commodities. This high level of aggregation was necessary because of difficulties in obtaining the appropriate disaggregated data from certain regions of the world.[12] Consequently, unless one is willing to resort to the aging 1985 ICP data, the 26 commodity aggregation must be used. While this may be appropriate for some research objectives, if one eventually seeks to match demand estimates with supply characteristics, great difficulties will be

---

[10] The benefit of the "fixity principle" is that results obtained in a regional comparison (e.g., an EU comparison) remain unchanged when more countries are added to the sample, and a new comparison is made (e.g., an OECD comparison). The downside is that the imposition of fixity may prohibit the sum of subcategories from equaling the total for a category as a whole. While this may create problems for demand system estimation, it appears to have been mostly resolved in recent versions of the ICP data. See United Nations (1992) and Seale (1998) for more information.

[11] These data were obtained from Mr. Yonas Biru of the World Bank, by way of Dr. Anita Regmi of the U.S. Department of Agriculture, Economic Research Service. At least two studies have made use of these data: Regmi, Seale, Bernstein (2001), and Regmi, Deepak, Seale, and Bernstein (2001).

[12] While more disaggregated versions of the 1990s data exist and have been used by some researchers (e.g., Eaton and Kortum, 2002), they are generally only for one or two individual regions (in particular, OECD, African, and CIS countries), and are not necessarily compatible even with each other.

encountered. This is because the ICP categories are incompatible with International Standard Industrial Classification (ISIC) categories, which is the basis for most production data sets.

The most significant problem is that both goods and services are classified together within each of the 26 ICP categories, whereas in ISIC categories, services are clearly distinguished from goods categories. Another issue is that the ICP categories of expenditure embody wholesale/retail trade margins as well as transportation costs, which are broken out in production and trade data. In theory, one could construct a transition matrix between producer and consumer categories to handle this issue (as in Ballard et al., 1985), but again this is unlikely to be a satisfying approach since much of the information that one wants is not available.

Despite these problems, the 1996 ICP data may be viewed as the "state of the art" regarding our understanding of international expenditure patterns. These data may have the most credible information regarding how prices vary across countries. They also contain the largest number of observations for the purpose of cross-country demand system estimation at one point in time.

IV. Global Trade Analysis Project Data

In many respects, the progression of the GTAP data since the early 1990s has been in the opposite direction of the ICP data. The size of the GTAP consortium (19 national and international agencies as of 2003) and the ensuing stability in financial support has ensured rapid progress. During the past decade there was no official release of ICP data, but the GTAP data base went through five public releases. The GTAP data have generally received high marks in terms of credibility and usefulness by a large pool of researchers. The sources and procedures used to create the data are extensively documented (Dimaranan and McDougall, 2002), and new documentation is provided with each new release.

There are other fundamental differences between the ICP and GTAP data. While continually expanding, the country coverage of the GTAP data base is still less extensive than that of the ICP data. And while the ICP data document international differences with respect to consumption and prices, GTAP data contain information on many other economic characteristics, since they have been constructed to operationalize a global general-equilibrium model. For example, GTAP data incorporate country-specific information regarding production, trade, technology, endowments, transportation, and protection.

The two datasets are similar, however, in that they both have detailed information on household consumption for individual countries. In particular, GTAP data allow dis-aggregation of private household consumption in each country into 57 commodities. In conjunction with population data, per capita household expenditure can be calculated for each commodity.[13] One can also calculate "comparative price levels" using GTAP data that are somewhat similar to those calculated using the ICP methodology. By way of GTAP's tariff information, a commodity's price in a particular country can be distinguished from the average world price for that commodity. This is accomplished by dividing a nation's expenditure on a commodity valued at domestic market prices, by its expenditure valued at c.i.f. prices.[14]

[13] We carried out the same sort of checks with the GTAP data that were done with the ICP data. For example, in comparing the sum of these per capita household expenditures to corresponding data from the World Bank WDI data, the values were very nearly the same across countries.

[14] In GTAP notation, divide VIMS (imports valued at domestic market prices, summed over all sources) by VIWS (imports valued c.i.f., summed over all sources).

Whether or not one feels comfortable with this notion of comparative price levels, the issue of prices may not be of critical importance to global demand system estimation. This is because international incomes vary by a factor of several hundred, while prices tend to vary by a factor of one or two times at most. Additionally, the assumption of direct additivity in the AIDADS demand system limits the amount of substitution across goods that occurs because of price differences.[15] As a result, the possibility that ICP comparative price levels are perhaps more credible than those of GTAP does not confer a significant advantage to the ICP data, for the purposes at hand.

V. Aggregation Issues

Now that background has been provided regarding the relevance of the ICP and GTAP data sets for estimating an international, cross section demand system, we turn to issues regarding the aggregation of countries and commodities. GTAP Version 5.0 data contain information specific to 52 countries, all of which are used to estimate AIDADS (Table A-3).[16] The ICP data, on the other hand, enable AIDADS to be estimated with 114 national observations (Table A-4). The greater country coverage of the ICP data reflects differences in the history, objectives, and organizational structure of the respective data sets.[17]

With regard to the commodities used to estimate the demand system, both data sets were aggregated up to 10 categories, so that $N = 10$, and $3N + 1 = 31$ parameters need to be estimated. This number was chosen based on historical practice for the ICP data set, and also represents what may be the practical limit of AIDADS. The particular commodity aggregations used in GTAP and ICP are given in Tables A-1 and A-2, respectively. The ICP aggregation is very similar to that used in other ICP applications, such as Hunter and Markusen (1991), and Regmi, Seale, and Bernstein (2001). To the greatest extent possible, the GTAP data follow a similar aggregation. However, there are two reasons why this match is imperfect, which were alluded to earlier. First, the categories of the ICP data do not distinguish between goods and services, as is done in GTAP, which is based on International Standard Industrial Classification (ISIC) and Central Product Classification (CPC) definitions. In the ICP data, goods and services are grouped together according to similarity in final use. For example, one ICP category is "Medical goods and services". This category contains not only expenditure on pharmaceutical products, for example, but also the fees paid to doctors who prescribe those products. In the GTAP data, commodities are grouped more nearly according to the factor used to produce them (i.e., labor-intensive activities are distinguished from land- or capital-intensive activities). Therefore, service categories are clearly distinguished from goods categories. This characteristic is generally found in other internationally comparable production and trade data sets, such as OECD STAN (OECD, 2002).

A second reason why GTAP categories are different from ICP categories is that the latter incorporate the activities necessary to convert a raw, producer commodity into a final, consumer commodity. These activities are distinguished in GTAP data by the wholesale/retail trade and transportation categories that reflect the margins between producers and consumers. As a result, the

[15] AIDADS was estimated both with and without price variation, and the results were nearly indistinguishable.

[16] There are 66 regions in total in the GTAP data base, but many of these are regional composites and do not contain original data.

[17] To facilitate comparison of the demand system estimation results we considered deleting the countries in the ICP data and the GTAP data that are not common to both data sets. However, the number of countries that are common to both is only 44. Deleting all other countries would have resulted in a loss of many degrees of freedom in each case. As a result, we elected to delete no country observations, using all 52 in the GTAP data set, and 114 of the ICP data set. In terms of demonstrating that the data sets provide similar qualitative results, the somewhat different mix of countries in the samples should only work against us.

ICP data can be thought of as "consumer" commodities, while the GTAP data represent "producer" commodities. Therefore, the reader should be mindful that in the following analysis, ICP and GTAP categories are distinct, even when they are similarly named.

VI. Demand System Estimation and Results

AIDADS is estimated using the procedure of Cranfield et al. (2000, p. 1909), and space constraints permit only a brief discussion of this approach.[18] These authors formulate the problem as a mathematical programming model in GAMS, and minimize a concentrated log-likelihood function according to a constraint set involving non-linear equality and linear inequality constraints. Starting values for the non-linear estimation are chosen to be consistent with an LES demand system, since it is easily estimated, and is a special case of AIDADS. Upper and lower bounds on all choice variables are included to reduce the size of the feasible set. Cranfield et al. (2000) carry out 100 bootstrap replications and find their estimators have very little bias, as well as a high degree of efficiency.[19]

We now turn to the estimation results. AIDADS parameter estimates based upon the ICP and GTAP data are presented in Tables 1 and 2, respectively. These tables also provide expenditure elasticities evaluated at the means of the data (ε_n), and correlations between the actual and fitted shares (ρ_n).[20] The results for both sets of data are consistent with one's intuition regarding how the composition of consumption is likely to differ across income levels. Observe in Table 1, for example, that the estimated subsistence budget shares (γ_n) for "Meat, dairy, fish", "Home furnishings and appliances", and "Transport and communication" are zero (note that these also represent three of four active bounds in Table 1). In contrast, for "Grains, other crops" the subsistence share is 0.690. This implies that consumption of the former three categories is not necessary for survival at the lowest levels of income, while staple grains are essential. Likewise, in Table 2 it is seen that estimating AIDADS with GTAP data results in subsistence budget shares for "Meat, dairy, fish", "Utilities, other housing services", and "Transport, communication" that are also zero (these estimates similarly represent three of the four active bounds in Table 2). Similar to the ICP-based estimates, staple foods tend to have large subsistence budget shares, at 0.298 and 0.142 for "Grains, other crops" and "Processed food, beverages, tobacco", respectively. Thus, as expected, both data sets imply that staple food products are necessary for survival at the lowest levels of income, whereas other foods, transport, communications, and home furnishings are not.

