A Comparison of the Environmental Impacts of Trade versus Domestic Distortions in the United States

By

Jared Creason, EPA, NCEE*
Michael Fisher, Abt Associates
Svetlana Semenova, Abt Associates
Susan F. Stone, EPA, NCEE*

Prepared for the

7th Annual Conference on Global Economic Analysis: Trade, Poverty and the Environment
Washington DC, USA
17-19 June 2004

*The views expressed in this paper are the authors and do not necessarily represent those of the U.S. Environmental Protection Agency. In addition, the paper has not been subjected to the Agency's peer and policy review process. No official Agency endorsement should be inferred. The paper is a draft and not for quotation or circulation.

Introduction

Beginning with NAFTA, continuing through Doha and Chile and more recently, the Central American Free Trade Agreement (CAFTA), there has been growing concern in the United States over the possible environmental effects of increasing trade. This concern was explicitly addressed when, in 1999, President Clinton signed Executive Order 13141, committing the United States to undertake formal environmental reviews for all future trade agreements. Since the Order was signed, there have been three completed environmental reviews (for free trade agreements with Chile, Singapore and Jordan) and there are currently four interim reviews pending completion (Australia, Morocco, CAFTA and Bahrain).

The effect of trade on the environment is the subject of a growing literature. Trade-induced environmental changes can be traced through changes in transportation, changes in income and growth, and changes in industry location and composition. The sovereignty of domestic regulation with respect to international agreements and commitments has been of particular concern to policy makers. There as yet is no consensus view on how these issues play out both within a country or between countries.

There are a number of empirical studies of the effect of trade on the environment. Many of these studies investigate the Environmental Kuznets Curve, the idea that economic growth and environmental quality are linked in a predictable way. Other studies take the approach of dividing potential effects of trade on the environment into three categories: scale, composition and technique (Grossman and Krueger 1993). Antweiler, Copeland and Taylor (ACT, 2001), investigate the relative contribution of each of these effects by modeling how openness to international trade affects sulfur dioxide (SO_2) concentrations. The scale effect predicts any economic expansion due to an increase in trade will increase pollution because, all things equal, more output means more pollution. Thus trade may increase levels of pollution in a country. However, trade does not effect all industries the same; some will experience a rise in output, others a fall. This compositional effect reduces pollution if the output from ‘dirty’ industries falls while the output from ‘clean’ industries expands. Finally, increases in output that come from advances in technique are usually associated with decreases in pollution, as ‘modern’ methods of production tend to be cleaner. However, technique can also have a negative impact on pollution. Capital-intensive industries are often associated with large pollution emissions, so that increases in capital-intensive industries will raise pollution level. Which effect ultimately dominates is an empirical question.

ACT (2001) conclude that freer trade is good for the environment. They find, overall, little change in SO_2 emissions from changes in the composition of national output. Estimates of trade-induced technique and scale effects imply a net reduction in pollution. ACT estimate that for every 1percent increase in national income resulting from trade liberalization, there is a 0.8 to 0.9 percent reduction in concentrations of SO_2. They also find that income gains brought about by further trade or neutral technical progress tends to lower pollution, whereas income gains from capital accumulation raise pollution. They attribute this to the fact that capital accumulation necessarily favors the production of pollution intensive goods where as neutral technical progress does not.

Using the GTAP model, Tsigas, Gray and Hertel (2002) examine the environmental effects of Western Hemisphere trade liberalization scenarios. They argue that there are 4 mechanisms linking trade policy and the environment: 1) international mobility of industry; 2) the changing composition of national output, 3) the intensity of production and 4) changes in consumer demand for environmental goods. Thus, they apply the same basic rationale as ACT (2001) with the added dimension of consumer behaviour. Tsigas, et al. find that liberalization leads to a decline in US environmental quality due to an expansion of pollution. This comes principally from an increase in output from grains, as well as the chemicals and metal manufacturing sectors. However, they find that increases in pollution abatement expenditures offset this increase in emissions leading to an overall improvement in environmental quality.

Frankel and Rose (2003) use the gravity model to estimate the effect of openness on several environmental measures, including particulate matter, SO_2 and nitrogen dioxide (NO_2) as well as estimates of carbon dioxide, deforestation, energy depletion and access to clean water. For all three air measures, the results show that openness reduces pollution. Openness is shown to be beneficial for energy depletion and clean water access, but of ‘borderline’ significance. Outcomes for CO_2 are the exception, showing an increase in emissions associated with openness.

Cooper, Johansson and Peters (2003) look specifically at trade liberalization in agricultural markets. They use a series of models to capture a multilateral trade liberalization scenario where all tariffs and domestic support programs in the agricultural sector are removed. They then examine how these world market changes affect US production and how these changes in production impact environmental outcomes. Specifically, they examine changes in nitrogen, phosphorous and pesticides loss to water; sheet, rill and wind related soil erosion and manure nutrient production. Unlike previous the studies, they then examine how these impacts play out geographically within the United States.

The results of their work show small changes in US output as a result of worldwide agricultural trade liberalization. The exceptions are corn and dairy. These small changes lead to small overall changes in environmental outcomes. However, they did note that there were important regional variations in their model. For example, the northern plains and northeast experience an increase in sheet and rill erosion while other parts of the country see a reduction.

The work presented here picks up on the Cooper, et al. paper by examining how a complete removal of trade barriers would affect environmental outcomes across the US. It also extends Frankel and Rose's work by examining outcomes on a variety of emission types. We attempt to provide some context for a trade liberalization scenario by contrasting those results with outcomes obtained removing domestic distortions. Thus, in the first simulation we remove domestic support (primary and intermediate input subsidies/taxes and output subsidies/taxes), across all 57 sectors and 78 regions reported in the GTAP database V5.4. In the second simulation, we remove all import tariffs and export subsides, again for all sectors and regions reported in GTAP's database. We then take the changes in US output for each sector and use this as an input to the EPA's Trade and Environmental Assessment Model (TEAM).

The TEAM model, which will be described in more detail later in the paper, is designed to estimate a wide range of environmental impacts resulting from national economic changes. The primary inputs to the model are changes in production. The model then uses static emissions baseline data sets to calculate emission factors and generate the projected emissions/resource use changes for each sector and/or facility by US county (Abt 2004).

The two main types of baseline data that are used in TEAM are (1) economic output by sector and county or by individual facility and (2) emissions by county or by facility (depending on data availability). TEAM then combines the economic and emission baseline to determine empirical emission factors for each facility or county and economic sector. TEAM can generate economic sector detail at the 6 or 4 digit NAICS level. The results presented in this paper are at the 6 digit NAICS sector.[1]

The GTAP model (version 6.1) used to generate the changes in economic output, is a comparative-static computable general equilibrium model with price taking behaviour for all economic agents. Commodity supplies are based on single-output production functions. Substitutions between inputs are modeled with two-level nested production functions. Demands for land, labor, and capital are based on constant elasticity of substitution (CES) functions. International trade clears commodity markets with commodities differentiated by place of origin. Trade policies operate as ad valorem distortions.

The government demand system in GTAP is based on a Cobb-Douglas per capita utility function. Thus, government demand is a function of total income, and not related to tax revenues. Thus we are assuming that despite changes in government revenues (taxes and tariffs) and expenditures (subsidies) existing policies, notably existing environmental programs, remain in place. This is, as stated above, a static analysis, thus we are also assuming no changes in production technology. The 78 regions in the database were aggregated to 11: ANZAC, US, China, Rest of NAFTA (NAF), EU, Rest of Europe, Southeast Asia, Rest of East Asia, South Asia, South America, Rest of the Word.[2]

It is difficult to say, *a priori*, how the removal of domestic distortions will impact US environmental outcomes. Removing domestic support will reduce the competitiveness of domestic production where subsidies were present, by raising prices, all else equal. When each region's domestic supports are removed, the ultimate outcome will depend on the relative size of the subsides and/or taxes imposed and the level of price responsiveness within, and across, each region.

[1] Abt Associates developed a concordance between the 57 GTAP sectors and the 6 digit NAICS. Details are available from authors upon request.
[2] A list of the countries included in each region is contained in Appendix A.

The same type of scenario plays out with the removal of foreign distortions. The removal of import tariffs decreases the price of imported goods and, again, all else equal, leads to a reduction of production from domestic competitors. But depending on the tariff structure of other regions, this may lead to an increase or a decrease in pollution producing industries. Removing export subsidies also increases prices, leading to a decrease in the competitive of these goods overseas. Again, depending on the structural change, the economic effects of all these on the environment may be positive or negative

Figure 1 shows the relative distribution of intermediate input subsidies for the US, NAF, ANZAC and the EU. Given the focus of the paper on the changes in emission for the United States, the sectors were chosen based on the existence of a subsidy in the US. As shown, the highest subsidies are in the wheat, grains and oilseeds sectors in the EU. The US has relatively high subsides in paddy rice, wheat and sugar production. The pattern shown in Figure 1 holds for subsides in land and capital inputs as well, except that the US has higher subsides for these two inputs in wool than ANZAC and the EU has higher land subsides than the US and ANZAC in sugar.

