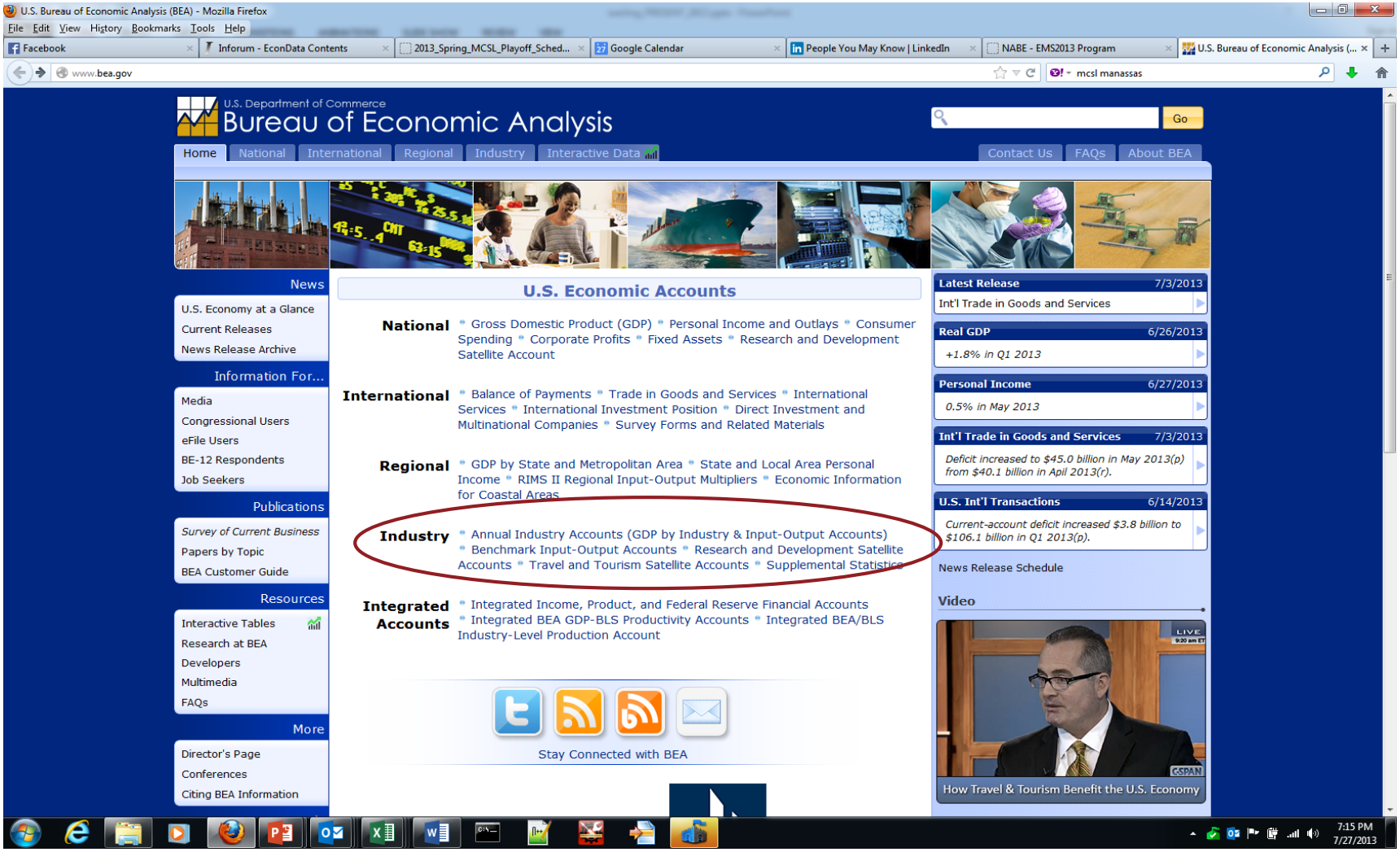
IO Multipliers in Practice: Examples for the United States

23rd Inforum World Conference

August 27, 2015

Input-Output (IO) and GDP by Industry Accounts



Interesting Applications of IO Data

- Association of Equipment Manufacturers: Upstream and downstream “footprint” of capital equipment.
- American Chemistry Council: Rail-content of everyday items
- Society of Plastics Industries: Upstream and downstream footprint of intermediate goods.
- All work is done with nominal tables.
- All work is completed in G7.
  (21st Century computers: Matrix inversion is almost instantaneous, while matrix unpacking is a good opportunity to go for coffee.)

