A Comparison of US and Canadian Industry Environmental Performance Using EIO-LCA Models

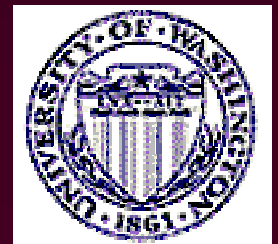## by

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An Overview…

- Basic concepts of the EIO-LCA model

- EIO-LCA in the US and Canada

- Creating the Canadian EIO-LCA model

- Comparisons between US, Canadian models

- Concluding remarks

What are Input-Output (IO) Models?

- Introduced by Wasily Leontief in 1941

- Assesses total economic impacts associated with an increase in "final demand"

- Based on lists of transactions between industries (System of National Accounts)

- Actively used in regional economic analysis

The Environment and IO Models

- Some researchers have predicted environmental effects with economic outputs:
  - Water use
  - Solid waste production
  - Ecological footprints
  - Energy use

- Carnegie Mellon Green Design Initiative: EIO-LCA Model

The EIO-LCA as an Equation

This model can be expressed in matrix form:

$$\Delta E = [E\ (I - BD)^{-1}]\ \Delta Y$$

where:
ΔE	=	change in environmental factors
E	=	environmental coefficients
B	=	direct requirements matrix
D	=	market share matrix
$(I - BD)^{-1}$	=	total requirements matrix
ΔY	=	column vector of demand change

Assessment of EIO-LCA Approach

- Advantages
  - economy-wide analysis aids boundary issue
  - quick results possible with analysis
  - provides an understanding of interrelationships

- Disadvantages
  - commodity sectors are very aggregated
  - not geographically sensitive
    (need for regional models)
  - use/disposal of product, life-cycle of capital not explicitly included

Economic Components of Model

- Based on 1998 data from Statistics Canada

- 1998 M-level input-output tables
  - 62 industries, 103 commodities
  - commodity-by-industry make and use tables
  - figures given in 1992 dollars

- Data suppression is a significant issue
  - some statistics unavailable - privacy concerns
 - coefficients estimated from 1992-1997 data

Environmental Components

- Greenhouse gas emissions
  - Data from Environment Canada GHG inventory
    (Source: Environment Canada, 2002)
  - carbon dioxide, methane, nitrous oxide

- Resource use
  - data from NRCan, Environment Canada
  - fuel use, aluminum, iron ore, copper, nickel

- National Pollutant Release Inventory (NPRI)
  - Source: Environment Canada (1999)
  - 1998 data - 130 waste compounds
 - air emissions, total waste emissions

Comparing the US and Canada

- Test scenario to compare models:
  - Green Design Initiative: 1997 US EIO-LCA Model
    (97 commodity sectors)
  - Unit increase in final demand: 1997 US$1 million
    (converted to 1992 C$1.11 million for Canadian model, OECD PPP)

- Ten commodities examined:

  - Motor vehicles
  - Fertilizers
  - Lumber and wood products
  - Plastic products
  - Electric power