Figure 2 shows the output taxes and subsides for the same regions for all sectors affected. The figure is meant to provide an indication of the pattern of output taxes/subsidies, rather than analyze any particular program, region or sector. The various GTAP sectors are represented along the horizontal axis. Values above the horizontal axis are taxes and those below are subsides. The US has taxes on outputs in the agriculture sectors. However, these output taxes are much smaller than the input subsidies applied to these sectors, resulting in net support for these industry groupings. The other regions apply output taxes to the agriculture sectors as well, but output subsides to the majority of sectors. The EU does apply output taxes on office equipment, motor vehicles output, as well as land transport and public sector services such as health and education.

Figures 3 and 4 illustrate selected export taxes/subsidies and import tariffs, respectively, for the same regions. Again, the sector/region details are not as important as the overall pattern. For the regions shown here, there are few large export subsidies with the exception of Australian wool, petroleum sectors and recreational activities. The EU has the largest number of export taxes, focusing mainly in the agriculture and food sectors.

Figure 4 shows the various import tariffs imposed by these regions. These values are clustered around the agriculture, food and textile sectors. The EU imposes some of the largest import tariffs, and they are on sugar cane and beet imports. NAF has high tariffs on wheat and other meat products imports, ANZAC on wearing apparel, and sugar and other crop imports by the US.

Based on the domestic subsidy/tax pattern picture provided by Figures 1 and 2, we would expect that US to do relatively worse in paddy rice and sugar output, but see improvement in some manufacturing sectors, where its competitors have large subsidies.

On the foreign distortions side, the US has few export subsides, so we would expect to see an improvement in some of its traditional export markets, especially where other regions do have export subsides, such as agriculture. The removal of tariffs should further benefit some US agriculture markets such as rice, and for many of the manufacturing sectors such as food production.

Results from GTAP

The discussion of results focuses on changes in US output as that will drive the environmental changes observed. Table 1 outlines some summary results for the two scenarios: domestic distortions removal and foreign trade distortions removal. Table 2 presents the top five sector results for the US for the two scenarios. Finally, Table 3 examines the welfare effects of each scenario. In the following discussion, scenarios referring to the removal of domestic distortions will be referred to as ‘domestic’, while the removal of trade distortions is called ‘foreign.’

Summary statistics and welfare changes

Changes in GDP are, as expected, quite small for all regions for both scenarios. China, under the foreign scenario, experiences the largest increase, at 1.34 percent. Looking at imports, the US has the largest change in the domestic scenario, falling almost 10 percent, while experiencing one of the smallest changes in the foreign simulation, 5.8 percent.

The US did experience the largest increase in exports in the domestic scenario, rising over 17 percent. The next largest change was the 16 percent decline in Southeast Asian exports. Under the foreign scenario, South Asia saw the largest change in both imports (rising almost 40 percent) and exports (rising over 37 percent). The US was among the smallest. Only the EU experienced smaller changes in trade variables in the foreign simulation.

While there are both gains and declines in output, exports and imports in the domestic simulation, all three statistics improve for all regions in the foreign scenario. This result, of overall gains in the foreign simulation and mixed results in the domestic simulation, are apparent in the welfare statistics presented in Table 3.

In the domestic simulation, the US, Rest of East Asia, South America and the Rest of the World, all experience welfare declines. For the US, this comes overwhelmingly from a decline in the terms of trade. This is true of the rest of East Asia as well. For South America and the Rest of the World, the main effects are losses due to changes in allocation. The EU also experiences a decline in welfare from the terms of trade effect, however the gains from the allocative effect more than compensate, leading to an overall increase in welfare.

Looking at the results for the foreign scenario, all regions gain in overall measures of welfare. Also, all have positive contributions from the allocative effect; the largest coming in the EU. The US gains across the board, with the largest contribution coming from an improvement in the terms of trade.

Changes in US Sector Output

Some sectors gain in one scenario but decline in the alternate scenario. For example, manufacture of luggage, handbags, etc (listed in the table as ‘leather’) experience the largest increase in output for the US, at 13 percent, in the domestic simulation. The results in this scenario come from an expansion in both exports and a reduction in imports. When trade distortions are removed, domestic output falls and imports rise.

Another reversal is the beverage and tobacco sector. When domestic distortions are removed, this sector's output fell in the US by over 3 percent. However, output goes up when foreign trade distortions are removed. Relatively speaking, US price declines from the universal removal of domestic support are less than other regions, leading to a decline in exports of over 35 percent and rise in imports of almost 18 percent. However, US faired better when trade distortions are removed. Here, imports again rose, but not by as much (12 percent) and exports increased by over 150 percent.

In the domestic scenario, the wheat experiences the largest declines. As alluded to earlier in this paper, this was one of the most highly subsidized sectors in the US. Construction declines come mainly from a decline in demand for these services across sectors. While the US and EU, in particular, experienced a reduction in input subsides related to the wood manufacturing industry, at the same time, other regions such as Asia remove taxes and increase exports. This led to the overall decline in wood manufacturing in the US. For the majority of sectors in the US, the price of domestic output falls, relative to import prices. Only six sectors saw an increase in the ratio of domestic to imported prices.

Transport equipment experienced one of the largest increases in exports, rising almost 27 percent leading to an increase in sector output of over 12 percent. Leather also experienced an increase in domestic sales of over 8 percent. The increases in office equipment, fisheries and gas extraction came from increases in domestic sales as these prices drop relative to import prices.

In the foreign simulation, rice sectors, milled and paddy, experienced the largest increases in output. Processed rice has no real export subsidies in the US and its import tariffs are relatively low. However, big import tariffs came off this sector in the EU and Southeast Asia, leading to large export gains in the US to these regions.

While the US applies export subsidies to its wheat production, these are small relative to those applied by Southeast Asia, the EU and the rest of Europe. Thus, US exports increased to these regions, especially to Southeast Asia, causing wheat to be one of the largest gaining sectors for the US in a trade liberalization scenario. Oilseeds are a similar story, although they do not see the same increases as wheat.

The US sectors experiencing the largest declines in a foreign scenario are those that have some of the largest protection associated with them: namely sugar and textiles.

The TEAM Model

TEAM estimates the environmental impacts of a trade or other economic event. A TEAM economic event is defined as the absolute total change in the value of domestic production for each 6-digit NAICS sector. TEAM's emission factors are based on environmental release and resource use inventories complied by EPA, US Department of Agriculture and the US Geological Survey, couple with economic activity data complied from the US Economic Census, the US Agricultural Census and the US Department of Energy and certain private sources of economic data, in particular, Dun & Bradstreet databases.

The event, however, may be specified in an economic sector framework other than NAICS, for a base year that differs from the TEAM 1997 base year, and as primary economic impacts to specific sectors rather than total impacts distributed among all linked sectors of the economy. TEAM includes methods to process the economic event input to make it consistent with the TEAM framework.

TEAM is designed to process economic changes as either *primary* or *total impacts*. When expressed as *primary* impacts, the economic event provides the primary sectors in which changes in economic activity are expected to occur and the magnitude of the changes, but does not account for the indirect economic effects resulting from linkages of these primary sectors to other sectors in the economy. To understand the total impact – in both economic and environmental terms – of an economic event expressed as *primary* impacts, it is therefore necessary to convert these impacts to *total impacts* that account for linkages between sectors either as purchasers or suppliers of intermediate inputs to production. TEAM provides an economic framework to convert primary impacts into total impacts. Given the outputs in this paper are generated using a general equilibrium model, no such conversion is necessary and the effects are entered as *total*.

TEAM uses the estimates change in economic activity in 1997 dollars to calculate changes in emissions/resource use by specific pollutant/resource media, economic sector, and location (county). TEAM calculates the change in emissions/resource based on emission factors for each of six pollutant emissions or resource use categories: water discharges, air emissions, hazardous waste generation, agricultural chemicals usage, land use, and water use. Each emission factor is defined as the value of baseline emissions/resource use – *for a given pollutant/resource, and entity (or sector and county)* – divided by the value of baseline economic activity *measured as value of shipments in 1997 dollars*.

For air emissions and water discharges, the TEAM Entity is based on *true* facilities, as identified in the National Emissions Inventory, Permit Control System and/or Toxic Release Inventory facility datasets. Although TEAM is configured to analyze all emissions/resource use categories on the basis of true facility data, data are not currently available and/or present in TEAM to support true facility analysis for the all emissions/resource use categories (Abt 2004). TEAM analyzes the other categories (hazardous wastes, agricultural chemicals, land use and water use) on the basis of so-called *pseudo*-facilities, which are defined based on the total value of economic activity and associated emissions/resource use in a given 6-digit NAICS sector by county.

