

# **The Global Trade Analysis Project: Issues and Future Directions**

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**Background Paper for the GTAP Advisory Board Meeting**

**Taipei, Taiwan  
June 2-3, 2002**

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## OBJECTIVES, GOALS AND ACCOMPLISHMENTS

In keeping with past tradition, we open this background paper with a statement of the objective of GTAP for your recollection, review and comment.

### Objective of GTAP

GTAP is dedicated to the development and support of a global research network, data base, and modeling framework for the analysis of international trade, environment and resource issues.

More specifically, GTAP comprises:

- \* a fully documented, publicly available data base,
- \* a standard modeling framework and associated software which are well-documented and flexible, and which lend themselves to straightforward replication of analyses by third parties,
- \* a global network of researchers, linked together via email and a Worldwide Web site, and finally,
- \* a Consortium of national and international agencies providing leadership and a base level of support. The vehicle, which has been set up for Consortium members to provide this guidance and direction, is the *GTAP Advisory Board*.

The Board advises the Director on matters of policy, research agenda and funding. In so doing, it helps to set the direction of future developments in the GTAP network, training courses, data base and modeling framework. In keeping with the title of "*advisory board*," responsibility for the final decision in these matters rests with the Director. In this way we hope to keep the project moving ahead on an effective and timely course.

### Assessment of Goals for Past Year

The goals for the past year, as laid out at the 2001 GTAP board meeting, are listed below, along with an assessment of our progress towards accomplishing these goals. (A complete summary of last year's board meeting is available from the consortium page of the GTAP web site: [http://www.agecon.purdue.edu/gtap/events/board\\_meetings/2001/default.asp](http://www.agecon.purdue.edu/gtap/events/board_meetings/2001/default.asp) .)

1. Establishment of working committees in specific areas of interest to GTAP board members.

Assessment: Appendix 2 lists the Working Committee assignments. Some of these committees have been quite active over the past year, while others have been inactive. I plan include brief summaries from the board chairs in the preliminary material distributed prior to the meeting. At the board meeting we should discuss what committees should be maintained in the coming year, and what new committees might be useful. One aspect of this arrangement that wasn't very effective was the idea of nominating individuals for membership on the committee. This seems

to be too much overhead. I propose a system of self-nomination in the future, such that anyone wishing to be on a committee contact the chairperson directly. Essentially this amounts to being put on an email list and thereby entering the “loop” of discussions on this topic.

2. Establish a wish-list for the GTAP-Version 6 data base specifications.

Assessment: This wish-list was developed in the wake of the 2001 board meeting and posted on the web site for comment/additions. It is quite comprehensive. This list, along with an assessment of progress on each item, is provided in a separate PDF file. We have grouped things into four categories: (1) already completed, (2) scheduled to be completed prior to version 6 release, (3) will be done if time permits, (4) will not be done under current planning. A key session at the board meeting will involve setting priorities for version 6 activities. In this regard, we would like the board members to look closely at items in categories (2) and (4) and react to our decisions there. Our discussions at the upcoming board meeting will focus on setting priorities for category (3).

3. GTAP-IFPRI collaboration on African data bases – contingent on available funds.

Assessment: No further progress has been made on this front to date. We will have an update on GTAP-related activities in Africa from Channing Arndt at the board meeting.

4. Quality of national data bases: We will place an increased emphasis on quality of national data bases in the future. Concrete measures will include: (a) Identifying anomalies in the original data base – i.e. significant departures from the norm. Focus specifically on conformance with respect to government consumption, dwellings and margins. (b) Providing information on the amount by which the national data bases are changed as a result of the FIT targets. (c) Providing one-region SAMs back to contributors, (d) Expanding GTAP technical paper #1 to aid contributors in evaluating their revised data base.

Assessment: Some progress has been made on this front in the process of documenting the version 5 data base. Specifically, we now have one individual who specializes in interacting with data base contributors and who supplies them with a standard set of information evaluating the submitted data bases. Robert McDougall has also developed summary measures of how much the national data bases are changed when they are run through the “FIT” program which brings them into the GTAP data base. For more details, see Chapter 19 of the data base documentation at the following location:

[http://www.gtap.agecon.purdue.edu/databases/v5/v5\\_doco.asp](http://www.gtap.agecon.purdue.edu/databases/v5/v5_doco.asp)

A project focusing on government consumption, dwellings and margins will be undertaken in the fall of 2002. We have not been working with contributors over the past year, due to the cycle of data base development, but as we work with them over the coming year, addressing points c and d will be relevant.

5. Margins: Begin development of a prototype data base/model with explicit incorporation of margins.

Assessment: We have begun the process of identifying existing data bases on domestic margins, by transaction. We have also identified an individual interested taking the lead on this project. However, it is not clear what the priority of this activity should be. Some guidance from the board would be helpful.

6. Improved treatment of government and foreign accounts, including: direct taxes, government transfers, foreign income payments, and remittances.

Assessment: This work has not been done, as we have not had a staff member at Purdue who has had time to dedicate to this topic. It has moved onto the version 6 “wish list” and will be considered in light of competing demands.

7. Increased attention to the proper citation of data bases projects supporting the GTAP effort.

Assessment: This point has been raised by IFPRI and the LEI, among others, who have invested considerable resources in the development of data bases that were ultimately used in GTAP (Southern Africa and the EU-15, respectively). Others are currently contemplating significant data contributions to GTAP, including CEPII/ITC-Geneva (protection data), and IDE-Japan (IO tables for Southeast Asia). Clearly we need to find ways to highlight these contributions and give the originating institutions credit when credit is due. I would like to explore ideas about how to better achieve this recognition at the board meeting. This is also an issue with the GTAP data base in general. Now that the version 5 documentation is out, it is important that this be cited in all papers using the data base. In the end, responsibility for acknowledging data base work falls on all of our shoulders, but perhaps there are some things we can do to make this easier to remember!

8. Data base infrastructure: There are quite a few specific items to be considered here. See detailed discussion of version 6 specifications and wish list.

9. Administrative (Assessment):

- a. Set-up institutional ID and password for web board to facilitate multi-person access (Done)
- b. Set up discussion section on the web board for each working committee (Not yet required. Email seems to do the trick at this point.)
- c. Establish web page to facilitate information exchange regarding past and future training opportunities related to global economic analysis by the consortium members. (We have established a place on the GTAP web site for advertising positions, courses, etc. More can be done, if deemed necessary.)

The final three objectives were neglected in the list published on the web, but they were certainly implicit in the 2001/02 schedule of activities.

11. Successful completion and publication of the version 5 data base documentation.

Assessment: It's done! Special congratulations go to Judy Conner and Betina Dimaranan for shepherding this through the editing and production process. Hard copy of the version 5 documentation should reach the GTAP board members about one week before the meeting in Taiwan. The formal reference for this is:

Dimaranan, Betina and Robert McDougall (2002). *Global Trade Assistance and Production: The GTAP 5 Data Base*, Center for Global Trade Analysis, Purdue University.

Production of this 600+ page document involving dozens of authors is almost as daunting as producing the data base itself. However, it is also a very important feature of GTAP – adding substantially to the credibility of our work and the research projects using GTAP data. In addition, by carefully documenting the data base, we have learned quite a bit more about its strengths, weaknesses and other features. For example, let me refer you to chapters 17 and 19 of the documentation which contain extensive discussion and evaluation of the quality of the individual region data bases.

This time around, we pursued a somewhat different strategy in which we posted intermediate versions of the chapters on the web as soon as they became available. This seemed to help a great deal in getting the necessary information into the hands of users before the full document was ready. Your reactions to this policy would be most appreciated.

11. Successful delivery of the Ninth Annual Short Course – to be held in August 2001 at Purdue University.

Assessment: The annual short course was again quite successful. This was the first year that all participants were required to take part in the eight-week, web-based course prior to the intensive short course. This made a big difference in the overall level of the course. In fact, we found that the instructors need to adjust their teaching style to better take advantage of the material that participants cover before arriving on campus.

12. Completion of a successful Fourth Annual Conference in Global Economic Analysis at Purdue University and preparations for the Fifth Annual Conference in Taipei.

Assessment: While the Fourth Annual Conference did not have the exotic locale of some of the earlier conferences, it did have an outstanding program. There has been a notable improvement in the quality of papers presented, compared to the First Annual Conference, also held at Purdue University. The 2002 conference in Taipei has attracted roughly twice the number of paper submissions and twice the number of participants, compared to the first four conferences. This has no doubt proved to be a challenge for the organizers, but they have risen to the task and are doing a very good job. We will have a report from Professor Chung-Huang Huang on day 2 of the board meeting. Something we will want to consider at the board meeting is whether there is an “optimal” size for the annual conference. If so, what mechanisms can be put in place to achieve this size.