  - Cigarettes and tobacco products
  - Furniture and fixtures
  - Newsprint and other paper
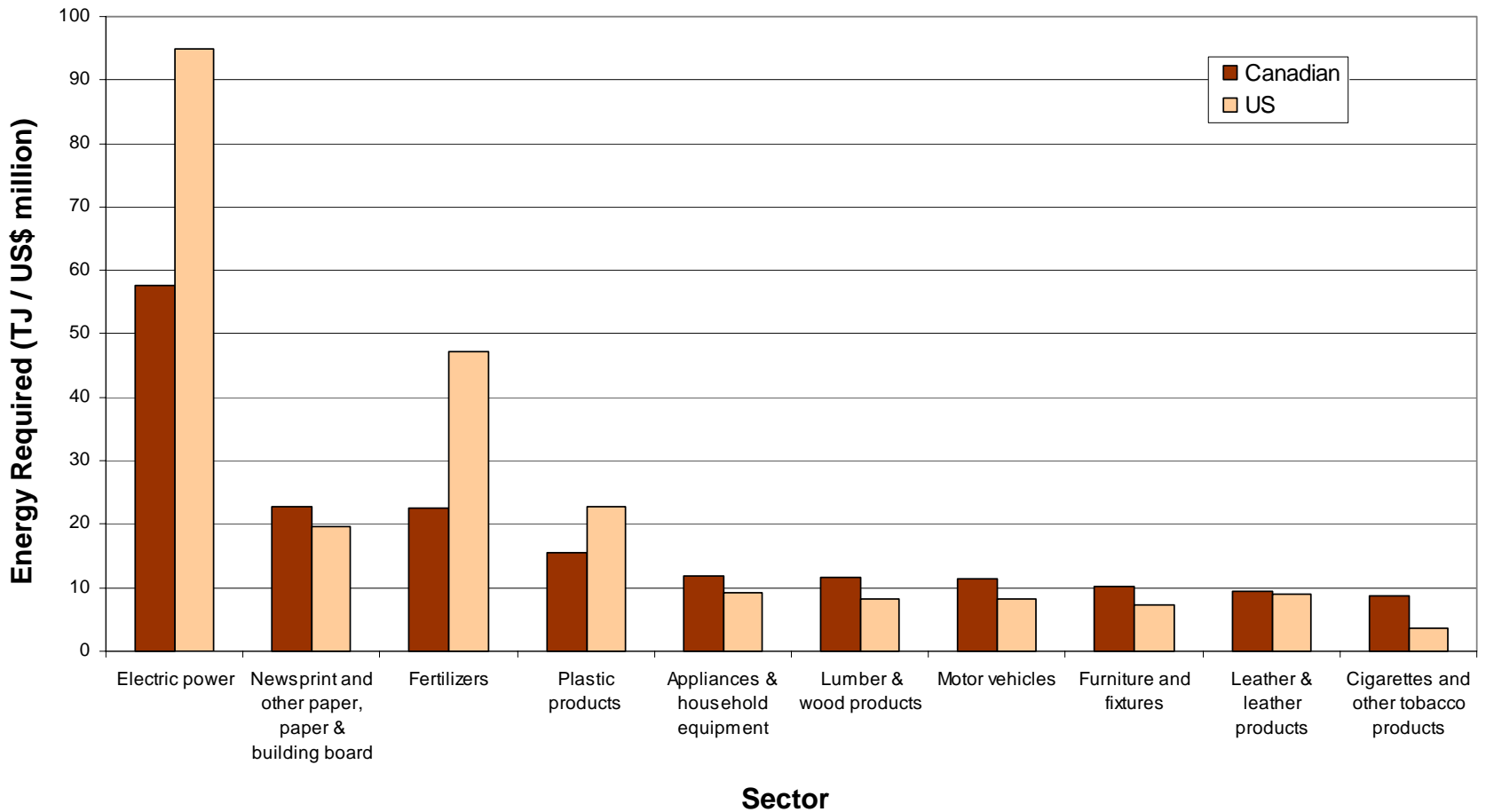 - Leather and leather products
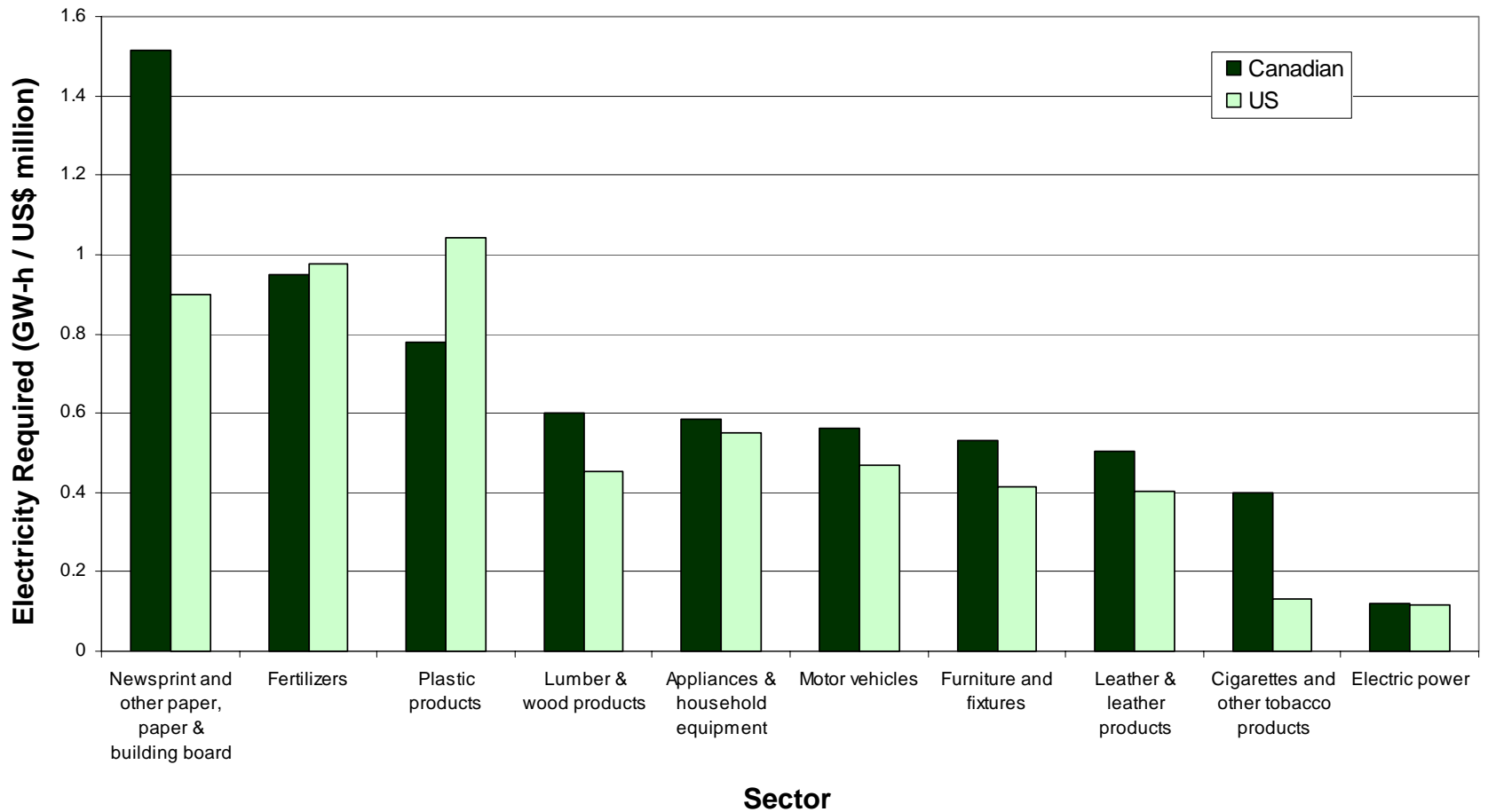 - Appliances