In most cases analyzed in TEAM, disaggregation and assignment of economic event data to individual counties and/or facilities is not needed for the calculation of change in emissions/resource use. Instead, (1) the national change in economic activity by sector are assumed to be spread over all locations in proportion to the baseline distribution of economic activity and (2) each Team entity's emission factors remain fixed at the baseline, static emission factor value. This means that the percent change in emissions/resource use for each TEAM entity is equal to the percent change in national level economic activity for the entity's economic sector.

TEAM generates estimates of the change in emissions/ resource use for all TEAM Entities, where TEAM Entities may be defined as *true* facilities (for air emissions and water discharges) or county-level *pseudo*-facilities. Table 4 lists the number of individual reporting elements by pollutant/resource media category for which TEAM calculates and reports changes in emissions/resource use. Elements here refer to chemicals, compounds, or indicators of resource use.

For the air and water pollution categories, in addition to calculating the change in emission/discharge for individual pollutants, TEAM calculates and reports *toxicity-normalized* aggregates for specific pollutant subsets in these pollutant categories. The toxicity-normalized estimates are calculated by use of toxic-weighting factors currently incorporated by EPA in the Risk Screening Environmental Indicators model.[3] Table 4 also indicates the number of individual pollutants/chemicals for which toxic weights are currently incorporated in TEAM and for which toxicity normalized aggregates of the change in pollutant emission/discharge are reported.

TEAM assembles estimates of the change in emissions/resource use at the level of the individual TEAM Entity by the reporting elements as summarized in Table 4. Data may be organized for reporting in a wide range of frameworks, including: aggregations by individual pollutant/resource category; toxicity-normalized emissions/resource use; by state or county; by industry, and various combinations of the above reporting frameworks. Changes in emissions/resource use may be reported both as absolute values and as change relative to baseline values.

Results of the TEAM Run

Tables 5A-5E and 6A–6E present the results of the TEAM runs for the domestic and foreign simulations, respectively. There is a great deal of information contained in these tables. We attempt to present here a general overview of the results and point out some interesting trends and sector results.

General trends

The domestic simulation saw a net reduction in 3 emission types while there are only two in the foreign simulation. Among the individual emissions/resource uses, hazardous waste experienced a net reduction in the foreign simulation and a net increase in the domestic. Further, the net increase in the domestic simulation is almost 7 times larger than the net reduction in the foreign simulation.

Water use under both simulation increases, but again, the increase in the domestic simulation is more than twice as large as that in the foreign simulation. Land use changers are almost identical, with the

[3] Developed by Abt Associates Inc. for U.S. EPA Office of Pollution Prevention and Toxics.

domestic simulation increasing use by 13 million acres and the foreign simulation almost 11 million. Agricultural chemical use increases at twice the rate in the foreign simulation than it does in the domestic scenario while the direct water discharge change in the foreign simulation is 4 times that of the domestic. Indirect water discharges increases are much larger (three times) in the domestic simulation than in the foreign.

Looking at changes in air emission, there is a net increase in point source in the domestic scenario and a decline in the foreign. However, these numbers are small, both less than 70,000 tons. Area source emissions, on the other hand, increase by over 1.6 billion tons in the foreign simulation while declining over 475 million tons in the domestic. Finally, the declines in mobile source air emissions seen in the domestic simulation are about twice as much as the net increase in the foreign scenario. Overall, air emissions increased 1.78 billion tons in the foreign simulation and fall 706 million in the domestic.

The tables discussed below present the top five sectors for each emission category in TEAM, for both simulations. The sectors are ranked by total change, as opposed to percent change. While percent changes often makes intuitive sense, as they more closely mirror the changes in output presented in the GTAP runs discussed above, they do not always provide an accurate picture of emission output changes. Consider two examples from the domestic distortions scenario. Sectors experiencing the largest change in indirect water discharges, ranked by percentage change, are various wood manufacturing sectors (wood preservation, other millwork, etc). The largest declines in hazardous waste output, again ranked by percentage change, are seen in the wheat and various construction related industries. However, if we rank these emissions by changes in the actual pounds of waste or tons of indirect water discharges experienced in sectors, we see that the largest declines in indirect water discharges (Table 5C) are actually experienced by various food manufacturing industries, and for hazardous waste (Table 5A), in the petroleum refineries industry. Both of these sectors experienced declines as a result of the shocks applied in the GTAP runs, but they are not among the top industries affected by the change in policy.

It is outcomes like this that drive home the sometimes counter-intuitive nature of environmental impacts from economic policy changes. To provide a feel for the type of information provided by the

TEAM model, the domestic simulation results will be discussed in terms of broad patterns and trends while the foreign simulation outcomes will be addressed in more detail.

Domestic Scenario

There are several broad trends worth noting in Tables 5A-5E. The first is that the correspondence of changes in economic output and changes in environmental outcomes varies by emission type. For example, the only sectors appearing in both Table 2 (sector output changes) and Table 5A are the declines reported in wood manufacturing and two construction industries. While the construction sector experienced the second largest decline in output in the GTAP simulation, this decline did not translate into a significant source of reduction in hazardous waste. Conversely petroleum refineries (which experience a less than 1 percent decline in output in the GTAP simulation) experience large declines (over 3 billion pounds) in hazardous waste. This fall, by far, dwarfed the declines in the other more 'economically' effected sectors.

Another broad trend is the net change for each emission type. Overall, the US experienced a decline in quantity output of GDP in the domestic scenario. However, this decline in overall economic activity only led to a reduction in area and mobile source air emissions and a decline in agricultural chemical use (driven by a reduction in construction and wheat farming). All other environmental indicators worsened. Hazardous waste and water use (Table 5A), land use (Table 5B), both direct and indirect water discharges (Table 5C) and point source air emissions (Table 5D) all saw a large net increase in their emissions/resource use.

While some emission categories experienced changes in a variety of sectors, other emissions outcomes were dominated by a single sector. For example, changes in area source air emissions (Table 5D) were fairly evenly spread across several industries (albeit, most in the construction sector). On the other hand, increases in water used in hay farming are three times larger than the next sector, nursery and tree production. This is true as well in direct water discharges (Table 5C). Declines in the other pressed and blown glass production sector are almost five times larger than those experienced in the next largest sector, petroleum refineries.

Along these same lines is the distribution of the regional changes. For example, all of the increases in hazardous waste from the photographic industry are experienced in New York. The same can be said for other pressed and blown glass. The declines in direct water discharges from this industry are enjoyed by Kentucky alone. As a matter of fact, all of the sector declines in direct water discharges are heavily concentrated in one geographic area (Table 5C).

Finally, as noted above, most of the sectors experiencing large changes in environmental outcomes, such as the increase in water use in hay farming, or the decline in hazardous waste outputs from the petroleum industry, do not pattern the economic changes as reported from the GTAP simulation. However, while this is true in general for the six non-air pollution types, it does not hold for declines air emissions. All three air pollution sources are dominated by changes in the construction industry. This has implications for previous studies linking trade and environmental outcomes. Most of these studies rely on changes in various types of air emissions, such as SO_2, NO_2 and Carbon. Thus, close linkages between large economic output changes and pollution changes could be more a function of media type (i.e. air) than true output/output relationships.

Foreign Scenario

Tables 6A-6E show the TEAM results from removing trade distortions. Again, the broad trend is for most emission/resource uses to increase. Only hazardous waste (Table 6A) and point source air (Table 6D) experienced net declines.

Table 6A show the results for hazardous waste. Semiconductor & related device manufacturing shows the largest increase of 1.17 billion pounds. Most of this activity occurs in the western states, with Arizona (38 percent of the total), New Mexico (29 percent of the total), and California (17 percent of the total), together making up 84 percent of the total change.

Water use changes are reported in the bottom panel of Table 6A. This resource use is dominated by agricultural sectors and shows the general substitution away from cotton, and sugar and towards wheat, rice and oilseeds.

These patterns are repeated in the results for land use in the top panel of Table 6B, and the bottom panel of Table 6B, Agricultural chemicals. Of course, hay and tree production are relatively insignificant users of agricultural chemicals, so fruit and vegetable crops occupy their spots in the bottom panel. Note that cotton is the only crop that receives less agricultural chemicals under this scenario. There are some zero changes, and Oranges, which shows the 5th smallest real change is actually expanding by 9.8 percent under this scenario.

Table 6C shows the results for direct and indirect water discharges. With the removal of foreign trade distortions, pressed and blown glass is the sector that has the largest increase, 32 million gallons in direct water discharges shown in the top panel of Table 6C. 100 percent of the top 10 locations for this activity are in the state of Kentucky. However, this represents a small change in water output from this sector. Under this scenario, direct water discharges only increase by 0.32 percent. Compare these results to the next highest sector, Cattle feedlots, which emit 25.5 million additional gallons of water, a 7.7 percent increase. This is another case where a small, indirect increase in a higher-emitting sector has a larger impact than a large direct increase in a lower emitting sector.

