

Integration of North America's auto industry: geography of vehicle production and parts sourcing

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Graduate student lecture

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June 15, 2018

Sao Paulo, Brazil

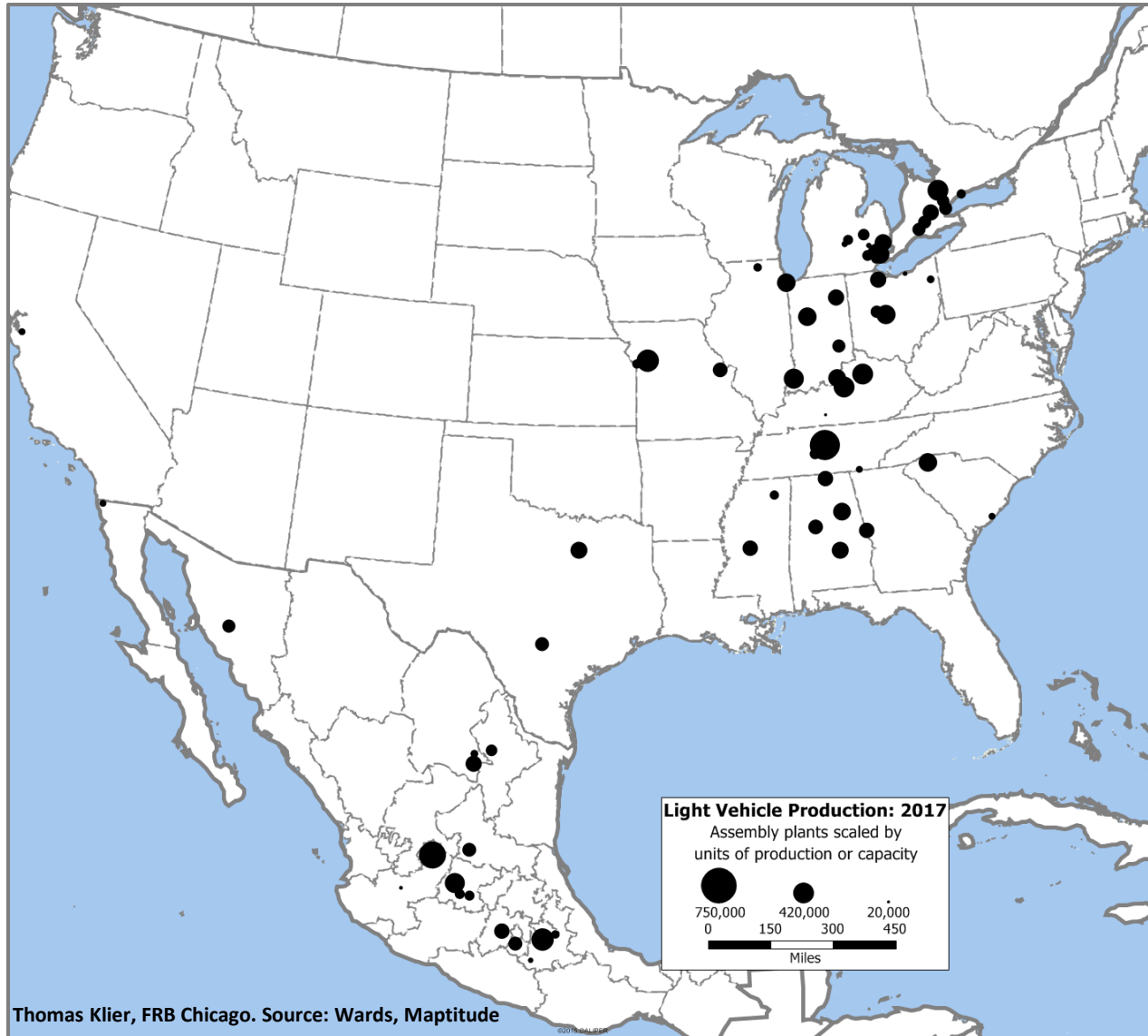
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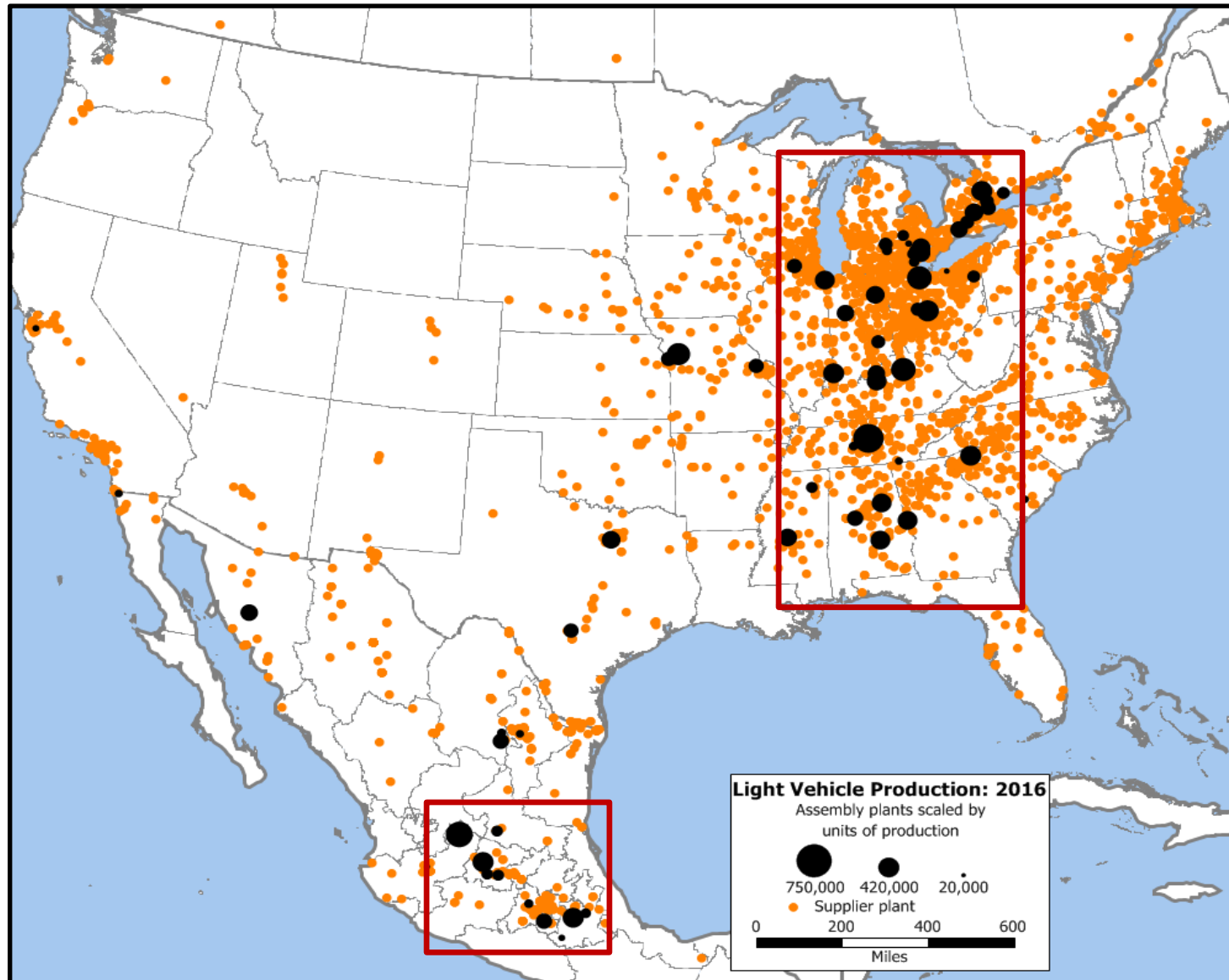
Outline