## **DATA BASE DEVELOPMENT**

## **Data Base Management**

Betina Dimaranan and Robert McDougall have proven to be a very effective data base development team. While the standards in version 4 were already much higher than previously, with version 5 they have raised the bar quite a bit further. As noted at last year's meeting, the software design now permits them to remake the data base overnight when new information becomes available. Each new version is archived so that it may be reproduced at a later date. This permits a process of continuous improvement which greatly facilitates production of interim releases as well as the final data base.

As noted at last year's meeting, we now maintain all of the GTAP source data at the level of more than 200 "standard countries". This facilitates the introduction of regional flexibility, whereby new regions can be added with a relatively modest amount of work. We are therefore going to be experimenting with interim releases later in 2002. There are several important new data bases coming available (IDE-Japan data bases for Southeast Asia, CEEC data bases, and a data base for Russia) and we would like to make these available to the consortium members as soon as possible. This will also help us in the transition to version 6. If we can incorporate most of the new regional data bases before the prerelease of version 6, then we can focus our attention on the international data bases and the software and procedures for making the version 6 data base.

As noted at last year's meeting, these interim releases will be exactly the same as version 5.0, excepting for the new regional coverage, or updated national data bases. Meanwhile, a separate build stream will be underway in which these problems and issues associated with the version 5 build process will be fixed and other improvements introduced. These revised programs, combined with updated trade, protection, macro and energy targets (for the year 2000) will be used in conjunction with the most recent regional data bases in order to build the first prerelease of version 6.

## **Individual Region Data Bases**

As you know, the GTAP data base consists of bilateral trade, transport, and protection matrices that link individual country/regional economic databases. The regional databases are derived from individual country input-output tables, from varying years. Version 1 of the GTAP data base relied exclusively on IO tables inherited from the Industry Commission's SALTER project. For this reason, GTAP adopted the SALTER concordance that identified 37 sectors/commodities. In the version 3 data base, 11 of the national databases still traced their roots back to the Australian Industry Commission's SALTER project. (Of course they were updated for each new release using the FIT program.) These IO tables were heavily concentrated in the Pacific Rim, reflecting SALTER's focus on APEC issues. Six of these were updated in version 4 (New Zealand, China, Philippines, Thailand, Taiwan, and Canada). This left old IO tables only for Japan, Korea, Malaysia, Singapore, and Hong Kong. Given the re-export problem with Singapore and Hong Kong, those economies will likely always present major problems. The good news with version 5 is that both Japan and Korea have now been updated. This leaves only Malaysia, Singapore, and Hong Kong as out-of-date databases. We have recently obtained a set

of 10 IO tables from the Institute for Developing Economies (IDE) in Japan which includes new IO tables for Malaysia and Singapore, among others. This leaves Hong Kong as the last remaining IO table inherited from SALTER. Since there is no actual IO table in existence for Hong Kong, this had to be “fabricated” by SALTER staff. We may wish to contemplate a change in the treatment of Hong Kong in the future – possibly re-estimating this IO table, or eventually combining Hong Kong with China. Input from the board on this issue would be most welcome.

In addition to these updates of the original SALTER IO tables, version 4 featured updates of four more existing regional databases, as well as entirely new databases for 14 countries (Vietnam, Sri Lanka, Venezuela, Colombia, Uruguay, UK, Germany, Denmark, Sweden, Finland, rest of EU, Turkey, Morocco and South Africa). Version 5 updated 16 national data bases (Australia, China, Japan, Korea, Taiwan, Vietnam, India, Colombia, United States, United Kingdom,) and added 23 more countries. These are identified in Table 11.A.1 excerpted from Chapter 11 of the data base documentation. This table also lists the reference period and source for all of the IO tables currently in the GTAP v.5 data base.

[Insert Table 11.A.1 here.]

The remaining 10 regions in the 66 region, version 5 data base are made up of composite databases representing groups of countries. The IO tables (or simplified social accounting matrices) for these *composite regions* are based on subsets of the 55 original databases and a one-to-one mapping between these individual regions and those countries in each of the composite regions. As new IO tables have been added to the data base, the economic size of these composite regions has rapidly diminished, and our ability to match up with the unknown countries has simultaneously improved. For example, in version 2 we had a single “South Asia” region, with “real data” only for trade and macro-economic totals. In version 3, India was added and the structure of the Indian economy was used as a starting point for estimating the SAM’s for several other countries in the “rest of South Asia” region. In version 4, Sri Lanka was added. This further reduced the size of the “rest of South Asia” region, while providing another proxy country to be used in estimating the structure of countries in that residual region. In version 5, Bangladesh has been added. This leaves a residual, “rest of South Asia” region that is dominated by Pakistan. This is an excellent example of how the GTAP system of dealing with missing domestic databases has led to a continual improvement of the data base.

There are essentially two ways that we have for renewing country databases and adding new ones. The first method is for individual contributors to step forward and offer a GTAP-ready data base. This has been the predominant vehicle in the past. There are basically three incentives for contributing to this public good: (1) this assures the user that they have the best available national data for their own country in any GTAP applications undertaken, (2) contributors receive a free copy of the final data base, as well as an aggregation of the pre-release, and (3) it’s the right thing to do. (There are still some idealists out there!) These individual contributions are sometimes simply one-off exercises that are not repeated. However, in many cases, once we have an established relationship with a contributor, they will update their contribution as new data become available.

The second vehicle for obtaining new databases is through special projects, aimed to support some particular line of research or policy analysis. In version 5 there were several such projects. The first, undertaken by the LEI, with partial funding from the European Commission, involved the production of a set of 15 new databases for the member countries of the EU. The purpose of this project is to support improved analysis of issues such as WTO2000 and EU enlargement and their impact on individual EU members. Since the EU-15 represent a very large share of world GDP, and since this work has been done with the latest available information, at the full, 57 sector level of disaggregation in version 5, it represented a very substantial upgrade to the full data base.

The European Commission supported development of two new country databases for Central Europe – Hungary and Poland – which have been incorporated into the version 5 data base. These were developed by Martin Banse, at the University of Goettingen. They have greatly expanded the scope for credible analysis of EU enlargement with respect to these two prospective entrants. More recently, Dr. Banse has extended this work to ten more Central and Eastern European economies. The European Commission has made them available for use by others. However, they are not yet GTAP-ready. This will take some additional work. Once they are ready, we plan to incorporate them into an interim release of version 5 and make them immediately available to consortium members.

In another important development, one of the GTAP consortium members, the US International Trade Commission, has provided modest financial assistance and substantial professional assistance to a group of economists at Moscow State University who are assembling an IO table for Russia. Given the importance of Russia in international trade as well as the global climate change debate, we are eager to incorporate this new data base into GTAP as soon as it becomes available. Accordingly, we will pull it into a version 5 interim release as well, when it becomes available.

Another major project with an important data base component built on the IO tables developed under IFPRI's MERISSA project, funded by the Danish aid agency, DANIDA. In order to incorporate these data bases into GTAP and improve the associated trade and protection data, Channing Arndt obtained funding from the UK's DFID. This was largely used to fund the work of Mark Horridge, at the Centre of Policy Studies, Monash University. As a result, there is now a substantial amount of research underway, focusing on regional trade and multilateral agreements involving Southern Africa.

This institutional model -- by which GTAP staff hook up funding agencies with data base experts in order to facilitate the extension of the GTAP data base to new countries -- appears to be becoming increasingly common. These initiatives are typically fueled by interest in getting these countries involved in trade negotiations. Discussions are underway to undertake similar projects for Albania and five countries in Central America. To date, we have not ruled out extending the data base to countries based on their size, but the issue of how far we should go in extending country coverage needs to be discussed at the board meeting. Should all of these countries be folded into the standard data base? How long will they be retained if the national data bases are not updated? Input from the board on these points would be most welcome.

In addition to the challenges of extending regional coverage, and keeping it up-to-date, we also face increasing problems of inadequate sectoral disaggregation in the source databases. This has been exacerbated by the further disaggregation of food and agricultural sectors in version 4, and of services in version 5. For example, it is not uncommon for individual IO tables to have only one aggregated agricultural sector and one food processing sector. Yet the v.5 GTAP data base has 20 farm and food sectors! In order to reduce this barrier to the contribution of new data bases, we have taken a more active role in the disaggregation of these sectors. Agricultural disaggregation has been supported by the work of Everett Peterson, at VPI University who has combined the FAO data with supplementary price information and detailed input-output relationships from some countries, in order to create a country-level data base containing targets for agricultural disaggregation in version 5.