Demand for Construction Machinery

2012 Construction Equipment Demand -- Millions of dollars

Year: 2012	Domestic Manufacturers' Value and Imports	Transport Margins	Wholesale Margins	Total Demand Purchasers' Value
Construction Machinery Purchases				
Capital Expenditure	**36,944**	**818**	**5,260**	**43,022**
Intermediate Demand	7,655	170	1,090	8,914
Government expenditures	1,969	44	280	2,293
Inventory investment	475	11	68	553
Exports	**19,458**	**314**	**2,022**	**21,794**
Agricultural Equip. Dealer Services			**5,400**	**5,400**
Total Demand for Equip. and Services	**66,501**	**1,356**	**14,120**	**81,976**

Sources: U.S. BEA Industry Accounts, U.S. BLS Employment, Hours, and Earnings,
U.S. Census International Trade Data, Inforum Estimates

Supply for Construction Machinery

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Table 2: 2012 Construction Machinery Supply -- Millions of dollars

	Domestic Production and Imports	Value Added	Employment (jobs)	Labor Compensation ($ per job)	Labor Compensation
			Direct Supply		
Domestic Construction Equipment Mfg.	**49,807**	**17,432**	**72,892**	**72,272**	**5,275**
Imports	**16,694**				
Downstream Businesses Total	**15,476**	**10,190**	**63,094**	**63,354**	**3,997**
Construction Equipment Transport Margins	1,356	570	6,248	62,021	388
Construction Equipment Wholesale Margins	8,720	5,941	35,106	63,500	2,229
Construction Equipment Dealer Services	5,400	3,679	21,740	63,500	1,380
Total Direct Domestic Supply	**66,501**	**27,623**	**135,986**	**68,137**	**9,272**
Total Equipment, Parts and Service Demand	**81,977**				
			Indirect Supply		
Upstream Supply Businesses	**61,557**	**29,520**	**232,767**	**70,180**	**16,336**
Agriculture, Mining, Utilities & Construct	3,014	2,075	8,003	72,346	579
Manufacturing	**29,052**	**9,584**	**71,129**	**72,692**	5,171
Wholesale and Retail Trade	5,219	3,530	24,705	68,956	1,704
Transport Services	2,849	1,431	15,312	56,848	870
Financial & Real Estate Services	5,477	3,316	12,409	94,577	1,174
Information and Business Services	**13,657**	**8,307**	**74,968**	**78,706**	5,900
Other Services	2,290	1,278	26,240	35,751	938
			Total Value Added and Employment		
Total Domestic Associated Supply	**126,840**	**57,142**	**368,752**	**69,443**	**25,607**
Direct Manufacturing	49,807	17,432	72,892	72,361	5,275
Downstream Direct Services	15,476	10,190	63,094	63,354	3,997
Indirect Upstream Supply	61,557	29,520	232,767	70,180	16,336
Manufacturing Multiplier	**1.5**	**2.3**	**4.1**		**3.9**
Total GDP, Employment and Avg Compensation		**16,244,600**	**139,741,000**	**61,685**	**6,669,300**
Percent share/Compensation multiplier		**0.352**	**0.264**	**1.13**	**0.384**

Sources: U.S. BEA Industry Accounts, U.S. BLS Employment, Hours, and Earnings,
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Invert Demand to find supply by industry.
Value Added and Employment determined by using IO table/NIPA ratios.
Compensation from IO Table/NIPA.

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$q = (I-A)^{-1} * f$ where f is all direct supply

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Information and Business Services	**13,657**	**8,307**	**74,968**	**78,706**	5,900
Other Services	2,290	1,278	26,240	35,751	938

Add it all up, compute “multipliers”

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Sources: U.S. BEA Industry Accounts, U.S. BLS Employment, Hours, and Earnings,
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Measuring the Embedded Rail Value in Final Consumer Goods

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Methodology

- Identify an *average price* for each product.
- Use I-O identity for *"total requirements"* of producing each good.

$$q = Aq + f$$
$$q = (I - A)^{-1} f$$

Where $(I - A)^{-1}$ is the "total requirements" matrix.

Each cell is the fraction from each input commodity (row) per each dollar of goods or services produced. Recognizes direct and indirect requirements.

- Find transport, wholesale and retail margins from PCE bridge. Separate *direct rail margin* from new transport margin with old PCE bridge.
- Compute *indirect rail content* in transport and trade margins with total requirements coefficients.