- Light vehicle production
 - Geography of production
 - Localization vs globalization
 - Changes within North America
 - Internationalization
- Vehicle parts sourcing
 - Measurement issues Two microdata-based measures

Auto industry is spatially concentrated



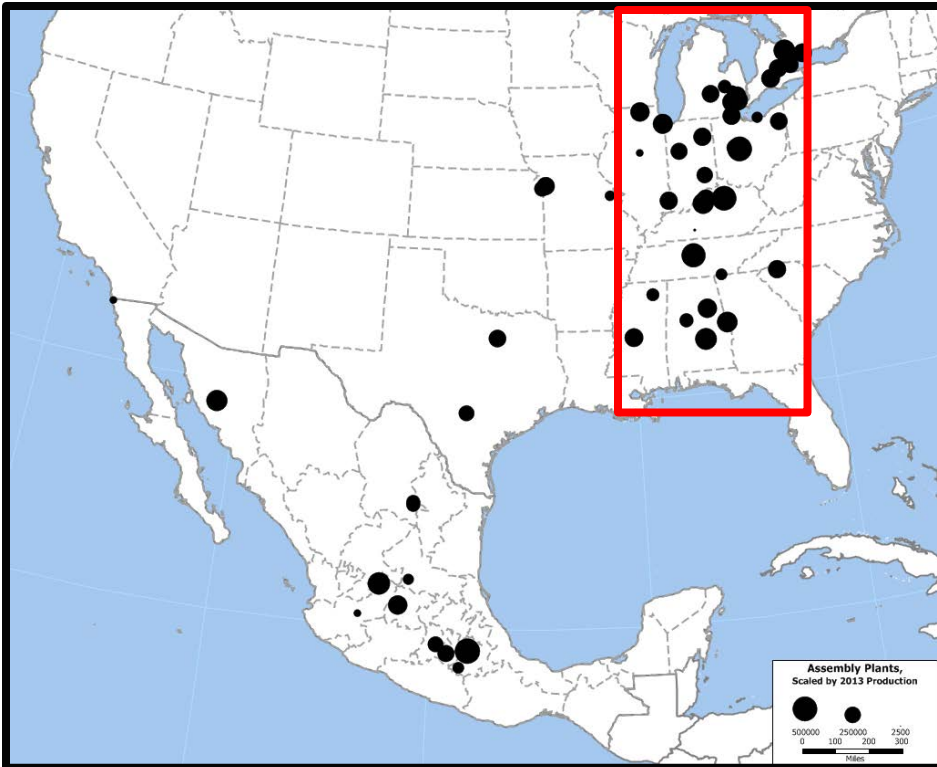
Parts and vehicle assembly co-locate



2016

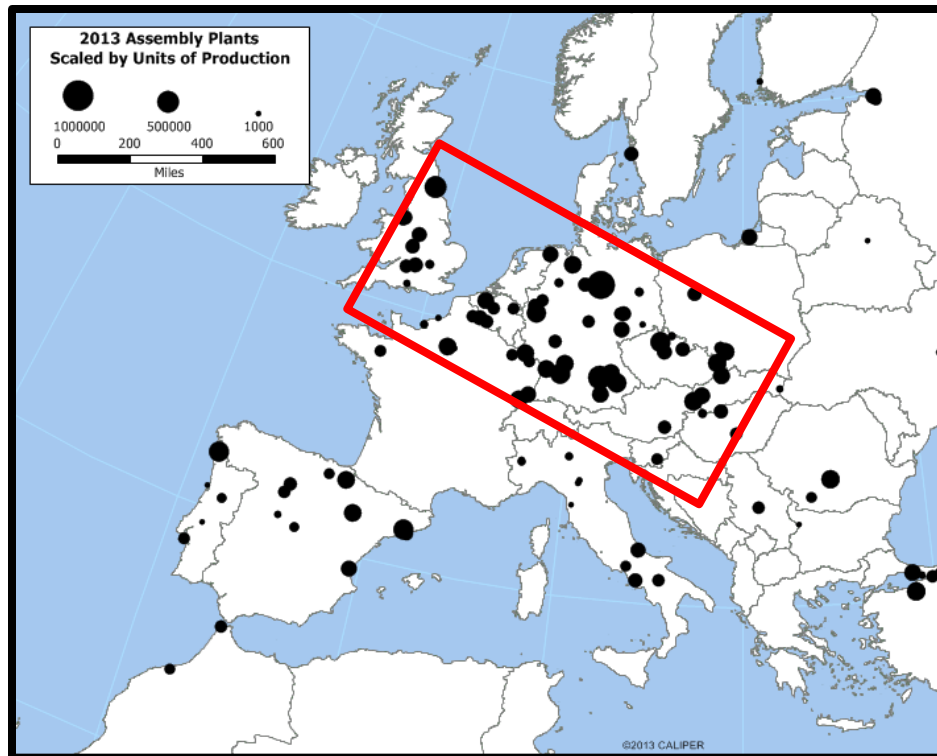
Light vehicle production is concentrated

North America, 2013



73% of region's assembly

Europe, 2013



77% of region's assembly

Agglomeration

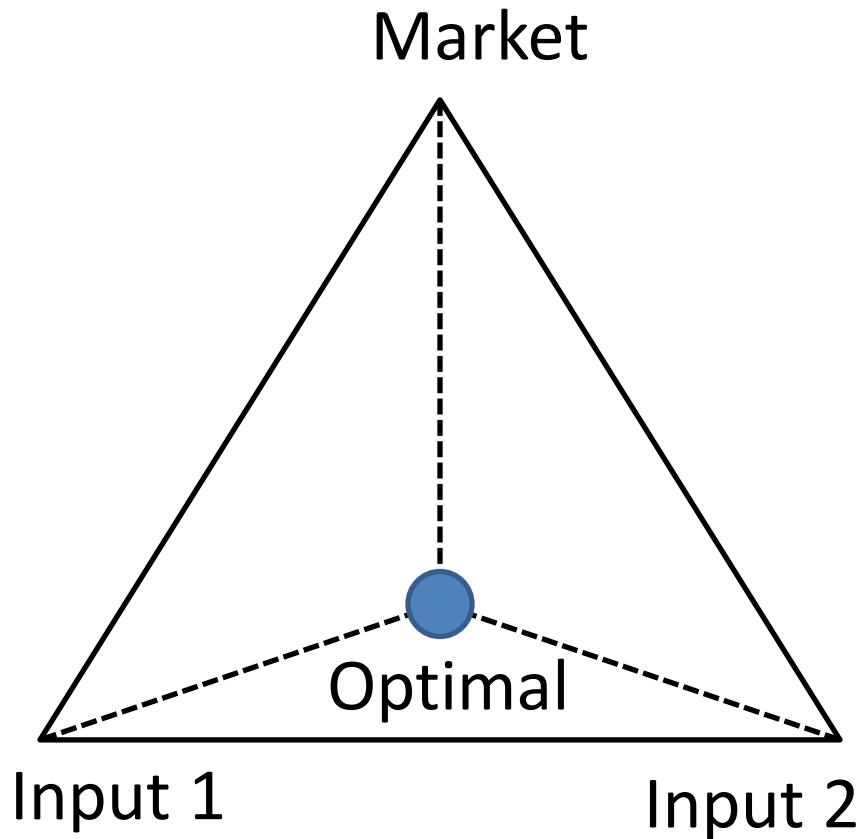
- Marshall (1920)
- Krugman (1991)
- Duranton and Overman (2005)
- Ellison et al (2010)