While the disaggregation is most severe in agriculture, it also crops up in other cases. When no other information is available, our default option is typically to use a worldwide representative IO table developed as the simple summation of the set of IO tables for which full sectoral detail was available. Wherever autos and parts, electronic equipment, or services need to be split, this representative table is used. As users of this data base, you need to be aware of these limitations. In particular, if you are looking at the auto industry in one of these regions — say Canada — the trade and protection data will be authentic, 1997 information. However, the structure of production, intermediate usage, and consumption will be derived from the representative table, subject of course to control totals for the relevant cells within the aggregated transport equipment sector. Thus, if you are working on a specific country, it is important to refer back to the basic IO table documentation on the GTAP web site to see if these were disaggregated in the original data base.

*Data base quality:* In accordance with the 2001/2002 objectives established at last year's board meeting, we have focused increased attention on the issue of data base quality — particularly quality of the individual country data bases. We have made considerable progress in this regard, although more remains to be done. Firstly, all of the contributed tables are now scrutinized by a single individual, Terrie Walmsley, who puts all of the IO tables through a common set of checks and compares them to a reference table. (See Chapter 11.A in the GTAP v.5 documentation for more details on this process.) Secondly, Robert McDougall has now developed an entropy-theoretic procedure for evaluating how much the contributed IO tables change when incorporated into GTAP. For your convenience, I have excerpted one of the tables from Robert McDougall's chapter on the fitting of the regional data bases to GTAP targets. Table 19.4 reports, in descending order, the entropy measure of change in the original IO table as a result of the FIT procedures. Not surprisingly, many of the tables requiring the greatest changes correspond to composite regions, such as "Other Southern Africa". Others are *entrepot* economies such as The Netherlands, Singapore and Hong Kong, for which estimated trade flows likely differ by a wide margin due to re-exports (we only attempt to correct for this in the case of Hong Kong). In other cases, the high measure of entropy coincides with out-of-date and potentially problematic IO tables (e.g., Malaysia). This kind of analysis should help us in setting priorities for future improvements to the national data bases. For example, the IDE-Japan has provided us with alternative IO tables for Malaysia, Philippines and Thailand. Given the relative high entropy value for the existing data bases, we will definitely want to consider using the new

IO tables in version 6. (There is quite a bit of additional discussion of the problems in fitting regional data bases in Chapter 19 of the data base documentation.)

{Insert Table 19.4 from the doco on the first full page following this point.}

## **Bilateral Trade Data**

*Merchandise trade:* The bilateral merchandise trade data linking the regional databases in GTAP comes from the Statistical Office of the United Nations. These data are ideal for our purposes, but their reliability is questionable. What exporters report as going to importers rarely coincides with importers' documentation of the same transaction. Mark Gehlhar, at ERS/USDA, has developed a set of procedures for reconciling discrepant trade statistics and producing balanced bilateral trade and transport matrices and he is the source of all of these data used in the GTAP data base. In addition to quality control, obtaining all of the trade data from one source assures us of consistency in procedures. Furthermore, as ERS/USDA continues to invest in improvements in these basic procedures, the GTAP data base will be able to capitalize on them. Mark's version 5 work closely parallels that for versions 3 and 4 and his general approach is documented in GTAP Technical Paper #10.

*Trade in Services:* Bilateral trade data for non-factor services present a much more difficult problem and this has been the focus of much of our work over the past two years. Versions 3 and 4 build on data from a variety of international institutions as well as the University of Michigan. In particular, Alan Fox (based on his joint work with Deardorff and Stern for 1990) supplied us with a bilateral matrix which forms the starting point for determining these flows. His data were then modified at Purdue to fit into the GTAP country/commodity concordance, and to match target totals from the IMF. Specifically, a RAS procedure is used in which the Michigan shares provide the starting values. We rely on the individual country IO tables to provide estimates of the composition of total exports and imports of services. Unfortunately not all of these tables apply the same conventions in classifying services. The area of government services trade is particularly weak and our RAS procedure has been problematic in this case. These weaknesses, combined with the likely importance of services in the upcoming WTO2000 negotiations, led us to launch a major initiative on trade in services as part of the version 5 data base.

There are two threads to this trade in services initiative. The first is additional disaggregation, so that the different types of services and different protection regimes can be more readily isolated. In particular, transport services are disaggregated by mode: land, sea and air, and finance, insurance and communications are disaggregated. The second thread involves obtaining improved data on services trade flows. Considerable progress was made by Wusheng Yu, during a short internship at the WTO in the fall of 1998. Under the direction of Mukela Luanga and Robert McDougall, he managed to assemble most of the publicly available information on bilateral trade flows of non-factor services. Robert McDougall has developed on a methodology (presented at last year's conference) for estimating the missing flows in this matrix, and reconciling the discrepant bilateral information. Unfortunately that work has proven

more problematic than anticipated, and Robert has been diverted by other data base problems. As a consequence, *the version 5 data will not contain outside information on bilateral flows.*

In general, the area of services trade and investment remains a difficult one for GTAP. Basically GTAP does not originate data, rather we establish standards that facilitate applied general equilibrium modeling of trade, resource and environmental policies, and then seek to assemble and modify existing data to meet these standards. Where uniform data have not existed (e.g., energy prices), we have occasionally been able to obtain outside funding to hire someone to do the job for us. Unfortunately in the services area the data often do not exist. This puts us in difficult situation, which is why progress has been so slow. We certainly need to discuss what can reasonably be accomplished in the services area and set appropriate goals for the coming year. This is an area where input from the board will once again be critical.

*Transport margins:* With the additional detail on transport services, we have been able to disaggregate the international transport margins by mode as well. This requires a new piece of data: VTWR(m,i,r,s) which corresponds to the amount of margins services of type m used to transport commodity i from region r to region s. These data are inferred based on commodity-specific modal shares (e.g., 80% by sea, 15% by air and 5 % other modes for commodity X) taken from US statistics, as provided by Mark Gehlhar. It would be very good if we could supplement this with data from other countries' trade in version 6. *Your suggestions on sources for such estimates would be greatly appreciated.* Are these data available for the EU? How about Japan?

## **Protection Data**

*Merchandise tariffs:* In spite of the large amount of time and energy already invested in this area, we are still looking forward to improvements in the tariff data base. The joint World Bank/UNCTAD effort to develop a protection data base and software interface (nicknamed "WITS") for accessing current merchandise tariff information which was reported on at the 2001 board meeting is now being used on a regular basis by those agencies. Betina Dimaranan and Alejandro Nin have compiled an extensive comparison of the WITS data base, with preferences, and the GTAP v.5 data base. Board members with an interest in this work should contact Will Martin or Betina Dimaranan.

In addition to the WITS system, we have recently learned of an important effort underway at the International Trade Center in Geneva, with support from our newest consortium member – CEPII. Nick-named MacMAPS, it seeks to provide detailed protection and trade information to individuals interested in exporting to or from developing countries. In compiling their data base, they have gone to great pains to deal with tariff preferences and antidumping duties. Thus, a GTAP-aggregated version of this data base could be a great asset to those working in trade policy. CEPII and the ITC-Geneva have offered to share the GTAP-aggregated version of their data base with us, for experimental purposes and potentially for incorporation in version 6. This is excellent news, and we look forward to a presentation of MacMAPS by Sebastien Jean of CEPII at the upcoming board meeting.

*Agricultural tariffs:* Due to the prevalence of specific and compound tariffs in agriculture, it is often necessary to draw on supplemental price data to compute *ad valorem* equivalent values for tariffs. This requires special expertise, which has been supplied by Paul Gibson, John Wainio and Daniel Whitley of ERS/USDA. Paul Gibson headed up the consortium of agencies (including three of our consortium members: ERS, OECD, and UNCTAD) involved in developing the Agricultural Market Access Database (AMAD) which is the premier data base in this area. (More information is available at: <http://www.amad.org>.) They contributed tariff data for food and agricultural commodities for all of the major trading partners in the world. These data were used in preference to the data sourced directly from WITS in light of the improved treatment of *ad valorem* equivalents. Where possible, applied rates were used. Where these were not available, bound rates were taken. It will be useful to compare these estimates, used in the version 5 data base, with those from MacMAPS.

*Agricultural Support:* Accurate assessment of the economic effects of agricultural support remains a specialized task requiring careful treatment, lots of data and good judgment. This has become more challenging as countries have sought to “de-couple” their agricultural support by shifting the emphasis from output subsidies to payments based on historical production as well as payments based on planted acreage and livestock numbers. Two of the consortium members – ERS/USDA and the SJFI – have worked extensively on this topic and we have had some lively debates about the treatment of certain controversial policies. As a result, we have adopted a two-track approach, whereby the public version 5 data base contains a relative simple division of agricultural support between output subsidies, intermediate input subsidies, and subsidies to land and capital, based on the OECD’s broad categorization of Producer Subsidy Equivalents (PSEs). Specialized users such as USDA may deviate from these allocations based on detailed knowledge of the programs in question, thereupon stimulating debate and perhaps consensus on future improvements in this relatively simple allocation scheme. So far, there has been lots of debate, but little consensus! This is an area where the agriculture working committee might usefully focus its efforts in the coming year. In order to facilitate further thinking on this topic, we have scheduled a special session with Jesus Anton of the OECD Agriculture Directorate on the day between the board meeting and the conference. Those interested in hearing more about the OECD’s current work on PSE’s and how this is being used in partial equilibrium modeling, are welcome to attend. Please contact Judy Conner for more details.