We now move on to assess the estimates of the AIDADS parameters α_n and β_n, which represent the bounds of the marginal budget shares. Looking at Tables 1 and 2, the parameter estimates appear to be quite sensible for all commodities in both the ICP and GTAP cases. Consider, for example, the values corresponding to the "Grains, other crops" category in Table 1. Its α_n estimate indicates that at low income levels, this category accounts for as much as 21.8 cents of each

[18] The authors are indebted to Dr. John Cranfield for providing the GAMS code to estimate AIDADS.

[19] Note that we attempted a bootstrapping exercise similar to Cranfield et al., but were unable to carry it out because of computational difficulties. Discussions with those authors suggested this is related to the fact that we are working with a larger number of goods (10 versus their 6). Despite our inability to generate standard errors, our estimation procedure is identical to that of Cranfield et al., and our results are very similar to the extent that they can be compared. Moreover, there are other means of evaluation at our disposal, and it will be shown that these lend a great deal of support to our results.

[20] These correlation coefficients give an indication of goodness-of-fit, but do not capture the important non-linearities that dominate. In the estimation procedure, the bounds of only four of the parameters in each of Table 1 and 2 were active (these correspond to the zeros within the top three rows of each table).

additional dollar of expenditure. However, its β_n estimate of zero suggests that at higher income levels, "Grains, other crops" is no longer part of any increases in expenditure (this is the remaining active bound in Table 1). Likewise, the β_n value corresponding to "Grains, other crops" for the GTAP data is zero (similarly, this is the remaining active bound in Table 2). If we compare the estimates of α_n between the two tables, we see that it is higher for the ICP-based estimates. There appear to be two primary reasons for this. First, the ICP data include more countries than do the GTAP data, and many of these additional countries are at very low income levels where staple grains dominate the budget. Second, α_n is higher when AIDADS is estimated with ICP data because wholesale/retail trade margins are included within each category. Whereas "Grains, other crops" is a retail good in the ICP data, it reflects a producer good in the GTAP data. Since margins are a luxury (see $\hat{\varepsilon}_n$ in Table 2), when they are combined with grains, we expect the resulting good to have a higher marginal budget share.

Before moving on, note that in both Tables 1 and 2, α_n does not equal β_n for any category of expenditure. This suggests that there is a great richness of behavior that would have been missed had we assumed that α_n equal β_n, such that marginal budget shares are constant, as in the LES demand system estimated by Hunter and Markusen (1988), among others.

Tables 1 and 2 also report expenditure elasticities evaluated at the means of the data ($\hat{\varepsilon}_n$). Again, the ICP and GTAP results are similar. For example, "Grains, other crops" has the lowest expenditure elasticity in both cases (it is 0.286 for ICP, 0.403 for GTAP). In contrast, expenditure categories relating to housing, health, and education services tend to have expenditure elasticities well above 1.00. For example, the ICP "Rent and housing utilities" and "Medical products and services" categories have expenditure elasticities of 1.200 and 1.322, respectively. Likewise, the GTAP category "Housing, education, health, public services" has an expenditure elasticity of 1.275. Overall, expenditure elasticities generated with GTAP versus ICP data are qualitatively similar.

We now move on to consider Figures 1a and 1b, which plot the ICP-based fitted budget shares evaluated at mean prices against the log of per capita household expenditure in 1996 U.S. dollars (the results have been split into two figures for clarity). First of all, note that in contrast to what would happen with demand systems of lower rank (e.g., AIDS, or Working's model), the fitted budget shares never become negative, even at extreme income levels. We see three basic shapes to the fitted shares: monotonically increasing, monotonically decreasing, and a *non*-monotonic pattern in which a good's share of the budget rises at low income levels, then falls at higher income levels. The most dramatic change over the observed income range occurs in the "Grains, other crops" category in Figure 1a, which goes from being the most important component of the consumption bundle at low income levels (43%), to the least important at high income levels (2%). In contrast to most of the food- and apparel-related commodities of Figure 1a, the commodities in Figure 1b have to do with services. Thus we see that budget shares increase in Figure 1b, and in the case of "Other goods and services" there is an interesting S-shaped curve. Clearly, AIDADS is a very flexible functional form when it comes to Engel responses.

Figures 2a and 2b plot the fitted budget shares when AIDADS is estimated with the GTAP data. In many respects the results are quite similar to those when ICP data is used, although one must be careful in making comparisons since none of the categories are identical, even those having the same name. Recall that whereas the ICP data include wholesale/retail trade in each of the consumption goods, the GTAP data distinguish those services as an individual category. This particular category, in fact, is quite an interesting feature and a unique contribution of the GTAP-based results. We see in Figure 2b that the proportion of the budget allocated to “Wholesale/retail trade” varies substantially over the income spectrum. It is estimated to be only 12% of the budget in the poorest countries, but takes up as much as 20% of the budget in the richest countries. This reflects the costs of overhead that might arise in the retailing of food, for example. Whereas a shopper in a developing country might purchase from a curbside vendor, a shopper in a rich country likely visits a vast, air-conditioned supermarket with computerized checkout facilities. Indeed, to our knowledge, this is the first explicit evidence as to how wholesale/retail margins vary internationally over the per capita income spectrum.

We now turn to Figures 3a and 3b. As with Figures 1 and 2, these plot the fitted AIDADS budget shares evaluated at mean prices against the log of per capita household expenditure. These figures are different, however, in that they have been designed to facilitate a more direct comparison of the ICP- and GTAP-based results. The graphs have been limited to three commodities that correspond quite closely to each other. In some cases the fitted budget shares of one commodity have been added to another commodity to overcome problems with definitions.

The first “commodity” to be compared is an aggregate of “Grains, other crops” and “Processed food, beverages, tobacco”.[21] We see in Figures 3a and 3b that “Grains, other crops; Processed food, beverages, tobacco” has an exceptionally high share of the budget in the poorest countries (54% and 42% for ICP and GTAP, respectively), and a very low share of the budget at the highest income levels (6% and 8%). The decline in this category’s share of the budget appears to be roughly linear in each case. The results would be even more similar if we had information on the wholesale/retail margins embedded within the ICP data, and incorporated these into the GTAP shares.

Figures 3a and 3b further reveal that “Meat, dairy, fish” has an interesting non-monotonic path. In the ICP data, this category’s share of the budget is only 11% in the poorest countries, but then rises across the income spectrum, peaking at 15% near the income level of Indonesia. It then falls in importance until it takes up only 2% of the budget at the highest income level. Impressively, this same non-monotonic path is captured using the GTAP data. There the respective percentages for “Meat, dairy, fish” are 7%, 10%, and 6%. The fact that this subtle pattern is picked up by both of the datasets speaks well of the performance of each one. It is also remarkable, given the very different provenance of these two data sets.

The third commodity that can be compared is an aggregate relating to housing, health, education and other expenditures (Figures 3a and 3b). The ICP-based estimates suggest that this aggregate is about 15% of the budget in poor country households, but nearly half of the budget in the rich country households. The GTAP-based estimates suggest that the corresponding figures are about 14% and 36%. Again, the lower GTAP values reflect the fact that margins have a separate category, as well as any remaining differences in the definition of the category.

In summary, for many applications there is no indication that one would get substantively different results by using GTAP data in place of ICP data, or vice versa. The results of these two estimations are remarkably similar considering that goods definitions are not precisely the same, numerous countries are represented in one but not the other, and the raw data are collected from

[21] Although each name is common to the data sets, there are still differences in definition, and combining them in this particular way limits the problems that otherwise result.

independent sources and compiled using distinct methodologies.[22] In this regard, the data sets strongly "corroborate" each other.

Given this finding we may want to ask: Which set of data is appropriate for endowing the consumption side of a general equilibrium model? The ICP data have the advantage of more observations, and likely has a better representation of price differences across countries. However, in estimating AIDADS with and without any price variation, we find that there are almost no qualitative or quantitative differences in the Engel responses. Moreover, the GTAP data have the great advantage of already being in ISIC producer categories, making them compatible with a large number of production and trade data bases, such as GTAP and OECD STAN. Therefore, if a researcher needs to estimate a demand system for analyses involving more than just the study of consumption, then the GTAP data are quite appealing as a source of per capita consumption information. Goods and services are not combined within GTAP categories, wholesale/retail margins are already broken out, and no transition matrix between consumer and producer commodities has to be constructed.[23]

Furthermore, applying the ICP-based estimates directly to producer goods categories is likely to result in under-estimation of the aggregate demand for wholesale/retail trade services as income rises, since the GTAP-based results suggest that wholesale/retail margins become a larger part of expenditure as countries develop. This also means that use of a single transformation matrix between consumer and producer goods would be inappropriate.

VII. Using GTAP Data to Estimate the Components of Final Demand

In this section we move on to consider another way by which the AIDADS demand system can be estimated using GTAP expenditure data. This exercise further develops two of the themes of this study: (i) there are important, systematic differences in the way that countries allocate their expenditures, and (ii) GTAP expenditure data in conjunction with the AIDADS demand system provide an excellent means of understanding these patterns. Whereas previous sections of this study focused on the composition of household consumption, this section focuses on the composition of overall, regional final demand. Specifically, the patterns by which three components of final demand vary over the income spectrum are examined: household consumption (C), investment (I), and government (G).[24]

As suggested in the Introduction, an exercise of this sort has a number of useful applications. For example, consider the theory of the "regional household" employed in the GTAP global AGE model (Hertel, 1997). In this model, each nation is assumed to have an aggregate "household" that acts as a sort of clearinghouse, whose behavior is governed by an aggregate utility function, specified over the three components of final demand.[25] To operationalize this concept, GTAP modelers have limited the behavior of the regional household by way of restrictive assumptions. In this section it will be shown, however, that the regional household's behavior can be estimated, using the AIDADS

[22] Additionally, our two sets of results compare favorably to the results of Cranfield et al. (2000, 2002), to the extent that comparisons are possible. Those studies were based upon 1985 ICP data, were aggregated into six goods having somewhat different definitions from ours, and were estimated with data from a somewhat different set of countries.