The other entries in Table 6C largely reflect the anticipated impacts of elimination of foreign trade distortions: less activity in footwear, textiles and apparel, and increases in animal agriculture and high tech.

Table 6D shows the results for area source air emission and point source air emissions. Three of the top 5 increasing sectors for point source air emissions are paper products manufacturing sectors, and Table 6D shows that the emissions all expand by 0.77 percent. This owes to the fact that they are all one sector in GTAP, and TEAM as split them out, applying the same growth factor to each.

The top five declining sectors in terms of point source air emissions are a mix of petroleum sectors and sugar sectors. The sugar cane and sugar beet sectors share the same declines in percentage terms because they also are derived from a single GTAP sector.

Corresponding to the decline in point source air emission from sugar manufacturing sectors, there is a decline in area source air emissions from sugar cane and beet farming shown in the bottom panel of Table 6D. All of the top five increasing and declining sectors in terms of area source pollution are agricultural, with the single exception of commercial and institutional building construction (a decline). This table reflects the substitution of cattle, pigs, wheat and soybeans for hay, tobacco cotton and sugar as a result of trade liberalization.

Table 6E shows changes in mobile source air emissions. There are increases from couriers, animal slaughtering (corresponding to the increases in animal agriculture reported in Table 6D), and trucking as well as beef cattle ranching and farming and wheat farming. The declines are mostly in building trades: plumbing, heating and air conditioning contractors, commercial and institutional building construction and single family housing construction and electrical contractors. These changes are all derived from a small decrease in the GTAP construction sector under this scenario.

Conclusions

Attempting to attribute changes in environmental outcomes due to the removal of trade distortions to scale, composition or technical effects is difficult. First, the scale of the US economy, as measured by quantity changes in GDP changed very little due to the multilateral liberalization. However, one could argue that, given many of these sectors did not have large support programs associated with them and their economic output changes were small, for most emission types, changes may have come about due to scale effects. The compositional effect is more apparent in air emission, where the sectors with the largest emissions changes were also those with the largest economic effects. For example, the large changes in crop outputs, and the resulting environmental emission changes, can be thought of as compositional changes. As sated above, evidence of substitution effects in the changes in point source air emission and show a net decline in the foreign simulation. This would provide support for increasing openness having a positive impact on the environment.

The overall results, however, show that, as far as air emission go, changes from the removal of domestic distortions cause emission to decline while foreign distortions removal are associated with increases. In that sense, it would appear that trade liberalization is bad for the environment.

However, amounts the other measures of environmental outcomes, the results are mixed. Multilateral trade liberalization improves outcomes for hazardous waste, water use, land use and indirect water discharges. Domestic liberalization appears to help agricultural chemical and direct water discharge emission more.

These results are preliminary in nature. Consideration as not been given to particular programs in place, or how these emission changes affect current permit standards or policies. One thing is certain; calls for greater empirical work to support environmental analysis of trade agreements are well placed.

References

Abt Associates, *Trade and Environment Assessment Model: Model Description*, prepared for US EPA, National Center for Environmental Economics, Contract 68-W-02-040, April 2004

Antweiler, W., B. R., Copeland and M.S. Taylor, "Is free trade good for the environment?', *American Economic Review*, September 2001, 877-908.

Cooper, J., R. Johansson, M. Peters, "Some domestic environmental effects of U.S. agricultural adjustments under liberalized trade, A preliminary analysis", presented at the *International Conference Agricultural Policy Reform and the WTO: Where are we headed?*, Capri, Italy, June 2003.

Frankel, J. and A. K. Rose, "Is trade good or bad for the Environment? Sorting out the causality" Faculty Research Working Paper Series, *Harvard University*, September 2003.

Grossman, G., and A. Krueger, "Environmental Impacts of a North American Free Trade Agreement', in *The US-Mexico Free Trade Agreement*, P.M. Garber, ed., MIT Press, Cambridge MA, 1993, pp. 13-56.

Smith, V.K. and J.A. Espinosa, "Environmental and trade policies: Some methodological lessons", Discussion Paper 96-18, *Resources for the Future*, April 1996.

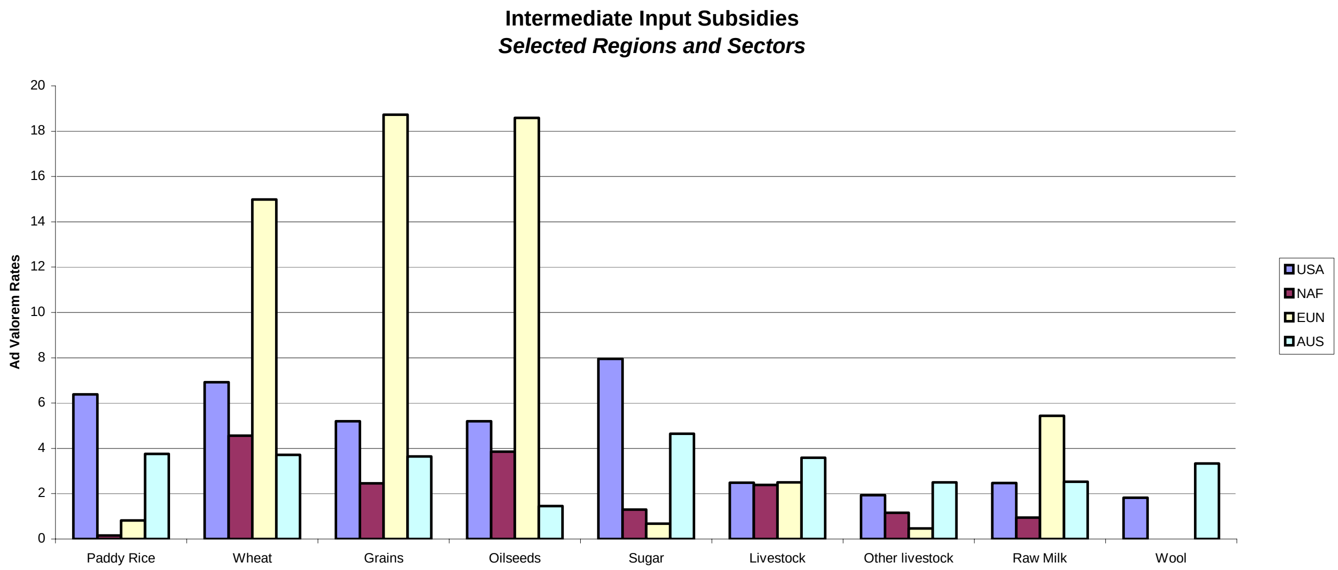
Tsigas, M.E., D. Gray and T.W. Hertel, 'How to assess the environmental impacts of trade liberalization", presented at *Sustainable Development and the General Equilibrium Approach*, 5th Annual conference on Global Economic Analysis, Taipei, June 2002.

