Quarterly Interpolation of Emissions from Economic Data

Evidence from an Integrated Air Emissions Physical Flows Account in the U.S.

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The views expressed in this presentation are those of the authors and do not necessarily represent the U.S. Bureau of Economic Analysis or U.S. Department of Commerce

Bureau of Economic Analysis
U.S. DEPARTMENT OF COMMERCE

National Strategy to Develop Statistics for Environmental-Economic Decisions

- Developed by large interagency working group, published by White House
- Involves many Federal agencies; broad leadership role for BEA
- Air Emissions (Phase I)
  - Physical Flows Account (BEA)
    - Identify data sources and develop methodologies to account for emissions by U.S. resident agents in a manner consistent with **international accounting standards**
    - Produce a proof-of-concept air emissions physical flows account capable of serving as a statistically reliable foundation for environmental-economic analysis of air emissions by policymakers and other stakeholders
  - Valuation (EPA/DOC)
    - Recommended follow-up to physical flows account
    - Provide estimated value of damages due to emissions in dollar terms

SEEA Supply and Use Framework

Pollutant\Industry	Agriculture	Mining	Utilities	Construction	Manufacturing	Wholesale	Retail	Transportation
Carbon Dioxide								
Methane								
Nitrous Oxide								
F-GHGs								
Sulfur Hexaflouride								
Nitrogen Triflouride								
Total GWP								

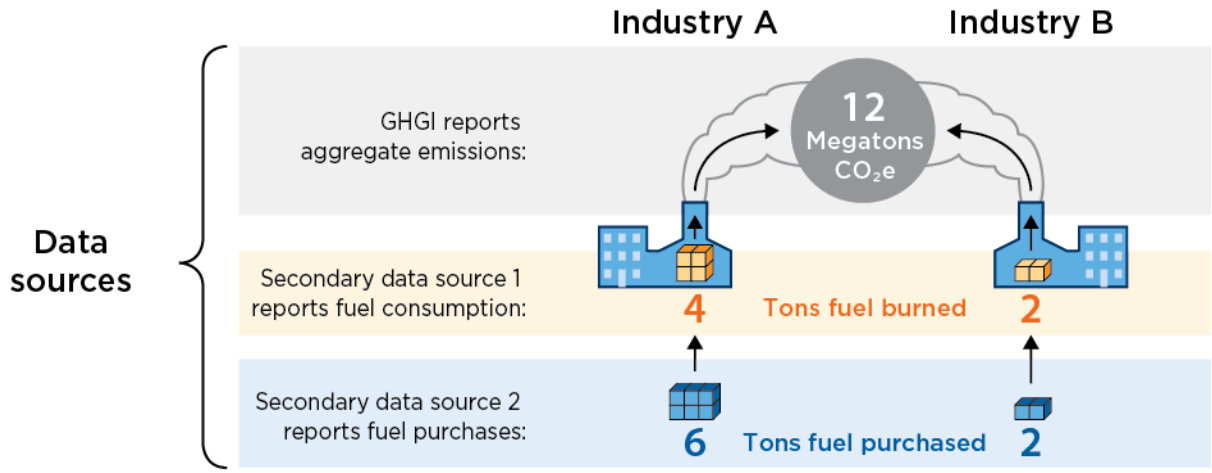
Pollutant\Industry	Information	Finance	Real Estate	Professional	Management	Administrative	Education	Health Care
Carbon Dioxide								
Methane								
Nitrous Oxide								
F-GHGs								
Sulfur Hexaflouride								
Nitrogen Triflouride								
Total GWP								

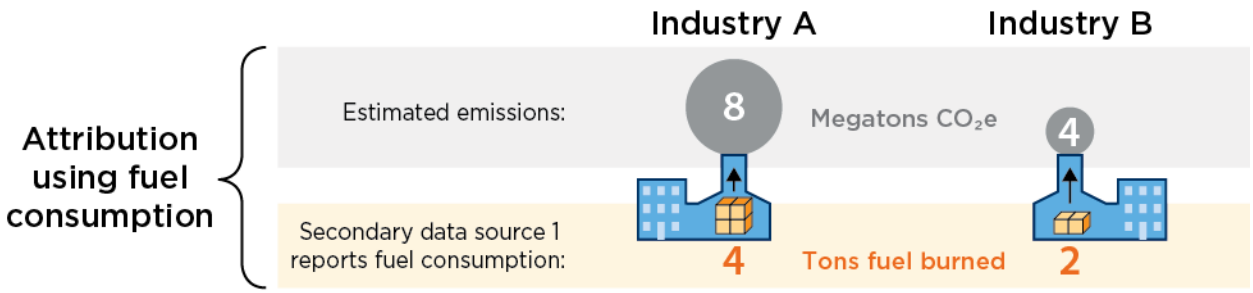
Pollutant\Industry	Entertainment	Hospitality	Oth. Services	Government	Households	Total Supply	Environment	Total Use
Carbon Dioxide								
Methane								
Nitrous Oxide								
F-GHGs								
Sulfur Hexaflouride								
Nitrogen Triflouride								
Total GWP								

