Microdynamics of Industrial Location

Work-in-progress

Vivek Ghosal*

Professor, School of Economics
Georgia Institute of Technology
Atlanta USA

Frank Southworth

Principal Research Scientist
School of Civil & Environmental Engineering
Georgia Institute of Technology
Atlanta USA

*Contact author

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, etc
- Project is strictly work in progress
  - Completion date – December 2013
- Will overview 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, 2005
  - Kia plant in GA, late-2008
- Kia plant in Troup County, GA
  - Truly rural county
  - GA offers $500 million in incentives
  - State-of-the-art advanced modern manufacturing facility locates
  - Start with 250,000 cars/year, now at 360,000/year
  - Potential for radical transformative change for region
  - Statistically identify effects
    - Typically this is a big challenge
    - Would not have been possible if this were Detriot
- Relatively clean ***natural experiment***

Maps – U.S. Southeast Region

Kia, 2008

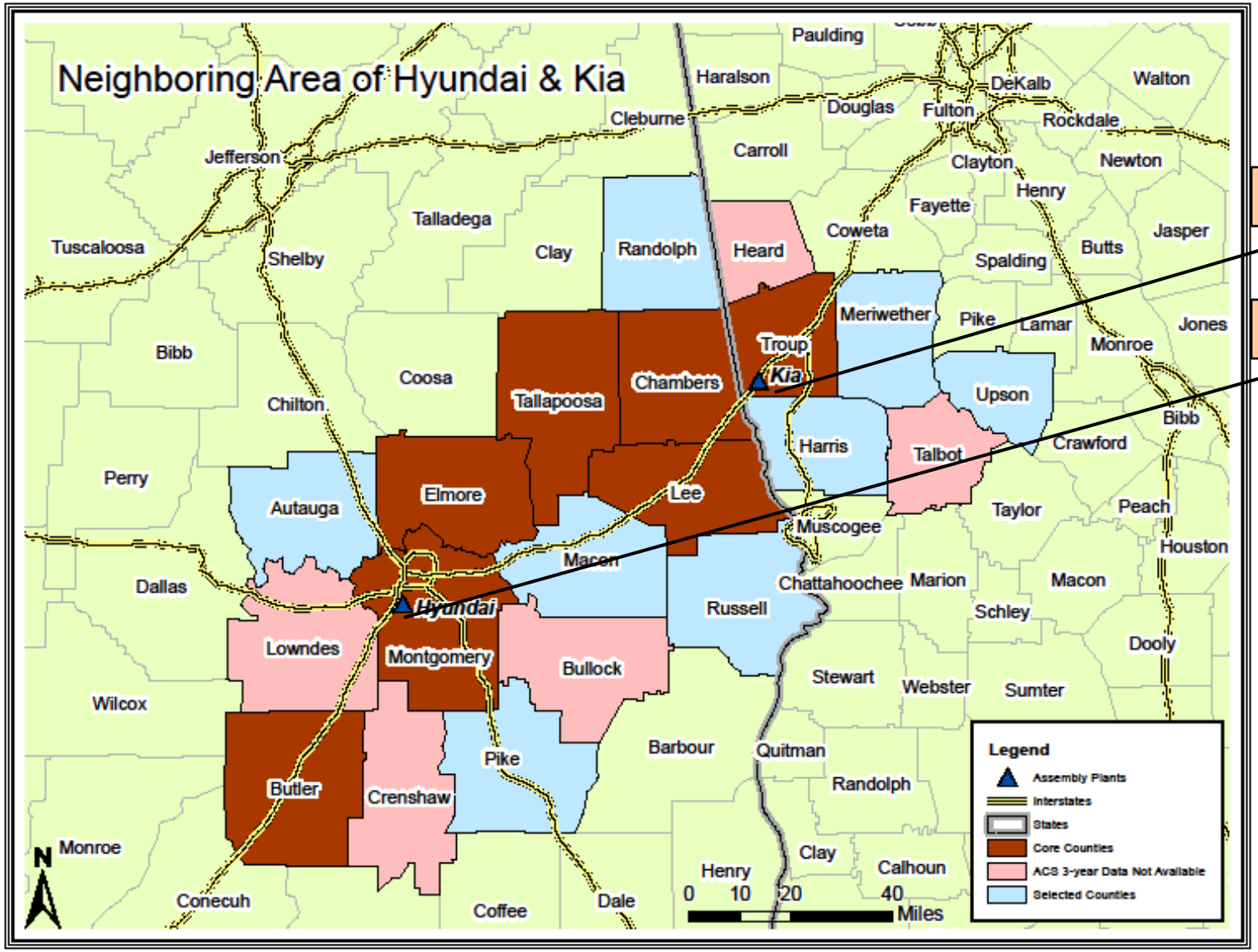
Hyundai, 2005