*Textiles and Apparel Quotas:* The only area in which we have NTB coverage in the version 5 data base has to do with textiles and apparel quotas. The associated quota rents (export tax equivalents) are based on the work of Joseph Francois and Dean Spinanger, drawing in detailed industry data, interviews and observations on quota rents for selected countries. More detail may be found in the version 5 documentation, Chapter 16.F. This remains a controversial area of the protection data base – in part due to the volatility of these quota rents, and in part due to the fact that most of them are unobserved.

*Barriers to Services Trade:* Finally, there is the question of barriers to services trade. These flows are becoming an ever more important feature of global trade. Furthermore, there is a perception that barriers in this sector are much larger than in merchandise trade. Therefore, omission of these barriers in our analyses has severe consequences for the analysis of changes in

allocative efficiency following any simulation that reallocates trade between services and non-services goods. The Productivity Commission, under the leadership of Philippa Dee, in collaboration with Australia National University has a major project in this area. Results are reported at their web site:

<http://www.pc.gov.au/research/memoranda/servicesrestriction/index.html>

At the 2001 board meeting, I raised the question about a possible timetable for bringing these estimates into the GTAP protection module. The feeling seemed to be that we should focus on getting the services trade data in place first, allowing more experimentation with the protection data until a consensus is reached on how best to measure and model these barriers. This seems to be a point that we should revisit each year, so I would like to get your thoughts on this at the upcoming, 2002 board meeting.

### **Energy Volumes Data Base**

Based on funding from the US Department of Energy, we successfully extended the GTAP data base to include volume flows that have been made consistent with the value flows in GTAP. This was a big, multi-year job, since there is no common data source on energy prices, and there are many infeasibilities if one simply applies observed prices to International Energy Agency (IEA) volume flows. In the end, bringing these two data bases together involved addressing many different problems of inconsistency in definitions and measurement. Chapter 17 of the version 5 data base documentation discusses these issues in considerable detail, also providing a comparison of implied prices between version 4E and version 5. From this, you can see that Jean-Marc Burniaux's adjustments in version 5 made a substantial improvement in the quality of the energy data base in GTAP.

The next challenge in the energy area is to develop stronger collaboration with the agencies originating these data. If we operate by analogy with the tariff data – in versions 1 and 2 these were obtained from WTO Trade Policy Review Publications. Then we got the WTO and the World Bank involved in the process of supplying these data directly. Now UNCTAD has gotten involved, which has brought us directly to the source of the tariff data. A lingering question that we should address at the board meeting is: *How can we institutionalize this aspect of the data base?*

### **Development of a Data Base on Land Use and Green House Gases (GHGs)**

One of the important new developments since last year's board meeting was the funding of a three year project on land use and non-CO2 GHGs by the US Environmental Protection Agency. The description of this project is provided in the appendix. It involves close collaboration with John Reilly and his colleagues at MIT, and Roy Darwin and his group at ERS/USDA, in order to develop a global data base on land use and associated net emissions of GHGs. Jean-Marc Burniaux is currently developing a proto-type extension of the GTAP-E model that incorporates alternative uses of land, and associated changes in net emissions, based on a highly stylized data base. We are in the process of hiring a post-doctoral researcher to work closely with MIT on estimating net emissions, and with ERS/USDA on land use, to take this beyond the prototype level and make the data base it available to researchers working on integrated assessments of climate change policy. A workshop, designed to solicit input from

experts in this field, will be held at MIT in September. There will be a short presentation on this project and some illustrative findings from the prototype model at the board meeting in Taipei.

### **Income Distribution and Poverty**

From its inception, GTAP-based analyses have tended to focus on the *inter*-regional incidence of policies, as opposed to the *intra*-regional incidence. This is clearly the comparative advantage of a multi-region, global model. However, as GTAP becomes more widely used, the pressure to say something about the distributional impacts of trade policies within countries – especially the developing countries – is becoming ever stronger. This has clearly been the case at conferences focusing on the new WTO round, and it is coming up in the context of national and regional trade policy liberalization as well. This is first and foremost a problem of data – how do we come up with information on expenditure and factor earnings profiles for disaggregate groups of households when we are struggling to simply put together a national data base for many countries? Can we bring the same network externalities to bear in this area, as have worked so successfully in the area of national IO tables? Can we establish a standard format for the submission of national household survey data that will permit researchers to say something about the regional or global impacts of multilateral trade policy on poverty? There will be a discussion of possible future directions for GTAP-based analysis of the trade and poverty issue at the upcoming board meeting.

### **Non-land, Primary Factor Usage**

[Unfortunately, there is little to add here at this point. The factor intensities in the model can make a big difference – particularly when one starts taking an interest in distributional issues. I will simply repeat the summary from last year's background document, along with a plea for more work in this area.]

This area of the data base has been dormant for the past three years. Version 4 incorporated the skilled/unskilled labor splits developed by Jing Liu and Nico van Leeuwen based on data from a sample of 14 countries. We have had surprisingly few complaints about these splits, but this is probably largely due to a lack of scrutiny. Much like the energy area, this is a feature of the data base where a great deal of quantity-based data is available. The International Labor Organization (ILO) maintains a data base reporting the number of workers by sector and skill. However, we do not have price data (wages) to go with this information. There is clearly scope for great improvements in this area, but it will take a special project, such as the US DOE project in the energy area, in order to make further headway.

The other area that was new in version 4 had to do with the introduction of natural resource inputs into the extractive sectors. The current approach to this problem is to determine a share which, when combined with the elasticities of substitution in the model, replicates a target level of supply response (based on estimates in the literature). This is inherently undesirable, as it introduces a model-dependency into the data base. A preferred approach would be to obtain direct estimates of natural resource rents. Some work along these lines has been undertaken by the Environment Department of the World Bank, but once again, a special project will be

required to bring this into the data base. The opportunity for more work is there – it is just a question of competing priorities.

Dividing value-added among the various primary factors of production is the most fundamental problem that we face in the primary factor area. In agriculture, where value-added is particularly volatile, we have taken the approach of relying on econometric studies of the sector. This has the advantage of eliminating the idiosyncrasies of the base year for the domestic data base, but it has the drawback that all agricultural sub-sectors within the economy exhibit the same primary factor intensities. In the case of non-agricultural sectors one of the biggest problems is the treatment of self-employed labor. To the extent that labor payments exclude these workers, then the returns to capital will be over-stated. There is good reason to believe that this measurement error has contributed to an excessive capital intensity of many developing countries' economies in the GTAP data base. Again, there is scope for a special project in this area aimed at straightening this relationship out.

[Note that the household surveys mentioned in the distributional section above may offer one possible solution to the problem of self-employed labor, since they report how many individuals are working in the family-owned enterprise, as well as their characteristics.]

### **Distribution of the GTAP Data Base**

*Products and pricing:* In theory, global welfare would be improved by giving away the data base for free – and better yet, giving away the software needed to build it. However, to date, our proposals to obtain public funds to do this have fallen on deaf ears. Meanwhile, data base sales continue to increase their share of the GTAP budget (now more than 25%). Consortium membership has leveled off in the 17 to 19 member range, while the number of data base users has continued to expand. We plan to maintain the same pricing structure for version 6, as was used for version 5. Note that we offer a very substantial discount to academic users. In addition, we sell an aggregation-constrained version of the GTAP data base for half the price of the full data base. This is particularly well-suited to students and faculty interested in small-dimensional applications. If they decide later on that they want the full data base, they can upgrade by paying the balance and receiving a license file that releases their aggregation constraint.

	<b>Version 5</b>
Government/Private sector	\$4000
Upgrade	\$2500
Multiple Academic users	\$1500
Upgrade	\$800
Single academic user	\$800
Upgrade	\$400

*Prerelease access:* We generally remind board members once a year about the restrictions on our prerelease policies. Our main goal with the prerelease has been to attempt to identify any mistakes or peculiarities in the data base before it gets wider distribution. A side benefit to the Consortium members is the early access to a new data base release. In this context, it is very important to avoid sharing the prerelease data with researchers outside of the

Consortium members' immediate organizations. Such sharing poses two problems. First, it makes it more difficult to keep control of the prerelease as a preliminary product to be substituted with the final release as soon as it is available. A second problem with leaks of the prerelease data is that it risks diluting the benefits to of joining the GTAP consortium. The GTAP policy on this is:

“that the prerelease data be *restricted* to use within the funding agency. In cases where joint work is under way with individuals outside the Consortium agency, please contact GTAP first before proceeding to share the prerelease data with the outside collaborators.”