“The benefits of agglomeration ultimately reflect gains that occur when proximity reduces transportation costs” (Ellison et al, 2010)

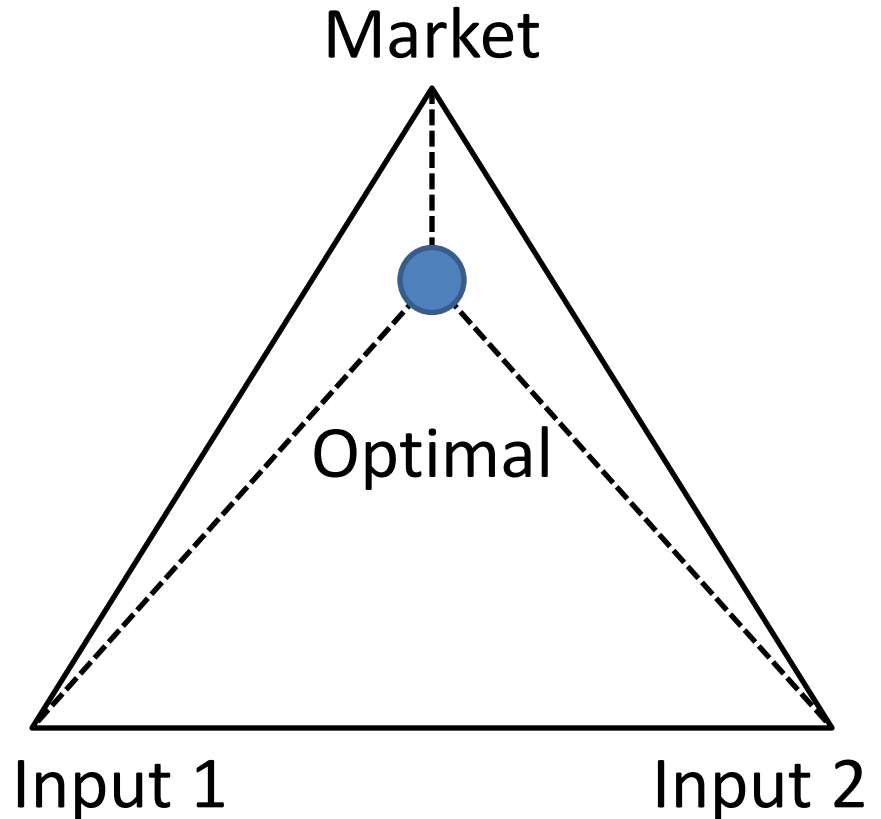
Location theory

- Weber (1929)
 - Minimize costs of shipping inputs as well as distribution of final good
- Moses (1958)
 - Embed location theory into theory of the firm
 - 3 problems: optimum output
optimum combination of inputs
optimum location

Weber: Optimal location varies by industry



Bulk-reducing industry
such as steel



Bulk-gaining industry
such as auto assembly

Localization vs globalization

- Two perspectives:
 - Where were vehicles sold in North America produced?
 - Where are vehicles produced in North America sold?

Vehicles typically sold where produced

Light vehicle sales in North America, by origin, %

	Vehicles sold in North America by country:					
Vehicles produced in:	Mexico		U.S.		Canada	
	1995	2017	1995	2017	1995	2017
NAFTA	98	52	87	77	88	75
Elsewhere	2	48	13	23	12	25
All	100	100	100	100	100	100

Source: Author's calculations based on data from Wards AutoInfobank

Vehicles typically sold where produced

Light vehicle production in North America, by destination, 2014, in %

		Vehicles produced in:		
Destination		Mexico	Canada	U.S.
Sold within NAFTA	Sold “at home”	18	12	79
	EX to other NAFTA	68	84	13
	EX elsewhere	14	4	8
	All	100	100	100
Vehicles (millions)		3.1	2.4	11.4

Source: Author’s calculations based on IHS Markit data

Changes within North America's production footprint

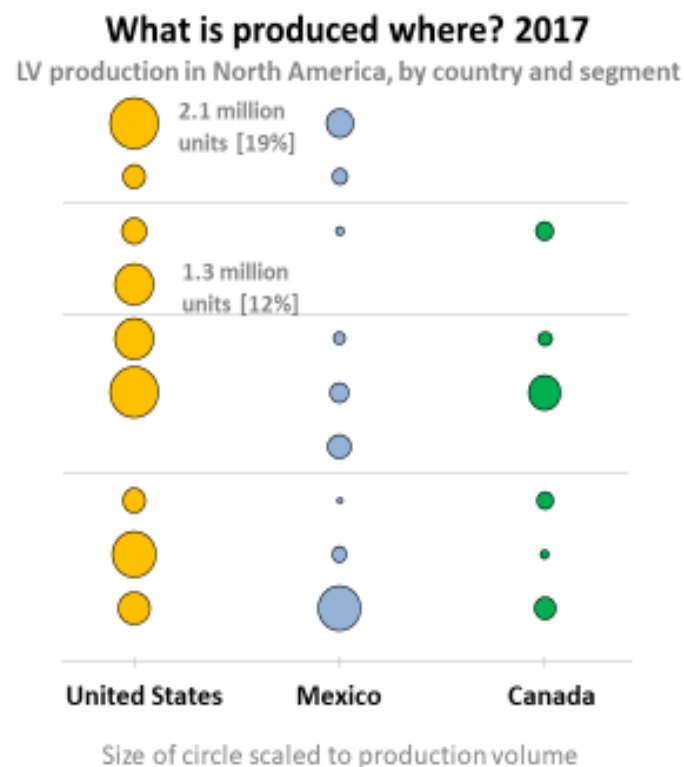
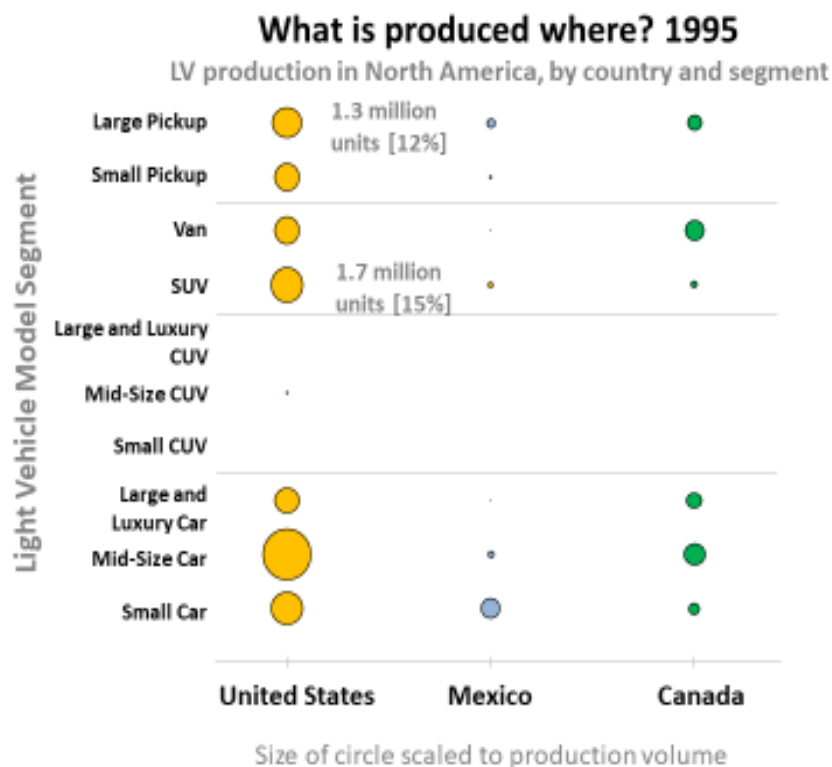
Mexico is now larger than Canada