[23] This is not to suggest that a margins matrix (if it were available) would not provide useful information about the structure of demand. Ideally one would have a well-specified margins sector that handles these activities.

[24] Here, "government expenditure" refers to direct spending on goods and services; it excludes transfers of income among citizens.

[25] Actually, "Savings" is the second component of GTAP regional household expenditure, not "Investment". We choose to work in terms of investment, however, since savings is calculated as a residual in GTAP, and for some countries savings is negative.

demand system in conjunction with *C*, *I*, *G* information from the GTAP data base. It will be shown that there are substantial differences in final demand allocation related to per capita income.

This exercise can also shed light on a number of hypotheses proposed by economists concerning the composition of final demand. One such hypothesis is Wagner's Law, which states that government spending tends to grow at a higher rate than does GDP (Islam, 2001). In estimating AIDADS, we would have empirical support for Wagner's Law if government expenditure is found to have an increasing share of final demand among successively higher income countries.

We can also formulate some additional hypotheses about how the relative sizes of *C*, *I*, and *G* might vary across per capita income levels. Consider that the shapes of their fitted expenditure shares may be related to the stage of a country's economic development. Additionally, the shapes could be related to demography, since poor countries tend to have very young populations, middle-income countries have a high percentage of working people, and rich countries tend to have aging populations.[26] For purely economic reasons, there is likely little investment in very poor countries because of their low stage of development. Indeed, population growth may be outstripping economic growth, with only a small share of the population at working age. Additionally, the scale of government activity may be low, since the effectiveness of taxation is limited, organized interest groups are few, and the provision of public goods is not yet a priority. In contrast, the relative size of investment in middle income countries may be quite large, since these economies are likely to be growing at a rapid rate, and may have a higher proportion of the population in the workforce than countries at other stages of development.[27] In turn, a very different situation might prevail in high income countries. There, economic growth is likely to have slowed, and so the importance of investment in final demand may also be declining. Furthermore, Wagner's Law suggests that government's share of overall expenditures will be quite high, perhaps even overtaking investment as the second largest component of *C+I+G*.

Now that we have motivated why we should be interested in estimating these components of final demand, and have described what we might expect, we turn to the results. As before, they were generated using the maximum-likelihood technique of Cranfield et al. (2000) in conjunction with *C*, *I*, and *G* data for the 52 GTAP countries identified in Table A-3. Table 3 provides estimates of the AIDADS parameters α_n, β_n, γ_n, as well as expenditure elasticities evaluated at the means of the data (ε_n).

Overall, the results are consistent with one's intuition about the relative size of *C*, *I*, and *G* at different per capita income levels. First, consider the "subsistence" expenditure shares γ_n in Table 3. Observe that the estimate is 0.000 and 0.050 for Investment and Government, respectively, but is 1.078 for private household consumption.[28] This implies that Investment and Government expenditure are much less important at the lowest levels of income, while (unsurprisingly) private household expenditure is important. Now move on to consider the estimates of α_n and β_n in Table 3. Recall that these represent the bounds of the marginal expenditure shares in the AIDADS share equation. We first inspect the results for Government. Its α_n estimate indicates that at low income levels,

---

[26] Bloom and Williamson (1998) provide an interesting account of how demography relates to economic growth. To our knowledge the proposed relationship between demographic structure and investment has not been suggested elsewhere.

[27] As an example, according to the U.N. World Population Prospects (http://esa.un.org/unpp), the number of children (aged 0-14) and retired people (aged 60+) per 100 people in the workforce is just 39 for South Korea (a fast-growing, middle income country), while the corresponding number is 52 for the USA (a slower growing, high income country) and 55 for Indonesia (a lower income country).

[28] The only active bound during estimation was the subsistence expenditure share parameter for Investment (Table 3).

Government accounts for as little as 12.3 cents of each additional dollar of expenditure. However, its β_n estimate suggests that the public sector accounts for as much 21.9 cents of each additional dollar of expenditure at higher income levels. Thus, our results are quite consistent with Wagner's Law, which states that Government is an increasingly larger share of GDP as countries develop. The high expenditure elasticity associated with Government (1.149) is also consistent with Wagner's Law.

For Consumption, the marginal expenditure share results tend to move in the same direction as for Government (Table 3), but here α_n and β_n are quite close in value to one another (0.598 and 0.645). With regard to Investment's marginal expenditure shares, we see that at low income levels this category accounts for as much as 28.0% of each additional dollar of expenditure, but the corresponding value at higher expenditure levels is only 13.6%. This suggests that Investment is a smaller component of the expenditures of higher income countries.

We now move on and consider Figure 4, which plots the fitted shares of *C*, *I*, and *G* against the log of per capita *C+I+G* in 1997 U.S. dollars. Observe that there is a considerable amount of variation in these three components across the income spectrum. Household consumption's share of final demand is as high as 76.1% in the very poorest countries, but this share generally declines as countries become more developed, dropping as low as 61.5% in upper-middle income countries. Government spending, in contrast, claims a successively larger share of GDP, as suggested by Wagner's Law. Its extreme values occur in the poorest and richest countries of the sample (8.7% and 18.3%, respectively).

Finally, Figure 4 shows that Investment follows an interesting, non-monotonic path, and has a hump-backed shape. In the poorest countries, Investment's share is as low as 15.1%, and is the least important component of *C+I+G*. Its importance increases until it reaches a peak of 25.2% at the median income level, which corresponds to Brazil in this sample. Investment's importance then declines as countries reach higher stages of development, falling to 18.8% in the richest country. In short, there is strong, empirical confirmation of our earlier conjectures about how the fitted expenditure shares of final demand may vary across income levels. Long run economic projections that abstract from the relationships between final demand and per capita income found here, may miss an important aspect of the international economy.

VIII. Conclusions

A variety of applications in economic research call for estimation of consumer demands at the international level, and for this behavior to be related back to production or trade data based on input-output accounts. In this study, a non-homothetic AIDADS demand system is estimated using cross-country, 1996 ICP data on per capita expenditures for each of 10 goods. This demand system is then re-estimated using per capita expenditure data from the GTAP version 5 data base, which corresponds to the year 1997. Both estimations make clear that the common assumption of homotheticity in demand is at odds with the data, as fitted budget shares vary to a great extent across the income spectrum. For example, the GTAP-based fitted budget shares for all food and beverages decline from 49% in the poorest countries, to only 13% of private household spending in the richest countries, which is a strong confirmation of Engel's Law. Per capita income is also found to explain much of the variation in international consumption for other goods and services. Thus we lend strong empirical support to Heston and Summers' contention that "the cliché that no single number tells more about households than their income also holds true for whole economies" (1996).

Another key finding is that the AIDADS results based on the GTAP data are remarkably consistent with those based on the ICP data, even though their origins and treatment of margins are quite different. In fact, for those categories that can be compared more or less directly, the GTAP data capture the same shapes in the fitted budget shares that are produced by the ICP data, even in those cases where the budget shares are non-monotonic in income. Given the similarity of results produced by the two sets of data, the estimation based on GTAP data is favored because its commodity definitions can be much more easily matched to production and trade data derived from input-output accounts. In addition, we find that the application of ICP-based demand estimates to such input-output based modeling would likely be misleading when it comes to the consumption of margins and transportation services. This is due to the fact that GTAP-based results show wholesale/retail margins occupying an increasing share of consumer expenditure as per capita income rises. This also implies that use of a single transformation matrix between producer and consumer expenditures would not be suitable for international studies.

In an additional exercise, it is found that estimation of AIDADS with the GTAP data is an effective means for studying how the shares of consumption, investment, and government spending in final demand vary across countries. Empirical support for Wagner's Law is found, which suggests that the scale of government activity expands as countries grow richer. Additionally, an interesting, non-monotonic shape is uncovered regarding the shares of investment in final demand. The pattern that emerges appears to be related to a country's economic development, and to its demographic composition.

In summary, this technical paper offers a comprehensive analysis of alternative approaches to the estimation of consumer demand behavior across the income spectrum. The preferred demand system for use in the GTAP model is that based directly on GTAP consumption data. In the future, researchers may wish to incorporate the estimated AIDADS demand system directly into the GTAP model. In the mean time, a more practical approach involves using the fitted income elasticities of demand to calibrate the parameters for the existing GTAP model. Appendix C provides the GAMS code to generate these new elasticity targets. An electronic version of this file is also available for downloading.