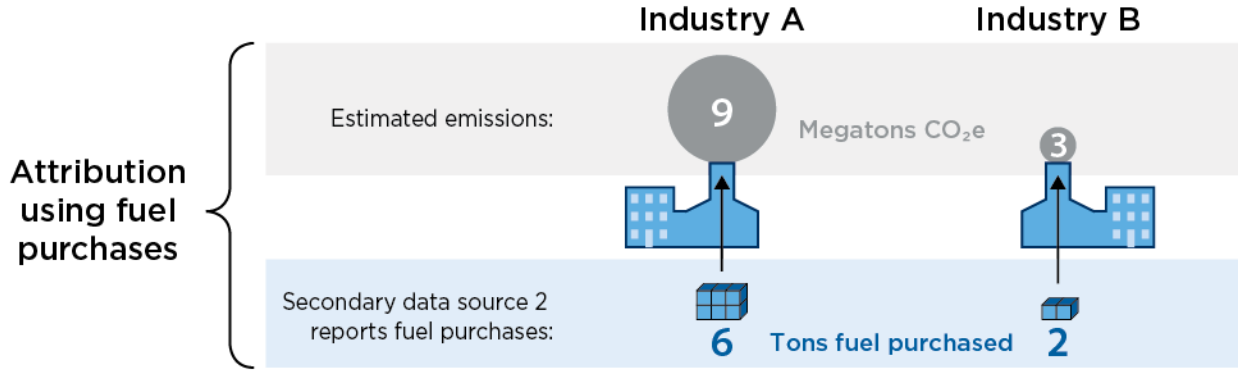
Methodology

- Greenhouse Gas Inventory (GHGI)
  - Prepared by EPA in accordance with treaty-mandated IPCC standards
  - Territory basis
  - Emissions are given by activity
- Adjustment from territory to residency basis
  - Directly estimate total emissions – Air
  - Directly estimate emissions adjustment – Marine
  - Estimate proportional adjustment – Trucking
- Attribution from activities to industries
  - Directly
  - In proportion to secondary measures of polluting activity