Share of NAFTA's light vehicle production (%)

Country	1995	2000	2005	2010	2017
Canada	16	17	17	17	13
Mexico	6	11	10	19	20
U.S.	78	72	73	64	67
Total	100	100	100	100	100
<i>Vehicles (millions)</i>	<i>14.9</i>	<i>17.2</i>	<i>15.7</i>	<i>11.9</i>	<i>17.7</i>

Source: Author's calculations based on Wards AutoInfobank

Mexico and Canada specialize



Source: Author's calculations based on Wards AutoInfobank

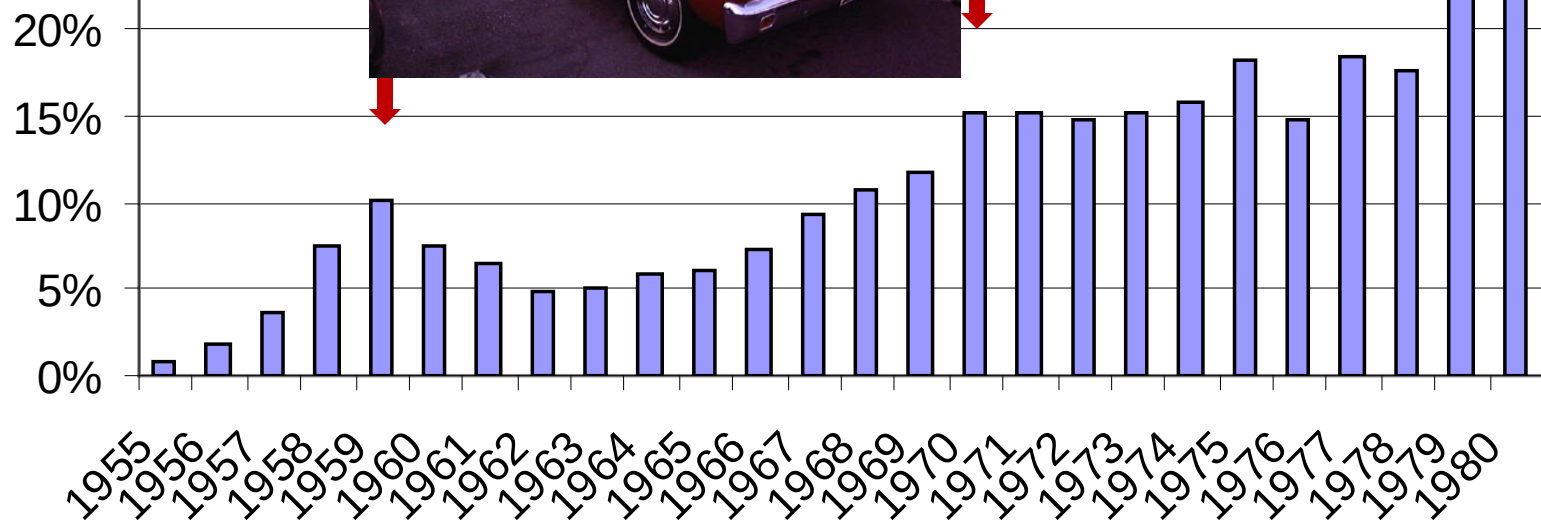
Internationalization



(1) Imports enter in three waves



Import share of U.S. car sales



(2) Internationals start local production

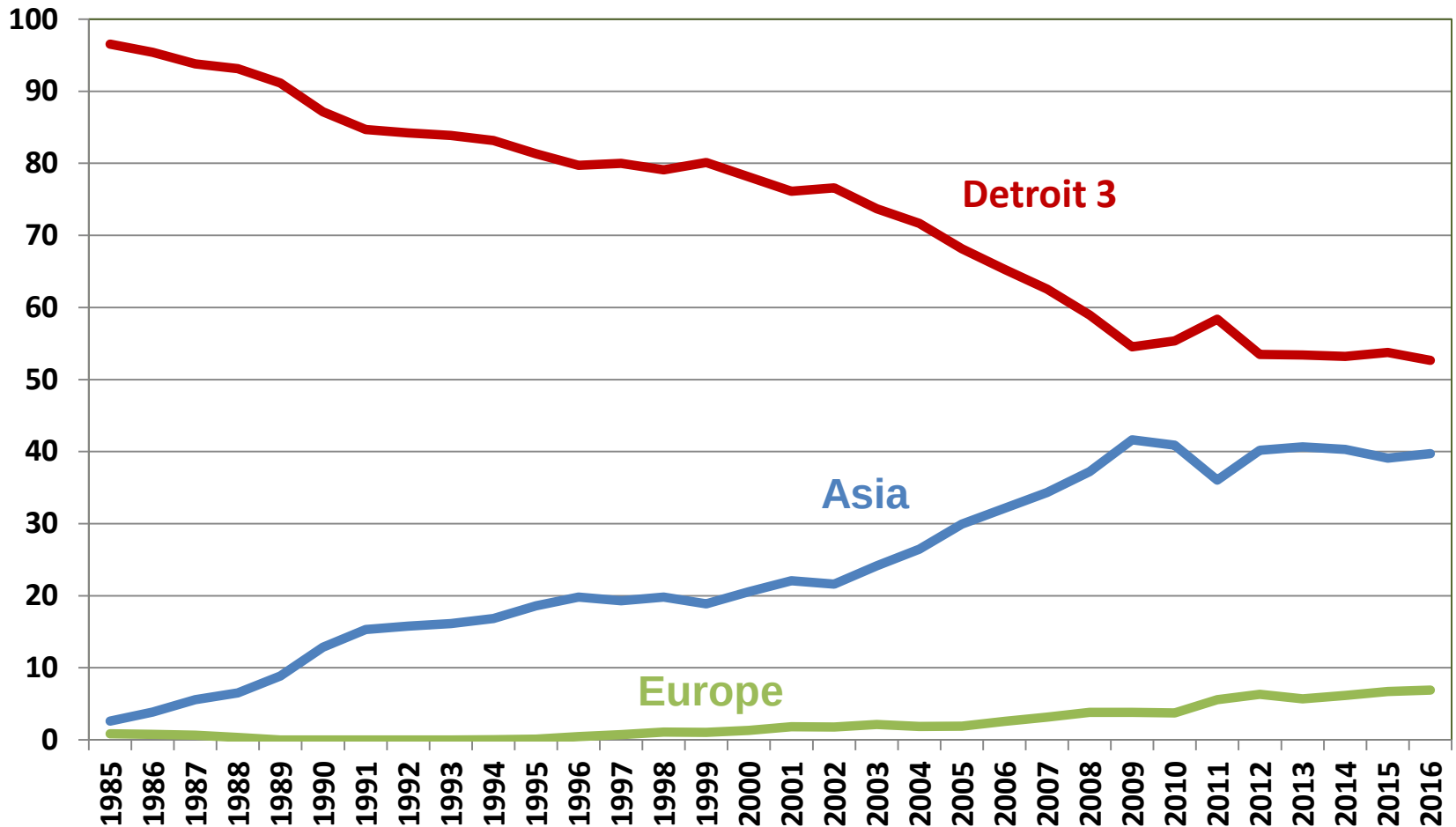
Foreign carmakers, by first year of producing in U.S.