Rail content of the average refrigerator

Retail Price

Refrigerator - Dollars

Note: Average refrigerator producer price from Census CIR

	Producer Price	Transport Margin: Direct Rail Margin	Transport Margin: Indirect Rail Margin	Wholesale margin	Retail margin	Total margin	Purchaser's Value
Refrigerator	526.84	2.25	11.59	73.42	245.49	332.75	859.48
Rail content	6.70	2.25	0.13	0.07	0.28	2.73	**12.15**
							1.41%

TR_2007_Rail.xlsx - total rail requirements for each product

NAICS	335222	Trucking	Wholesale	Retail
Total Rail Requirements	0.0127	0.0112	0.0010	0.0011

PCE BRIDGE

(NewPCEBridge_2007_Detail.xlsx)

NIPA Line	PCE Category	Commodity Code	Commodity Description	Producers' Value	Transport Costs	Trade Margins: Wholesale	Trade Margins: Retail	Purchasers' Value	Year
28	Major househ	335222	Household ref	4951	130	690	2307	8077	2007
					0.026	0.139	0.466	1.631	

(Old_PCEBridge_ 1998-2011.xls)

NipaLine	Commodity Code	Commodity Description	Producers' value	Rail	Truck	Water	Air	Trade Margins: Wholesale	Trade Margins: Retail	Purchasers' value	Year
33	335	Electrical equi	23313	111	500	0	72	2889	11347	38232	2007
				0.163							

Autos and light trucks

Automobile, Domestic -- Dollars

	Producer Price	Transport Margin: Direct Rail Margin	Transport Margin: Indirect Rail Margin	Wholesale margin	Retail margin	Total margin	Purchaser's Value
Automobile	15552.68	150.09	297.15	1825.04	4440.45	6562.64	22265.41
Rail content	167.00	150.09	3.32	1.79	3.28	158.48	325.49
							1.462%

TR_2007_Rail.xlsx					
NAICS	336111	Trucking	Wholesale	Retail	
Total Rail Requirements	0.0107378	0.0111783	0.0009806	0.0007393	

Light Truck

	Producer Price	Transport Margin: Direct Rail Margin	Transport Margin: Indirect Rail Margin	Wholesale margin	Retail margin	Total margin	Purchaser's Value
Light Truck	24482.27	169.57	335.72	361.79	3724.31	4591.39	29073.66
Rail content	286.52	169.57	3.75	0.35	2.75	176.43	462.95
336112 Light Truck and Utility Vehicle Manufacturing							1.592%

TR_2007_Rail.xlsx				
NAICS	336112	Trucking	Wholesale	Retail
Total Rail Requirement	0.0117	0.0111783	0.0009806	0.0007393

	Purchaser's Price	Rail Content, Production	Rail Content, Delivery	Total Rail Content	Total Rail Content, Percent of Purchaser Price
Single Family Home	$ 185,698.85	$ 1,331.29	NA	$ 1,331.29	0.72%
Light Truck (SUV, etc.)	31,985.42	337.26	$ 103.49	$ 440.75	1.38%
Automobile	$ 24,239.08	$ 205.34	$ 93.80	$ 299.13	1.23%
Annual Grocery Bill	12,358.80	108.29	$ 30.62	$ 138.91	1.12%
Annual Electric Bill	$ 1,287.36	$ 22.79	NA	$ 22.79	1.77%
Refrigerator	970.34	8.05	$ 2.77	$ 10.82	1.12%
Washer / Dryer	$ 544.60	$ 4.42	$ 1.21	$ 5.63	1.03%
Dishwasher	529.21	4.25	$ 1.16	$ 5.41	1.02%

Washers, dryers, dishwashers

Laundry (Avg of Washer and Dryer)

	Producer Price	All transport	Wholesale margin	Retail margin	Total margin	Purchaser's Value
Laundry Machine	290.86	5.55	40.52	134.70	180.77	471.63
Rail content	3.64	0.95	0.04	0.21	1.21	4.85
						1.028%

TR_2007_Rail.xlsx						
NAICS	335224	Trucking	Wholesale	Retail		
Total Rail Requirement	0.0125	0.0111783	0.0009806	**0.0016**		

Dishwasher

	Producer Price	Transport Margin Direct Rail Margin	Indirect Rail Margin	Wholesale margin	Retail margin	Total margin	Purchaser's Value
Dishwasher	289.56	0.88	4.56	40.38	134.11	179.93	469.49
Rail content	3.83	0.88	0.05	0.04	0.10	1.07	4.91
							1.05%