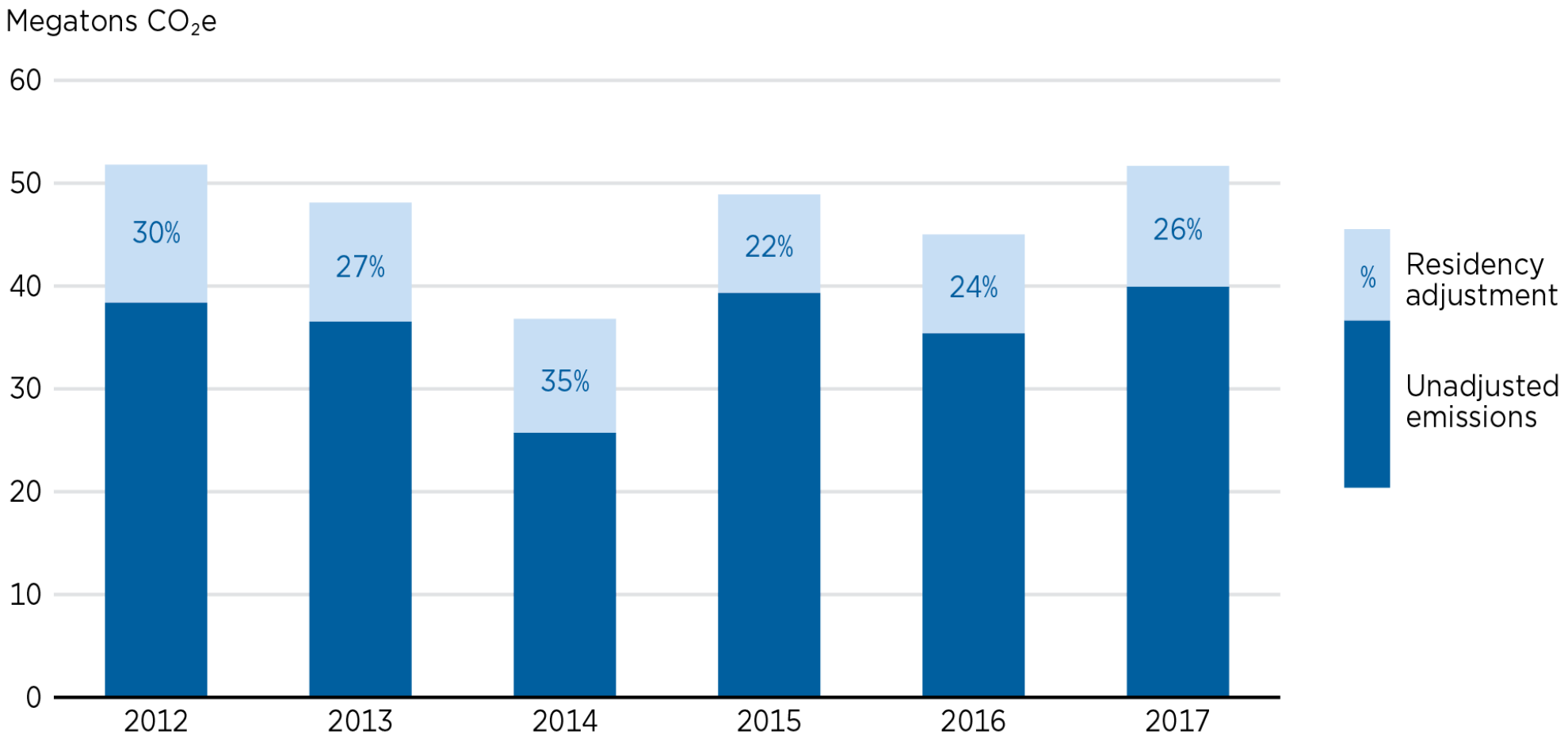
Proportional Attribution



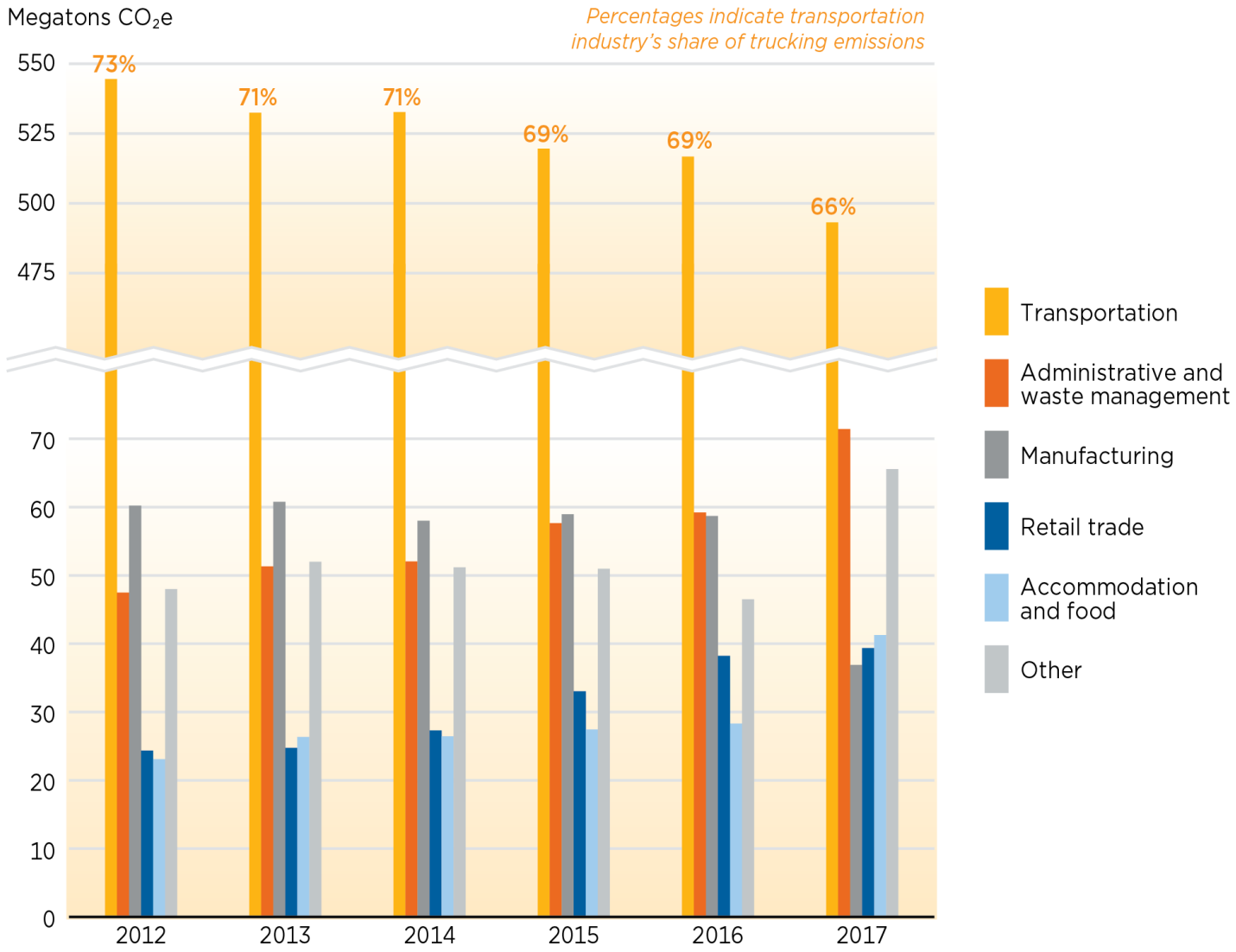




SEEA vs. GHGI — Water