VW (1)	1978
Honda	1982
Nissan	1983
Toyota	1984
Mitsubishi, Mazda	1987
Subaru	1989
BMW	1994
Mercedes	1997
Hyundai	2005
Kia	2009

(1) Closed in 1989, new plant opened in 2011

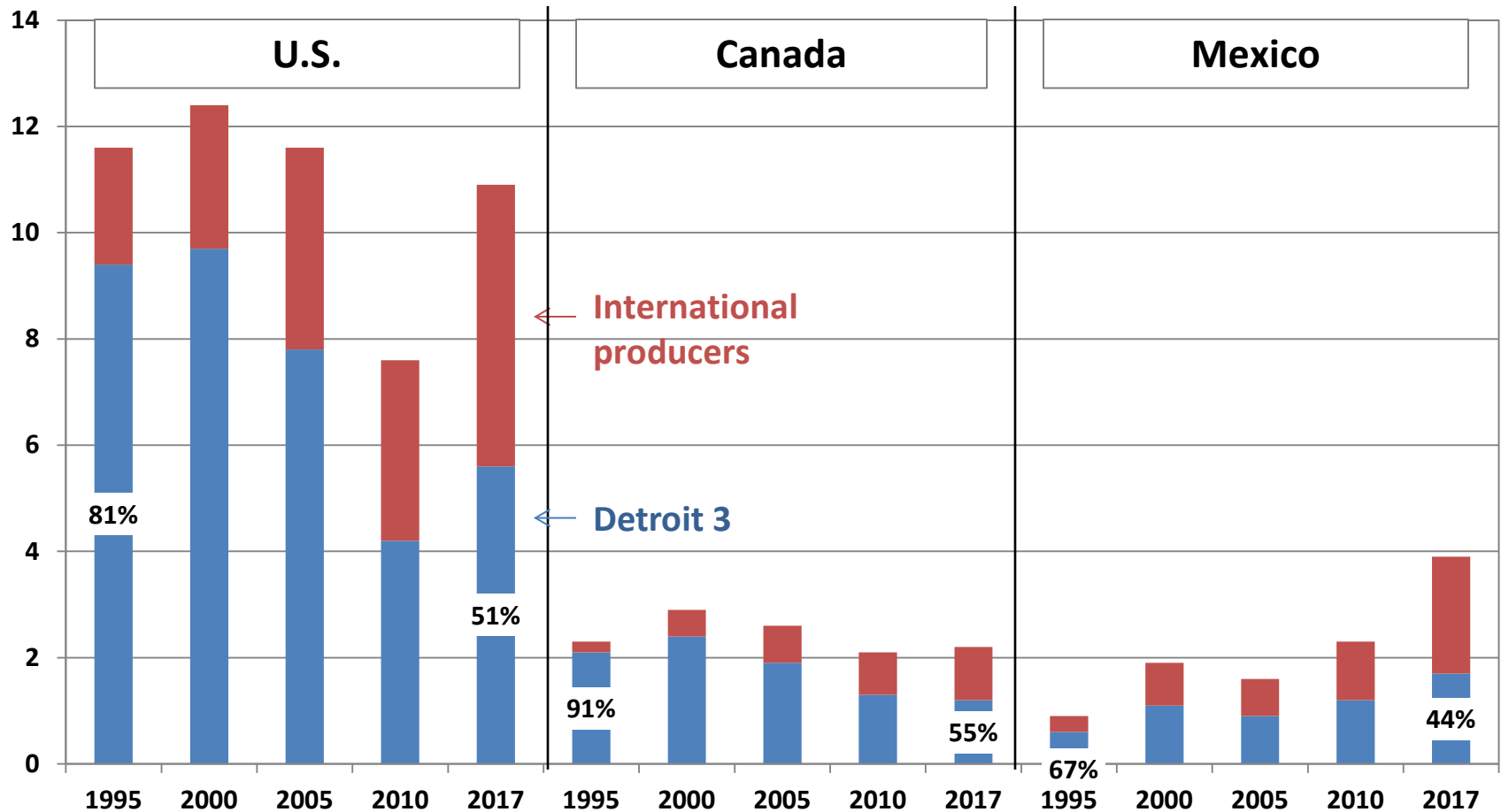
From Big 3 to Detroit 3

U.S. light vehicle production, by home region of OEM, %



Home team drops share to foreign team

Light vehicle production by OEM group and country, in million units



Source: Author's calculations based on Wards AutoInfobank

All six up in MEX, none in U.S., mix for CDN

Vehicle production footprint for the six largest OEMs

Company	Share of North American light vehicle production in:					
	Canada (%)		Mexico (%)		U.S. (%)	
	1995	2017	1995	2017	1995	2017
FCA	21	23	8	27	71	50
Ford	13	9	5	10	82	81
GM	19	12	4	25	77	63
Honda	15	23	0	11	85	66
Nissan	0	0	17	47	83	53
Toyota	12	29	0	7	88	64
<i>INDUSTRY</i>	<i>16</i>	<i>13</i>	<i>6</i>	<i>20</i>	<i>78</i>	<i>67</i>

Source: Author's calculations based on data from Wards AutoInfobank

Parts sourcing

- Measurement issues
- Two microdata examples

Try to measure this!



Example: journey of a seatbelt

1. Produce nylon fibers



2. Dye and weave fibers



3. Cut and sew finished cloth



4. Fit finished seat belt into car



American Automobile Labeling Act (AALA)

- AALA passed in U.S. in 1992, requires data to be displayed next to vehicle price to inform purchase decision. Data collection starts in 1997
- Data provided, by model year, on:
 - Percent of U.S./Canada parts content
 - Names and % of any other country with >15% parts content
 - Country of final assembly
 - Country of origin of engine and transmission
- <https://www.nhtsa.gov/part-583-american-automobile-labeling-act-reports>

Starts
in
2011

North American parts content stable

	Source of parts content for light vehicles produced in:					
Country of origin for parts:	Mexico (%)		U.S. (%)		Canada (%)	
	2011	2016	2011	2016	2011	2016
Mexico	43 → 48		12 → 14		12 → 14	
U.S./CDN	28	27	64	59	66	64
NAFTA	71	75	76	73	78	78

Source: Author's calculations based on data provided by AALA

Supply chains extend across borders



The average Mexican content in U.S.-produced vehicles is 14% (2016 MY data)

The average U.S./CDN content in Mexico-produced vehicles is 27% (2016 MY data)

Source: author's calculations based on AALA data

Regional re-allocation of parts content

	<u>U.S./Canadian</u> parts content in vehicles produced in:		
	Mexico (%)	U.S. (%)	Canada (%)
2016	27	59	64
2010	31	67	66
2005	46	76	78
2000	53	81	83
1997	63	79	82

Source: Author's calculations based on data prided by the AALA

Powertrain sourcing

- Engine (14%) and transmission (7%) represent 21% of the cost of car (Menk et al, 2012).
- We observe comprehensive data on engine and transmission sourcing for vehicles produced in North America, by country and vehicle model.
- We don't know where engine and transmission components are sourced.