Appendix A

Regional aggregation mapping

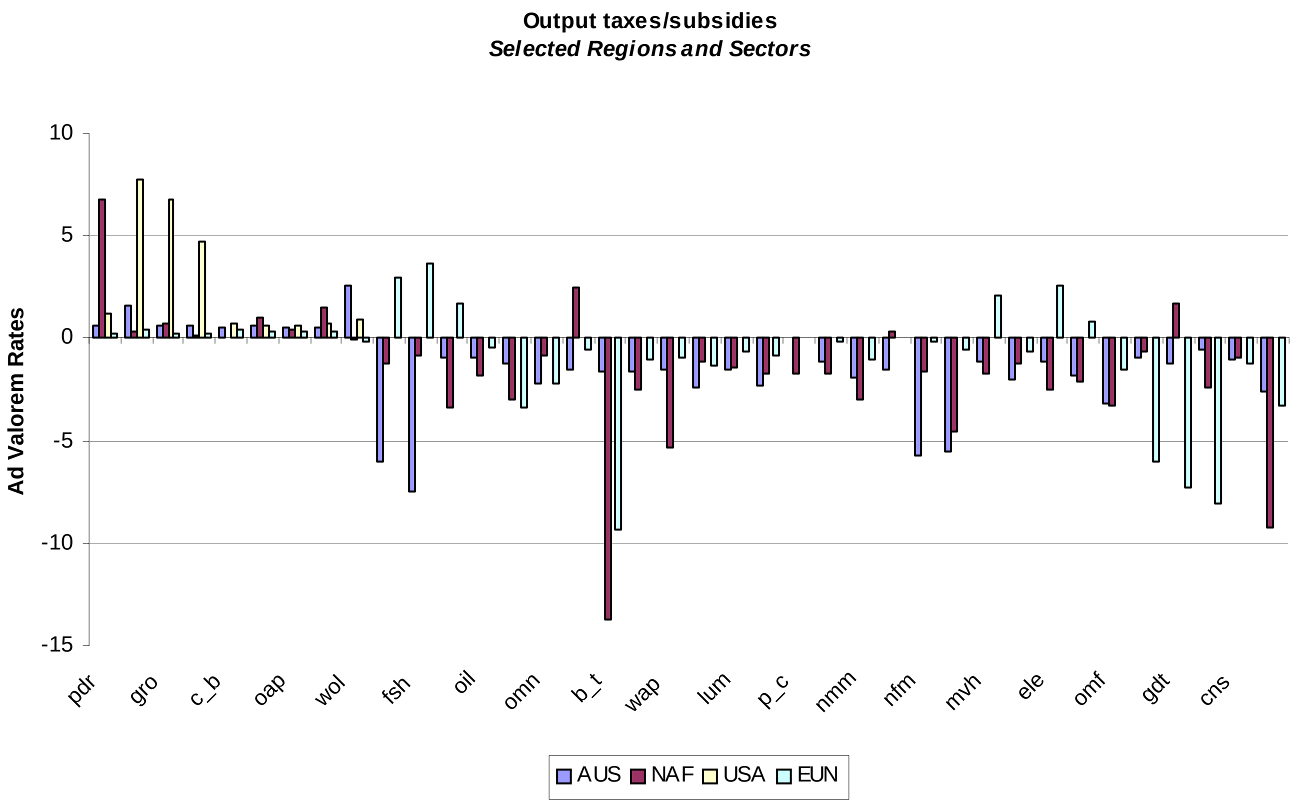
Simulation Sector	**Components**
Anzac	Australia, New Zealand
China	China
USA	United States
Southeast Asia	Hong Kong, Japan, Korea, Taiwan
Rest of East Asia	Indonesia, Malaysia, Philippines, Singapore, Thailand, Viet Nam
South Asia	Bangladesh, India, Sri Lanka, rest of South Asia
South America	Colombia, Peru, Venezuela, Argentina, Brazil, Chile, Uruguay, rest of Andean Pact, rest of South America
European Union	Austria, Belgium, Denmark, Finland, France, Germany, United Kingdom, Greece, Ireland, Italy, Luxemburg, Netherlands, Portugal, Spain, Sweden
Rest of North America	Canada, Mexico, Central America and the Caribbean
Rest of Europe	Switzerland, rest, of EFTA, Albania, Bulgaria, Croatia, Czech Republic, Hungary, Malta, Poland, Romania, Slovakia, Slovenia, Estonia, Latvia, Lithuania, Russian Federation, former Soviet Union
Rest of World	Turkey, Cyprus, rest of Middle East, Morocco, rest of North Africa, Botswana, rest of SACU, Malawi, Mozambique, Tanzania, Zambia, Zimbabwe, rest of southern Africa, Uganda, rest of sub-Saharan Africa, rest of World

Figure 1



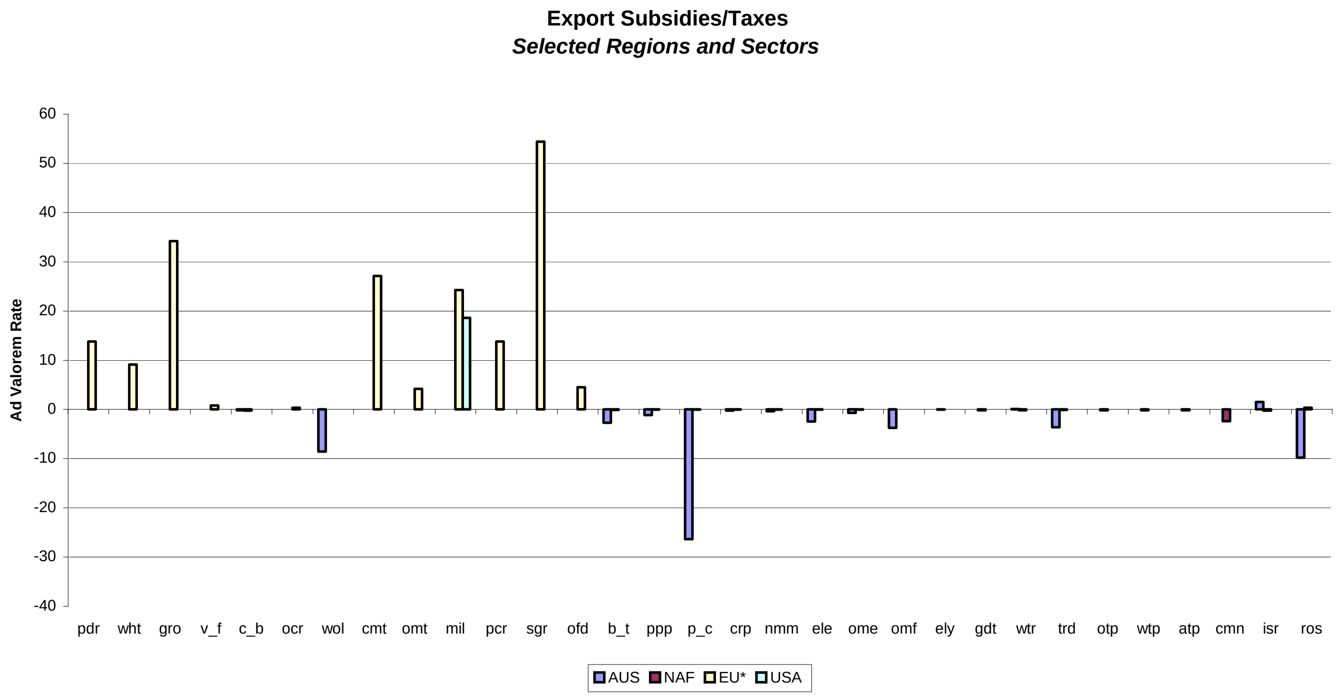
Source: GTAP Database 5.4

Figure 2



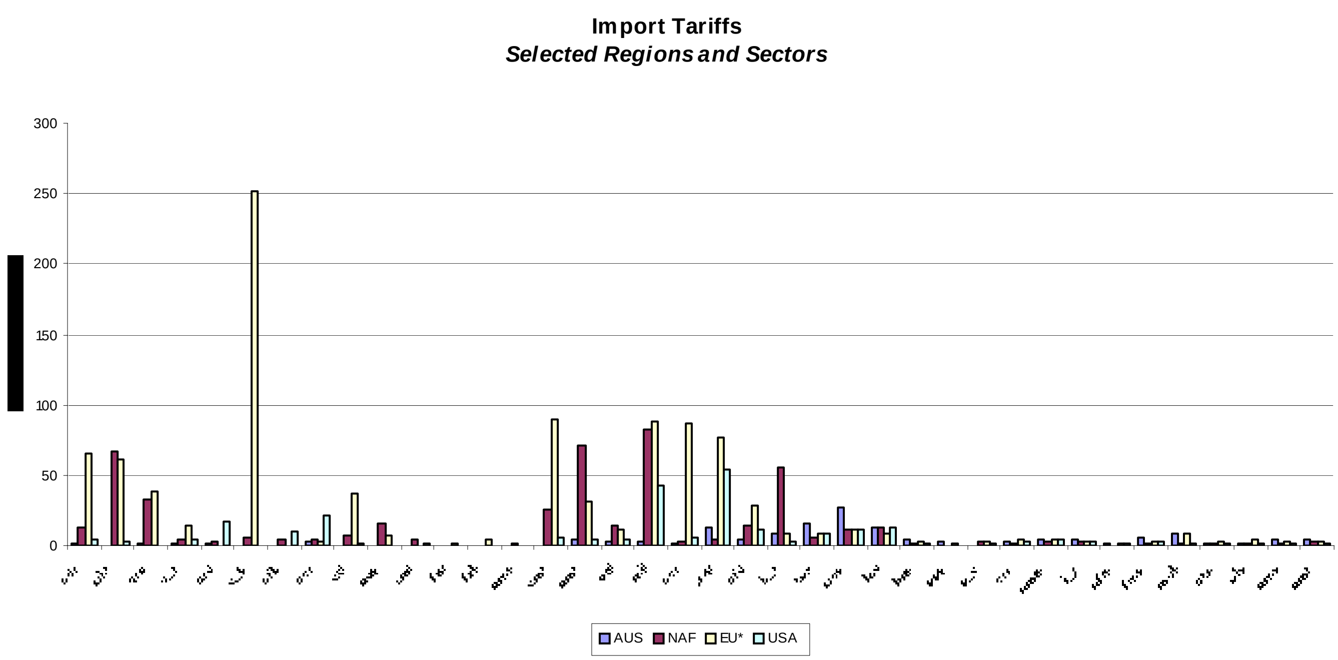
Source: GTAP Database 5.4

Figure 3



Source: GTAP Database 5.4
**Does not include intra-EU trade*

Figure 4



Source: GTAP Database 5.4
**Does not include intra-EU trade*

Table 1 Summary Statistics (percentage change)

