Microdynamics of Industrial Location

Work-in-progress

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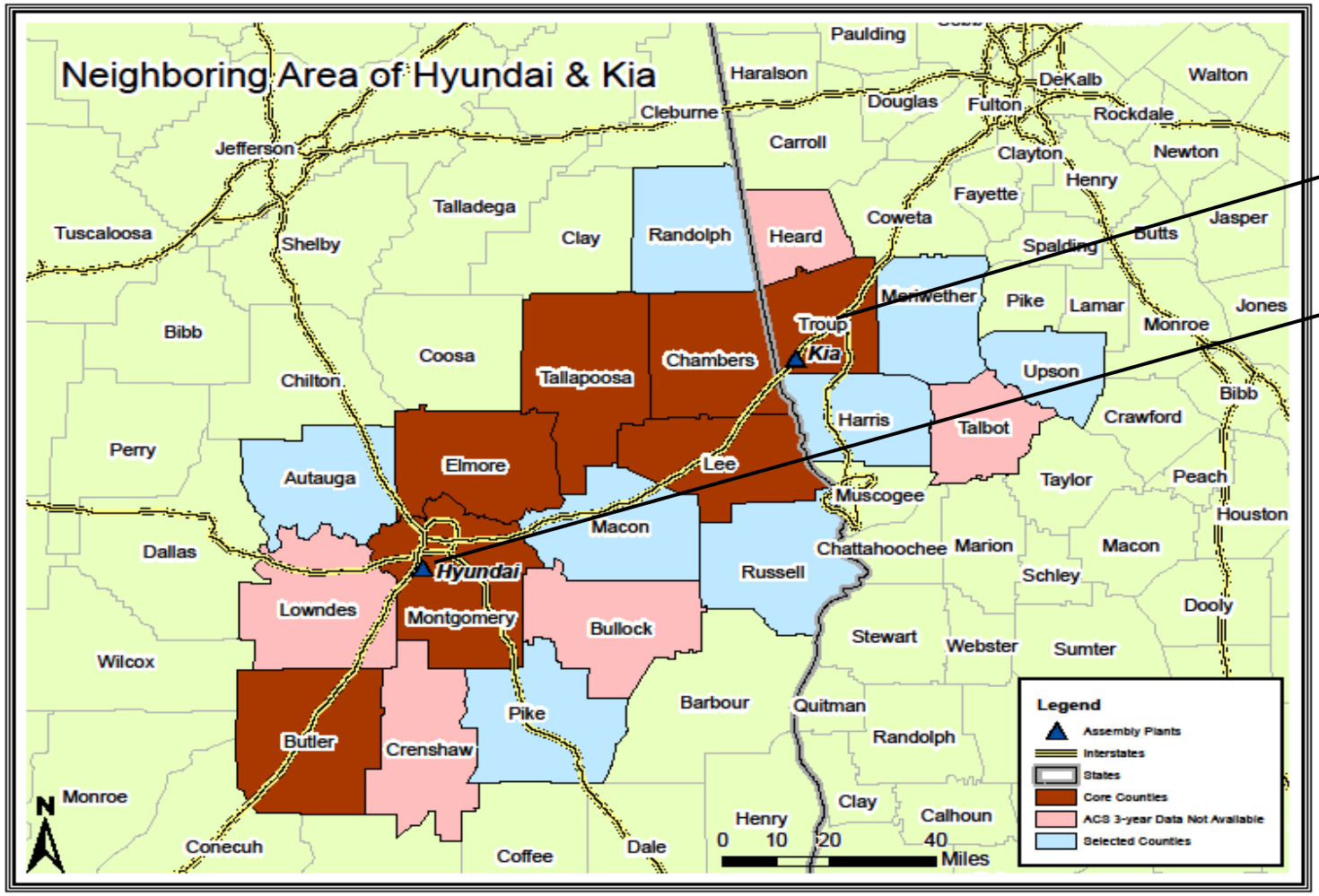
Motivation

- States and Nations offer incentives to attract businesses
- Project examines the effects of new industrial location
  - Shorter-run
    - Immediate employment and investment effects
    - Location of complementary businesses
  - Longer-run
    - Business and economic development of region
    - Development and infusion of human capital
    - Transportation networks, congestion, infrastructure investments
- Project is strictly work in progress
  - Completion date – December 2013
- Will overview framework and selected items today

Project Specifics
Automobile Assembly Plant Location

- Effects of location of Kia and Hyundai plants in GA and AL
  - Hyundai plant in AL, first autos produced in 2005
  - Kia plant in GA, first autos produced in 2009
- Kia plant in Troup County, GA
  - Truly rural county
  - GA offers $500 million in incentives
  - State-of-the-art advanced modern manufacturing facility locates in West Point, GA
  - Starts with 250,000 autos/year, now at 360,000 autos/year
  - Potential for radical transformative change for the region
  - Statistically identify effects
    - Typically this is a big challenge
    - Would not have been possible if this were Detroit
- Relatively clean ***natural experiment***
  - Troup County was rural with no existing business-economic base

Map 1 – Kia and Hyundai County Areas



Business and Economic Effects

- American Community Survey: we use two 3-year waves
  - 2005-2007, and 2008-2010
  - Perfect segmentation for the Kia experiment
    - Plant locates in 2008 November
  - We study wide-ranging effects – for example:
    - Changes in Population Migration
    - Changes in Occupations (manuf., retail, education, healthcare, etc)
    - Changes in Population and Income
    - Changes in Schooling
    - Changes in Educational Attainment
    - Car registrations