North America dominates in powertrains

Origin of powertrains used in vehicles assembled in North America

		Engines		Transmissions	
Sourced from:		<u>2000</u>	<u>2016</u>	<u>2000</u>	<u>2016</u>
<i>Sourced from within NAFTA</i>	Same country that builds vehicle	57.6	55.1	49.4	49.0
	Imported from within NAFTA	30.8	30.6	25.6	27.5
		<i>88.4</i>	<i>85.7</i>	<i>75.0</i>	<i>76.5</i>
	Imported from elsewhere	11.6	14.3	25.0	23.5
	<i>All</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>
	<i>All (units)</i>	<i>17.1 mio</i>	<i>17.8 mio</i>	<i>17.1 mio</i>	<i>17.8 mio</i>

Source: Author's calculations based on IHS Markit data

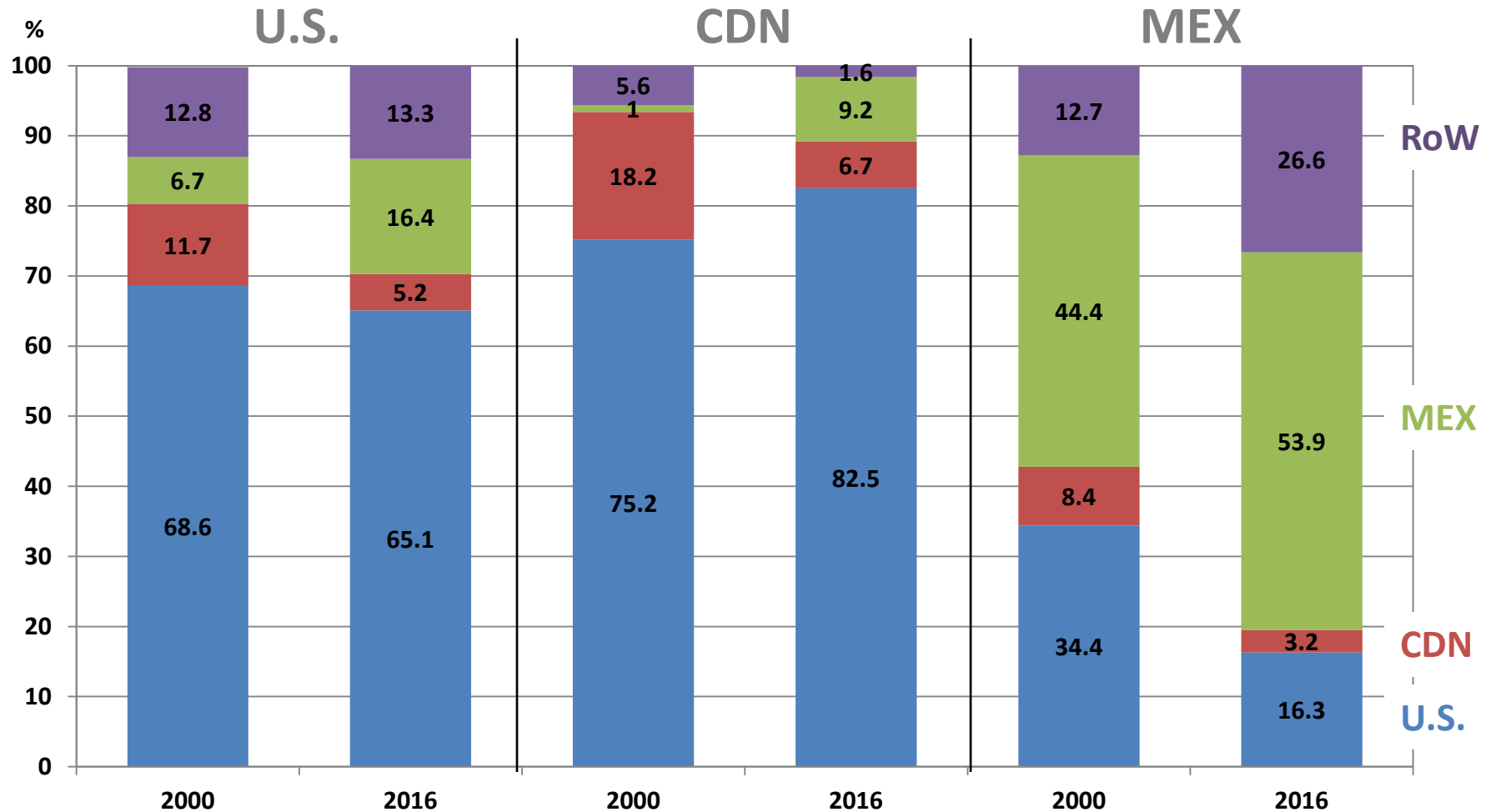
Within North America: Mexico grows

Origin of powertrains used in vehicles assembled in North America

	Engines		Transmissions	
Sourced from:	<u>2000</u>	<u>2016</u>	<u>2000</u>	<u>2016</u>
Canada	12.5	5.0	5.4	1.0
Mexico	9.8 →	22.8	1.6 →	19.0
U.S.	66.1	57.9	68.0	56.4
elsewhere	11.6	14.3	25.0	23.5
All	100%	100%	100%	100%
All (units)	17.1 mio	17.8 mio	17.1 mio	17.8 mio