TR_2007_Rail.xlsx	335228 Other Major Household Appliance Manufacturing					
NAICS	335228	Trucking	Wholesale	Retail		
Total Rail Requirement	**0.0132**	0.0111783	0.0009806	0.0007393		

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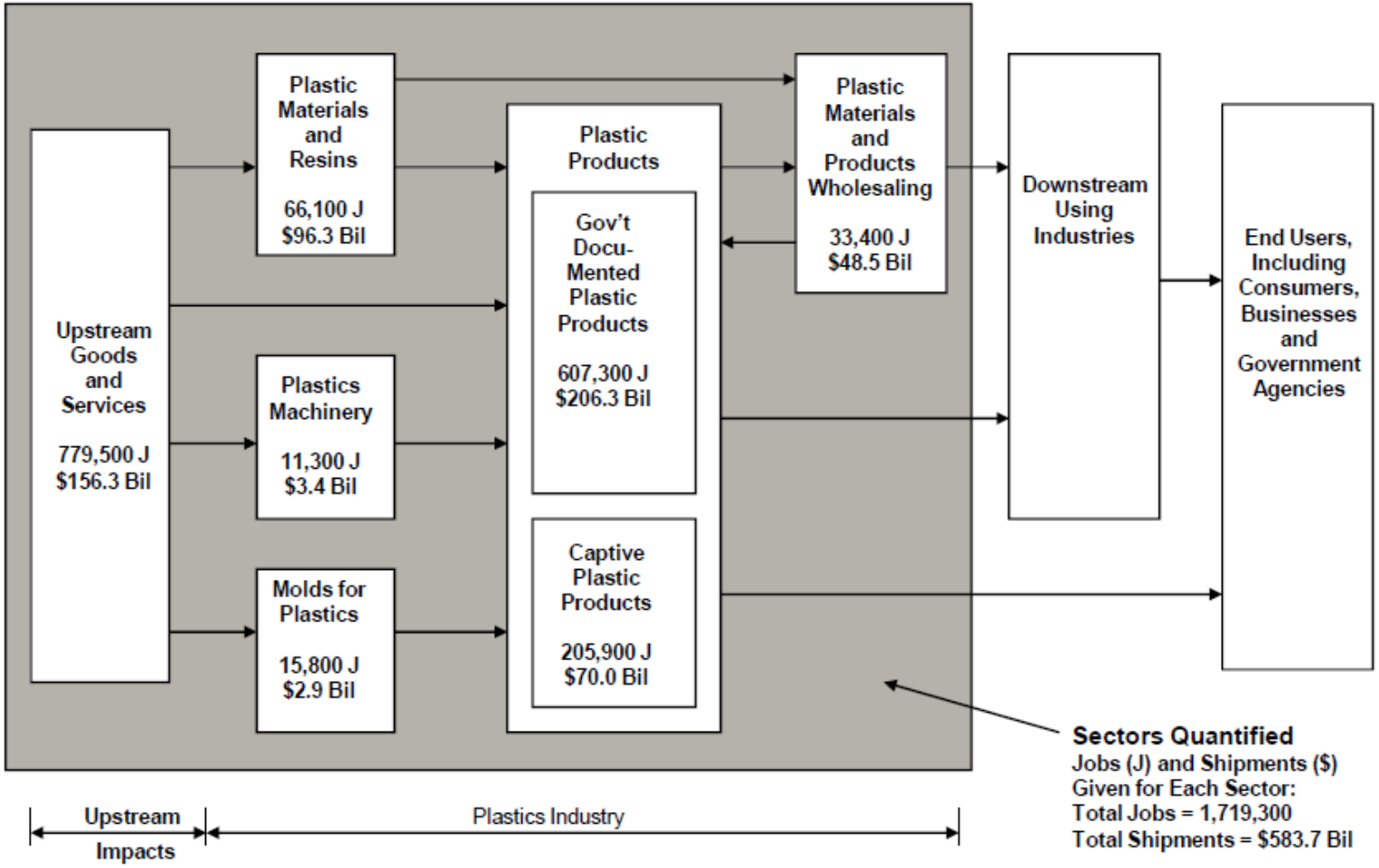
THE DEFINITION, SIZE AND IMPACT OF THE U.S. PLASTICS INDUSTRY