State	County	Core	Ss	ds	abr	popus	popfor	popnat	npop
			06-10	06-10	06-10	06-10	06-10	06-10	06-10
AL	AL		-0.16	-14.70	-14.97	3.48	28.77	25.05	30.43
AL	Autauga	0	37.09	4.33	-49.62	11.93	31.07	-30.79	120.76
AL	Bullock	0							
AL	Bulter	1	29.37	-21.98		2.41	565.00		
AL	Chambers	1	37.11	-38.80	136.67	-3.23	262.50	746.67	198.23
AL	Crenshaw	0							
AL	Elmore	1	-25.46	-22.47	-19.07	4.50	39.79	-9.80	83.41
AL	Lee	1	2.66	7.24	-18.63	8.98	41.00	3.41	57.86
AL	Lowndes	0							
AL	Macon	0	22.47	-31.52	231.82	-6.40	21.91	425.00	-87.50
AL	Montgomery	1	-2.50	3.83	-40.83	1.04	32.76	55.58	22.29
AL	Pike	0	-4.42	77.33	688.46	7.52	94.45	16.36	101.68
AL	Randolph	0	-32.69	-41.34	-12.96	0.14	161.54	78.57	192.11
AL	Russell	0	42.20	23.96	329.51	6.93	-17.73	-33.38	15.21
AL	Tallapoosa	1	-22.25	98.62	142.22	0.87	125.89	105.83	131.88
GA	GA		-5.95	-26.10	-25.61	3.15	11.89	29.17	3.92
GA	Atlanta MSA		-4.95	-33.54	-30.04	1.66	8.69	29.34	-0.71
GA	Harris	0	0.51	-71.79	12.12	14.24	-8.61	-1.35	-26.92
GA	Heard	0							
GA	Meriwether	0	86.80	-69.41	-90.00	-2.96	-25.60		
GA	Talbot	0							
GA	Troup	1	4.20	-28.74	335.09	4.56	92.27	116.92	83.67
GA	Upson	0	-20.75	-53.77	-100.00	-1.37	-0.21	101.03	-26.26