Source: Author's calculations based on IHS Markit data

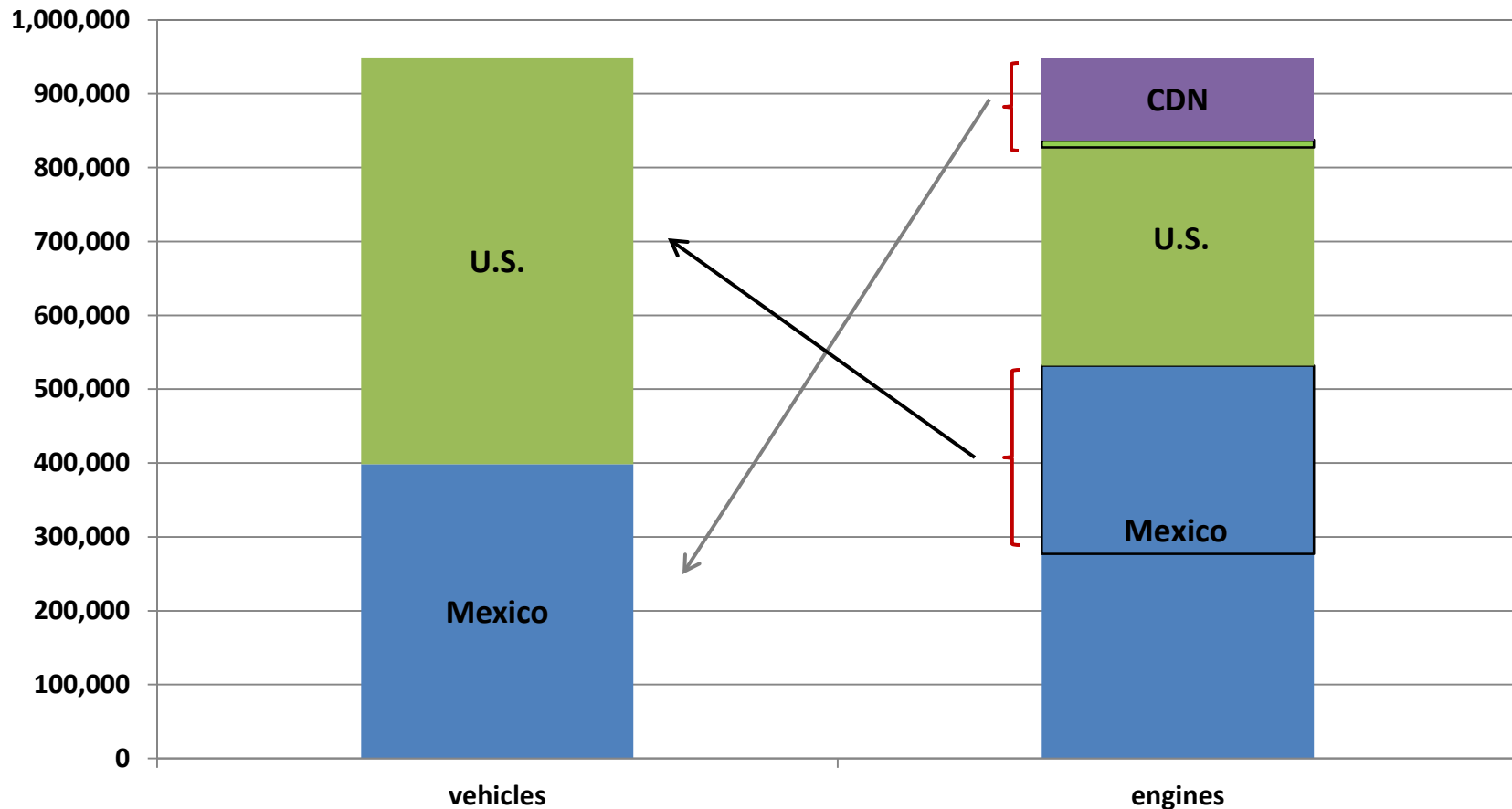
Engine sourcing by country



Source: Author's calculations based on data from IHS Markit powertrain production as of October 2017

Example: 39.6% of engines cross borders

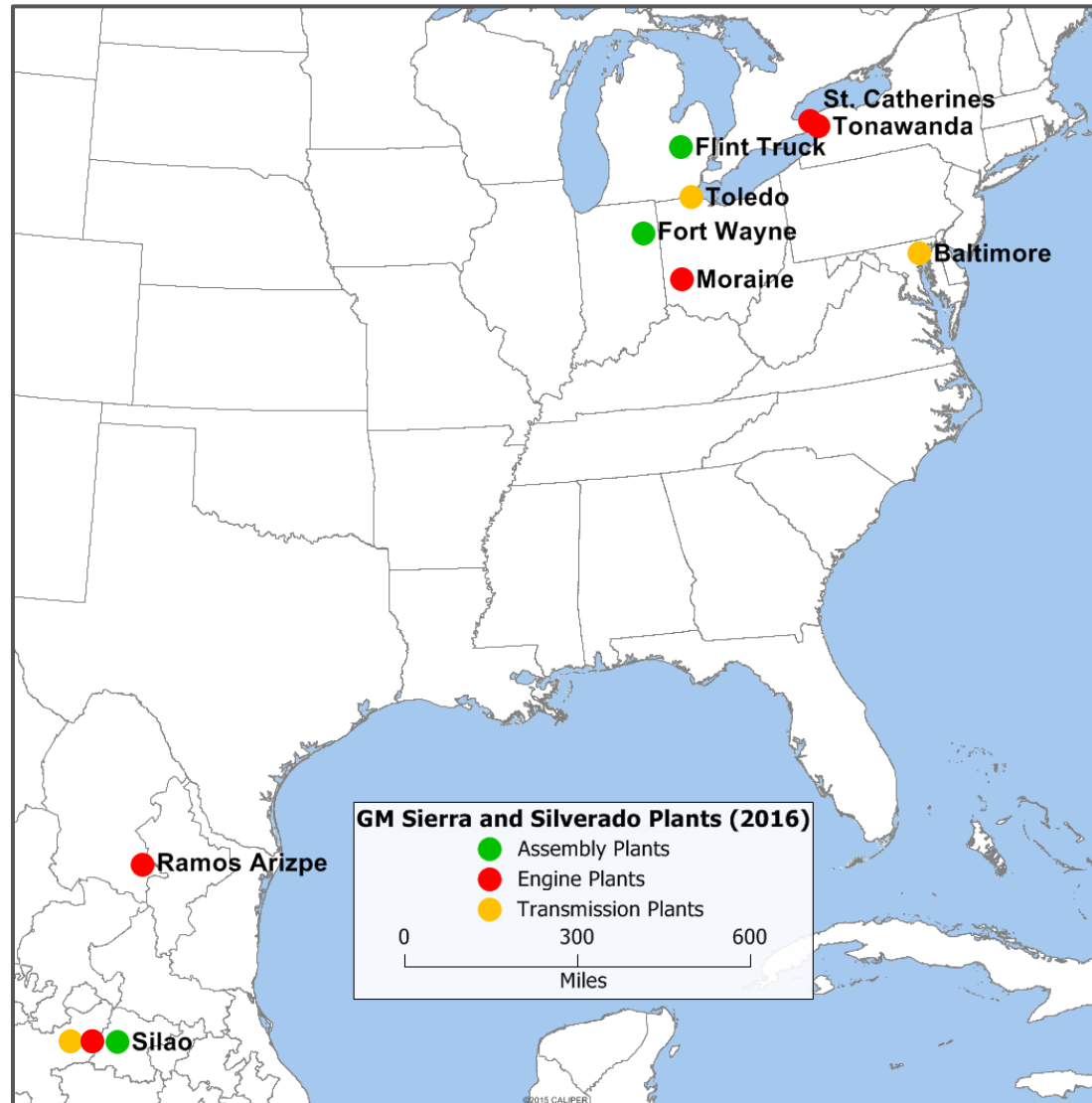
Sierra/Silverado engine installation, 2016



Source: Author's calculations based on data from IHS Markit powertrain production as of October 2017