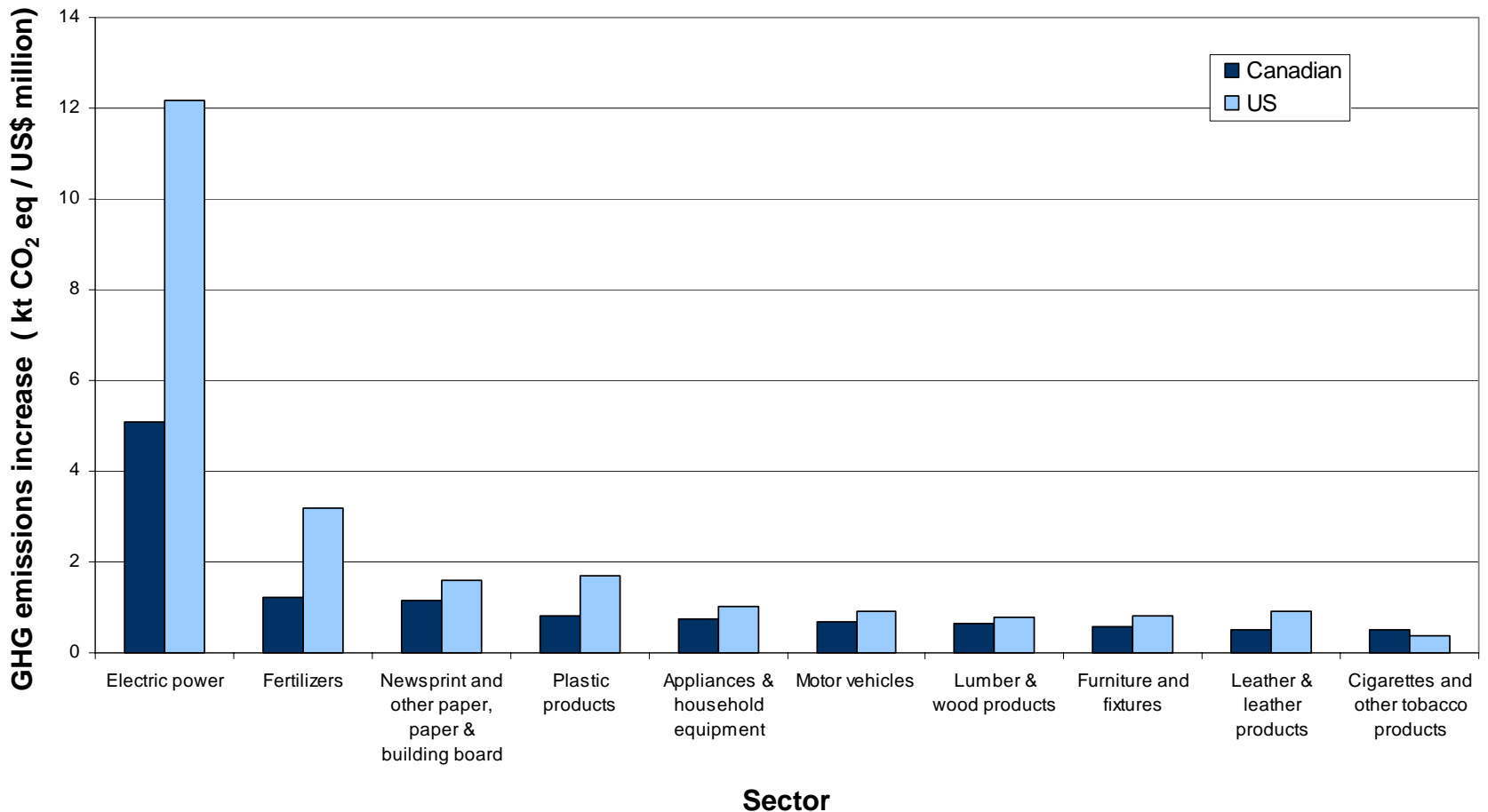# Comparison - Total Output
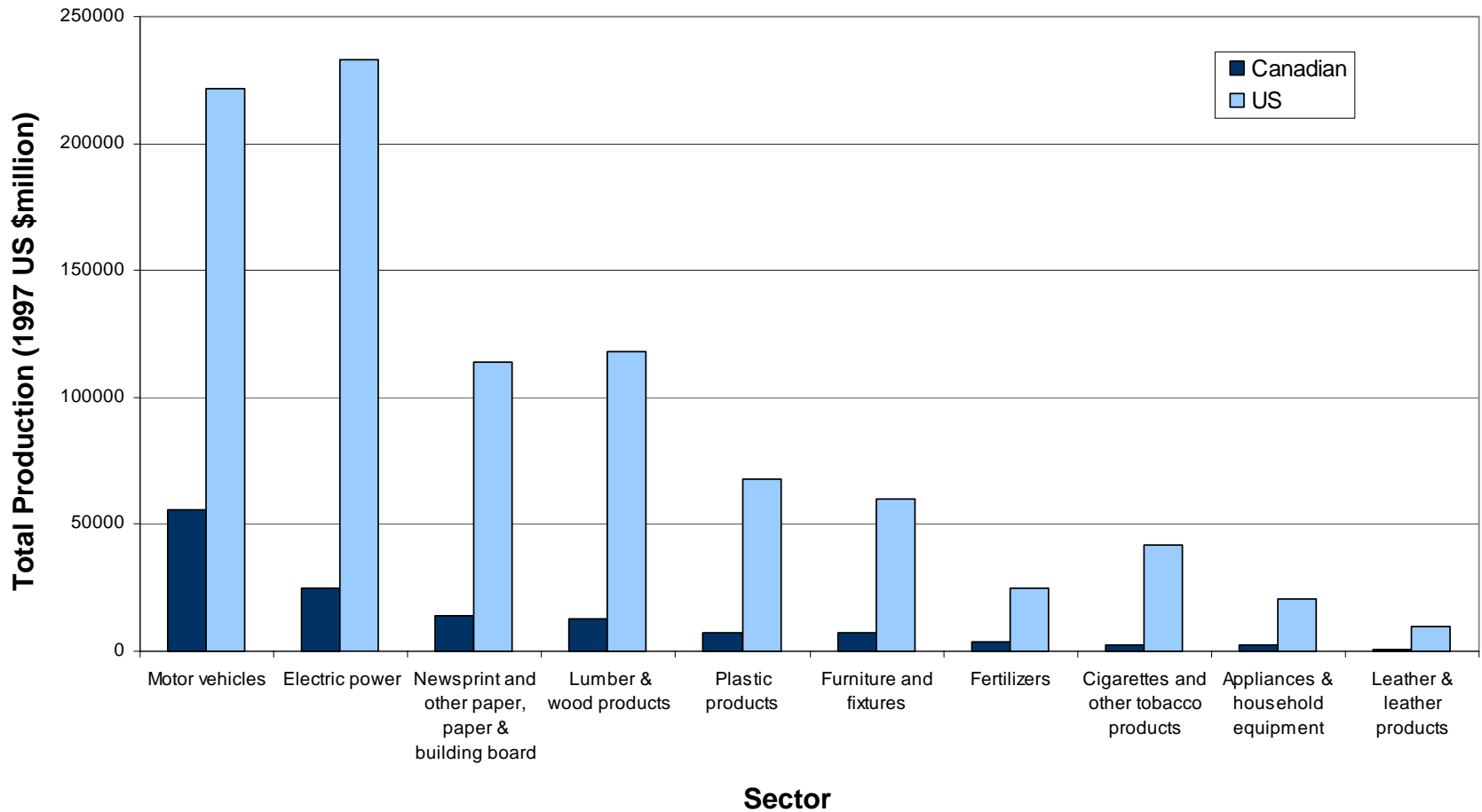