	Domestic distortions			**Foreign trade distortions**		
	Changes in GDP*	**Changes in Imports**	**Changes in Exports**	**Changes in GDP***	**Changes in Imports**	**Changes in Exports**
Anzac	-0.05	-1.00	-0.57	0.09	11.90	7.61
China	0.06	3.80	-10.65	1.34	35.25	29.08
USA	*-0.03*	*-9.81*	*17.31*	*0.025*	*5.83*	*9.84*
Southeast Asia	0.25	6.30	-16.16	0.31	12.51	10.92
Rest of East Asia	-0.01	1.65	2.75	0.51	9.92	7.94
South Asia	0.14	2.27	-9.95	0.99	39.93	37.11
South America	-0.21	-7.17	13.38	0.53	28.96	26.04
European Union	0.12	-0.54	-1.70	0.27	2.72	3.95
Rest of North America	0.06	1.50	-0.37	0.24	5.91	7.23
Rest of Europe	0.27	2.62	-4.87	1.09	16.92	13.36
Rest of World	-0.13	-2.48	0.43	0.97	19.32	18.27

*****Quantity index

Table 2 Changes in US sector output

Domestic				**Foreign trade**			
Top five gaining sectors		***Top five declining sectors***		***Top five gaining sectors***		***Top five declining sectors***	
Leather	13.02	Wheat	-12.55	Milled rice	158.0	Wearing apparel	-28.84
Manufacture transport equip	12.25	Construction	-9.58	Rice	29.30	Sugar	-17.40
Manufacture Office equip	10.81	Wood Manuf	-3.70	Wheat	20.23	Cane/beet	-17.08
Fisheries	7.95	Beverage & tobacco	-3.39	Beverage & tobacco	8.69	Textiles	-11.44
Gas	7.71	Grains	-1.26	Oilseeds	7.62	Leather	-8.62

Table 3 Welfare Effects (1997 $US million)

Region	Aggregate Welfare Effect	Contribution of Terms of Trade	Contribution of Allocation	Contribution of Investment/Savings
Removal of domestic distortions				
Anzac	1,060	1,295	-240	5.6
China	4,842	4,803	534	-495
USA	-37,133	-33,965	-2,019	-1,148
Southeast Asia	41,251	28,522	12,823	-95
Rest of East Asia	-714	-736	-36	58
South Asia	2,482	1,617	741	123
South America	-6,602	-2,735	-3,169	-697
European Union	6,193	-6,059	9,503	2,749
Rest of North America	3,949	3,172	618	158
Rest of Europe	6,212	2,765	3,625	-178
Rest of World	-2,536	-110	-1,943	-482
Removal of foreign trade distortions				
Anzac	3,767	3,246	450	71
China	5,726	-5,529	11,405	-150
USA	5,387	3,306	2,055	25
Southeast Asia	27,768	12,772	15,772	-776
Rest of East Asia	4,520	1,028	3,336	156
South Asia	2,181	-2,917	5,250	-152
South America	10,516	2,548	7,845	122
European Union	20,305	-2,182	21,147	1,340
Rest of North America	133	-2,881	2,687	327
Rest of Europe	13,536	-910	14,311	136
Rest of World	4,845	-8,678	14,622	-1,098

Table 4: Reporting Elements By Pollutant/Resource Category in TEAM

Pollutant/Resource Category	Reporting Elements	Reporting Elements (Chemicals) with Toxic Weighting Factors
Point Source Air Emissions	396	270
Area Source Air Emissions	149	127
Mobile Source Air Emissions	31	21
Indirect Water Discharges	244	206
Direct Water Discharges	233	157
Hazardous Waste Groups	10	10
Agricultural Chemicals*	215	NA
Land Use	1	NA
Water Use	6	NA

*54 agricultural chemicals have toxic weights. However, the health and environmental risk impact concepts underlying development of the toxic weights are not generally applicable to analyzing risks of agricultural chemical usage. As a result, TEAM does not apply toxic weighting factors to agricultural chemicals usage.
NA – not applicable.

Table 5A Emissions changes from removing domestic distortions

Emission Type	**Hazardous Waste** (in pounds)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Semiconductor and related Industry	3,954,841,602	8.4	AZ (38%), NM (29%), CA(17%)
Photographic film, etc manufacturing	2,102,624,745	4.06	NY (99%), MA(1%)
Photographic & photocopying equipment	1,371,809,384	4.06	NY (99%), MA(1%)
Bare printed circuit board manufacturing	1,275,031,057	8.39	CA (44%), VA (35%)
Iron and steel plants	980,468,423	3.97	PA (83%), MI (9%)
Top five declining sectors (ranked by total change)			
Petroleum refineries	-3,187,094,782	1.34	PA (29%), TX(23%), CA (17%), LA (13%)
Wood preservation	-85,867,876	-4.97	GA (83%), MO (10%)
Spice and Extract Manufacturing	-26,544,985	-4.27	IL (73%), TX(12%), CT(9%)
Plumbing, heating & AC	-17,799,161	-11.24	NS
Other heavy construction	-10,080,117	-11.24	NS
Emission Type	**Water use** (millions of gallons per year)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Hay Farming	1,622,859	14.65	CA(30%), CO(16%), WY(19%), OR(18%), WA(10%)
Nursery & Tree Production	516,097	24.91	CA(73%), CO(9%)
Other vegetable and melon farming	322,175	10.91%	CA(85%),
Oilseed (except soybean) farming	282,216	4.8%	CO(30%), WY(30%), CA(12%), ID(12%)
Fossil fuel electric power	208,895	0.43%	NS
Top five declining sectors (ranked by total change)			
Wheat farming	-525,897	-14.18	ID(57%), CA(23%), WA(20%)
Rice farming	-238,122	-14.27	CA(68%), AR(23%)
Corn farming	-91,832	-2.27	NE(43%), CO(23%), TX(9%)
All other grain farming	-83,221	-4.53	ID(43%), WY(23%), TX(19%), CO(9%)
Petroleum refining	-5,823	-1.34	LA(51%), TX(27%), IN(11%)

*States shown where ‘significant’ results are stated (i.e. greater than 10% of total).
If totals are spread over large number of states, NS (not shown) is reported.

Table 5B Emissions changes from removing domestic distortions

Emission Type	**Land Use** (in acres)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Nursery & tree production	10,256,650	24.9	PA(64%), CA(34%)
Hay farming	8,320,879	14.65	NE(31%), CA(19%), WI(16%), SD(10%),
Soybean farming	3,141,451	4.82	IL(54%), MN(18%), ND(10%), IA(9%)
Cotton farming	1,229,675	9.41	TX(68%), CA(23%)
Oilseed and grain combination	856,612	9.5	TX(31%), ND(30%),LA(11%), WA(11%)
Top five declining sectors (ranked by total change)			
Wheat farming	-8,272,131	-14.2	ND(59%), MT(23%), WA(11%)
Corn farming	-1,589,248	-2.27	IL(64%), NE(26%), IA(10%)
Rice farming	-442,519	-14.27	AR(41%), CA(31%), LA(28%)
All other grain	-404,502	-4.53	TX(31%), ND(30%), LA(11%), WA(11%), MS(10%)
Citrus (except orange)	NA	NA	NA
Emission Type	**Agricultural chemicals** (pounds applied)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Cotton farming	188,651,065	9.41	CA(39%), TX(24%), TN(16%), MO(11%), AR(11%)
Soybean farming	157,311,075	4.81	IL(72%), OH(18%), MI(10%)
Potato farming	51,846,461	8.65	ID(66%), WA(28%)
Other vegetable & melon farming	13,232,534	10.91	CA(79%(, FL(13%), AZ(8%)
Dry pea & bean farming	2,556,966	9.14	WI(51%), OR(33%), MI(8%)
Top five declining sectors (ranked by total change)			
Wheat farming	-690,800,046	-14.18	ND(71%), MN(21%)
Corn farming	-335,573,416	-2.27	IL(92%), IA(8%)
Beef cattle ranching & farming	-10,624	-0.28	PA(70%), NY(30%)
Dairy cattle & milk production	-2,126	-0.48	TX(80%), OK(14%) CO(6%)
All other grain farming	-159	-4.53	MN(52%), KS(37%),

*States shown where ‘significant’ results are stated (i.e. greater than 10% of total).
NA- not available