## MODEL DEVELOPMENT

The basic philosophy behind GTAP is “one data base -- many models”. Therefore, model development has naturally played a lesser role at the board meetings. Since many board members have their own models that utilize the GTAP data base, there is little need to agree on a common model structure. However, we do seek to provide a standard model with a suite of extensions. We also find that we cannot effectively contemplate data base extensions without having a proto-type model in hand with which to evaluate the trade-offs involved in this kind of exercise. Hence the need for the GTAP-E model, in conjunction with the energy data base project, as well as the new prototype model, developed in conjunction with the US-EPA project on land use and net GHG emissions. More generally, we have found that it is important to involve Center staff in a combination of modeling and data base activities as a way of preserving balance, retaining perspective on the data and continuing to attract high caliber individuals to the Project.

This section reports on some of the recent modeling activities that we would like to bring to the attention of the board members.

*Standard model:* The standard model is used by quite a few member agencies, in addition to hundreds of researchers in the broader GTAP network. The most recent TAB file, version 6.1 (released in September, 2001) as well as earlier versions dating back to 1994 (version 2.2a used in the GTAP book), are all available on the GTAP web site, along with documentation of the associated modifications. Version 6 saw some major changes which accommodated the new data structure in the version 5 data base, as well as remedying a number of defects in the earlier model. At this point we do not anticipate changes in this standard model. We also released a new version of the RunGTAP software interface last year which accommodates the new TAB file and data structure. Again, we do not foresee changes in this software in the near future.

Given the large number of GAMS users in the research community using the GTAP model, it is also important to have available a version of the model which is readily accessible to GAMS users. Most of you are aware of the fact that Tom Rutherford has developed a general-purpose model, nick-named “GTAPinGAMS”, that will run on top of the GTAP data base. There are quite a few significant differences between this model and the standard GTAP model. In addition, the data preparation stage for GTAPinGAMS introduces a few more differences. It would be attractive to narrow this gap and permit replication of work using either approach. If

you have a standard version of GTAP implemented in GAMS, please share it with us so that we can evaluate what can be done to make this kind of tool more widely available.

*Parameter estimation and model validation:* As GTAP-based models become more widely used, the issue of model validation has begun rearing its head with greater frequency. With the ready proliferation of different model structures, we need some method of discriminating amongst alternative specifications. Even more basic is the question of parameter values. Are the trade elasticities in the standard GTAP model too large – as the structuralists would have us believe? Or are they too small, as the more market-oriented economists argue? Ultimately this is an empirical issue with which we must come to grips. Given its importance, we have devoted some of our resources at Purdue to this issue.

There are three separate lines of work that we have been engaged in. Firstly, there is a working paper in circulation (Liu, Arndt and Hertel), documenting an attempt at model validation, parameter estimation and hypothesis testing using a modified GTAP model. We have also re-estimated the elasticities of substitution among imports using one of David Hummels' econometric models of trade elasticities at the disaggregated, GTAP commodity level. It is likely that we will use these parameters in the version 6 data base – or at least offer them as an alternative. Finally, we have continued with our work involving international cross-section estimation of consumer demand. We expect this work to provide us with a new set of consumer demand elasticities for the version 6 data base.

Other consortium members have also been working in the area of model validation and parameter estimation, and we have set aside a specific time slot in the board meeting to discuss this issue. In addition, we will hear from Renger van Nieuwkoop about a proposal to create an open-source data base on elasticities for use in CGE modeling.

*Dynamic GTAP model:* This model, developed by Elena Ianchoichina and Robert McDougall, emphasizes international capital mobility and tracking cross-country ownership of assets. It is now being used by a number of researchers for specific policy applications. Most of these individuals have been involved in some way with the model's development, or they attended the dynamic modeling course offered in the fall of 2000. We are aware that there is a substantial demand among a broader audience for this model. However, supporting a dynamic model is much more costly than supporting a static model, and we do not currently have the personnel to go to this next level. However, we hope to do so in the future, and this will factor into our staffing plans.

In the meantime, we are focusing our efforts on developing a shared, baseline data base, which can be used by consortium members for their own dynamic modeling work. We have been discussing this "GTAP baseline" at the past two board meetings, and we will do so again this year. This work, led by Terrie Walmsley, is steadily progressing, and it is being used more and more widely. We need continued input from the board in order to ensure that this is useful to those who have a requirement for a baseline, and also to ensure that we are capitalizing on all available inputs.

## **ANNUAL CONFERENCE ON GLOBAL ECONOMIC ANALYSIS**

As noted previously, the Fourth Annual Conference was a success and preparations for the Fifth Annual Conference on Global Economic Analysis are nearly complete. It is due to take place immediately following the board meeting, June 5-7 in Taiwan. Professor Chung-Huang Huang has done an outstanding job promoting this conference, as he now expects 250 participants. Professor Huang will give us a briefing on this conference at the board meeting.

The Sixth Annual conference will be hosted by the CPB, the LEI and Erasmus University, in The Hague, in June of 2003. The board has already approved this proposal, and we have asked for a presentation of more specific plans at the upcoming board meeting. Please come prepared to share your ideas on this annual event.

## **WEB SITE DEVELOPMENT**

The GTAP Web site is our most important window to the outside world. Under the leadership of Melanie Bacou, we released a totally new web site in 2001 which has taken on an even more significant role in our activities. We will distribute statistics related to the web site at the board meeting, for those who would like more detail. The statistics are remarkably stable across months. In brief, the number of (non-Purdue) hits per month is typically around 55,000, with about 6,700 visits and 3,100 unique IP addresses (presumably unique people). This represents a very substantial, sustained level of activity. There are now about 1,500 “members” of the network, as measured by the number of profiles on the GTAP web site. About half of these have attended a course or conference or have purchased the data base. The others are “volunteers” who have simply taken the time to establish a profile on the web site out of interest in this area of work.

The web site has played a particularly important role in facilitating the last two annual conferences, which have been managed almost entirely via the web-driven data bases, including: submission and review of papers, management of the review process and final decisions, registration, etc. Having done this all the “old-fashioned” e-mail way, I can attest to the efficiency gains of this new approach. However, this does entail a substantial commitment of consortium resources to maintain this level of web support. I’ve asked Melanie to provide a summary of effort involved in supporting the annual conference. I have no doubt that this is a worthwhile investment, but it is important for you to know how your money is being spent!

## **FUNDING AND STAFFING OF GTAP ACTIVITIES**

To be distributed at the board meeting, along with a budget.

## **GOALS FOR THE COMING YEAR**

To be developed at the board meeting.

## **NOMINATIONS FOR RESEARCH FELLOWS**

When the honor of GTAP Research Fellow was created in 1996, we did not think about a specific term for this appointment. Two years ago, the decision was made to make these appointments valid for three years. And at last year's meeting, we decided to begin implementing this rule in 2002. So this year, we must revisit all of the individuals selected over the period: 1996-1999. Please consider whom you would like to re-nominate from this group. In addition, please submit your nominations of deserving individuals whom you think exhibit the kind of capabilities and commitment to excellence in global economic analysis that warrant this honor. To do so, simply submit their name, a brief statement of why you think they are appropriate, and their CV in advance of the board meeting. It would be best if these nominations were made in advance of the meeting, so that we can have the necessary background materials on hand for the board's consideration.