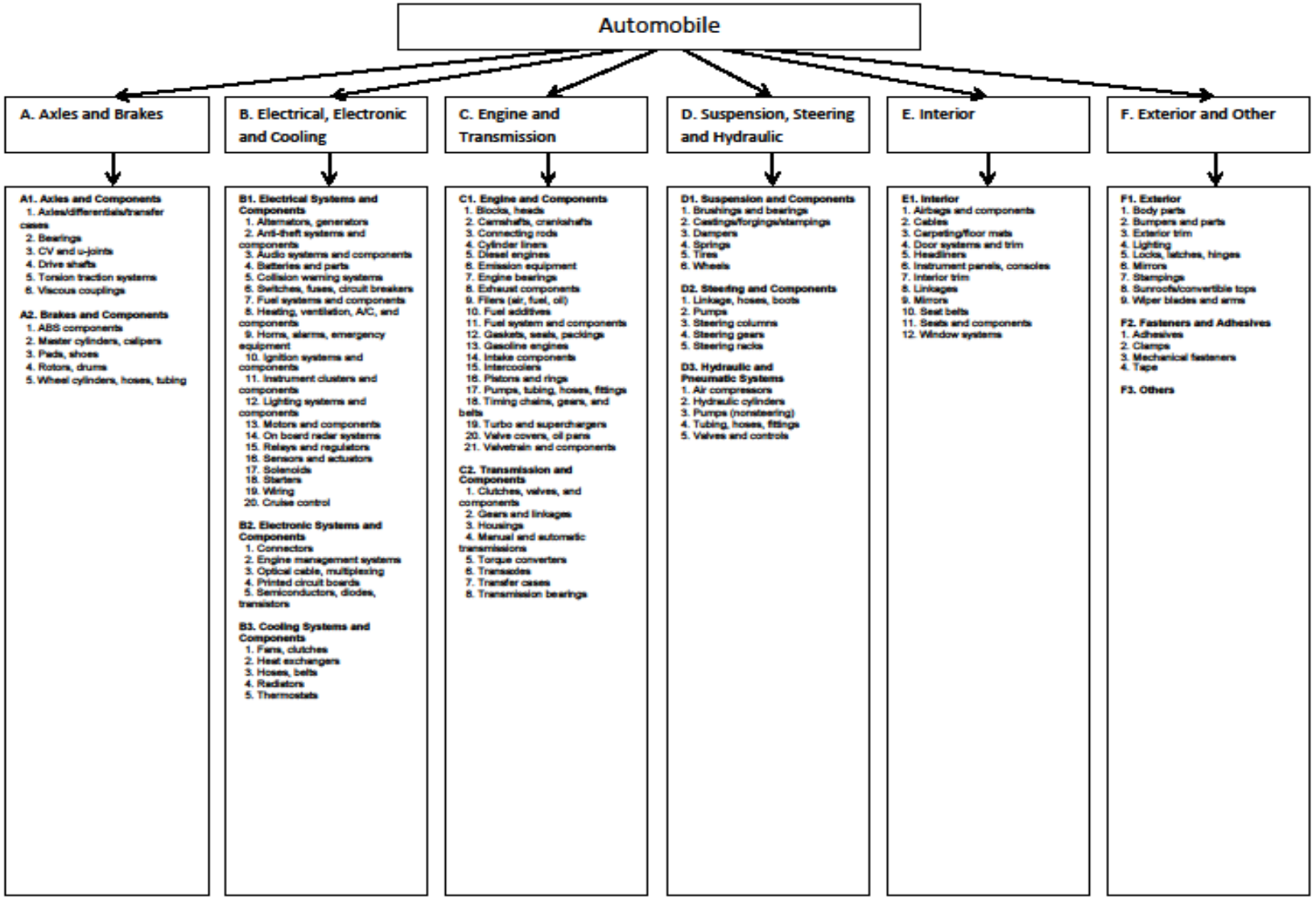
Population Migration Patterns

State	County	Core	tclfm	tclfse	tclfsa	tclfeco	tclfem	tclfews	tclfere	tclfetra	tclfefin	tclfeedu
			06-10	06-10	06-10	06-10	06-10	06-10	06-10	06-10	06-10	06-10
AL	AL		5.18	10.32	-1.58	-13.86	-11.68	-22.22	-2.16	-3.12	-5.15	8.49
AL	Core Avg.		14.59	10.36	-5.26	-25.67	-18.17	-15.81	8.55	-2.00	-17.71	22.14
AL	Non-core Avg.		12.78	10.11	-1.96	-18.24	15.59	-37.17	-15.45	-1.33	-19.09	18.32
AL	Autauga	0	14.76	10.74	0.48	-31.19	-14.74	-14.77	5.71	48.87	9.09	30.51
AL	Bullock	0										
AL	Bulter	1				-10.76	-46.48	26.83	14.65	12.06	-10.74	2.09
AL	Chambers	1	9.57	-20.14	-11.92	-38.1	-36.25	-8.09	2.49	-25.89	3.59	8.64
AL	Crenshaw	0										
AL	Elmore	1	37.94	39.53	2.14	-32.36	4.21	-7.9	13.42	-27.72	-4.49	60.83
AL	Lee	1	7.25	16.99	-2.84	-21.37	-6.27	-34.97	2.99	17.82	-18.89	11.81
AL	Lowndes	0										
AL	Macon	0	-24.52	12.08	-22.55	0	66.36	-63.48	-28.47	8.8	-77.44	-2.75
AL	Montgomery	1	-1.74	15.23	0.51	-23.39	-10.29	-10.81	2.02	0.4	-14.4	6.21
AL	Pike	0	11.9	3.62	3.84	-14.81	20.41	-23.22	-16.44	-24.43	-24.39	15.3
AL	Randolph	0	28.07	-13.99	4.22	-32.07	0.29	-51.32	-39.17	-20.85	-17.75	14.03
AL	Russell	0	33.7	38.09	4.22	-13.13	5.63	-33.04	1.12	-19.04	15.03	34.53
AL	Tallapoosa	1	19.93	0.17	-14.19	-28.05	-13.92	-59.89	15.72	11.36	-61.3	43.28
GA	GA		3.43	6.87	-5.45	-25.8	-10.55	-15.06	-1.2	-5.59	-12.85	10.64
GA	Core Avg.		-4.47	-3.56	0.51	-31.39	-10.36	-12.70	19.05	17.66	6.79	-1.17
GA	Non-core Avg.		8.65	4.13	3.46	-24.14	-20.08	20.57	7.17	-22.44	-40.05	31.29
GA	Atlanta MSA		1.36	7.45	-7.96	-27.54	-5.44	-15.39	-3.16	-5.97	-15.98	10.11
GA	Harris	0	28.81	2.91	1.16	-3.09	1.05	128.89	2.71	-7.86	-31.47	58.56
GA	Heard	0										
GA	Meriwether	0				-34.52	-23.94	2.35	22.71	-35.41	-33.68	7.69
GA	Talbot	0										
GA	Troup	1	-4.47	-3.56	0.51	-31.39	-10.36	-12.7	19.05	17.66	6.79	-1.17
GA	Upson	0	-11.51	5.35	5.75	-34.8	-37.36	-69.54	-3.92	-24.05	-54.99	27.62

Occupational Patterns

Automotive Supply Chain

- An automobile has several thousand components
- We construct somewhat aggregated supply-chain
- Purpose?
  - Allows us to identify and track components
  - Distinguishes components by category


Automobile
A. Axles and Brakes
B. Electrical, Electronic and Cooling
C. Engine and Transmission
D. Suspension, Steering and Hydraulic
E. Interior
F. Exterior and Other
A1. Axles and Components
1. Axles/differentials/transfer cases
2. Bearings
3. CV and u-joints
4. Drive shafts
5. Torsion traction systems
6. Viscous couplings
A2. Brakes and Components
1. ABS components
2. Master cylinders, calipers
3. Pads, shoes
4. Rotors, drums
5. Wheel cylinders, hoses, tubing
B1. Electrical Systems and Components
1. Alternators, generators
2. Anti-theft systems and components
3. Audio systems and components
4. Batteries and parts
5. Collision warning systems
6. Switches, fuses, circuit breakers
7. Fuel systems and components
8. Heating, ventilation, A/C, and components
9. Horns, alarms, emergency equipment
10. Ignition systems and components
11. Instrument clusters and components
12. Lighting systems and components
13. Motors and components
14. On board radar systems
15. Relays and regulators
16. Sensors and actuators
17. Solenoids
18. Starters
19. Wiring
20. Cruise control
B2. Electronic Systems and Components
1. Connectors
2. Engine management systems
3. Optical cable, multiplexing
4. Printed circuit boards
5. Semiconductors, diodes, transistors
B3. Cooling Systems and Components
1. Fans, clutches
2. Heat exchangers
3. Hoses, belts
4. Radiators
5. Thermostats
C1. Engine and Components
1. Blocks, heads
2. Camshafts, crankshafts
3. Connecting rods
4. Cylinder liners
5. Diesel engines
6. Emission equipment
7. Engine bearings
8. Exhaust components
9. Filters (air, fuel, oil)
10. Fuel additives
11. Fuel system and components
12. Gaskets, seals, packings
13. Gasoline engines
14. Intake components
15. Intercoolers
16. Pistons and rings
17. Pumps, tubing, hoses, fittings
18. Timing chains, gears, and belts
19. Turbo and superchargers
20. Valve covers, oil pans
21. Valvetrain and components
C2. Transmission and Components
1. Clutches, valves, and components
2. Gears and linkages
3. Housings
4. Manual and automatic transmissions
5. Torque converters
6. Transaxles
7. Transfer cases
8. Transmission bearings
D1. Suspension and Components
1. Bushings and bearings
2. Castings/forgings/stampings
3. Dampers
4. Springs
5. Tires
6. Wheels
D2. Steering and Components
1. Linkage, hoses, boots
2. Pumps
3. Steering columns
4. Steering gears
5. Steering racks
D3. Hydraulic and Pneumatic Systems
1. Air compressors
2. Hydraulic cylinders
3. Pumps (nonsteering)
4. Tubing, hoses, fittings
5. Valves and controls
E1. Interior
1. Airbags and components
2. Cables
3. Carpeting/floor mats
4. Door systems and trim
5. Headliners
6. Instrument panels, consoles
7. Interior trim
8. Linkages
9. Mirrors
10. Seat belts
11. Seats and components
12. Window systems
F1. Exterior
1. Body parts
2. Bumpers and parts
3. Exterior trim
4. Lighting
5. Locks, latches, hinges
6. Mirrors
7. Stampings
8. Sunroofs/convertible tops
9. Wiper blades and arms
F2. Fasteners and Adhesives
1. Adhesives
2. Clamps
3. Mechanical fasteners
4. Tape
F3. Others