Transportation Residency Adjustment



SEEA vs. GHGI — Transportation Emissions



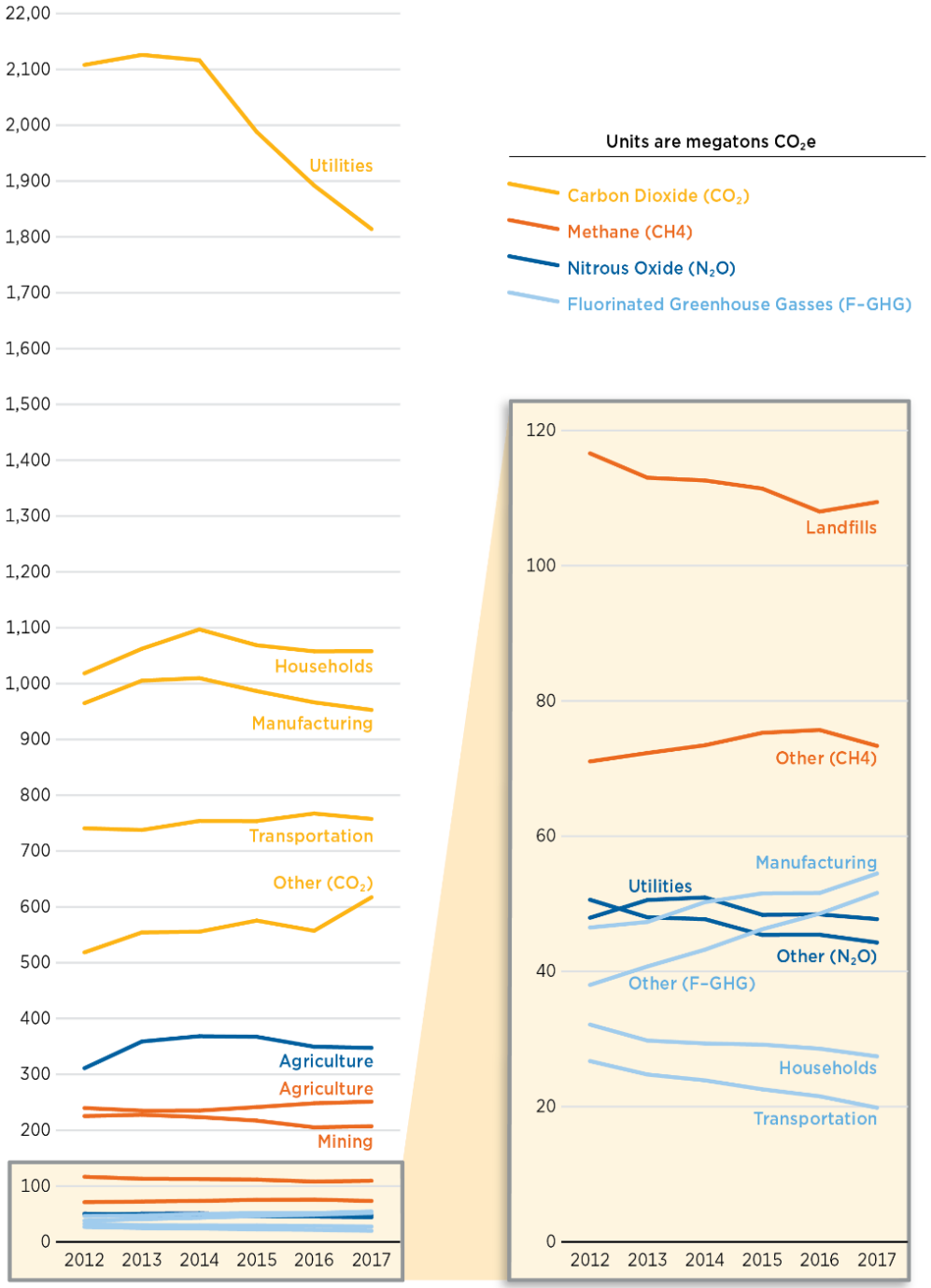
Supply-Use Table (2017)