Table 1. ICP-Based AIDADS Estimates: Household Consumption Expenditures

	Grains, other crops	Meat, dairy, fish	Processed food, beverages, tobacco	Apparel, footwear	Rent and housing utilities	Home furnishings and appliances	Medical products and services	Transport and commun-ication	Recreation and education	Other goods and services
$\hat{\alpha}_n$	0.218	0.205	0.176	0.089	0.083	0.060	0.016	0.076	0.055	0.020
$\hat{\beta}_n$	0.000	0.012	0.028	0.044	0.207	0.069	0.132	0.144	0.177	0.186
$\hat{\gamma}_n$	0.690	0.000	0.022	0.077	0.052	0.000	0.081	0.000	0.024	0.042
$\hat{\varepsilon}_n$	0.286	0.415	0.557	0.810	1.200	1.044	1.322	1.155	1.239	1.336
$\hat{\rho}_n$	0.839	0.644	0.622	0.296	0.552	0.282	0.731	0.547	0.633	0.703

Notes: $\hat{\varepsilon}_n$ are expenditure elasticities evaluated at the means of the data. $\hat{\rho}_n$ are correlation coefficients between the actual and fitted budget shares. Other estimates correspond to parameters in the AIDADS share equation.

Table 2. **GTAP-Based AIDADS Estimates: Household Consumption Expenditures**

	Grains, other crops	Meat, dairy, fish	Processed food, beverages, tobacco	Textiles, apparel, footwear	Utilities, other housing services	Whole-sale/retail trade	Manu-factures, elect-ronics	Transport, commun-ication	Financial and business services	Housing, education, health, public services
$\hat{\alpha}_n$	0.084	0.122	0.138	0.068	0.035	0.132	0.169	0.115	0.030	0.108
$\hat{\beta}_n$	0.000	0.026	0.032	0.030	0.047	0.238	0.099	0.097	0.118	0.313
$\hat{\gamma}_n$	0.298	0.000	0.142	0.030	0.000	0.078	0.002	0.000	0.014	0.086
$\hat{\varepsilon}_n$	0.403	0.649	0.645	0.784	1.092	1.164	0.867	0.964	1.337	1.275
$\hat{\rho}_n$	0.852	0.452	0.632	0.379	0.618	0.497	0.378	0.524	0.449	0.542

Notes: As discussed in the text, the ten GTAP-based goods of this table do not correspond directly to the ten ICP-based goods of Table 1.

Table 3. GTAP-Based AIDADS Estimates: Overall Final Demand Expenditures

	Consumption	Investment	Government
$\hat{\alpha}_n$	0.598	0.280	0.123
$\hat{\beta}_n$	0.645	0.136	0.219
$\hat{\gamma}_n$	1.078	0.000	0.050
$\hat{\varepsilon}_n$	1.012	0.864	1.149

Figure 1a. ICP-Based Fitted AIDADS Budget Shares (Goods 1-5)

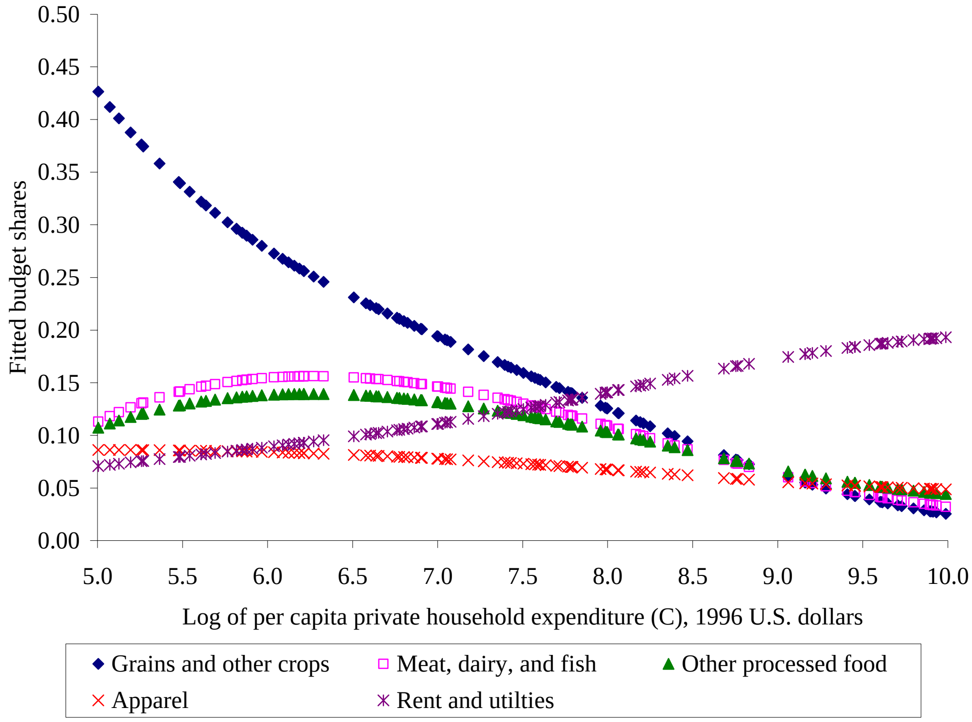


Figure 1b. ICP-Based Fitted AIDADS Budget Shares (Goods 6-10)

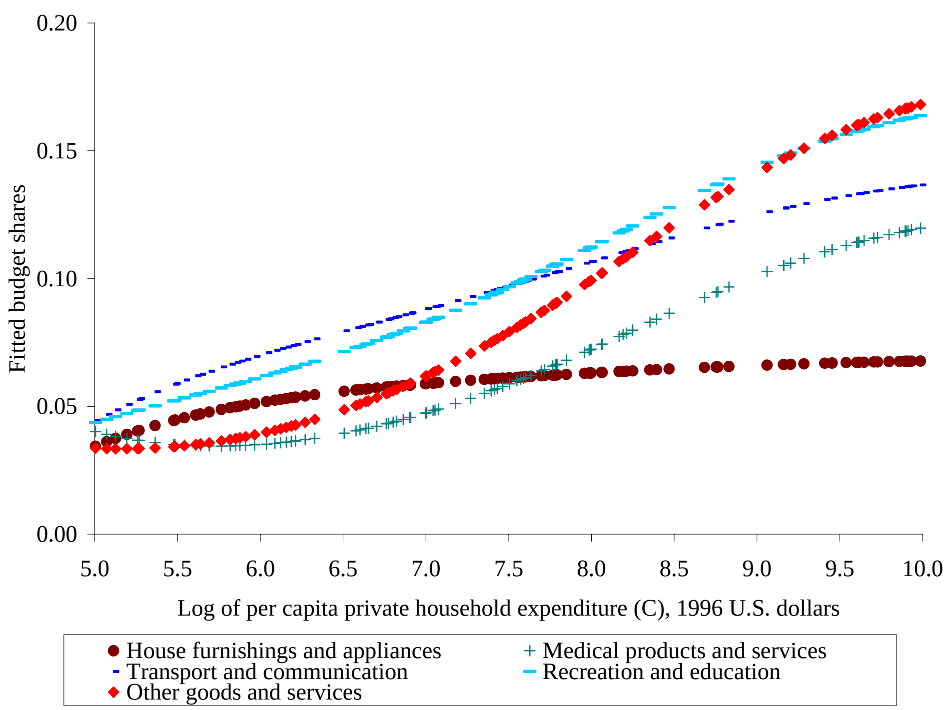


Figure 2a. GTAP-Based Fitted AIDADS Budget Shares (Goods 1-5)

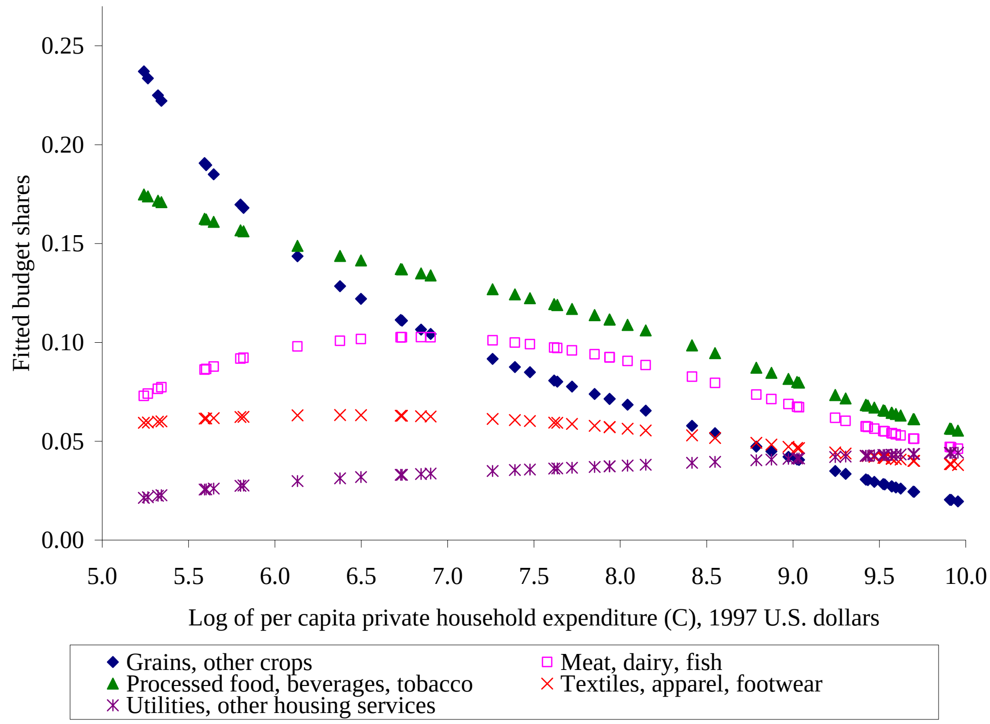


Figure 2b. GTAP-Based Fitted AIDADS Budget Shares (Goods 6-10)