Table 5C Emissions changes from removing domestic distortions

Emission Type	Direct Water Discharge (tons)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Pulp mills	14,008,557	1.61	NC(45%), FL(22%), AR(11%)
Paper (except newspaper) mills	11,707,676	1.61	AL(58%), WI(10%), LA(7%)
Steel & Iron	11,333,585	3.97	WV(50%), IN(20%), OH(14%), WI(7%)
Electric power generation	10,871,736	0.42	KY(96%)
Broiler & other meat type chicken production	10,325,966	3.33	AL(20%), AR(19%), DE(18%), VA(11%), CA(9%)
Top five declining sectors (ranked by total change)			
Other pressed & blown glass	-30,771,917	-0.35	KY(100%)
Petroleum refineries	-6,213,661	-1.34	CA(84%), IL(8%)
Hardwood & veneer	-2,909,178	-4.97	FL(100%)
Wood window & door manufacturing	-2,230,766	-4.97	KY(100%)
Dairy cattle & milk production	-1,372,788	-0.48	CA(88%), TX(6%), PA(6%)
Emission Type	**Indirect Water Discharge** (tons)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Semiconductor and related devices	775,372	8.3	AZ(25%), CA(20%), TX(18%), MO(14%)
Pulp mills	594,339	1.6	OR(24%), TX(20%), FL(19%), MN(16%), MI(11%), PA(10%)
Plastic material & resin manufacturing	394,640	0.81	TX(49%), NJ(38%), MA(7%)
Electroplating, plating, etc	386,435	3.82	IL(24%), OR(21%), MN(17%), OH(11%), MA(10%)
Electronic capacitor manufacturing	373,486	8.24	AL(78%), SC(20%), VA(2%)
Top five declining sectors (ranked by total change)			
Cheese manufacturing	-53,617	-0.77	CA(50%), MN(23%), WI(16%)
Petroleum refineries	-49,006	-1.34	CA(54%), TX(28%), PA(7%)
Spice & extract manufacturing	-40,649	-4.27	OK(35%), MA(20%), WI(15%), TN(11%)
All other miscellaneous food manufacturing	-39,123	-3.41	AR(30%), WI(19%), TN(15%), NJ(13%), IA(7%)
Dry condensed & evaporated dairy	-37,846	-.077	SD(77%), WI(8%)

*States shown where 'significant' results are stated (i.e. greater than 10% of total).
NA- not available

Table 5D Emissions changes from removing domestic distortions

Emission Type	**Point Source Air** (tons)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Fossil fuel electric power generation	28,683	0.43	KY(25%), IN(37%), NC(23%), MD(14%)
Primary aluminum production	26,427	4.72	TX(23%, MO(13%), KY(18%), WA(16%)
Crude petroleum & natural gas extraction	16,866	3.66	ND(22%), LA(21%) AL(15%), MS(14%), WY(12%)
Iron & Steel	13,806	3.97	OH(44%), IL(25%), AL(11)
Natural gas liquid extraction	13,806	4.55	NM(56%), TX(44%)
Top five declining sectors (ranked by total change)			
Petroleum refineries	-12,948	-1.34	TX(33%), IL(24%), DE(12%), LA(17%)
Sawmills	-5,930	-4.97	ME(21%), OR(16%), MS(17%), CA(30%)
Reconstituted wood product manufacturing	-5,865	-4.97	TX(30%), LA(15%), MI(15%),OR(11%),
Softwood veneer & plywood manufacturing	-5,477	-4.97	AR(23%), TX(17%), LA(14%), MT(10%), MS(10%), OR(9)
Non upholstered wood household furniture manuf.	-3,662	-4.97	NC(51%), VA(20%), MS(18%)

Emission Type	**Area Source Air** (tons)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Hay farming	280,743,287	14.66	OR(42%), ID(23%), CA(10%)
Cotton farming	188,249,252	9.41	GA(31%), TX(19%), AL(13%), MI(10%)
Soybean farming	143,578,119	4.82	IL(23%), IA(15%), IN(11%), MN(10%), OH(9%), MI(8%)
Tobacco farming	140,967,762	15.25	NC(36%), GA(29%), KY(11%), SC(9%)
Other vegetable (except potato) & melon farming	134,611,112	10.91	FL(21%), GA(20%), CA(20%), OR(17%), WA(7%)
Top five declining sectors (ranked by total change)			
Commercial & institutional building construction	-393,620,326	-10.85	TX(23%), NY(15%), CA(10%), GA(10%), FL(9%)
Single family housing construction	-332,819,985	-10.85	TX(22%), FL(16%), CA(12%), NC(9%)
Wheat farming	-303,602,492	-14.18	ND(17%), KS(17%), ID(16%), MT(13%), OK(10%)
Plumbing, heating & air conditioning	-194,870,325	-11.25	(TX(23%), NY(14%), FL(10%), CA(95)
Electrical contractors	-138,806,455	-10.85	TX(21%), NY(17%), CA(11%), FL(10%)

*States shown where 'significant' results are stated (i.e. greater than 10% of total).

Table 5E Emissions changes from removing domestic distortions

Emission Type	**Mobile Source Air** (tons)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
General freight, long distance, truckload	87,829,287	2.64	AL(11%), OH(11%), WI(11%), TN(11%), MI(11%), FL(9%)
General freight, long distance, less than truckload	40,003,776	2.64	CA(17%), OH(12%), GA(11%), PA(10%), TN(10%), TX(9%)
Specialized freight (except used goods) trucking, long distance	34,342,753	2.64	TX(17%), OH(13%), CA(13%), GA(10%), MI(9%)
Specialized freight (except used goods) trucking, local	33,613,500	2.64	CA(23%), OH(12%), TX(12%), MI(9%), PA(9%), VA(9%)
Couriers	26,674,657	1.43	CA(24%), NY(10%), PA(10%), KY(9%), TX(9%), OH(9%)
Top five declining sectors (ranked by total change)			
Plumbing, heating & air conditioning	-127,915,692	-11.25	TX(20%), FL(13%), CA(12%), OH(12%), NY(10%), IL(8%)
Commercial & institutional building construction	-105,999,174	-10.85	CA(23%), TX(12%)< NY(11%), FL(8%), IL(8%)
Single family housing construction	-92,886,801	-10.85	CA(25%), FL(13%), TX(10%), VA(9%), MI(9%)
Electrical contractors	-89,846,365	-10.85	TX(18%), CA(15%), FL(14%), NY(12%), OH(10%)
Concrete contractors	-37,237,861	-10.85	TX(18%), OH(15%), CA(14%), FL(13%), IL(10%)

*States shown where ‘significant’ results are stated (i.e. greater than 10% of total).

Table 6A Emissions changes from removing foreign trade distortions

Emission Type	**Hazardous Waste** (in pounds)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Semiconductor & related device manufacturing	1,170,654,669	2.48	AZ(38%), NM(29%), CA(17%), PA(4%)
Photographic, film, paper, plate & chemical manufacturing	526,240,777	1.02	NY(99%), MA(1%)
Bare printed circuit board manufacturing	377,416,142	2.48	CA(44%), VA(35%), AZ(7%)
Paper board mills	353,506,581	0.77	LA(99%), GA(1%)
Photographic & photocopying equipment manufacturing	343,333,748	1.02	NY(99%), MA(1%)
Top five declining sectors (ranked by total change)			
Petroleum refineries	-3,571,501,353	-1.50	PA(29%), TX(23%), CA(17%),LA(13%), KY(10%)
Iron & steel	-34,919,954	-0.14	PA(83%), MI(9%)
Motor vehicle seating & interior trim manufacturing	-31,937,934	-13.17	MA(80%), CO(20%)
Fastener, button, needle & pin manufacturing	-25,665,909	-5.51	GA(100%)
Motor vehicle steering & suspension components	-20,714,538	-1.78	NE(82%), MI(7%)
Emission Type	**Water use** (in millions of gallons per year)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Wheat farming	1,028,070	27.73	ID(57%), CA(23%),WA(20%)
Rice farming	465,502	27.89	CA(68%), AR(23%)
Oilseed (except soybean) farming	408,661	6.98	WY(30%), CO(30%), ID(12%), CA(12%)
Other vegetables (except potato) & melon farming	345,433	11.70	CA(85%)
Oilseed & grain combination farming	255,199	13.89	ID(43%), WY(23%), TX(19%), CO(9%)
Top five declining sectors (ranked by total change)			
Hay farming	-1,142,988	-10.32	CA(30%), WY(19%), OR(18%),CO(16%),WA(10%)
Nursery & tree production	-320,061	-15.45	CA(73%), CO(9%), HI(9%)
Sugar beet farming	-131,480	-19.02	ID(37%), WY(24%), CA(21%), CO(8%)
Cotton farming	-84,203	-3.86	CA(76%), TX(24%)
Floriculture	-80,183	-15.47	LA(26%), WY(19%), CO(19%), ID(18%), TX(9%)

*States shown where ‘significant’ results are stated (i.e. greater than 10% of total).