## **APPENDIX 1**

### **SYNOPSIS OF LAST YEAR'S (2001) GTAP ADVISORY BOARD MEETING**

**This year we have made this available on the web site. You may find the associated files by visiting the following URL:**

**[http://www.agecon.purdue.edu/gtap/events/board\\_meetings/2001/default.asp](http://www.agecon.purdue.edu/gtap/events/board_meetings/2001/default.asp)**

## APPENDIX 2: Working Committees

Committee Name	Chairperson	GTAP Center	Terms of Reference
Services	Philippa Dee	Robert McDougall, with input from Joseph Francois	<ol style="list-style-type: none"> <li>1. Oversee assembly of Services data on GTAP web site.</li> <li>2. Evaluate alternative measures of protection.</li> <li>3. Possibly organize a special session at the Fifth Annual Conference in Taiwan.</li> </ol>
Technical Barriers to Trade	Frank van Tongeren	Thomas Hertel	<ol style="list-style-type: none"> <li>1. Explore the possibility of using the Hummels method to identifying ad valorem tariff equivalents associated with TBTs.</li> <li>2. Try to identify a graduate student or other researcher to implement this scheme on a prototype basis.</li> </ol>
Agricultural Support	Soren Frandsen	Betina Dimaranan	<ol style="list-style-type: none"> <li>1. Collect feedback on the treatment of agricultural support in the version 5 data base.</li> <li>2. Explore alternative approaches to the measurement and incorporation of domestic support in the data base.</li> <li>3. Identify links with primary factor splits in agriculture</li> <li>4. Propose a “patch” to version 5 designed to improve on this aspect of the data base.</li> </ol>
UN-SNA	Sherman Robinson	Channing Arndt	<ol style="list-style-type: none"> <li>1. Explore possible links with the UN Statistical Office.</li> <li>2. Advise GTAP staff on SNA guidelines that will improve quality of country submissions.</li> </ol>
Russia/Eastern Europe	Robert Koopman	Robert McDougall	<ol style="list-style-type: none"> <li>1. Initiate contacts with potential data base contributors for this region.</li> <li>2. Explore funding possibilities with the US Dept. of Commerce for work on Eastern Europe</li> <li>3. Encourage increased collaboration in region.</li> </ol>
Baseline	Dominique van der Mensbrugge	Terrie Walmsley	<ol style="list-style-type: none"> <li>1. Update material presented by Terrie at 2001 board meeting to reflect most recent GEP forecasts.</li> <li>2. Update baseline to reflect version 5 data base.</li> <li>3. Post revised baseline inputs on web site for 211 countries and 66</li> </ol>

			GTAP regions.
Energy	John Reilly	Jean-Marc Burniaux	<ol style="list-style-type: none"> <li>1. Evaluate version 5 data base with respect to energy quality.</li> <li>2. Explore links with IEA and US DOE for future supply of volume and price data.</li> </ol>
Primary Factor Splits	Member from CPB	Thomas Hertel	<ol style="list-style-type: none"> <li>1. Explore possibilities for removing self-employed labor payments from capital in contributed data bases.</li> <li>2. Explore possibilities for improving the skilled/unskilled split within labor payments.</li> </ol>
Open-sourcing	Thomas Hertel		<ol style="list-style-type: none"> <li>1. Work with GTAP board to identify potential funding sources for the open-source/free data idea.</li> </ol>

**APPENDIX 3: EPA PROJECT ON INTEGRATED ASSESSMENT OF CLIMATE  
CHANGE POLICY**

**Workplan Narrative**

*Towards an Integrated Data Base for Assessing the Potential for GHG mitigation.*

*A Proposal to the Methane and Sequestration Branch of the US Environmental Protection  
Agency (EPA).*

*Principal Investigator:  
Thomas Hertel, Purdue University*

*Co-Investigators:  
Jean-Marc Burniaux, Purdue University and OECD  
John Reilly, MIT*

*January, 2002*

## ***Towards an Integrated Data Base for Assessing the Potential for GHG mitigation.***

### *Abstract*

Many economic analyses of climate policy use applied general equilibrium (AGE) models of the world economy to track emissions of greenhouse gases and to evaluate costs of climate policies. AGE models have many advantages compared with other modeling approaches because they account for broad sectoral interactions and international trade effects. They also allow calculation of costs in terms of the theoretically preferred equivalent variation measure of welfare. The major drawback in using AGE models is that the data demands are substantial in several ways. They require: (1) full social accounting matrices with input-output tables (2) world-wide data coverage with adequate sectoral and regional disaggregation (3) regular updating of these data because structural changes (e.g. the collapse of the FSU, reconfiguration of Germany and Eastern Europe, greater integration of an European Common Market, the rapidly developing market economy of China) can mean an older base year data set will not reflect recent history (4) physical measures for key inputs and outputs in the economy so that results can be integrated with other integrated assessment model components (e.g., terrestrial ecosystem models, atmospheric chemistry and climate models).

The Global Trade Analysis Project (GTAP) has filled an important need in the integrated assessment community by providing regular updates of a world-wide data set with significant disaggregation of regions and sectors, including (beginning with GTAP version 4E) supplementary data on physical flows of energy. This proposal will further extend this database with the aim of filling the existing information gap with regard to the link between changes in land use and changes in net Green House Gas (GHG) emissions from agriculture and forestry. The coverage of this extended database involves all GHGs from all major sources, with a special focus on GHG emissions related to land-use and cultivation practice changes in agriculture and forestry. The project will also identify a methodological approach to integrate GHGs emissions from agricultural and forestry activities into a modified version of the standard GTAP model, while representing the range of alternative technological options that are or will become available to reduce these emissions in order to provide an aggregate assessment of their mitigation costs.

So far, lack of data on land use and related net GHG emissions has restricted study of GHG mitigation policies. The proposed project would remedy this gap. These supplemental data will be an essential component of integrated assessment activities that seek to evaluate the economic implications of managing carbon beyond simply examining emissions reductions. Such economic data and the analyses it facilitates are highly complementary to recent long terms plans for carbon cycle analysis (Sarmiento and Wofsy, 1999; Rosenberg, et al. 1999; US DOE, 1999).

The supplemental data will be fully documented and made publicly available in order to promote dialogue among users within the integrated assessment community and with experts on land use who can improve the quality of the data. This will ensure that these data can be updated when future GTAP updates are conducted. As more special and supplementary components of GTAP become available, creating data that can be easily and regularly updated becomes ever more important if the update task is to remain feasible within the resource limits of the GTAP consortium.

## I. Background

As the world economy becomes more integrated, the demand for quantitative economic analysis of global problems and policies is increasing dramatically. A key area in which global economic policies have assumed prominence on the world stage derives from efforts to mitigate climate change under the Framework Convention on Climate Change Policies (FCCC). Deliberations over such policies have generated demand for formal assessments of the international economic impact of alternative emission abatement schemes. Just a few examples of international trade issues that arise in climate change analysis include spill-over effects of domestic policies internationally, leakage of carbon due to relocation of industry, effects of mitigation policies on competitiveness, shifting comparative advantage among regions due to the impacts of climate change, and the effects of introducing a new international market for tradable permits in greenhouse gas emissions (Weyant, J (ed.), 1999; Babiker, and Jacoby, 1999; Babiker, Reilly, and Jacoby, 2000; Babiker, Bautista, Jacoby, and Reilly, 2000; Burniaux and O'Brien, 1999). Recent policy discussions have focused on the importance of forest and agricultural sinks for carbon dioxide.

Analysis of the international economic implications of the FCCC policies is a demanding task. Due to the importance of domestic and international spill-over effects, climate change policy analysis has required development of models with: (a) worldwide coverage, (b) adequate sectoral and regional disaggregation, (c) appropriate representation of international trade and capital linkages. Models that best meet these requirements are world Applied General Equilibrium (AGE) models. Such models are data intensive; they are based on a full representation of the world economy in a particular base year, including disaggregated bilateral trade flows and Social Accounting Matrices (SAMs). It is also important that these data be regularly updated, due to the importance of structural changes such as the collapse of the Former Soviet Union, the reconfiguration of Germany and Eastern Europe, and the rapid economic growth in China.

In the past few years, the Global Trade Analysis Project (GTAP) has filled an important need in the integrated assessment community by providing regular updates of a world-wide data set with significant disaggregation of sectors and regions, including (beginning with version 4E) supplementary data on physical flows of energy. GTAP is an academic-based, publicly supported project, housed in the Center for Global Trade Analysis at Purdue University. The goal of GTAP is to improve the quality of quantitative analysis of global economic issues in an economy-wide framework (<http://www.gtap.org>). The centerpiece of this project is a global data base describing bilateral trade patterns, production, consumption and intermediate use of commodities and services. Version 4, released the fall of 1998, disaggregates world output into 45 regions and 50 sectors. The version 4 data base was supplemented with energy volume and price data. The resulting combined data base, called "4E" has been widely used in climate change analysis in the past two years (visit <http://www.gtap.org> and select "Data bases | Special Project"). The Version 5 data base extends this coverage to 65 regions and 57 sectors and incorporates updated energy volume and price information from the International Energy Agency. This is an excellent example of the potential long-term benefits of enhancing the GTAP data base for climate change policy analysis.

The number of users of the GTAP data base now exceeds 400 individuals in 40 countries (visit <http://www.gtap.org> and select “People”). The widespread use of GTAP is evidenced by the 375 applications listed on the GTAP web site. Core funding for GTAP comes from a consortium of seventeen national and international agencies. Additional support comes from the sale of the data base as well as from grants and training courses in global economic analysis. These funds support the maintenance of a core data base of international trade, protection, production and consumption which is widely used in the quantitative analysis of global economic issues.