SELECTED DATA ON THE PLASTICS INDUSTRY, 2014

	Number of Estabs	Number Employees (Thous)	Annual Payroll ($Mill)	Average Production Workers (Thous)	Production Worker Wages ($Mill)	Value Added ($Mill)	Cost of Materials ($Mill)	Value of Industrial Shipments ($Mill)	Capital Expendi-tures ($Mill)
Plastics Manufacturing									
Plastics Materials and Resins, NAICS 325211	1,170	66.1	4,945.7	43.9	2,820.6	28,687.2	67,783.2	96,314.6	3,985.4
Custom Compounding, NAICS 325991	430	18.1	1,000.6	12.0	526.9	3,763.3	7,586.0	11,294.3	245.5
Plastics Bags, NAICS 326111	344	24.6	1,155.8	19.5	738.2	4,232.5	5,746.8	9,937.3	290.9
Plastics Packaging Film & Sheet, NAICS 326112	433	31.7	1,734.0	25.2	1,251.6	5,598.8	8,807.0	14,360.8	591.5
Plastics (Except Pkg) Film & Sheet, NAICS 326113	570	39.5	2,370.7	28.2	1,333.8	9,834.8	11,477.8	21,177.5	596.0
Plastics Profile Shapes, NAICS 326121	398	19.1	984.3	14.3	598.4	4,201.5	3,279.1	7,530.6	216.5
Plastics Pipe & Pipe Fittings, NAICS 326122	489	21.1	946.5	16.5	640.9	4,281.7	6,571.4	10,668.1	286.1
Laminated Plate, Sheet & Film, NAICS 326130	230	10.2	519.0	7.4	311.5	1,802.9	1,802.6	3,605.5	90.7
Polystyrene Foam Products, NAICS 326140	445	24.7	1,024.9	19.5	682.1	4,442.8	5,411.6	9,656.4	197.9
Urethane & Other Foam Products, NAICS 326150	632	28.5	1,285.7	21.5	734.2	4,148.6	6,550.1	10,889.1	181.2
Plastics Bottles, NAICS 326160	465	31.1	1,392.5	25.4	1,029.4	5,079.2	7,491.5	12,620.6	580.8
Other Plastics Product Manufacturing, NAICS 32619	6,663	359	15,379	274	9,367	48,433	46,404	94,556	3,509
Plastics Working Machinery, NAICS 3332201	432	11.3	661.4	6.7	294.1	1,592.0	1,660.0	3,375.8	66.1
Molds for Plastics, NAICS 33351105	700	15.8	865.3	12.2	601.5	1,806.3	1,086.5	2,892.8	175.4
Total Plastics Manufacturing	13,401	700.5	34,265.6	526.2	20,930.0	127,904.3	181,657.1	308,879.7	11,013.2
Wholesale Trade for Plastics Materials, Forms and Shapes (NAICS 424610)*	3,405	33.4	2,164.3	#N/A	#N/A	#N/A	#N/A	48,493.9	#N/A
Government Documented Plastics Industry	16,806	733.9	36,429.9	#N/A	#N/A	#N/A	#N/A	357,373.6	#N/A
Captive Plastic Products	#N/A	205.9	9,425.2	157.1	5,837.6	32,494.1	37,685.6	69,959.4	2,301.3
Plastics Industry Totals	#N/A	939.9	45,855.2	#N/A	#N/A	#N/A	#N/A	427,333.0	#N/A

* The Wholesale Trade for Plastics Materials, Forms and Shapes "shipments" figure of $48,493.9 million is actually a "sales" number and therefore does not include shipments among establishments of the same enterprise or company.

PLASTICS-RELATED GOODS AND SERVICES: IMPACTS OF PLASTICS QUANTIFIED, 2014



Plastics

- Upstream:

direct input:	$dq = A * q$
imported:	$dqm = m/dd * dq$
domestic:	$dqd = dq - dqm$
indirect input:	$iq = (I-A)^{-1} * dq$
domestic input:	$iqd = (I-AD)^{-1} * dq$

direct employment:	$e = dqd * en/qn$
indirect employment:	$e = iqd * en/en$

Plastics Content of Final Demand

- Downstream (final demand)

  l_{ij} = total requirements coefficient of product i into product j

  $$p_{ijk} = l_{ij} * fd_{jk}$$

  $$\sum_i p_{ijk} = q_i + m_i$$

What to do about the diagnol?

- Diagonal TR element general exceeds 1.0.
- Therefore standard total requirements calculation implies demand exceeds output for any given sector.
- Options:
  - Set $a_{ii} = 1.0$
  - Set all $aa_{ij} = a_{ij/} a_{ii}$