Microeconometric Analysis

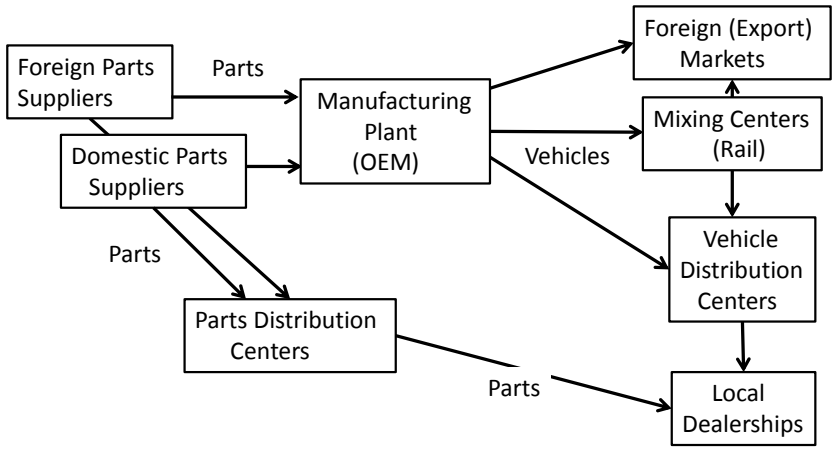
- Estimate multipliers for each of our business and economic variables
  - Paper by Greenstone 2010 provides good review and framework related to theory and econometrics

- Estimate multipliers for **transportation** related effects
  - Demand for transportation is "derived" demand – from area business and economic growth

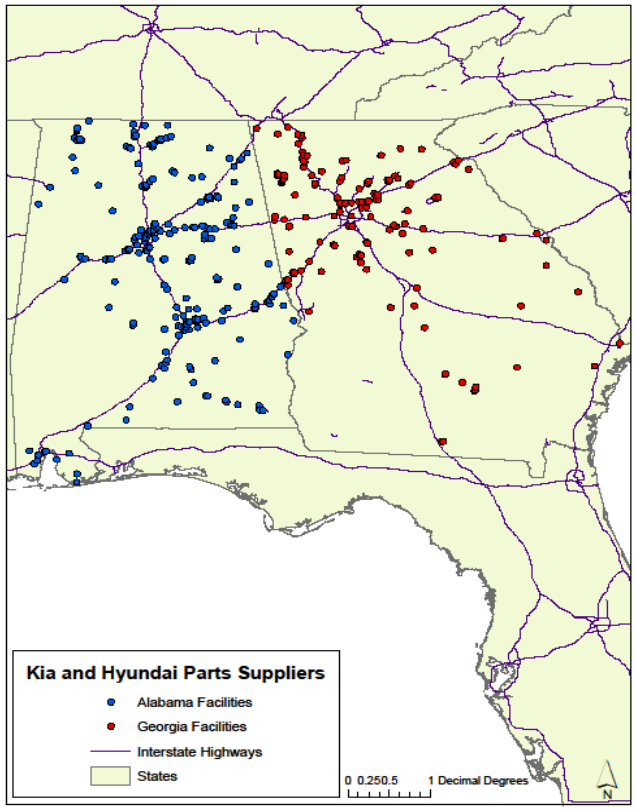
Tracking The Automotive Supply Chain

- Track component suppliers who locate locally
- Track component suppliers from further away: S. Korea, Japan, Germany, Thailand, among others
- Track component inflows
- Demand for transportation, by mode