Since its inception in 1993, GTAP has rapidly become a common “language” for many of those conducting global economic analysis. Indeed, GTAP-based analysis has assumed considerable prominence in recent meetings of the Intergovernmental Panel on Climate Change (IPCC). For example, at the June 1999 expert meeting of Working Group III in The Hague, four of the key analytical groups drew on the GTAP data base (Bernstein, Montgomery and Rutherford, 1999; McKibbin, Ross, Shackleton, and Wilcoxon, 1999; Bollen, Manders, and Timmer, 1999; Babiker and Jacoby, 1999). Since then, use of GTAP for climate change modeling has exploded. The upcoming GTAP-sponsored Fourth Annual Conference on Global Economic Analysis to be held at Purdue University has attracted sixteen papers on the topic of climate change from authors in China, Japan, Germany, Finland, France, The Netherlands, Norway, Spain, Taiwan, Turkey, and the US. (See appendix for a listing of these papers, authors and affiliations.)

## **II. Motivation**

Most of the AGE-based analysis referred to above focuses on the quantification of economic costs of implementing the climate change policies as well as the impact of the three so-called “flexibility mechanisms” (see Weyant and Hill, 1999; Burniaux and O’Brien, 1999). However, most of these studies only consider carbon dioxide emissions. A few studies have attempted to extend the cost analysis of climate policies to non-CO<sub>2</sub> gases (see Brown et al., 1999; Reilly et al., 1999; Burniaux, 2000) and to forest sinks (Reilly et al., 1999). However, information about the costs of reducing the non-CO<sub>2</sub> emissions as well as the cost of inducing carbon sinks by reducing the net-emissions from land-use changes remains much more limited and what exists is rarely in agreement. An important part of these divergences arises from the large uncertainty about the magnitude of net GHG emissions from agricultural and forestry activities. Furthermore, when information about net emissions from land-use changes exists (see, for instance, Houghton, 1999; B.A. McCarl, 1998), it is not readily available in a format that economic modelers can incorporate into their AGE models.

This proposal is motivated by this information gap – particularly with regard to the link between changes in land use and changes in net emissions from agriculture and forestry. It aims to provide a data base infrastructure which will assist the integrated assessment community in remedying this gap.

The coverage of this project involves all GHG from all major sources, with a special focus on GHG emissions related to land-use and practice changes in agriculture and forestry. The project will also identify a methodological approach to integrate GHG emissions from

agricultural and forestry activities into AGE models and to represent the range of alternative technological options that are, or will become, available to reduce these emissions in order to provide an aggregate assessment of their mitigation costs. This would extend the inventory methods developed at MIT (Babiker, et al., 2001, Mayer, et al., 2001) to the GTAP disaggregation supplemented with improved inventories developed by the US EPA (2001a,b,c) and other sources.

The earlier inclusion in GTAP of physical flows on energy was highly successful and has supported studies of CO<sub>2</sub> emissions reductions policies. A further extension of the GTAP data base by incorporating supplemental data set on land uses and net emissions rates is a core component of the proposed project. It is critical in evaluating the economic implications of attempts to mitigate the emissions of GHGs. Such economic data and the analyses it facilitates are highly complementary to recent long terms plans (Sarmiento and Wofsy, 1999; Rosenberg, et al. 1999; US DOE, 1999) for carbon cycle research that stress the physical science research needed.

The supplemental data will be fully documented and made publicly available in order to promote dialogue among users within the integrated assessment community and with experts on land use who can improve the quality of the data. This will ensure that these data can be updated when future GTAP updates are conducted. As more special and supplementary components of GTAP become available, creating data that can be easily and regularly updated becomes ever more important if the update task is to remain feasible within the resource limits of the GTAP consortium.

### **III. Development of a Land-use/Emissions Module**

There are two ways land use can mitigate GHG emissions: i) land can be shifted, e.g., from crops to forestry, thereby resulting in carbon sequestration, or ii) land practices, e.g., tillage options, can be modified so as to lower the release of carbon into the atmosphere. Both changes may have spill-over effects on agricultural practice. This kind of “leakage” effect can be caused, for example, by increasing use of fertilizer in response to higher crop land rents caused by the additional sequestration demand, leading in turn to additional nitrous oxide emissions. In order to capture these effects, it makes sense to consider all activities that compete for land as a whole within an AGE framework. These changes also have dynamic, stock-flow implications as the carbon sequestered in trees or in agricultural land is likely to be released in the atmosphere after a certain period of time.

In the above context, the aim of the land-use modules to make available to economic modelers a set of standardized data that would enable them to take better account of the net GHG emissions from agricultural and forestry activities in their analysis of the strategies to stabilize the earth’s climate. In particular, this framework should help estimating: a) the demographic pressure on agricultural land uses in the baseline scenario; b) the potential for sequestering carbon through induced land changes, and changes in agricultural practices, both over the medium and the longer term; and c) the resulting impact on agricultural and non-agricultural land availability and prices, as well as on agricultural production and prices.

From a methodological point of view, the proposed approach to meet these goals is three-fold. First, it will involve the development of a land-use data base that is compatible with the GTAP economic data base and could be used to support analysis of land-use changes under a baseline as well as alternative scenarios. Second, it will involve the estimation of land-type and product-specific net emission coefficients in order to achieve a comprehensive estimate of the potential of agricultural and forestry activities to mitigate GHGs emissions. Third, it will identify a methodology to incorporate alternative technological options that reduce emissions (such as changes in agricultural practices) into an AGE framework in order to generate an assessment of the costs of GHGs mitigation. We now turn to a more detailed description of these aspects.

### Establishing a land-use data base

Establishing a land-use data base that is compatible with the SAMs used in AGE models involves the estimation of multi-product, multi-land class matrices. These matrices will cover all types of lands used by all economic activities, including agriculture, forestry, industries, residential and recreational lands. Initial work has been undertaken at the USDA Economic Research Service (ERS). The original ERS data base on land use divided the world into 12 geographic regions—the United States, Canada, the European Community (as of 1990), Japan, other East Asia (South Korea and China, including Taiwan and Hong Kong), southeast Asia (Indonesia, Malaysia, Philippines, Singapore, and Thailand), Australia and New Zealand, the former Soviet Union plus Mongolia, eastern and northern Europe plus Greenland, western and southern Asia, Latin America, and Africa. Each region had up to 6 land classes based on length of growing season—the longest continuous period during the year that soil temperature and soil moisture supports crop growth. Length of growing season was calculated in a soil moisture model (Eswaran *et al.*, 1995) that requires mean values of temperature and precipitation for all months (Leemans and Cramer, 1991).

All acreage in each region was allocated to one of four land-use types—cropland, permanent pasture, forest, and other uses, based on 1990 data in the Food and Agriculture Organization of the United Nations (FAO, 1992). Regional land-use acreage was allocated to land classes based on land use and cover data in Olson (1989-91). Irrigated acreage (FAO, 1992) was distributed to the land classes based on irrigated land data in Wilson and Henderson-Sellers (1985), crops and settlements data in Olson (1989-91), and length-of-growing-season data. Water use was from the World Resources Institute (1992). Each land class within a region is associated with the production of a unique set of commodities. Results from regression analyses were used to allocate 1990 crop production (FAO, 1992) to the land classes on a region by region basis. Livestock production for 1990 (FAO, 1992) was distributed among the land classes based on animal densities in Lerner, Matthews, and Fung (1989). Forestry production for 1990 (FAO, 1992) was allocated to land classes based on distributions of coniferous, broadleaf, and mixed forests (Olson, 1989-91).

USDA/ERS is currently revising the land and water resources data base. Data sources include: (1) FAO data on production and land use for 1997; (2) a 0.5 degree lat/long gridded meteorological data set of monthly surface climate extending from 1901 to 1997 over global land

areas (excluding Antarctica) prepared by the University of East Anglia's Climate Research Unit; (3) river basin data derived from a global 30 arc-second elevation data base compiled by the U.S. Geological Survey's Topographic Data group at the EROS Data Center; (4) a 1-km resolution global land cover characteristics data base generated by the U.S. Geological Survey, the University of Nebraska-Lincoln, and the European Commission's Joint Research Centre; and (5) a 1-km resolution LandScan 1998 global population data base from Oak Ridge National Laboratory.

The goal of this project will be to incorporate this new land use data base into the GTAP structure, so it can be readily used for quantitative analysis by the integrated assessment community. In contrast to the earlier work, the 1997 update of the land and water resources data base is being implemented at the country level. This makes it compatible with the GTAP data base, as well as most other international trade modeling data bases. In particular, we will seek to bring it into conformity with open-source standards so that, as new and improved information becomes available, it can be readily incorporated by integrated assessment analysts. The resulting data base should permit integrated assessment analysts to capture all substitution possibilities between forestry land-use on one side and agricultural and non-agricultural land uses, on the other side, within a consistent multi-output/multi-input framework.