Savannah, GA

Brunswick, GA

Mobile, AL

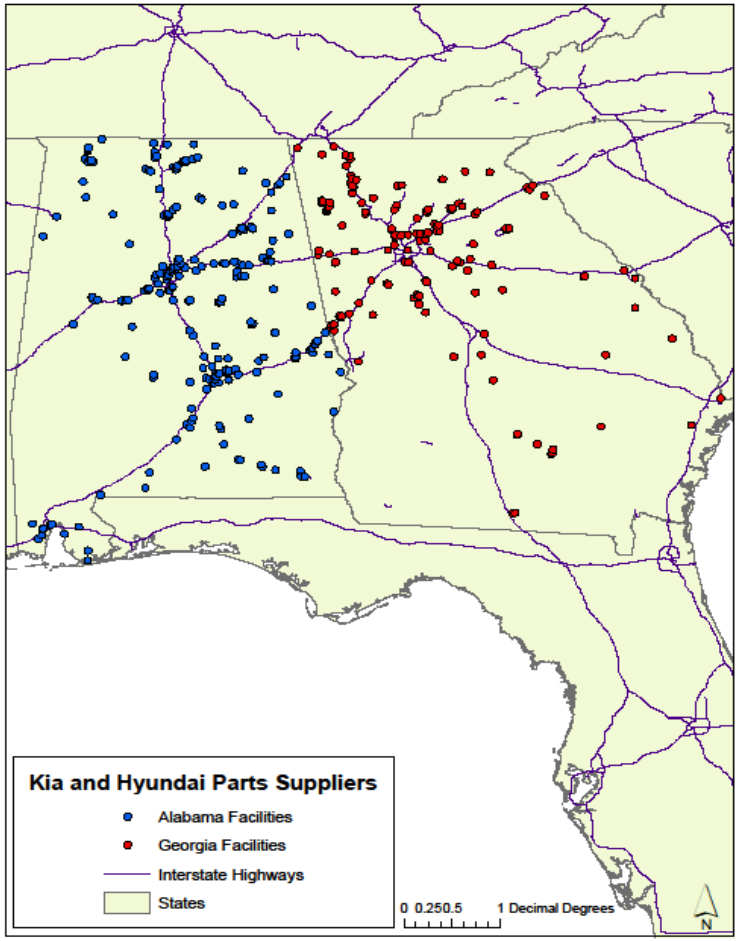
Map 1 – Kia and Hyundai County Areas



Kia, 2008

Hyundai, 2005

Map 2 – Local Component Suppliers



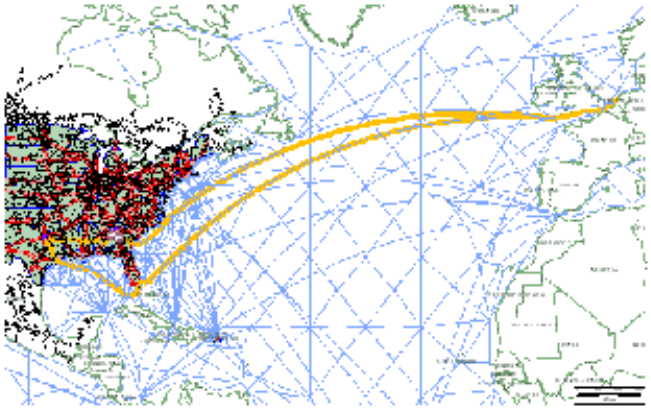
Map 3 – Multimodal Shipping

Multimodal Shipment Routings

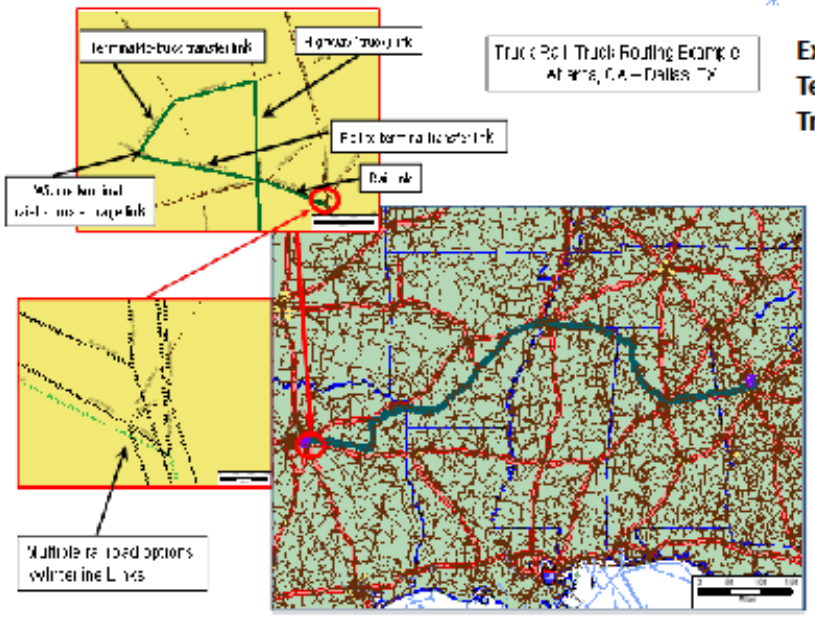
incorporating:

1) Line-haul Links
+2) Storage Links
+3) Intermodal Transfer Links

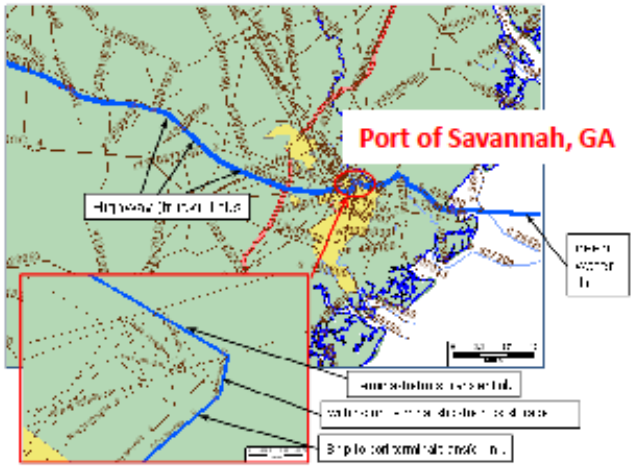
Example Trans-Oceanic-Overland Network Routings:



Example Truck-Rail-Truck Network Routing:

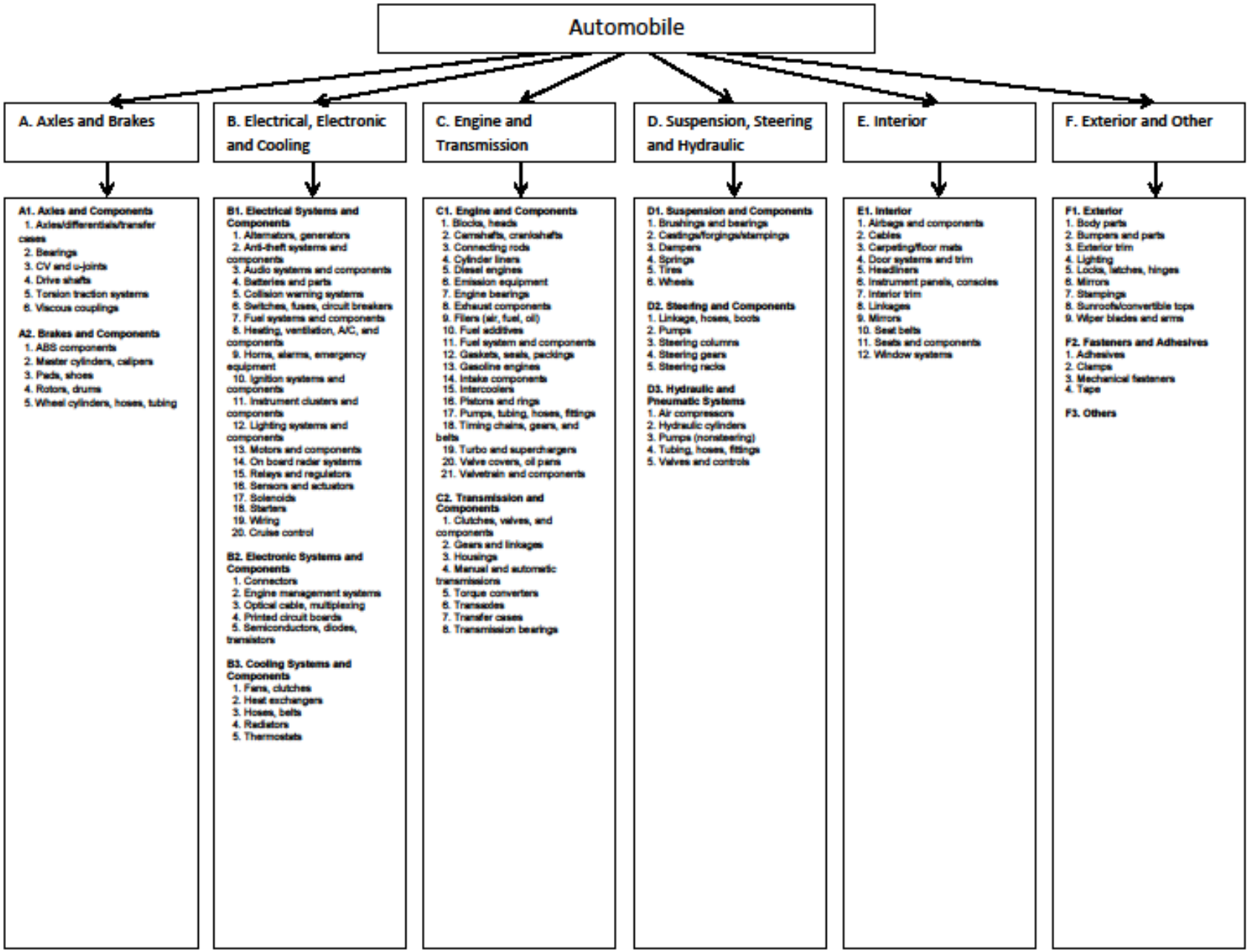


Example Routing Showing Ship-to-Port Terminal, Terminal Storage, Terminal-to-Truck Transfer and Truck Line-Haul Links



Automotive Supply Chain

- Automobile has several thousand components
- We construct somewhat aggregated supply-chain
- Purpose?
  - Allows us to identify and track components
  - Distinguish 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

Automotive Supply Chain

- Track component suppliers who locate locally
- Suppliers from further away
- Track flows
- Demand for transportation, by mode

Automotive Component Suppliers

- We track every component supplier for Hyundai and Kia locating in AL and GA

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

- Local and global supply chain patterns

Shipping Data

- Collecting port shipping data
  - 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 models and production volumes
  - We know major components per car, obtain multiple
  - Shipping volumes
  - **Focus on only major components**
    - **Examples**

Business and Economic Effects

- American Community Survey, 3-year waves
  - 2005-2007
  - 2008-2010
  - Perfect segmentation for the Kia experiment
    - Plant locates in 2008 November
  - Effects – for example:
    - Changes in Population and Income
    - Changes in Occupations (manf, retail, education, healthcare, …etc)
    - Changes in Schooling
    - Changes in Educational Attainment
    - Car registrations
    - Changes in Population Migration

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

Microeconometric Analysis

- Estimate multipliers for each of our business and economic variables

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

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
  - Potential necessary investments to facilitate smooth functioning of supply chain and sustain economic development