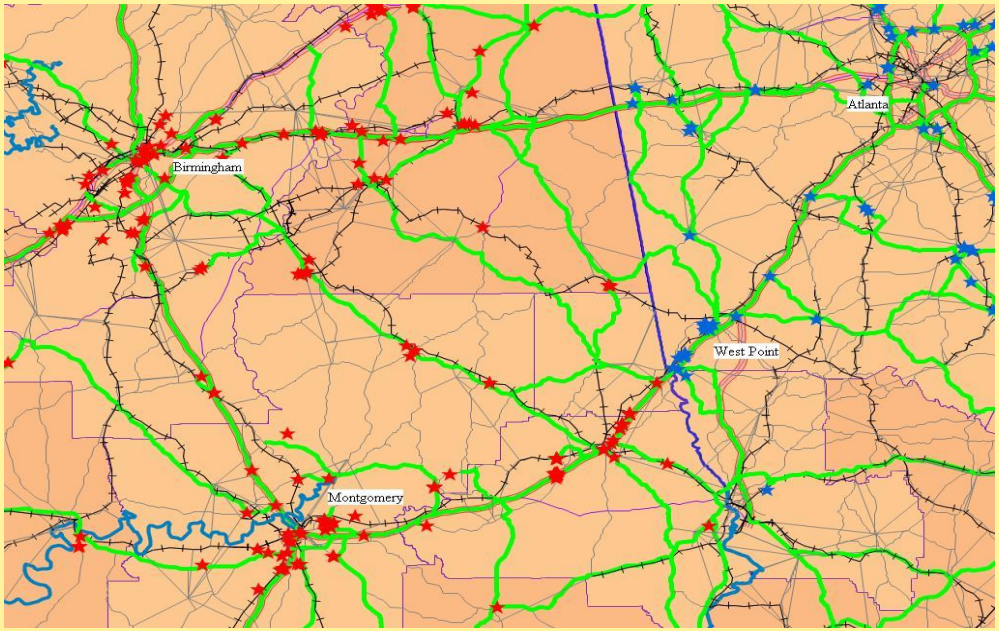
Transportation Links in An Automotive Industry Supply Chain (Generic)



Supply Chain – Local Component Suppliers & Truck Routes



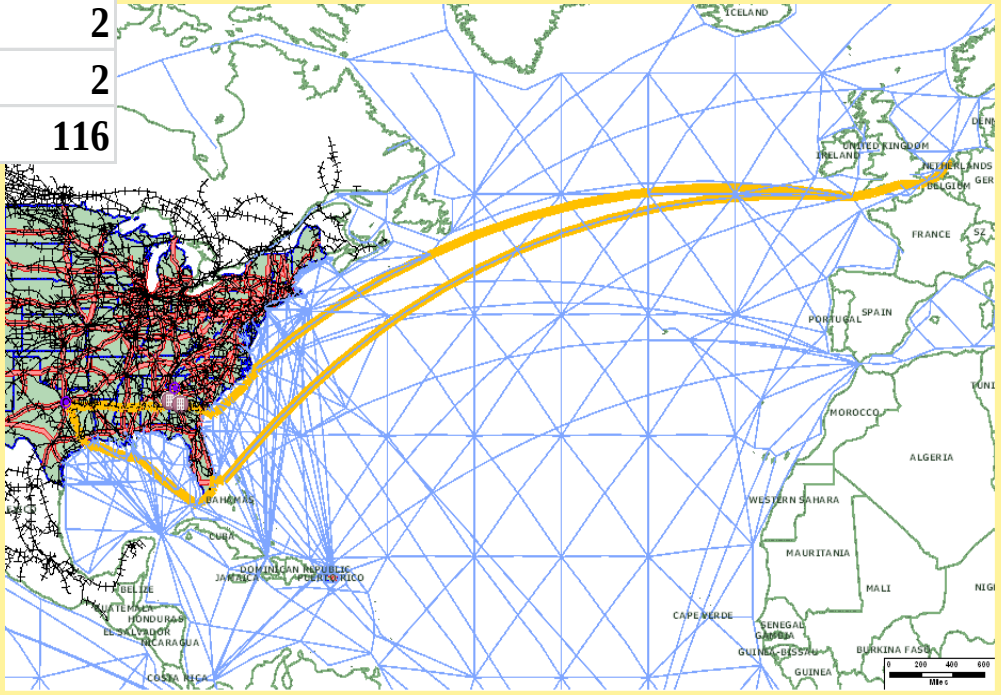
We have created a database that contains both local and foreign parts suppliers for the Hyundai and Kia plants located in AL and GA.



Supply Chain- Global Component Suppliers & Intermodal Transportation Links

Foreign Suppliers:

Country	GA: Suppliers	AL: Suppliers	Total
Korea	18	38	56
US	4	45	49
Japan	2	5	7
Germany	0	2	2
Others	0	2	2
Total	24	92	116



Shipping Data

- Completed and analyzing port shipping data for inflow of components
  - Savannah (GA), Brunswick (GA), Mobile (AL)
- Shipments in and out
  - Hyundai, Kia
  - Local component suppliers – as much as possible
- Once this is done – at least a reasonable snapshot
  - We know exact auto models being built and their production volumes
  - We know major components per auto
  - Shipping volumes
  - **Focus is on only major components**

Transportation – Freight Supply Chains & Their Costs

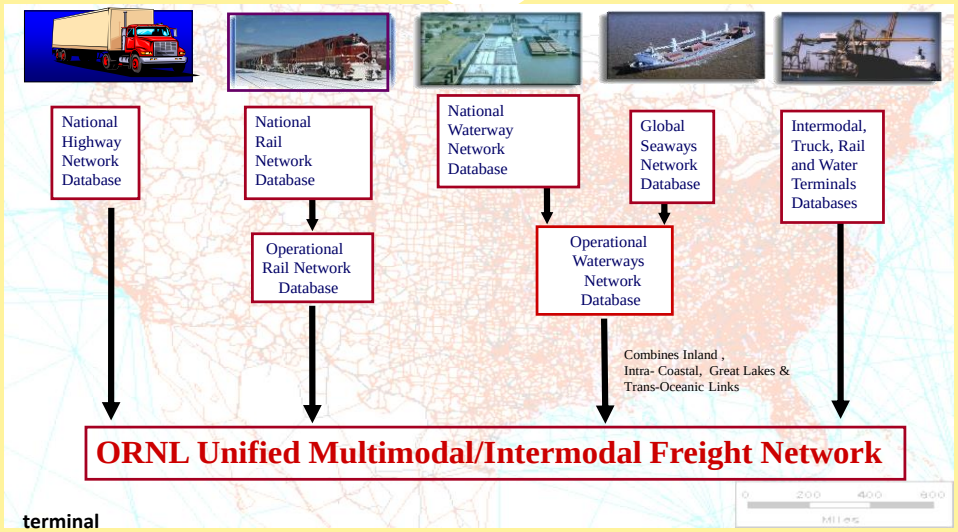
Freight flows: detailed data on local supplier volumes (various sources) and global import shipments (proprietary data source)