### **Estimate land-type and product-specific net emission coefficients**

To make the land-use data base useful to analyze the carbon sequestration issue requires establishing a link between agricultural and forestry activities, alternative land uses and net emission rates. In principle, this involves estimating the net emission rates associated with each land type and use. However, existing models that incorporate carbon sequestration use aggregate carbon absorption curves (or marginal abatement curves) at regional or country levels (see for instance, Reilly et al., 1999; P. Read, 1999). There also exist historical data on the net carbon fluxes from land-use changes with a worldwide coverage and a regional breakdown (Houghton, 1998) as well as various studies that provide more or less disaggregate estimates of the potential for carbon sequestration in forests both worldwide or for the US. Some of these potential estimates consider costs (for instance, McCarl, 1998; Stavins, 1999; Sedjo and Sohngen, 2000), other not (Nilsson and Schopfhauser, 1995). Similar data also exist for the net emissions and abatement costs of non-CO<sub>2</sub> gases in agriculture (methane from enteric fermentation and manure management of livestock, methane from rice cultivation and nitrous oxide from fertilizer use).

This part of the project will involve collecting and comparing the available information and, to the greatest possible extent, making it compatible with the multi-input/multi-output framework described above. It will involve a preliminary review (see below) of the resources that are available in existing integrated assessment and carbon cycle models, data base as well as in the literature and to identify a methodology that allows making this information compatible with the land-use model. Due to the heterogeneity of the available information, this methodology will necessarily rely on judgment, sensitivity analysis of alternative assumptions and calibration methods, possibly involving the generalization of parameters observed in some countries to countries/regions for which no information is available. The coverage will include carbon sequestration activities as well as abatement of the main sources of GHGs emissions.

## **Incorporating alternative technological options**

The investigators on this project have considerable experience characterizing the abatement possibilities for CO<sub>2</sub> from fossil fuel burning (e.g., Burniaux and O'Brien, 1999). These possibilities are restricted to substitution between fuels, production factors and products. The analogous problem is much less straightforward for GHGs, where the sources for potential abatement may involve substitution between a wide range of alternative technologies<sup>1</sup>. It is impossible – and not desirable – to introduce all engineering information about these technologies into an aggregate world AGE model. Therefore, one of the aims of the proposed project will be to identify a commonly accepted methodology for integrating engineering information into global economic models by using reduced-form response functions<sup>2</sup> and the data that need to be collected in order to parameterize these functions. Hyman (2001) has developed an approach for compactly integrating control costs of these substances into an AGE model that captures the overall cost implications of abatement developed in technologically rich models without the need to explicitly treat the technologies. This has been applied in the MIT EPPA model (Reilly et al., 2001) successfully. Further development of these methods will proceed at MIT and, we would expect to develop a GTAP technical paper describing the application of these methods to the GTAP modeling framework.

### *IV. Workshops*

Development and evaluation of the land-use/emissions module will be greatly facilitated by the use of workshops, organized by the project PI's. These workshops will bring together policy makers, economists and data base experts in Geographic Information Systems, agricultural and forestry production data bases and terrestrial ecosystem data bases.

An initial workshop will be held with the purpose of identifying key information requirements for policy analysis, offer an inventory of existing data sources, and propose a modeling approach that will best meet the policy information needs based on existing data availability, while leaving the opportunity for incorporating data that might become available in the future. It will combine expertise from staff developing the climatically defined data on land use and model climate change impacts (Darwin, Tsigas, Lewandrowski, and Raneses, 1995, Darwin, Tsigas, Lewandrowski, and Ranesesm 1996; Darwin and Tol, 1998; Darwin, 1999), analysts at MIT with expertise in greenhouse gas emissions and climate change mitigation modeling (Reilly, Prinn, Harnisch, Fitzmaurice, Jacoby, Kicklighter, Melillo, Stone, Sokolov, and Wang, 1998), and the Marine Biological Laboratory (MBL) who have expertise in terrestrial ecosystem modeling (Tian, Melillo, Kicklighter, McGuire, and Helfrich, 2000). The workshop would seek participation from organizations such as the Food and Agriculture Organization (FAO), the Australian Bureau of Agricultural and Resource Economics (ABARE), the Electric Power Research Institute (EPRI), the World Bank, and other economists and scientists working

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<sup>1</sup> For instance, methane emitted by cattle manure can be recovered in covered lagoon systems and used to power a on-farm electricity generator. The recovery can be improved by using digesters that enhance the anaerobic decomposition of manure. The practice of conservation tillage in land management also reduces the amount of CO<sub>2</sub> that is released in the atmosphere by agricultural lands.

<sup>2</sup> See Burniaux, 2000 for an example of such approach.

on global change.

The basic format of the workshop will be to lay out the specific approaches and data sets that will be used in the GTAP project (or at least that we propose to use at this time). Sequential sessions will provide ample time for presentation and discussion of the details, methods, requirements, limitations, and applicability of the data and methods to the analysis tasks we imagine will be conducted with this expanded data and modeling capability. Invitees are people who have themselves made significant contributions to the area of land use/greenhouse gas emissions modeling and have a similar interest of the GTAP project—i.e. of developing a global modeling capability with links between physical and economic data/models. The guidance, ideas, suggestions, and comments of all participants are eagerly sought. As potential or likely users of the data/modeling system or developers of data needed for the project we need practical suggestions on how to make this as useful as possible, and how best to incorporate and use existing data. We intend to keep the meeting to no more than 20 so that the discussion can be fruitful and focused.

A follow-up workshop will be held in the third year of this project at which the completed data base will be presented, coupled with a set of applications based on this work. In addition, we plan to organize special sessions each year at the Annual Conference on Global Economic Analysis. This international conference typically attracts 100 participants and about 60 papers are presented. It was held in Denmark in 1999, Australia in 2000, Purdue in 2001. (select Events|Conferences on <http://www.gtap.org>). Locations for upcoming conferences are as follows: 2002 – Taiwan, 2003 – Europe, 2004 USA.

## ***VI. Implementation and Evaluation Plan***

The proposed project would run for three years. Table 1 lists the goals for each year of the project.

***Table 1. Evaluation Milestones  
Year 1: 2002***

<b>1.1</b>	Develop a framework for bringing GHGs and sequestration into a global AGE model
<b>1.2</b>	Conduct an inventory of existing data on GHG emissions
<b>1.3</b>	Design a land-use module that will link existing land-use data bases to present and future versions of the GTAP global economic data base
<b>1.4</b>	Initial workshop at which key groups will present their current analyses relating to climatically defined data on land use and net emissions
<b>1.5</b>	Finalize design of data base on net emissions

### ***Phase II: 2002-3***

<b>2.1</b>	Release pilot version of the land use data base
<b>2.2</b>	Release pilot version of the net emissions data base
<b>2.3</b>	Preliminary applications of data base are circulated for discussion and review
<b>2.4</b>	Organize a session at the June 2003 Conference on Global Economic Analysis in Europe

	at which preliminary work will be reported and additional feedback will be solicited
Phase III: 2003-4	
3.1	Finalize land use data base and make it available via the GTAP web site
3.2	Finalize net emissions data base and make it available via the GTAP web site
3.3	Final workshop at which key groups will present their work based on the climatically defined data on land use
3.4	Finalize documentation for project and publish this on the web, as well as in a special edition of the GTAP documentation

## VII. Management

The project will be managed through the Center for Global Trade Analysis at Purdue University, with oversight from Dr. Thomas Hertel, the Center's Director. Also at Purdue University will be Dr. Jean-Marc Burniaux, the lead co-investigator. Dr. John Reilly, from MIT, also will be a co-investigator providing in-kind contributions to the project.

## VIII. Summary

In summary, the proposed project would build on an existing effort, namely the Global Trade Analysis Project, which currently supplies a vital input into much of the contemporary analysis of climate change policy. On the basis of network economies, the pool of GTAP users has grown rapidly over the past decade. With each additional individual who becomes fluent in this new language, the virtual network of users becomes more valuable to existing members. This positive feedback has fueled extraordinary growth, and the network is now reaching a point at which new challenges are emerging. These issues can only be satisfactorily resolved by making the data base publicly available and fully documented, thereby enhancing the empirical foundations of the associated environmental-economic models

Upon completion of this project, individuals anywhere in the world will be able to access the land-use data base via the web, replicate the work of others, and extend it as appropriate for the analysis of specific aspects of climate change policy. The potential for positive feedback on future development of the data base is enormous, since the further development of this land-use module will be possible anywhere in the world. If funded, this project would result in a tool that will enhance the productivity of existing analytical groups working on climate change policy, and lay the foundation for more credible analyses of links between economic activity, land-use and global carbon management.

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**APPENDIX 4: 2000-2001 BUDGET**  
(To be distributed at the board meeting.)