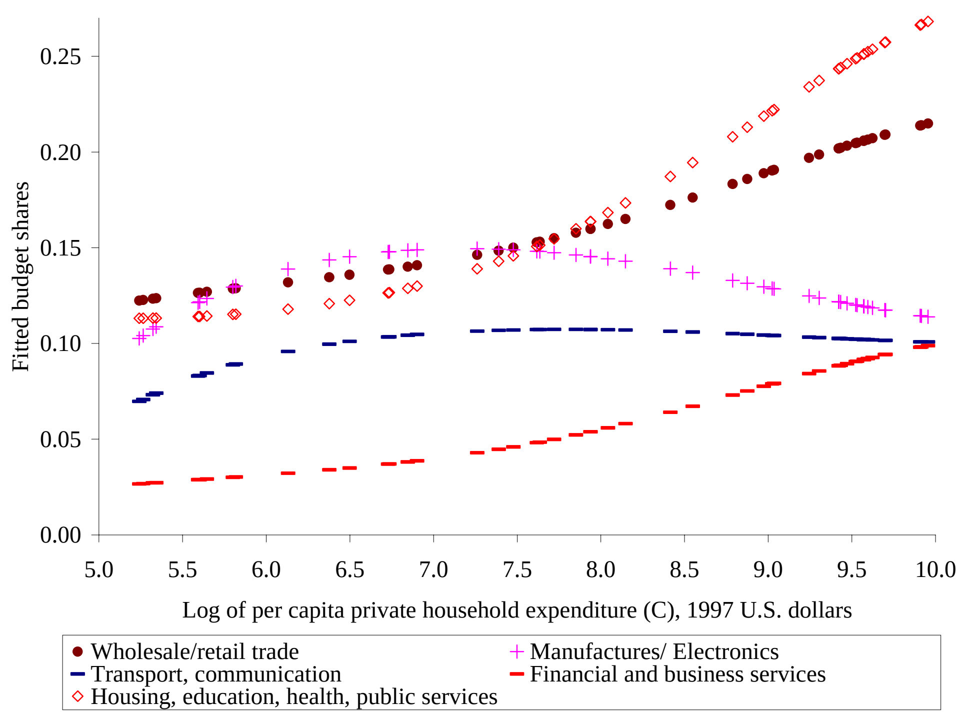


Figure 3a. Selected ICP-Based Fitted Budget Shares

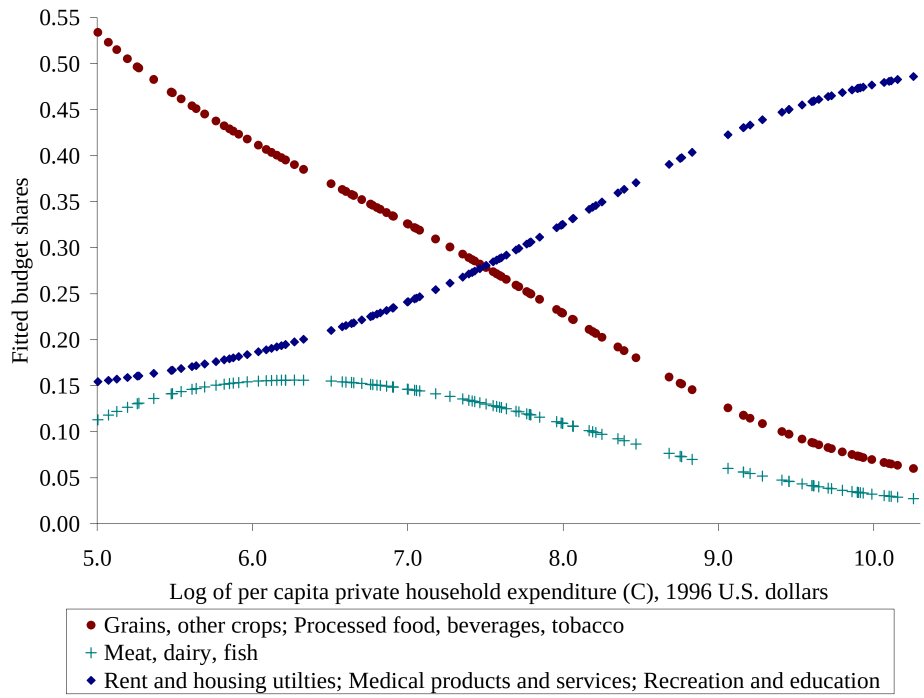


Figure 3b. Selected GTAP-Based Fitted Budget Shares

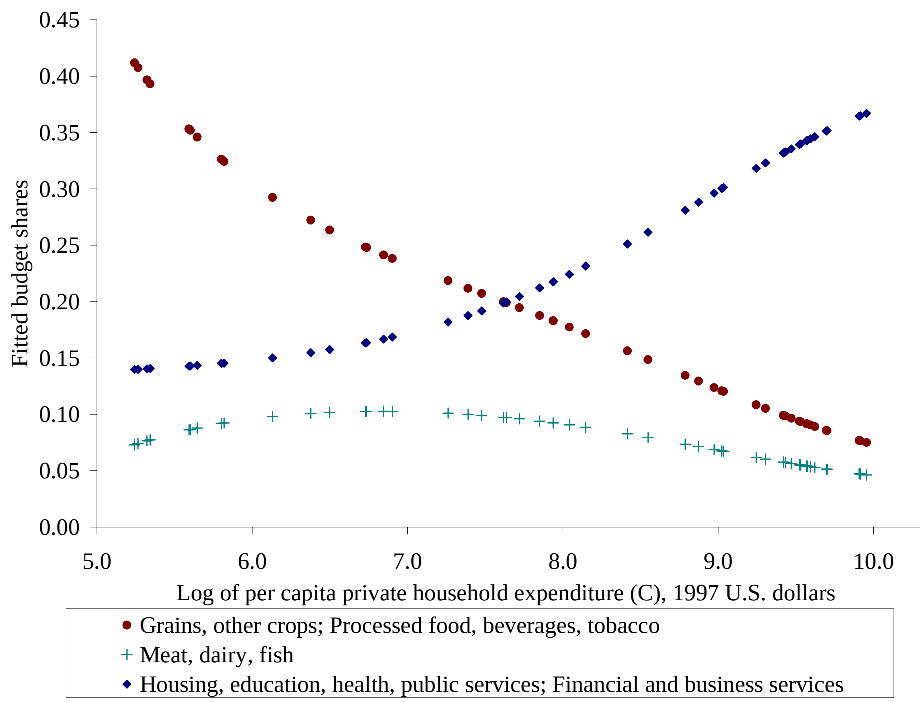
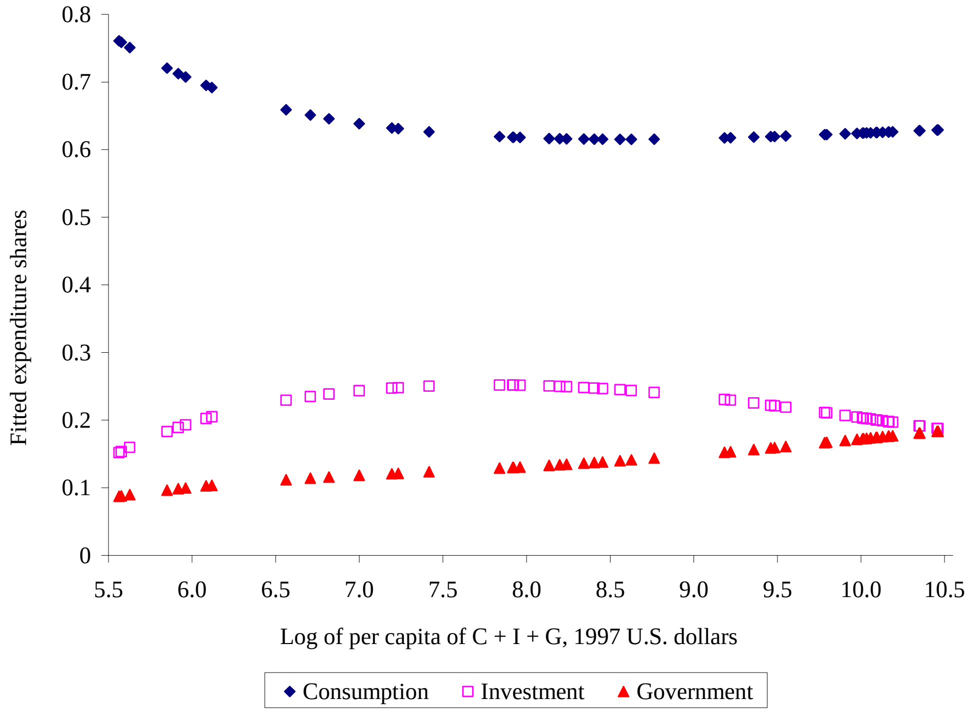


Figure 4. GTAP-Based Fitted Shares of Final Demand



References

ABS (Australian Bureau of Statistics). 1999a. *Australian National Accounts, Input-Output Tables, 1994-95*, ABS Catalogue No. 5209.0 (Canberra, ABS).

Central Intelligence Agency World Fact Book. 2002 (Accessed February). Internet site: www.cia.gov/cia/publications/factbook/

Clements, Kenneth W., and Dongling Chen. 1996. "Fundamental Similarities in Consumer Behavior", *Applied Economics*, 1996, 28, pp. 747-757.