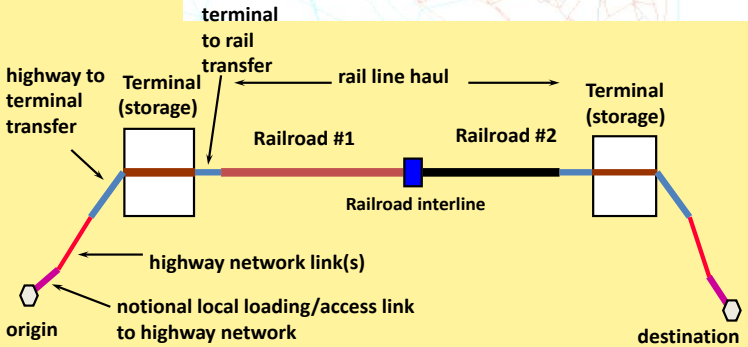
Multimodal/Intermodal/International freight transportation network database: We are currently adding links and nodes to the latest version of the ORNL North America/Trans-Oceanic Freight Network (public domain) database: as used to route freight in past U.S. Commodity Flow Surveys.

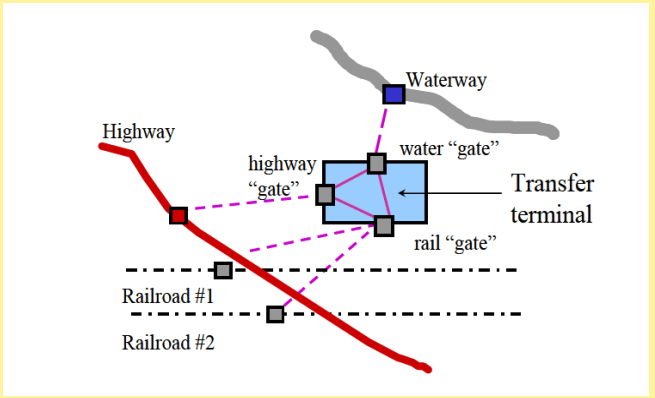
Freight transport cost modeling: of raw materials, auto parts, finished autos, estimated transport costs between supply chain participants and SC "tiers", using a number of different sources (ATRI, CFIRE, ITIC-ST, LMT, STB, WFR)

Network links carry mode specific line haul, intermodal transfer and warehouse/ distribution center/seaport storage and handling costs.

Multimodal/Intermodal Transportation Routing & Freight Cost Modeling – Network Database