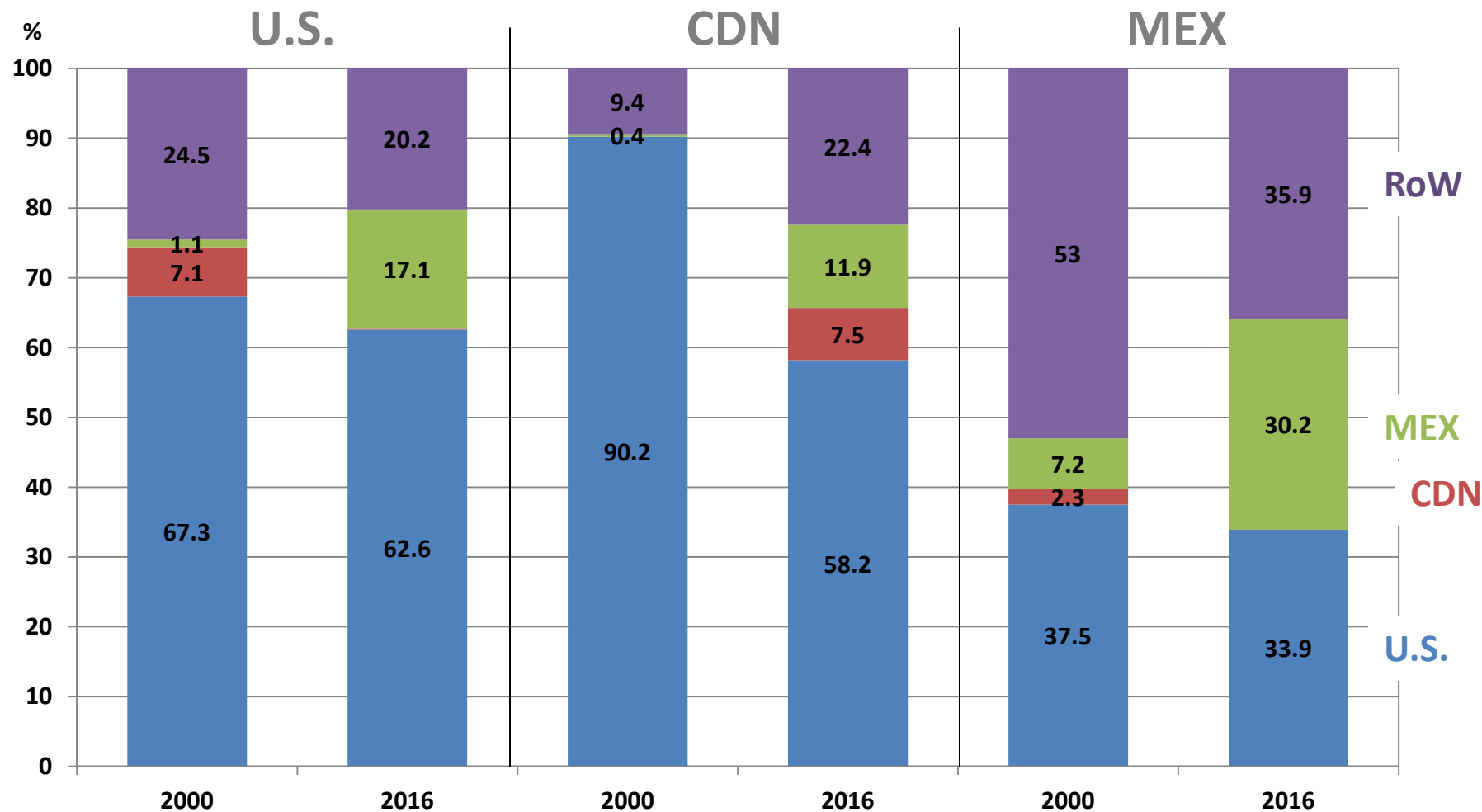
Same example – geographic detail

- All 3 transmission plants supplied all 3 assembly plants in 2016
- Of 5 engine plants, 3 supplied all assembly plants (Moraine, Tonawanda, and Ramos Arizpe)
- Silao supplied Silao and Ft Wayne
- St Cath. supplied only Silao



Source: IHS Markit powertrain production

Transmission sourcing by country



Source: Author's calculations based on data from IHS Markit powertrain production as of October 2017

Summary

- Vehicles tend to be produced in the region where they are sold. Within North America, Mexico's vehicle industry has grown substantially.
- OEMs producing in North America have re-balanced their assembly footprint.
- Parts sourcing is integrated across North America:
 - There is substantial North American parts content in vehicles assembled in each of the NAFTA countries.
 - In 2016, 86% of engines and 77% of transmissions installed in vehicles produced in North America were sourced in North America, but only about half in same country as assembly.
 - Parts footprint within North America is changing as Mexico is growing assembly and parts.

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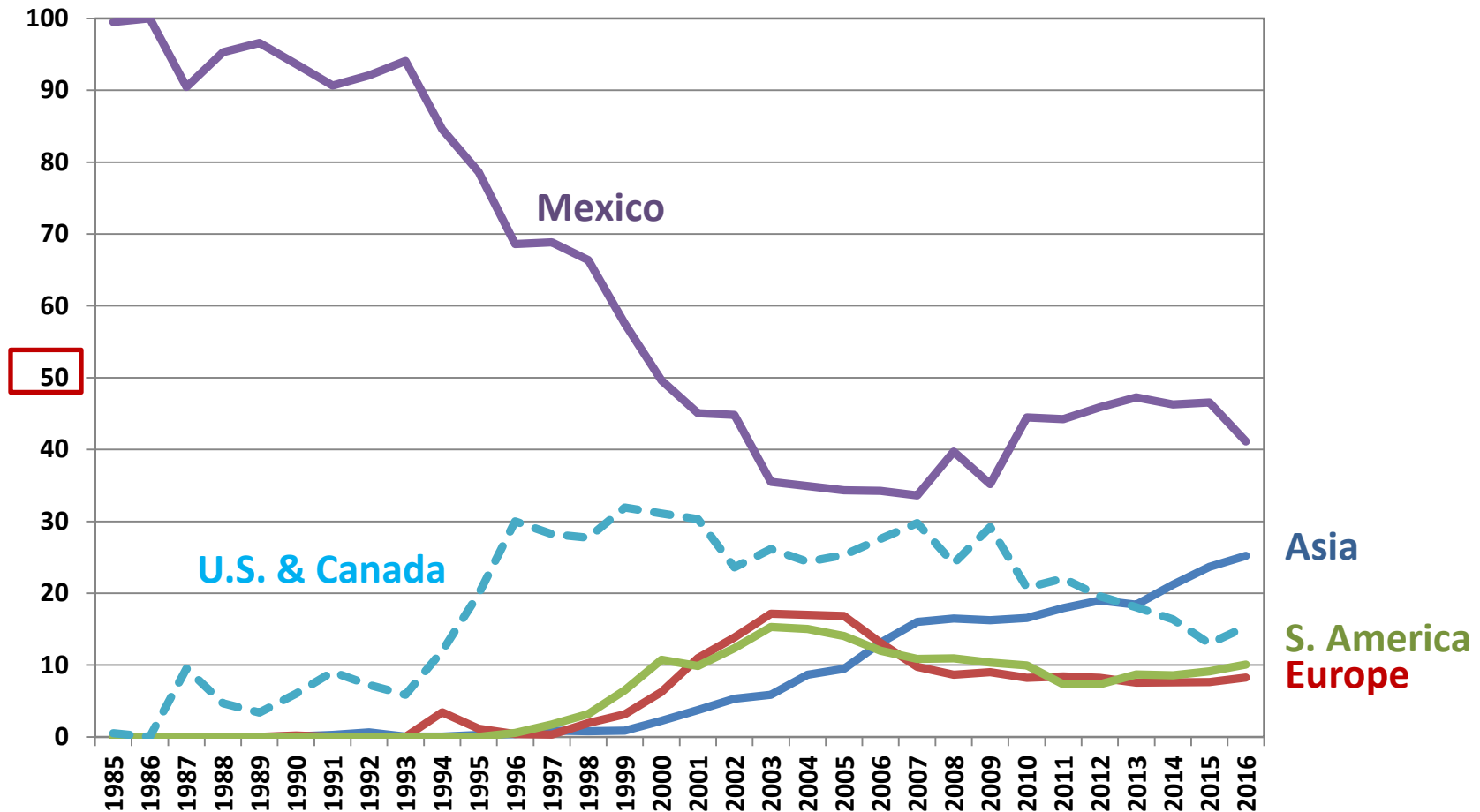
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extras

Majority of Mexican sales are imported

Mexican light vehicle sales by region of production, %



Source of Mexico's imports

Light vehicle sales in Mexico, by country of production, 2016

Country	Light vehicles (1,000)
Mexico	640
US & CDN	264
India	194
Japan	134
Brazil	110
All others	259
<i>Total</i>	<i>1,601</i>