Cranfield, John A.L., Paul V. Preckel, James S. Eales, and Thomas W. Hertel. 2000. "On the Estimation of 'An Implicitly Additive Demand System'", *Applied Economics,* 32, pp.1907-1915.

Cranfield, John A.L., James S. Eales, Thomas W. Hertel, and Paul V. Preckel. 2002. "Model Selection when Estimating and Predicting Consumer Demands using International, Cross Section Data" forthcoming in *Empirical Economics*.

Daniels, Joseph P., and David D. VanHoose. 1999. *International Monetary and Financial Economics*. New York: South-Western College Publishing.

Davis, Donald R., David E. Weinstein, Scott Bradford, and Kazushige Shimpo. 1997. "Using International and Japanese Regional Data to Determine When the Factor Abundance Theory of Trade Works", *American Economic Review*, 97: 421-46.

Deaton, Angus, and John Muellbauer. 1980. *Economics and Consumer Behavior*. Cambridge: Cambridge University Press.

Dimaranan, Betina D., and Robert A. McDougall, eds. 2002. *Global Trade, Assistance, and Protection: The GTAP 5 Data Base*. Center for Global Trade Analysis, Purdue University.

Hertel, Thomas W. 1997. *Global Trade Analysis: Modeling and Applications.* New York: Cambridge University Press.

Heston, Alan, and Robert Summers. 1996. "International Price and Quantity Comparisons: Potentials and Pitfalls", *American Economic Review Papers and Proceedings*, Vol. 86, May.

Hunter, Linda, and James R. Markusen. 1988. "Per Capita Income as a Basis for Trade", in: Robert Feenstra, ed., *Empirical Methods for International Trade*, Cambridge: MIT press.

Islam, Anisul M. 2001. "Wagner's Law Revisited: Cointegration and Exogeneity Test for the USA", *Applied Economics Letters*, 8, pp. 509-515.

Eaton, Jonathan, and Samuel Kortum. 2002. "Technology, Geography, and Trade." *Econometrica*, vol. 70 (5).

Kravis, I.B., Heston, A.W., and Summers, R. 1982. *World Product and Income: International Comparisons of Real Gross Products*. Baltimore: The John Hopkins Press.

Lawson, Ann M. 1997. "Benchmark Input-Output Accounts for the U.S. Economy, 1992", *Survey of Current Business*, Nov., pp. 36-82.

Lenzen, Manfred. 2001. "A Generalized Input-Output Multiplier Calculus for Australia", *Economic Systems Research*, Vol. 13, No. 1.

Lewbel, Arthur. 1991 "The Rank of Demand Systems: Theory and Nonparametric Estimation", *Econometrica*, 59, pp. 711-730.

Lluch, Constantino, Alan A.L. Powell, and Ross A. Williams. 1977. *Patterns in Household Demand and Savings*. Oxford: Oxford University Press.

Oanda. 2002 (Accessed in February). Internet site: www.oanda.com.

OECD (Organization for Economic Cooperation and Development). 2002. "The OECD STAN Database for Industrial Analysis." Internet site: www.oecd.org.

Piergiovanni, Roberta, and Stefano Pisani. 1998. "The Impact of Trade Margins on Statistical Sources", paper presented to the 13th Voorburg Group Meeting, Rome, Italy.

Prais, S.J., and H.S. Houthakker. 1955. *The Analysis of Family Budgets*. Cambridge: Cambridge University Press.

Regmi, Anita, James Seale Jr., and Jason Bernstein. 2001. "International Evidence on Food Consumption Patterns." Paper presented to the Southern Agricultural Economics Association (SAEA) meetings, Fort Worth, TX.

Regmi, Anita, M.S. Deepak, James L. Seale Jr., and Jason Bernstein. 2001. "Cross-Country Analysis of Food Consumption Patterns." In Regmi, ed., *Changing Structure of the Global Food Consumption and Trade*, Economic Research Service, U.S. Dept. of Agriculture, Agriculture and Trade Report, WRS-01-1.

Reimer, Jeffrey J., and Thomas W. Hertel. 2003. "Non-Homothetic Consumer Demands and the Factor Content of Trade", *mimeo*, University of Wisconsin-Madison.

Rimmer, Maureen, and Alan Powell. 1992. "An Implicitly Additive Demand System," *Applied Economics*, 28, pp. 1613-1622.

Ryten, Jacob. 1999. "Evaluation of the International Comparison Programme." United Nations Economic and Social Council, E/CN.3/1999/i.

Seale, James Jr. 1998. "Changes in the Structure of Global Food Demand: Discussion." *American Journal of Agricultural Economics*, 80 (No. 5): pp. 1062-1063.

Stigler, G.J. 1954. "The Early History of Empirical Studies of Consumer Behavior" *Journal of Political Economy*, Vol. 62, pp. 95-113.

Theil, Henri, and Kenneth Clements. 1987. *Applied Demand Analysis: Results from System-Wide Approaches.* Cambridge, MA: Ballinger Publishing Co.

Theil, Henri, Ching-Fan Chung, and James L. Seale, Jr. 1989. *International Evidence on Consumption Patterns*. Greenwich, CT: JAI Press.

United Nations. 1992. *Handbook of the International Comparison Programme*, ST/ESA/STAT /SER.F/62 (United Nations publication, Sales No. E.92.XVII.12), New York.

World Bank. 2002. Personal communication.

Appendix A: Aggregation of Goods and Regions

In this appendix several tables are presented that identify the countries and commodities used in estimating the AIDADS demand system. Further description of these data is provided in the main text.

Table A-1. GTAP Commodity Aggregation

GTAP Codes	ISIC Revision 3 Codes	Central Product Classification Codes
1. Grains, other crops (GrainCrops)		
1 pdr		011*
2 wht		011*
3 gro		011*
4 v_f		012, 013
5 osd		014
6 c_b		018
8 ocr		015, 016, 017, 019*
23 pcr		231
2. Meat, dairy, fish (MeatDairy)		
9 ctl		021*, 029*
10 oap		021*, 029*
11 rmk		029*
14 fsh	015, 05	
19 cmt		211*, 216*
20 omt		211*, 216*
22 mil		22
3. Processed food, beverages, tobacco (OthFoodBev)		
21 vol		216*, 217, 218
24 sgr		235
25 ofd		21*, 23*
26 b_t		24, 25
4. Textiles, apparel, footwear (TextAppar)		
7 pfb		019*
12 wol		029*
27 tex	17, 243	
28 wap	18	
29 lea	19	
5. Utilities, other housing services (HousUtils)		
15 col	101, 102	
17 gas	111*, 112*	
43 ely	401	
44 gdt	402, 403	
45 wtr	41	
46 cns	45	
53 isr	66	

Table A-1. GTAP Commodity Aggregation

G

GTAP Codes	ISIC Revision 3 Codes	Central Product Classification Codes
6. Wholesale/retail trade (WRtrade)		
47 trd	50, 51, 52*, 55	
7. Manufactures, electronics (Mnfcs)		
13 for		03
18 omn	12, 13, 14	
30 lum	20	
31 ppp	21, 221*, 222, 223	
33 crp	241, 242, 25	
34 nmm	26	
35 i_s	271, 2731	
36 nfm	272, 2732	
37 fmp	28	
38 mvh	34	
40 ele	30, 32	
41 ome	29, 31, 33	
42 omf	36, 37	
8. Transport, communication (TransComm)		
16 oil	111*, 112*, 103	
32 p_c	231, 232, 233	
39 otn	35	
48 otp	60, 63	
49 wtp	61	
50 atp	62	
51 cmn	64	
9. Financial and business services (FinService)		
52 ofi	65, 67	
54 obs	70, 71*, 72, 73, 74	
10. Housing, education, health, public services (HousOthServ)		
55 ros	92, 93, 95	
56 osg	75, 80, 85, 90, 91, 99	
57 dwe		

* Denotes that only a sub-section of this category is included.

Table A-2. ICP Commodity Aggregation

ICP Aggregate	ICP Base Commodities
1. Grains, other crops	
	Bread and cereals
	Fruit, vegetables and potatoes
2. Meat, dairy, and fish	
	Meat
	Fish
	Milk, cheese and eggs
3. Processed food, beverages, tobacco	
	Oils and fats
	Other food
	Non-alcoholic beverages
	Alcoholic beverages
	Tobacco
4. Apparel, footwear	
	Clothing, including repairs
	Footwear, including repairs
5. Rent and housing utilties	
	Gross rent and water charges, including maintenance
	Fuel and power
6. Home furnishings and appliances	
	Furniture and floor coverings, including repairs
	Other household goods and services
	Household appliances and repairs
7. Medical products and services	
	Medical care, including both services and goods
8. Transport and communication	
	Personal transportation equipment, repairs
	Operation of transportation equipment
	Purchased transport services
	Communication
9. Recreation and education	
	Recreation and cultural goods and services
	Education services
10. Other goods and services	
	Restaurants, cafes and hotels
	Other goods and services, nec