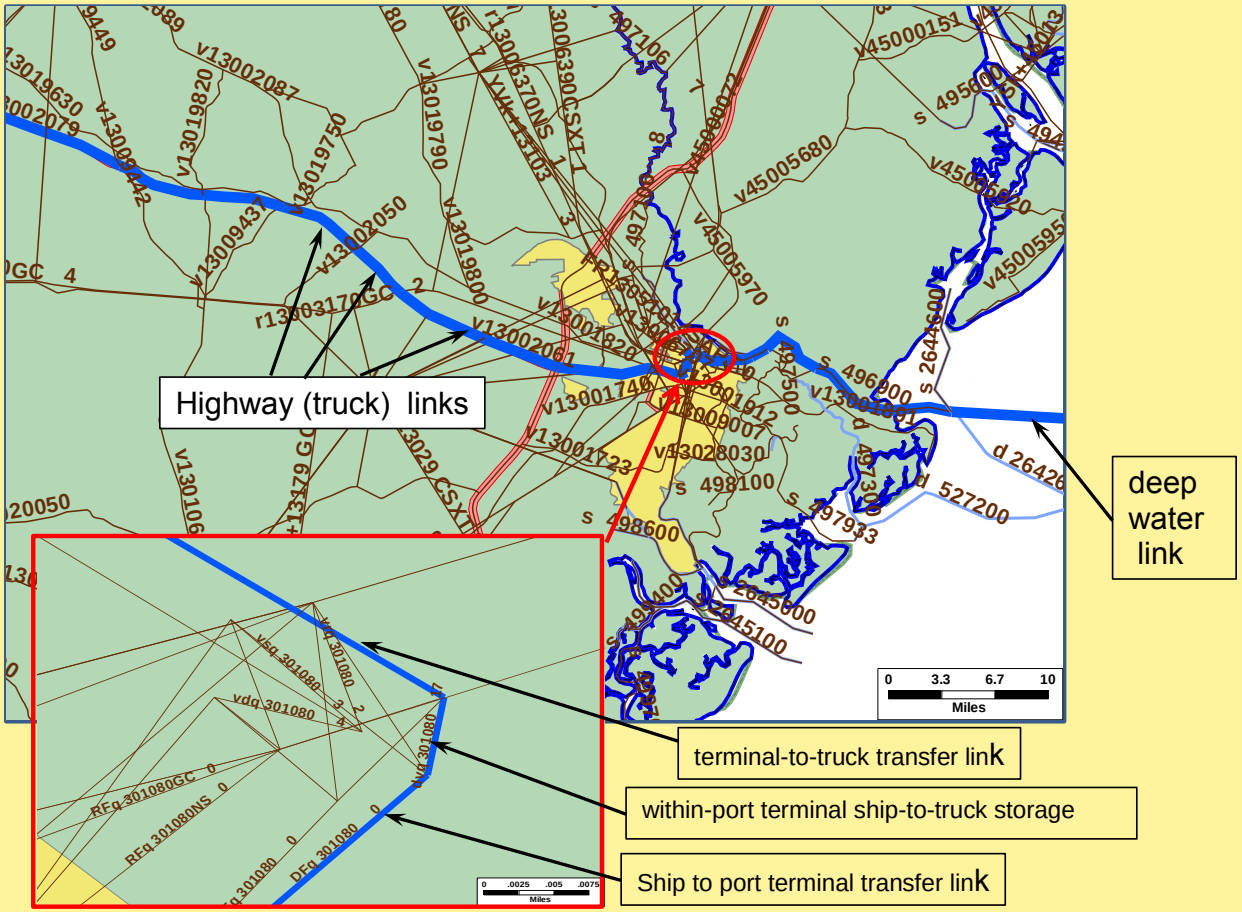




Route Impedance = modal line-haul travel costs
+ intra-terminal storage/holding costs
+ inter-carrier (interlining) costs
+ local network to terminal transfer costs
+ terminal to local network transfer costs

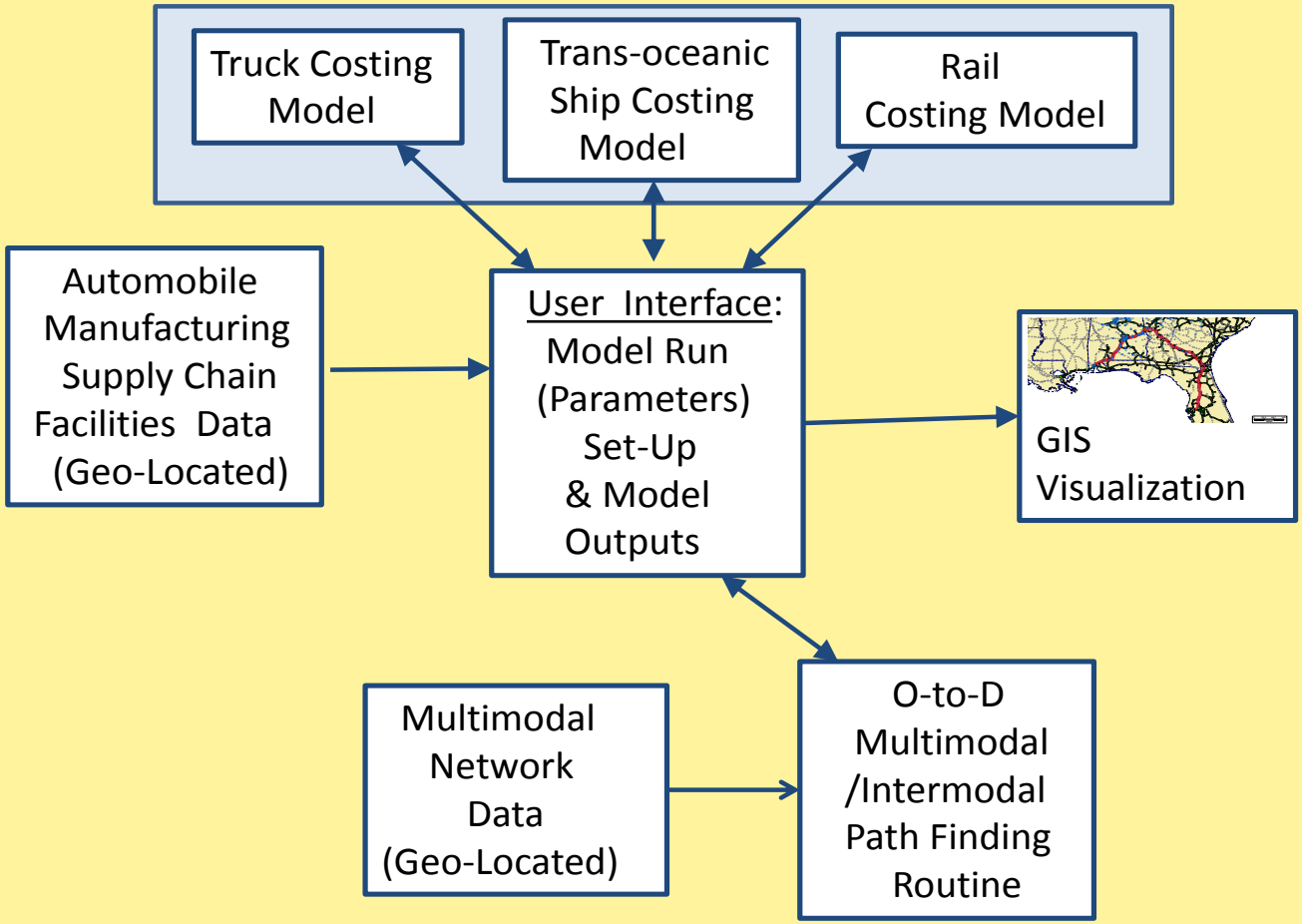
Simulating Flows Through A Seaport (Savannah)