Comparison - Economic impact
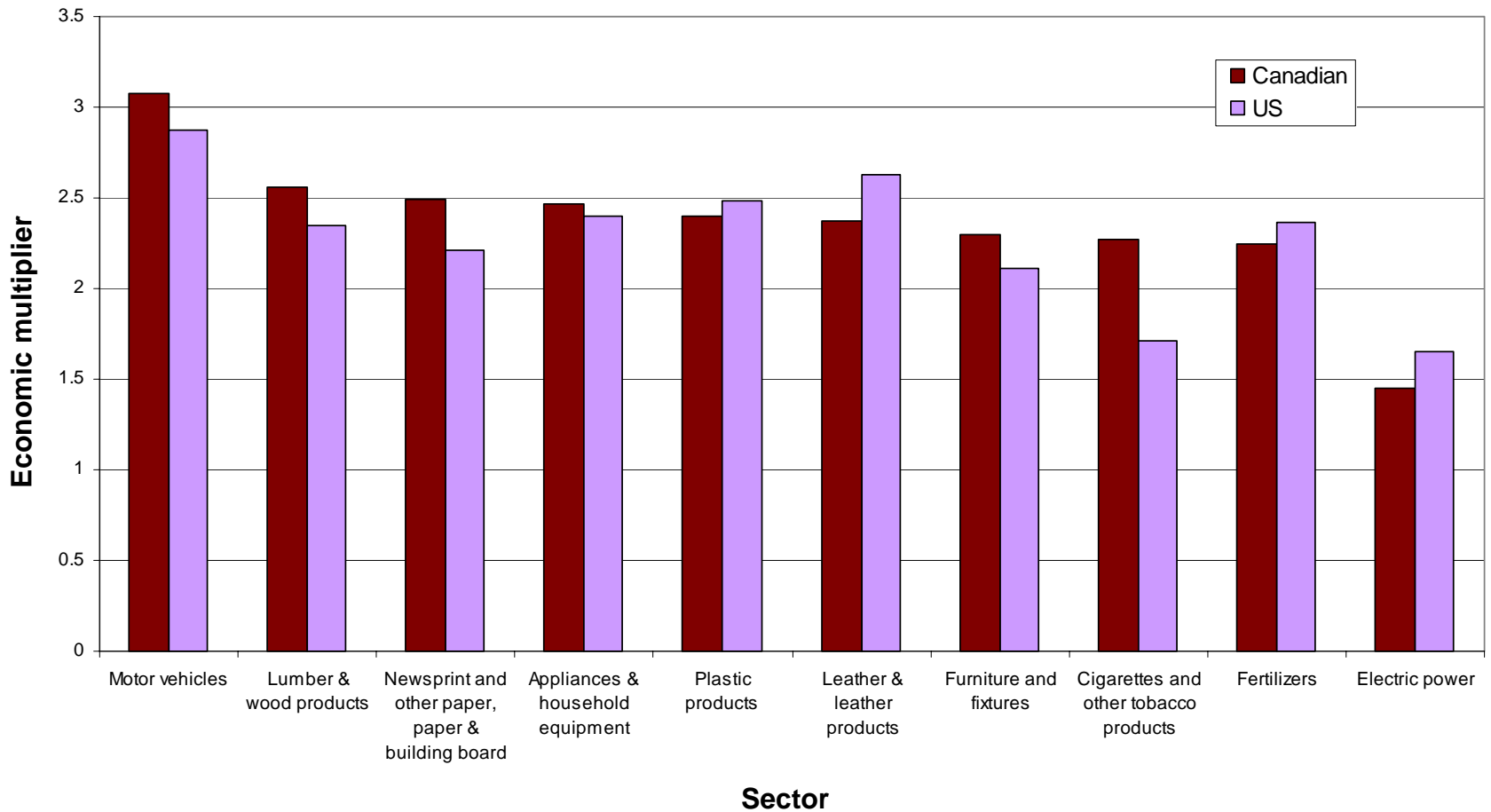
Comparison - Energy