Table 6B Emissions changes from removing foreign trade distortions

Emission Type	**Land Use** (in acres)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Wheat farming	16,171,078	27.73	ND(59%), MT(23%), WA(11%)
Soybean farming	4,548,942	6.98	IL(54%), MN(18%), ND(10%), IA(9%), MS(9%)
Oilseed & grain combination farming	1,240.408	13.89	TX(31%), ND(30%), LA(11%),WA(11%),MS(10%)
Oilseed (except soybean) farming	1,068,521	6.98	ND(74%), SD(26%)
Rice farming	865,075	27.89	AR(41%), CA(31%), LA(28%)
Top five declining sectors (ranked by total change)			
Nursery & tree production	-6,360,739	-15.45	PA(64%), CA(34%)
Hay farming	-5,860,438	-10.32	NE(31%), CA(19%), SD(16%), SD(10%)
Cotton farming	-503,594	-3.85	TX(68%), CA(23%), AR(8%)
Sugar beet farming	-273,316	-19.05	MN(58%), ND(19%), ID(15%), MI(8%)
Sugar cane farming	-173,627	-19.03	FL(58%), LA(42%)
Emission Type	**Agricultural chemicals** (pounds applied)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Wheat farming	1,350,437,761	27.73	ND(72%), MN(21%), MT(8%)
Soybean farming	227,792,403	6.98	IL(73%), OH(18%), MI(9%)
Potato farming	55,589,296	9.32	ID(66%), WA(28%), ME(6%)
Other vegetable (except potato) & melon farming	14,187,801	11.70	CA(79%), FL(13%), AZ(8%)
Corn farming	3,093,562	0.02	IL(92%), IA(8%)
Top five declining sectors (ranked by total change)			
Cotton farming	-77,259,082	-3.85	CA(39%), TX(24%),TN(16%) MO(11%), AR(11%),
Berry (except strawberry) farming	NA	NA	NC**
Citrus (except orange) groves	NA	NA	FL (100%)
All other grain farming	1.45	0.04	SD, MN KS**
Orange groves	1,009	9.8	FL**

*States shown where ‘significant’ results are stated (i.e. greater than 10% of total).
** Shares not available
NA- not available

Table 6C Emissions changes from removing foreign trade distortions

Emission Type	Direct Water Discharge (tons)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Other pressed & blown glass and glassware manufacturing	32,320,251	0.36	KY(100%)
Cattle feedlots	25,561,946	7.70	TX(44%), CO(31%), OK(9%) CA(9%)
Hog & pig farming	16,802,173	7.77	NC(63%), OK(13%), IA(13%), MN(11%)
Broiler & other meat type chicken production	11,565,186	3.74	AL(20%), DE(18%), AR(19%), VA(11%), CA(9%)
Turkey Production	6,724,103	3.74	NC(45%), VA(28%), AR(10%), TX(9%), MN(9%)
Top five declining sectors (ranked by total change)			
Beet sugar manufacturing	-18,974,368	-20.86	MN(99%), MT(1%)
Petroleum refineries	-6,963,113	-1.50	CA(84%), IL(8%)
Weft knit fabric mills	-2,054,533	-34.42	NC(95%), SC(5%)
Other hosiery & sock mills	-1,923,849	-34.42	MS(97%), NC(3%)
Broadwoven fabric finishing mills	-1,600,627	-13.37	SC(39%), NC(23%), AL(18%), RI(14%)
Emission Type	**Indirect Water Discharge** (tons)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Animal (except poultry) slaughtering	412,895	6.52	VA(51%), IA(26%), MO(11%)
Pulp mills	282,028	0.77	RO(24%), TX(20%), FL(19%), MN(16%), MI(11%), PA(10%)
Semiconductor & related devices manufacturing	229,514	2.48	AZ(25%), CA(20%), TX(18%), MO(14%), OR(12%)
All other food miscellaneous manufacturing	139,679	12.17	AR(30%), WI(19%), TN(15%), NJ(13%)
Electronic Capacitor manufacturing	122,076	2.69	AL(78%), SC(20%), VA(2%)
Top five declining sectors (ranked by total change)			
Fabric coating mills	-179,864	-13.30	DE(97%), OH(1%), IN(1%), MS(1%)
Textile & fabric (except broadwoven) finishing mills	-102,850	-13.38	SC(70%), NC(19%), NJ(8%)
Broadwoven fabric finishing mills	-90,388	-13.36	SC(44%), NC((26%), RI(19%)
Leather & hide tanning & finishing	-63,417	-6.88	MN(27%), MO(20%), TX(16%), WI(14%), ME(12%)
Broadwoven fabric mills	-61,679	-13.38	GA(45%), VA(24%), AL(12%), SC(9%)

*States shown where ‘significant’ results are stated (i.e. greater than 10% of total).
NA- not available

Table 6D Emissions changes from removing foreign trade distortions

Emission Type	**Point Source Air** (tons)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Primary Aluminum	7,697	1.38	TX(23%),MO(13%),KY(11%),WA (9%)
Paper (exc. Newsprint) Mills	5,369	.768	AL(26%)WI(17%)GA(17%)AR(15%)MD(10%)
Pulp Mills	5,074	.7679	GA(40%)VA(14%)OH(13%)TN(11%)
PaperBoard Mills	3,242	.7679	GA(55%), WI (10%), FL(10%)
Distilleries	2,208	10.95	KY(70%), TN(17%), IN(9%)
Top five declining sectors (ranked by total change)			
Sugarcane Mills	-20,570	-20.86	FL(80%) LA(15%)
Petroleum Refineries	-14,510	-1.5	TX(41%)IL(29%) DE(20%)
Beet Sugar Manufacturing	-9,090	-20.86	ND (53%), MN(19%)ID(28%)
AO Petroleum and Coal Prod.	-8,033	-1.64	IN(77%)MD(16%)LA(7%)
Crude Petrol and Nat Gas Ext	-3,852	-0.84	ND(33%), LA(24%), AL(22%), MS(21%)
Emission Type	**Area Source Air** (tons)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Beef Cattle Ranching & Farm'g	851,710,375	8.67	TX(22%)OR(15%)AL(10%)GA(9%)
Wheat Farming	593,543,655	27.73	ND(17%)KS(17%)ID(16%)MT(13%)OK(10%)
Hog & Pig Farming	247,620,844	7.77	NC(26%)IA(24%)MN(10%)IL(10%)
Cattle Feedlots	235,647,729	7.70	NE(21%)KS(19%)TX(16%)IA(11%)CO(10%)
Soybean Farming	207,906,568	6.98	IL(23_IA(15%)IN(11%)MN(10%)OH(9%)
Top five declining sectors (ranked by total change)			
Hay Farming	-197,728,945	10.32	OR(42%)ID(23%)CA(10%)
Tobacco Farming	-99,284,322	10.74	NC(36%)GA(29%)KY(11%)SC(9%)
Cotton Farming	-77,094,527	3.86	GA(31%)TX(19%)AL(13%)MS(10%)
Comm.Inst. Building Const.	-50,436,557	1.39	TX(23%)NY(15%)CA(10%)GA(10%)FL(9%)
Sugarbeet Farming	-47,689,344	19.02	MN(32%)ND(19%)OR(12%)MI(10%)ID(10%)
SugarCane Farming	-45,426,949	19.02	LA(75%)FL(23%)TX(2%)HI(0%)

*States shown where 'significant' results are stated (i.e. greater than 10% of total).

Table 6E Emissions changes from removing foreign distortions

Emission Type	**Mobile Source Air** (tons)		
Sector	**Total Change**	**Percent Change**	**State (% of total)***
Top five increasing sectors (ranked by total change)			
Couriers	59,341,446	2.85	CA(24)NY(10)PA(10)KY, OH,TX(9)
Animal Slaughtering	50,181,392	6.52	CA(22)Tx(14)OH(11)GA(9)
General Freight Trucking	32,139,326	0.97	AL,OH,WI,TN,MI(11); FL,TN,PA,AR (9)
Beef Cattle Ranching & Farm.	28,160,131	8.67	TX(19)OK(18), CO(13)
Wheat Farming	19,985,846	27.73	ND(21) OK(14) KS(12) CO(12) MT,ID(10)
Top five declining sectors (ranked by total change)			
Plumbing, heating & air conditioning	-15,683,854	-1.38	TX(20%), FL(13%), CA(12%), OH(12%), NY(10%), IL(8%)
Hay Farming	-14,893,844	-10.32	ID(14)GA(14)CO(11)NM, OR,MS(10)
Commercial & institutional building construction	-13,582,209	-1.39	CA(23%), TX(12%)< NY(11%), FL(8%), IL(8%)
Single family housing construction	-11,902,054	-1.39	CA(25%), FL(13%), TX(10%), VA(9%), MI(9%)
Electrical contractors	-11,512,468	-1.39	TX(18%), CA(15%), FL(14%), NY(12%), OH(10%)

*States shown where ‘significant’ results are stated (i.e. greater than 10% of total).