Example of Link-Node Based Deep Sea to Truck Transfer: Port of Savannah, GA

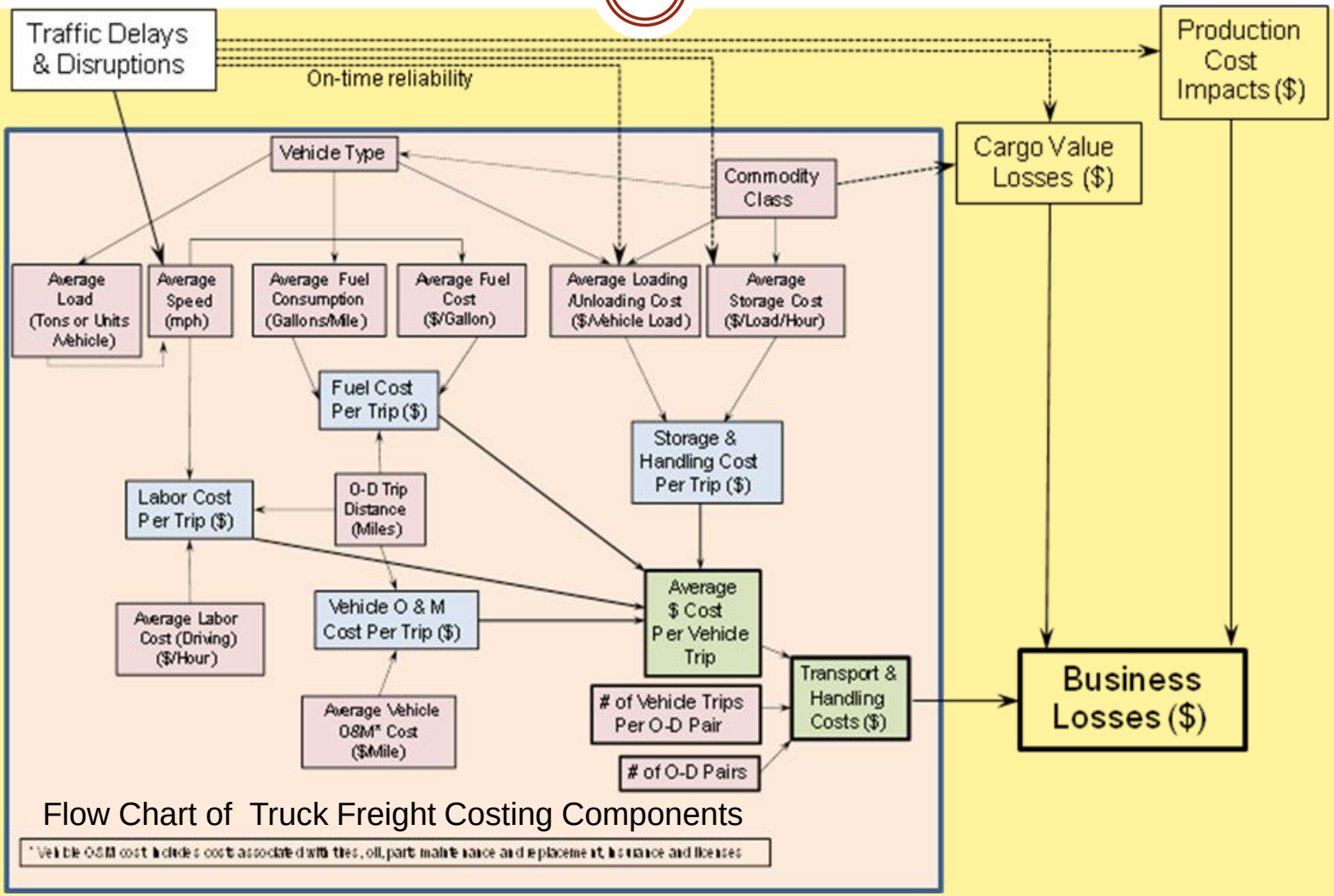


Multimodal/Intermodal Transportation Routing & Freight Cost Modeling

Freight Routing Supply Chain (FRSC) Model – In Progress DRAFT



Candidate extended freight costing mode (Draft)



Flow Chart of Truck Freight Costing Components

Prototype User Interface for FRSC Model

Input Parameters for Running FRSCMOD:

Set Mode Specific Routing Impedance Factors:

(Ctrl m = All Modes; Ctrl h = Highway; Ctrl r = Rail ; Ctrl n = Non-Rail; Ctrl p = Air)

Highway	Rail	Inland Water	Great Lakes	Deep Sea	Air
1	1000	1000	1000	1000	1000

READ IN MODEL INPUTS

Set Intermodal Terminal Transfer (DEFAULT =2) and Throughput Impedances (DEFAULT =1):

2	1

Run FRSCMOD

Set Origin Facility and Destination Facility TIERS for this model run:

3	7

UPDATE Model OUTPUTS

Set ICP = 1 for travel time based routing (DEFAULT); = 2 for distance based routing

1

Set ISEA = 1 to include deep water links, = 0 to leave these links out of routing (model runs MUCH faster)

0

Highway	Rail	Inland Water	Great Lakes	Deep Sea	Air
MODE SPECIFIC DEFAULT AVERAGE TRAVEL SPEEDS (in MPH)*					
60	22	20	24	25	400
RAGE VEHICLE TRAVEL COSTS/HOUR (in DOLLARS)					
56	30	20	15	10	100
ERMINAL TRANSFER TIMES (in MINUTES)*					
60	120	120	120	120	120
MINAL TRANSFER COSTS/HOUR (in DOLLARS)					
15	15	15	15	15	15

Average Within Rail Terminal Holding Times (in minutes) and Costs (in $/hour):

240	5

Average Within Seaport Terminal Holding Times (in minutes) and Costs (in $/hour):

300	5

Average Within Airport Terminal Holding Times (in minutes) and Costs (in $/hour):

300	5

Microeconometric Analysis

- Business and economic effects
  - Clear natural experiment
  - Core v. non-core counties
  - Controls: State-wide, as well as State largest Metro area
    - E.g., GA and Atlanta, MSA controls
    - Then examine effects of location

- Once supply-chain and shipping data are complete
  - Effects on transportation
  - Congestion issues
  - Potential necessary investments to facilitate smooth functioning of supply chain and sustain economic development