Comparison - Electricity

Comparison - GHG emissions

Comparing the US and Canada

- Notable results from comparison:
  - Similar results for many sectors
  - Lower GHG emissions for most Cdn sectors
  - Higher energy, electricity use for most Cdn sectors
  - Fertilizers, plastic products dissimilar:
    - Significantly lower energy consumption
    - Possible differences in commodity composition, aggregation of outputs of industry?
  - Cigarettes and tobacco products dissimilar:
    - Higher economic effects, energy demand, GHG emissions
    - Differences in commodity composition, efficiency?

Comparing the US and Canada

- Differences in Canadian context:
  - Dispersed population, colder climate
    - (Higher energy / electricity use)
  - More hydroelectric capacity
    - (Lower GHG emissions for electric power, other sectors)
  - Net exporter of natural resources
    - (Greater share of effects incorporated in the model)
  - Differences in regulations, reporting strategies

- Possible differences in commodities!
  - May complicate comparability with US

Concluding Remarks

- Notable differences in model results
    - differences in classifications, economic structure
        (complicate comparability)
    - errors in data analysis
    - actual differences in impacts between countries

- Significant regional differences
    - Manitoba, Quebec: more hydroelectric generation
    - Alberta, Saskatchewan: more fossil-fuel generation

- Further research to refine model, comparisons with US results

Concluding Remarks

- Final goal: creating a bi-regional EIO-LCA model
  - Importance of bilateral trade:
    - 35% of US exports are sent to Canada
    - 90% of Canadian exports are sent to US
  - Increasing integration of economic sectors:
    - Automotive parts / assembly
    - Hydroelectricity
    - Forestry
    - Oil and gas
  - Necessary to provide an international scope

Acknowledgements