Table A-3. GTAP Regions for Demand System Estimation

No.	Region name	Code	Per Capita Household Expenditure (1997 US$)	Per Capita GDP (1997 US$)
1	Tanzania	TZA	189	216
2	Mozambique	MOZ	193	219
3	Vietnam	VNM	205	274
4	Malawi	MWI	209	290
5	India	IND	269	336
6	Uganda	UGA	271	356
7	Bangladesh	BGD	283	416
8	Zambia	ZMB	331	446
9	China	CHN	337	695
10	Zimbabwe	ZWE	460	720
11	Sri Lanka	LKA	588	841
12	Indonesia	IDN	664	1,042
13	Philippines	PHL	836	1,097
14	Morocco	MAR	843	1,280
15	Botswana	BWA	941	1,566
16	Rest of world	XRW	994	2,361
17	Thailand	THA	1,423	2,658
18	Colombia	COL	1,619	2,664
19	Peru	PER	1,767	3,082
20	Malaysia	MYS	2,033	3,116
21	Turkey	TUR	2,070	3,222
22	Poland	POL	2,253	3,676
23	Venezuela	VEN	2,568	4,028
24	Mexico	MEX	2,800	4,140
25	Hungary	HUN	2,802	4,825
26	Brazil	BRA	3,108	4,896
27	Chile	CHL	3,453	5,208
28	Uruguay	URY	4,517	5,837
29	South Korea	KOR	5,160	9,138
30	Portugal	PRT	6,553	9,687
31	Argentina	ARG	7,148	9,901
32	Taiwan	TWN	7,892	10,961
33	Greece	GRC	8,293	13,248
34	Spain	ESP	8,385	13,747
35	Ireland	IRL	10,346	17,303
36	New Zealand	NZL	10,991	18,149
37	Finland	FIN	12,339	19,608
38	Canada	CAN	12,352	21,047
39	Italy	ITA	12,490	21,198
40	Australia	AUS	12,974	21,818
41	Sweden	SWE	13,668	22,703
42	Netherlands	NLD	13,781	22,719
43	France	FRA	14,330	23,007
44	Austria	AUT	14,352	23,485
45	United Kingdom	GBR	14,363	23,600
46	Germany	DEU	14,693	24,426
47	Belgium	BEL	15,105	25,117
48	Luxembourg	LUX	16,261	25,729
49	Denmark	DNK	16,341	29,260
50	Japan	JPN	20,086	31,149
51	United States	USA	20,237	33,750
52	Switzerland	CHE	21,059	35,190

Table A-4. ICP Regions for Demand System Estimation

No.	Region Name	Per Capita Real Household Expenditure (1996 US$)	Per Capita Nominal Household Expenditure (1996 LCUs)
1	Tanzania	424	92,568
2	Nigeria	600	14,430
3	Tajikistan	700	29,762
4	Zambia	720	339,273
5	Yemen	720	44,587
6	Malawi	792	2,972
7	Madagascar	794	1,035,865
8	Mali	826	109,287
9	Mongolia	889	162,633
10	Benin	1,017	163,257
11	Kenya	1,129	13,659
12	Nepal	1,197	9,294
13	Sierra Leone	1,209	176,888
14	Turkmenistan	1,258	457,690
15	Congo	1,356	270,551
16	Senegal	1,445	214,327
17	Bangladesh	1,462	11,176
18	Vietnam	1,496	2,660,390
19	Pakistan	1,694	13,063
20	Azerbaijan	1,776	1,589,102
21	Cote D'Ivoire	1,817	255,528
22	Kyrgyzstan	1,957	4,567
23	Uzbekistan	1,995	16,214
24	Cameroon	2,008	250,328
25	Moldova	2,009	1,547
26	Bolivia	2,103	3,889
27	Ecuador	2,138	3,508,085
28	Sri Lanka	2,223	31,116
29	Armenia	2,238	182,540
30	Jordan	2,362	839
31	Albania	2,567	77,005
32	Indonesia	2,587	1,684,393
33	Jamaica	2,631	54,608
34	Zimbabwe	2,648	4,825
35	Guinea	2,713	458,145
36	Syria	2,871	31,969
37	Georgia	2,899	837
38	Ukraine	3,182	1,137
39	Philippines	3,455	22,620
40	Peru	3,490	4,455
41	Botswana	3,501	3,179
42	Panama	3,528	1,688
43	Thailand	3,567	42,053
44	Morocco	3,656	8,010
45	Venezuela	3,687	793,053
46	Macedonia	3,856	73,253
47	Belize	3,863	4,006
48	Egypt	3,869	3,051
49	St. Vincent & Gren.	3,894	5,246
50	Swaziland	4,093	3,308

Table A-4.ICP Regions for Demand System Estimation (Cont.)

No.	Region Name	Per Capita Real Household Expenditure (1996 US$)	Per Capita Nominal Household Expenditure (1996 LCUs)
51	Lebanon	4,181	4,623,088
52	Belarus	4,237	12,799
53	Dominica	4,271	6,372
54	Kazakhstan	4,326	67,468
55	Latvia	4,464	860
56	Brazil	4,516	3,185
57	Bulgaria	4,540	177
58	Russia	4,679	8,935
59	St. Lucia	4,818	7,717
60	Grenada	4,841	6,511
61	Fiji	4,959	2,778
62	Turkey	5,026	182,342,855
63	Lithuania	5,062	6,504
64	Romania	5,165	3,754,516
65	Iran	5,314	2,246,085
66	Mexico	5,490	19,475
67	Bahrain	5,605	1,325
68	Chile	5,675	1,312,176
69	Antigua & Barbuda	5,694	11,926
70	Poland	5,888	7,113
71	Trinidad & Tobago	6,179	17,853
72	Estonia	6,208	28,966
73	Gabon	6,263	1,058,222
74	Tunisia	6,389	1,277
75	St. Kitts & Nevis	6,479	9,930
76	Uruguay	6,534	34,253
77	Slovakia	6,636	67,490
78	Hungary	7,198	452,731
79	Argentina	8,016	5,897
80	Oman	8,371	1,472
81	Slovenia	9,093	926,382
82	Singapore	9,162	14,003
83	Czech Republic	9,388	97,947
84	Greece	10,096	2,291,017
85	Korea	10,182	5,147,070
86	Portugal	10,525	1,328,650
87	Spain	10,583	1,362,900
88	Ireland	10,868	7,625
89	Mauritius	11,614	43,496
90	Qatar	11,930	23,069
91	Israel	12,021	40,686
92	New Zealand	12,190	18,582
93	Finland	12,227	77,101
94	Bahamas	12,359	9,528
95	Sweden	13,291	133,848
96	Netherlands	13,449	27,668
97	United Kingdom	14,275	9,559
98	France	14,286	97,976
99	Belgium	14,438	557,102
100	Norway	14,474	140,352
101	Italy	14,591	23,128,408

Table A-4. ICP Regions for Demand System Estimation (Cont.)

No.	Region Name	Per Capita Real Household Expenditure	Per Capita Nominal Household
102	Austria	14,893	209,997
103	Germany	14,951	30,381
104	Australia	15,237	19,768
105	Japan	15,435	2,562,253
106	Canada	15,861	18,930
107	Bermuda	16,287	24,303
108	Hong Kong	16,444	114,419
109	Switzerland	16,527	35,165
110	Barbados	16,566	9,593
111	Iceland	16,683	1,318,840
112	Denmark	16,836	142,913
113	Luxembourg	20,235	794,841
114	USA	20,592	20,592

Appendix B: Modifications Needed for the 1996 ICP Data

This appendix documents some problems concerning the 1996 ICP data set contained within the "ToolPak" aggregation program obtained from the World Bank. In this section we document our approach to dealing with these problems, and in the end feel that we have a very high quality data set.

We first discovered errors concerning the "real expenditure" data that are calculated using the 1996 ICP ToolPak aggregation software. In particular, the PPP rates for several Asian nations were not expressed relative to the U.S. dollar (as in all other countries), but according to the Hong Kong dollar.[29] Following the approach of Regmi, Seale, and Bernstein (2001), we used 2001 World Bank "World Development Indicators" (WDI) data to get an estimate of Hong Kong's 1996 per capita expenditure relative to U.S. per capita expenditure in 1996. We calculated this ratio to be 79.86%. Accordingly, the real expenditures of all the mischaracterized Asian countries were multiplied by 24.78.[30] The approach and accuracy of the resulting real expenditure figures were verified as correct through graphical comparison with WDI and GTAP data, as well as in correspondence with researchers at the U.S. Dept. of Agriculture, Economic Research Service. We also checked whether several aggregated values, such as per capita household expenditure and GDP, were comparable to those of the World Bank WDI and GTAP data. In scatterplots and in tabular comparisons we found no problems of significance.

[29] The set of nations for which this is a problem includes Bangladesh, Fiji, Hong Kong, Indonesia, Iran, Korea, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, and Vietnam.

[30] This is because the unmodified ICP per capita expenditure for Hong Kong is 664. It needs to be scaled up to 16,444 in order to be exactly 79.86% of the U.S. ICP per cap expenditure. 664 multiplied by 24.78 is 16,444. Note that one should multiply only real expenditure (not nominal expenditure or PPP rates) by 24.78.