Pollutant\Industry	Agriculture [1]	Mining	Utilities	Construction	Manufacturing	Wholesale	Retail	Transportation
Carbon Dioxide	37.25	112.85	2108.14	12.81	964.96	6.07	25.20	740.82
Methane	239.72	225.36	35.18	0.01	1.23	0.02	0.02	30.80
Nitrous Oxide	311.14	2.02	47.93	0.02	19.60	0.01	0.20	8.26
F-GHGs	-	0.95	0.06	1.20	46.49	3.18	2.83	26.73
Sulfur Hexaflouride	-	-	4.80	-	2.10	-	-	-
Nitrogen Triflouride	-	-	-	-	0.60	-	-	-
Total GWP	588.10	341.18	2196.12	14.04	1034.97	9.28	28.26	806.61

Pollutant\Industry	Information	Finance	Real Estate	Professional[2]	Management	Administrative[2]	Education	Health Care
Carbon Dioxide	4.89	13.08	107.78	5.34	11.84	55.95	18.59	19.67
Methane	0.01	0.03	0.38	0.01	0.02	2.03	0.04	0.06
Nitrous Oxide	0.04	0.01	0.59	0.03	0.08	2.40	0.03	4.43
F-GHGs	4.87	0.14	0.66	2.75	0.50	5.79	0.62	4.98
Sulfur Hexaflouride	-	-	-	-	-	-	-	-
Nitrogen Triflouride	-	-	-	-	-	-	-	-
Total GWP	9.80	13.27	109.40	8.13	12.44	66.17	19.29	29.14

Pollutant\Industry	Entertainment [3]	Hospitality[3]	Oth. Services	Gov't	Acc.[3]	Households	Tot. Supply	Environment	Total Use
Carbon Dioxide	3.07	29.17	6.16	48.81	-	1018.39	5350.85	5350.85	5350.85
Methane	0.06	0.03	0.03	-	116.60	1.10	652.73	652.73	652.73
Nitrous Oxide	0.23	0.20	0.11	0.33	-	12.00	409.66	409.66	409.66
F-GHGs	0.35	4.91	1.90	2.30	-	32.13	143.36	143.36	143.36
Sulfur Hexaflouride	-	-	-	-	-	-	6.90	6.90	6.90
Nitrogen Triflouride	-	-	-	-	-	-	0.60	0.60	0.60
Total GWP	3.72	34.31	8.21	51.43	116.60	1063.62	6564.08	6564.08	6564.08

Annual Time Series



Quarterly Interpolation

- Linkage with economic data
- High frequency time series used as indicator for low-frequency series
- Chow-Lin interpolation
  - $Y_t = \alpha + \beta X_t + \epsilon_t$
  - Y_t is the low-frequency series (emissions)
  - X_t represent one or more high frequency indicator series
  - ϵ_t represent an error term assumed to follow an AR(1) process
  - Estimated via generalized least squares
  - Easy to add additional indicator series and robust to outliers

Economic Indicator Series

- Output as proxy for polluting activity
- Not seasonally adjusted (NSA)
- Quarterly Services Survey (QSS)
  - Total revenue
- Manufacturers' Shipments, Inventories, and Orders Survey (M3)
  - Shipments + change in finished goods inventories (or total inventories)
- No readily available NSA indicator series for utilities or agriculture

Quarterly Time Series

Next Steps

- Quarterly interpolation:
  - Identify indicator series for utilities, agriculture, and other missing industries
- Air emissions account:
  - Extend GHG portion of account to 2020
  - Add PM 2.5
  - Business use of passenger cars