Appendix C: Household Consumption Expenditure Elasticity Estimation

In this appendix a GAMS program is presented that has been designed to compute expenditure elasticities for any country for which the per capita expenditures of the 10 categories in Table A-1 are known. This can be carried out for a GTAP country outside of the sample, or for the projected expenditure for one of the countries in the sample. The GAMS program uses AIDADS parameter estimates generated with the GTAP data as described in the main text, but these estimates can be easily changed as needed. The GAMS program requires an input file called “data.prn”, which is essentially a table that has the VIMS, VIWS, and VPA data described below. These data come from the GTAP Baseview.har file that results from aggregating data in GTAPAgg as shown in Table A-1. Once the GAMS program runs successfully, one only needs to look at the output at the very bottom for the parameter “Elas” to get the expenditure elasticities specific to the 10 goods. The program is set up to work for one country at a time (this could be changed if desired).

```
*  GAMS program to calculate expenditure elasticities for one country at a time
*  Written by Jeff Reimer, November 2002

option decimals=4 ;
sets i /c1*c10/
     k /VIMS,VIWS,VPA/ ;

* To run this program, this is the information required from the GTAP database:
*  (1) VIMS (imports valued at domestic market prices, summed over all sources)
*  (2) VIWS (imports valued cif, summed over all sources)
*  (3) VPA (household expenditure valued at agent's prices, in Baseview.har
*      this is Cost Structure of Consumption, Sum DIR, Sum PURCHVALUE)
*  (4) Population (the unit is a single person, NOT in millions or otherwise)
* Each time you change the country, you must change the values within the
* "data.prn" file.  This can be modified using Microsoft Excel.  Make sure that
* the path is correct.

$include c:\data\reimer\GTAPtech\data.prn

************ The values below should not normally be changed  ****************
parameter alpha(i)
 / c1 0.084, c2 0.122, c3 0.138, c4 0.068, c5 0.035, c6 0.132, c7 0.169
   c8 0.115, c9 0.030, c10 0.108 / ;

parameter beta(i)
 / c1 0.000, c2 0.026, c3 0.032, c4 0.030, c5 0.047, c6 0.238, c7 0.099
   c8 0.097, c9 0.118, c10 0.313 / ;
```

```
parameter gamma(i)
 / c1 0.298, c2 0.000, c3 0.142, c4 0.030, c5 0.000, c6 0.078, c7 0.002
   c8 0.000, c9 0.014, c10 0.086 / ;

scalar kappa
 / 1.977 / ;

alias(i,j) ;

Parameters u, price(i), nomexp(i), realexp(i), x(i), m, phi(i), what(i), xhat(i)
           mbs(i), elas(i) ;

price(i) = data(i,"VIMS")/data(i,"VIWS") ;
nomexp(i) = 1000000*data(i,"VPA") ;
realexp(i) = nomexp(i)/price(i) ;
x(i) = realexp(i)/population/100 ;
m = sum(i,price(i)*x(i)) ;
u = -9.994879656896 + 1.138117884571*log((m*100)) ;
what(j) = gamma(j)*price(j)/m + (alpha(j)+beta(j)*exp(u))/(1+exp(u))*
          (1-sum(i,price(i)*gamma(i))/m) ;
xhat(i) = what(i)*m/price(i) ;
phi(i) = (alpha(i) + beta(i)*exp(u))/(1 + exp(u)) ;
mbs(i) = phi(i)-(beta(i)-alpha(i))*power(sum(j, (beta(j)-alpha(j))*log(xhat(j)
          -gamma(j)))-power(1 + exp(u),2)/exp(u),-1);
elas(i) =  mbs(i)/what(i) ;

display elas, m, u ;
```

The table below gives the expenditure elasticities for countries within the GTAP sample. For a given commodity, the elasticity will vary across countries according to a country's per capita income, and its price for that commodity. Country names and per capita incomes are provided in Table A-3.

Table D-1. Expenditure Elasticities Evaluated At Observed, Country-Specific Price Levels

Region code	Grains, other crops	Meat, dairy, fish	Processed food, beverages, tobacco	Textiles, apparel, footwear	Utilities, other housing services	Whole-sale/ retail trade	Manu-factures, electronics	Tran-sport, commun-ication	Financial and business services	Housing, education, health, public services
TZA	0.342	1.633	0.765	1.128	1.662	1.106	1.625	1.649	1.246	1.011
MOZ	0.361	1.591	0.761	1.071	1.620	1.097	1.584	1.608	1.233	1.007
VNM	0.376	1.566	0.726	1.083	1.596	1.106	1.561	1.582	1.241	1.022
MWI	0.384	1.538	0.737	1.060	1.569	1.100	1.535	1.556	1.232	1.019
IND	0.433	1.359	0.778	1.052	1.399	1.088	1.364	1.382	1.214	1.040
UGA	0.388	1.377	0.836	1.079	1.418	1.102	1.383	1.400	1.232	1.055
BGD	0.440	1.327	0.798	1.046	1.369	1.085	1.334	1.351	1.211	1.044
ZMB	0.484	1.243	0.844	1.040	1.291	1.045	1.254	1.271	1.173	1.047
CHN	0.415	1.308	0.811	1.076	1.356	1.117	1.318	1.335	1.245	1.089
ZWE	0.520	1.164	0.839	1.017	1.227	1.088	1.182	1.200	1.206	1.077
LKA	0.558	1.092	0.865	0.995	1.173	1.084	1.118	1.139	1.228	1.113
IDN	0.613	1.054	0.849	0.985	1.147	1.080	1.085	1.108	1.232	1.121
PHL	0.587	1.022	0.872	0.976	1.135	1.096	1.061	1.089	1.261	1.155
MAR	0.614	1.026	0.853	0.973	1.133	1.093	1.063	1.089	1.252	1.148
BWA	0.651	0.983	0.865	0.957	1.112	1.089	1.029	1.059	1.262	1.158
XRW	0.623	0.994	0.853	0.963	1.121	1.099	1.039	1.069	1.271	1.169
THA	0.643	0.936	0.837	0.930	1.104	1.115	0.998	1.038	1.306	1.208
COL	0.648	0.904	0.832	0.915	1.097	1.120	0.977	1.022	1.319	1.221
PER	0.651	0.896	0.833	0.911	1.095	1.119	0.972	1.018	1.319	1.221
MYS	0.611	0.869	0.818	0.898	1.097	1.135	0.959	1.011	1.342	1.248
TUR	0.620	0.871	0.807	0.901	1.098	1.136	0.960	1.012	1.343	1.249
POL	0.621	0.865	0.791	0.897	1.099	1.141	0.957	1.011	1.350	1.256
VEN	0.615	0.824	0.783	0.871	1.093	1.144	0.934	0.995	1.353	1.263
MEX	0.594	0.810	0.773	0.866	1.094	1.149	0.927	0.992	1.360	1.271
HUN	0.596	0.815	0.770	0.869	1.096	1.150	0.930	0.995	1.362	1.272
BRA	0.590	0.790	0.759	0.852	1.093	1.152	0.918	0.987	1.361	1.275
CHL	0.567	0.768	0.743	0.841	1.093	1.156	0.908	0.982	1.361	1.279
URY	0.511	0.718	0.702	0.815	1.094	1.163	0.888	0.973	1.360	1.285
KOR	0.458	0.698	0.681	0.807	1.098	1.171	0.883	0.973	1.366	1.293
PRT	0.402	0.649	0.647	0.785	1.090	1.161	0.868	0.964	1.330	1.269
ARG	0.385	0.638	0.637	0.780	1.090	1.162	0.865	0.963	1.328	1.269

Table D-1. Expenditure Elasticities Evaluated At Observed, Country-Specific Price Levels

Region code	Grains, other crops	Meat, dairy, fish	Processed food, beverages, tobacco	Textiles, apparel, footwear	Utilities, other housing services	Whole-sale/ retail trade	Manu-factures, electronics	Tran-sport, commun-ication	Financial and business services	Housing, education, health, public services
TWN	0.352	0.624	0.623	0.775	1.089	1.160	0.862	0.962	1.320	1.264
GRC	0.335	0.617	0.622	0.775	1.085	1.153	0.862	0.962	1.302	1.251
ESP	0.332	0.616	0.620	0.774	1.086	1.154	0.862	0.962	1.303	1.251
IRL	0.271	0.598	0.607	0.773	1.079	1.142	0.862	0.961	1.271	1.228
NZL	0.257	0.595	0.605	0.773	1.077	1.138	0.863	0.962	1.263	1.221
FIN	0.224	0.589	0.600	0.775	1.074	1.132	0.865	0.963	1.248	1.209
CAN	0.225	0.584	0.594	0.770	1.076	1.136	0.862	0.961	1.257	1.217
ITA	0.221	0.590	0.602	0.776	1.073	1.130	0.866	0.963	1.244	1.206
AUS	0.214	0.590	0.602	0.777	1.072	1.128	0.867	0.963	1.239	1.202
SWE	0.199	0.590	0.604	0.780	1.070	1.124	0.869	0.964	1.229	1.195
NLD	0.196	0.590	0.603	0.780	1.069	1.123	0.869	0.964	1.229	1.194
FRA	0.187	0.591	0.605	0.783	1.068	1.120	0.871	0.964	1.222	1.189
AUT	0.187	0.591	0.606	0.783	1.067	1.120	0.871	0.964	1.221	1.188
GBR	0.186	0.590	0.604	0.782	1.068	1.121	0.870	0.964	1.223	1.189
DEU	0.182	0.591	0.606	0.784	1.067	1.119	0.872	0.965	1.218	1.186
BEL	0.175	0.592	0.607	0.786	1.066	1.117	0.873	0.965	1.214	1.182
LUX	0.158	0.596	0.612	0.791	1.063	1.111	0.877	0.966	1.202	1.173
DNK	0.159	0.596	0.612	0.791	1.062	1.110	0.877	0.966	1.201	1.172
JPN	0.100	0.599	0.616	0.800	1.059	1.103	0.884	0.969	1.185	1.159
USA	0.116	0.612	0.630	0.808	1.054	1.096	0.888	0.970	1.171	1.147
CHE	0.090	0.591	0.602	0.796	1.060	1.105	0.881	0.968	1.188	1.162